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Who do you trust: Peers or Technology?

A conjoint analysis of computational reputation mechanisms

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Abstract. Peer-to-peer sharing platforms are taking an increasingly key role in the platform economy due to their sustainable business model. By sharing private goods and services, the challenge arises to build trust between peers online, primarily without a physical presence. Peer rating has been proven to be an important mechanism. In this paper, we explore the concept called trust score, a computational rating mechanism adopted from car telematics, which can play a similar role in carsharing. For this purpose, we conducted a conjoint analysis in which 77 car owners chose between fictional user profiles. Our results reveal that, in our experiment, the telemetric-based score slightly outperforms the peer rating in the decision process, and the participants perceived the peer rating to be more helpful in retrospect. Further, we discuss potential benefits regarding existing shortcomings of user ratings and various concerns that should be considered in concepts such as the telemetric-based reputation mechanism that supplements existing trust factors, such as user ratings.

Introduction

Consumption behavior has changed in recent years, and consumers have increasingly given up individual ownership for demand-based access to goods. Accordingly, business models in which consumers simply pay for access to services or goods are rising (Wilhelms, Henkel, and Merfeld 2017). Benefiting from this development in society and from the commitment to a more sustainable business model, carsharing has gained public attention for several years (Münzel et al. 2018). In Germany, the number of carsharing customers rose to 2.46 million in the last year. In addition to car rental and commercial carsharing (station-based and free-floating), platforms, such as Turo, Getaround, or Getaway, allow private car owners to lend their cars to previously unknown individuals for an agreed period and price (Wilhelms, Henkel, and Merfeld 2017).

The Internet allows most transaction steps to be carried out online, which lowers the transaction costs but makes the collaboration more anonymous. Lack of trust in other "buyers" or "sellers" is one of the most frequent reasons for rejecting peer-to-peer (P2P) sharing platforms (Owyang, Tran, and Silva 2013). As a result, transparency, reputation, and trust are considered essential for success in the P2P sharing economy, which is also often called the share economy or shareconomy (R. Belk 2007; Botsman and Rogers 2011; Hawlitschek, Teubner, and Weinhardt 2016).

Sharing platforms typically use various, complementary trust-building mechanisms, such as showing self-provided information (e.g., pictures or personal information) and peer-provided information (e.g., consumer reviews and ratings) (Bente, Baptist, and Leuschner 2012). The Internet of Things (IoT) could serve as a third trust-building mechanism, using computationally provided information (Stevens et al. 2018). In P2P carsharing, for instance, the driving behavior of a car renter could be monitored. In principle, this information could be used by car owners to evaluate the driving behavior of a person who is currently renting their car.

So far, such information is used only by car insurance companies (Merzinger and Ulbrich, n.d.) and not by reputation systems for carsharing platforms. Hence, it is unclear whether users would trust such IoT-based ratings. This leads to the question regarding whether a computational rating has the same relevance as peer ratings, which are currently viewed as the gold standard among various reputation mechanisms in the sharing economy (Hawlitschek, Teubner, and Weinhardt 2016; Teubner et al. 2016).

To answer this question, we conducted a conjoint analysis in which people had to choose between two fictional profiles of people who sent a request to rent a car. The profiles included information about the peer rating, number of ratings, telematic-based driving scoring, and how many kilometers the person has driven with cars from the platform.

The major finding was that telematic-based scoring not only had a significant influence on the selection behavior, but the effect was slightly higher than the corresponding peer rating. More interestingly, at the end of the online survey, we also asked the participants about the relevance of the provided information. In this case, the peer rating was perceived as the most helpful and slightly better than the telematic-based scoring. This indicates an action-perception gap, in which we trust more in technology in making our decisions, whereas we trust more in other people in reflection.

Related Work

Carsharing

The sharing economy describes an "economic model enabled by modern ICT [information and communications technology], based on the sharing of digital content, physical goods, or the participation in commercial, cultural or social projects to access underutilized assets for monetary or non-monetary benefits" (Richter, Kraus, and Syrjä 2015). The basic idea is a joint consumption in the sense of "using instead of owning" (Pakusch et al. 2016). Products are not acquired by the consumer. Instead, they only obtain the temporary right to use the service or good, normally for a certain fee (R. Belk 2007). Among others, economic motivations, such as cost-savings, reducing the burden of ownership, or increasing access to resources, play an important role (Hamari, Sjöklint, and Ukkonen 2016). Digitalization further lowers both search and transaction costs, making it economically attractive to monetize under-used resources. A comparably old example is carsharing. It provides customers with on-demand access to any vehicle without having to buy and maintain it themselves. Payment is made only for the respective period of use and/or the driven distance (Witzke 2016).

Over time, different forms of carsharing have emerged. For services of classic station-based providers, members can pick up a car at a certain point after it has been booked, use it for a certain period and then return it to the dedicated parking space (Witzke 2016). With so-called fully flexible (station-independent) free-floating carsharing systems, vehicles are distributed arbitrarily over a corresponding business area in public parking spaces. In contrast to the previously described system, no fixed carsharing stations exist for these vehicles. Members can use available cars spontaneously without a prior reservation and then park the cars elsewhere in the business area (Witzke 2016). Both station-based and free-floating carsharing vehicles are owned and provided by commercial providers. Hence, these two types of commercial carsharing have much in common with commercial car rental.

In this paper, we focus on P2P carsharing in which car owners lend their private vehicles for a short period (Hampshire and Gaites 2011). According to a study with over 10,000 participants by the Ford Motor Company (Ford Motor Company 2016), 48% of respondents in Germany would lend their car for a fee, but few studies have investigated using P2P carsharing (e.g., Wilhelms, Henkel, and Merfeld 2017; (Lewis and Simmons 2012); (Ballús-Armet et al. 2014; Nobis 2006). The typical P2P carsharing users are young, predominantly male, well educated, and urban and have a good job (Lewis and Simmons 2012). Various motivations exist for car sharing, but economic reasons (e.g., reducing mobility and vehicle costs) and situational-practical reasons (e.g., availability, convenience, and flexibility) are often mentioned (Ballús-Armet et al. 2014; Nobis 2006). Wilhelms et al. (2017) found that car owners want to reduce their vehicle costs and earn small additional amounts of money that they can spend on other purposes. They also like to enable other people without a vehicle to travel. However, compared to the Ford study, a large gap exists between the intention to lend a private car for a fee and the actual behavior.

One barrier is the practicability of carsharing offers. For instance, lending a private car via a P2P platform includes the effort of entering the availability of the car, arranging handover dates and a follow-up check to determine whether the car has been damaged. In addition, a general fear of sharing a good with strangers exists (Wilhelms, Henkel, and Merfeld 2017; Shaheen and Cohen 2013). In particular, people often have a personal and emotional bond with their cars (Gatersleben 2007), which increases the fear of loss (R. W. Belk 1988) because others might not treat the rented car with care or might have an accident or return it late or dirty.

Trust

> [Trust is] the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the agility to monitor or control that other party. (Mayer, Davis, and Schoorman 1995)

Trust is of particular importance in potentially risky and uncertain transactions where parties are interdependent (McKnight and Chervany 2001). Such situations are typical in the sharing context, as the key steps of P2P transactions are conducted online. Therefore, transparency, reputation, and trust are considered essential (R. Belk 2007; Botsman and Rogers 2011; Hawlitschek, Teubner, and Weinhardt 2016). This creates a paradoxical situation in which trust is essential because it is an efficient method of reducing transaction costs in such social exchanges (Huurne et al. 2017). However, building and sustaining trust online is more difficult because common trust factors, such as physical interaction or personal knowledge, do not exist (Hawlitschek, Teubner, and Weinhardt 2016; Möhlmann 2015).

As a research topic, trust has been studied as a multifaceted topic and complex phenomenon in many disciplines since the 1950s (Corritore, Kracher, and

Wiedenbeck 2003). In general, trust refers to a multidimensional, socio-psychological construct (Hawlitschek, Teubner, and Weinhardt 2016; Huurne et al. 2017).

On the individual level, the question arises regarding how trust forms and influences actions and decision-making processes. Due to the openness of the future, a decision can always turn out to be wrong in retrospect, even if it seemed to be the right one in the situation. Hence, the outcome of a situation is always uncertain and can never be guaranteed; therefore, we must trust and hope for the best. In developmental psychology, Erikson (1993) stressed the human's ability to develop a sense of basic trust rather than distrust during infancy.

This basic trust refers to generalized trust as a learned trust behavior, which a person has built through numerous experiences during their lives and which has been condensed into a stable, long-term disposition. Generalized trust must be distinguished from particularized and situated trust, which is shaped by the situation and particular circumstances (Bjørnskov 2007). When deciding whether and how much to trust, people search for cues (e.g., trustworthiness attributes) helping them to interpret the situation (M. K. Lee and Turban 2001). The generalized trust of a person magnifies or reduces the signals that the cues provide and vice versa. People rely on previous experiences that contribute to how they interpret the individual cues and the whole situation in terms of trust. In addition, establishing trust is an interactive process based on positive feedback that reinforces the initial trustworthy behavior, so that trust gradually increases (Trcek 2017). Hence, the outcome of the situation contributes to whether we link trust or distrust to such situations and its actors in the future.

Trusting a situation always means interpreting the situation. From this stance, we reformulate Blumers' (1969) well-known premises of symbolic interactionism as follows:

1) Humans act toward things on the basis of the meanings resp. **trust** they ascribe to those things.
2) The meaning resp. **trustworthiness** of such things is derived from, or arises out of, the social interaction that one has with others and the society.
3) The meaning resp. **trustworthiness** of such things is handled in, and modified through, an interpretative process used by the person in dealing with the things he/she encounters.

The first point refers to the fact that things (physical objects, actions, concepts, etc) have both personal meaning and personal trustworthiness. The second point refers to the fact that this trustworthiness is derived from our previous experiences with the physical objects, actions, and concepts and our social interactions that provide additional information about the physical objects, actions, and concepts.

On a social level, one can assess the role of trust in the functioning of societies and economies. For instance, Luhmann (2018) stressed that trust presents an important resource for societies because it provides a means to decrease complexity

by reducing the number of options to consider in a given situation. The promotion of trust is therefore a duty for the functioning of society (Corritore, Kracher, and Wiedenbeck 2003). In economics, this view is reflected in the principal-agent theory (Sappington 1991; Ensminger 2001) and the transaction cost theory (Schneider 1987; Williamson 1979). Generally, trust can reduce control costs and transaction costs, thus contributing to economic prosperity. Trust has been studied in various areas, particularly concerning social media (Ridings, Gefen, and Arinze 2002), online privacy (Jakobi et al. 2019; Dinev and Hart 2006), online shopping (Gefen 2002), and the sharing economy (Hawlitschek et al. 2016; Hawlitschek, Teubner, and Weinhardt 2016). The studies reveal that trust has a positive effect on exchange relationships, which is expressed by the willingness to participate, disclose information, make a transaction, and so on.

Sectoral trust. In principle, general and situated trust are not a dichotomous category but a continuum. Moreover, people have a kind of basic trust that relates to different areas. This kind of trust can also be understood as sectoral trust, which mediates the particular situation and generalized trust. As a result, when dealing with a situation, person, organization, and so on, we use trust at different levels. Sectoral trust is more stable than situated trust but less stable than generalized trust.

Sectoral trust can be different in varying areas. For example, it may be that someone has a low level of trust in an individual but a high level of trust in the government as a whole (or vice versa). In the P2P sharing economy, products or services are usually offered by private individuals. Thus, users must trust other peers, the platform, and the offered products and services (Hawlitschek et al. 2016; Hawlitschek, Teubner, and Weinhardt 2016). In addition, using algorithmic reputation mechanisms, three sectoral trust areas are of special interest: *trust in people, trust in organizations,* and *trust in technology*.

Interpersonal trust. Trust in other people is probably one of the most elementary forms of trust, and some authors equate it to generalized trust. For instance, Erikson's (1993) developmental psychological considerations about basic trust focus on interpersonal relationships with parents and people from the immediate environment. Rotter (1967) defined interpersonal trust as the generalized expectancy that the verbal statements of others can be relied upon. Various scales have been suggested in the literature for measuring interpersonal trust. Interpersonal trust depends on several factors, such as perceived competence, dependability, benevolence, empathy, and familiarity (Evans and Revelle 2008; Rotter 1967; Beierlein et al. 2012).

In the P2P sharing economy, interpersonal trust comes into play in two ways: First, one must trust the person who asks for a good or the person who offers a good. Second, interpersonal trust plays a key role in user ratings. If a person does not trust others, this person would also not trust the user ratings. While the first point is essential for a sharing economy to work, we focus on the second point in this paper. In our study, we adopt the short scale by Beierlein et al. (2012) to

measure the participants' sectorial trust in other people and their peer-rating competence and benevolence.

Organizational trust. People have a certain amount of trust in companies and organizations when they buy products or use a service. In the case of online shopping, trust covers two dimensions: trust in the seller and trust in the goods offered. In particular, buyers must have a certain level of confidence in the seller's integrity, benevolence, and competence (Gefen 2002; Bart et al. 2005; Urban, Amyx, and Lorenzon 2009). Competence refers to the ability of the vendor to fulfill promises (e.g., deliver a product on time). Integrity is shown by the company acting consistently, reliably, and honestly (e.g., if a fair cancellation is emphasized in advertising, the customer can simply return goods if he or she is not satisfied). Benevolence means that a seller puts customer interests above its own and displays a sincere concern for the well-being of the customers (e.g., by making the customer aware of better products, even if the profit margin is smaller; (Chen and Dhillon 2003). The range of application of this basic trust in the integrity, benevolence, and competence can vary. It can apply to the entire economy, a specific sector, or a particular company.

The role of trust in providers of a P2P sharing platform was investigated in various studies. In particular, Hawlitschek et al. (2016) pinpointed that this trust model can also apply to the sharing economy. Despite its importance, however, this trust propensity is out of the scope of our research, as we focus on the effects of reputation systems and not the effect providers have.

Technology trust. Systems must be trusted to be used. To be trustworthy, it is important that the system is reliable and meets user expectations. Donick (2019) referred to the fear of flying as a paradigmatic case of technology (dis)trust: *This fear often has nothing to do with high altitude - a lot of people with high anxiety have no problem looking out of the window of an airplane. Fear of flying is rather due to the unfamiliar technology that you rarely have to deal with and that you have to expose yourself to for several hours.*

The reverse case of faith in technology also exists, where people trust something because it is the result of scientific or technical procedures that do not suffer from human weaknesses, such as prejudices, attention deficits, limited processing capacity, and so on. For example, in the multiplication of large numbers, one might use a calculator because this technology is more trustworthy than mental arithmetic.

Regarding system design, Lee and See (2004) also emphasized the danger of both under-trusting and over-trusting. If users place too little trust in technology, the system capabilities are neglected, leading to disuse. If users place too much trust in technology, users could become gullible, perform risky actions, or be tempted toward other forms of misuse. Therefore, trust must be calibrated so that trust matches the system capabilities, leading to appropriate use. Interactions such as obtaining feedback and experiences are helpful to calibrate trust.

Due to the complexity, technology trust has recently been researched, especially regarding artificial intelligence and autonomous systems. Concerning human-automation interaction in general, Lee and See (2004) emphasized that trust depends on the performance, process, or purpose of an automated system. Palmer et al. (2016) outlined a list of dimensions needed for creating system trust in autonomous systems:

- such as *perceived competence* referring to the belief that the system can perform the task in question,
- *benevolence* referring to the belief that the system supports the mission,
- *understandability* referring to the belief that the conclusions that a system reaches can be understood,
- *reliability* referring to the belief that the system has only a small chance of failing during a mission, and
- *the false-alarm rate* referring to the fact that certain error rates are known and acceptable.

Davis (2020) suggested a scale measuring the propensity to trust autonomous systems. The scale consists of four subscales:

- *capability* measuring the general trustworthiness of autonomous systems using the capability of humans as a baseline for comparison,
- *legitimacy* measuring a person's perception that autonomous systems make legitimate significant decisions independent of human direction,
- *collaboration* addressing that decision-making should integrate both humans and autonomous systems, and
- *transparency* addressing the transparency of autonomous systems and how easy it is for a person to judge whether an autonomous system is trustworthy.

To the best of our knowledge, no study measures consumer trust in telematic technologies, especially concerning P2P carsharing. Hence, we adopt general considerations about trusting autonomous systems to measure the participants' sectorial trust in technology.

Reputation Systems

As an important substitute for trust mechanisms in the offline world, reputation systems play an important role in the online world (Huurne et al. 2017; Ert, Fleischer, and Magen 2016). The basic idea is that the parties rate each other (e.g., after concluding a transaction) and derive a trust or reputation score from the aggregated ratings of a particular party that can help other parties decide whether

to interact with that party in the future. Reputation systems also create an incentive for good behavior and therefore tend to have a positive effect on market quality. They could also be described as collaborative sanctioning systems to reflect their collaborative nature. Reputation systems are related to collaborative filtering systems (Schafer, Konstan, and Riedl 1999) because the systems use the opinions of a community of users or customers to help individuals more effectively identify relevant content from a potentially overwhelming set of choices. In their seminal work, Resnick and Zeckhauser (2002) provided a functional definition of a reputation system; it must do the following:

(1) provide information that allows peers to distinguish between trustworthy and untrustworthy peers,
(2) encourage peers to be trustworthy, and
(3) discourage participation from those who are not trustworthy.

A vast amount of information exists that is consciously and unconsciously used by people as indicators regarding whether someone is trustworthy, such as appearance, behavior, and what others say about someone. Here, the trustworthiness of the source from which the information originates plays an important role. People typically use information from different sources to come to a decision. If the information from different sources points in the same direction, the information is usually reinforced. However, if the information is contradictory, the information is weighted, where a weighted mean is formed considering the trustworthiness of the information and its source.

In the literature on the P2P sharing economy, various sources of information are mentioned that contribute to building trust. We classify them in four categories; yet, they are neither exhaustive nor mutually exclusive.

Self-provided information. Peers could provide information about themselves and the goods or services they offer. For instance, Airbnb, eBay, and BlaBlaCar allow their users to create a profile adding personal attributes and describing their products and services in their own words. Repschläger et al. (2015) pinpointed that personal attributes, such as name, age, address, and uploaded pictures serve as trust factors. Concerning the service description, Teubner et al. (2016), through the analysis of Airbnb offers, showed that the number of photos, for example, has a positive effect on the willingness to pay. However, compared to peer ratings, the effect is comparably low.

Platform-provided information. Self-provided information is always suspected of being embellished. This trust dilemma can be partially resolved by other external sources, especially by the platform provider as an intermediary. For instance, some P2P platforms have procedures in place to verify the authenticity of the information, such as name, age, and driver's license (Repschläger et al. 2015). However, these procedures contribute to building trust only if the procedure itself and the platform providers are trustworthy. A kind of spillover effect exists in which the reputation of the platform provider is passed on to the platform user.

Frauds, for instance, take advantage of this spillover effect by setting up fake shops on eBay, Walmart, or the Amazon marketplace to profit from the popularity of and trust in the platform (Doyle 2017).

Peer-provided information. Another important source is peers, where peer and consumer ratings and reviews serve as a proxy for word of mouth recommendations (Zhu and Zhang 2010). Peer reviews are usually written to either recommend the product to others or to warn others to stay away from the product (Hennig-Thurau, Walsh, and Walsh 2003; Sen and Lerman 2007). Users tend to write reviews mostly for products that they perceive to be exceptionally good or exceptionally bad (Dellarocas and Narayan 2006). Generally, consumers read reviews to evaluate products and reduce the risk of making a wrong purchase decision (King, Racherla, and Bush 2014). Online reviews influence the willingness to pay and often serve to build trust and customer loyalty (King, Racherla, and Bush 2014).

Customer review management is a common activity of online retailers (Zhu and Zhang 2010). The positive effects of online reviews are also accompanied by the risk of purchased reviews, where products seem to be better than they are or where competitors are devalued with purchased poor ratings (Zhu and Zhang 2010). Consumers typically pay more attention to negative reviews than positive reviews. Further, the depth, length, and quality of reviews (Mudambi and Schuff 2010) and the number of reviews and ratings (Li and Hitt 2008) have an effect. In particular, in the early stages of product introduction, when only a few consumer reviews and ratings existed, the recommendations seem more susceptible to bias (Li and Hitt 2008). Teubner et al. (2016) uncovered that the average rating score has the most influence on the price. Compared to this, the review counts have less influence (and counterintuitively, a negative one).

Technology-provided information. This category includes all information that is not provided by the entity or the peers but is automatically collected by devices or sensors. Users consider such information to help identify trustworthy peers. This includes information collected by the platform regarding user activity or membership duration. Such information can serve as an indicator of trustworthiness (Repschläger et al. 2015; Vanderveld et al. 2016). The benefit of the computationally provided information is that the information is not collected manually; therefore, no additional effort is necessary for the user. Second, the information is based on objective measures and is more difficult to manipulate than self- and peer-provided information (or at least tampering requires additional effort). Despite these benefits, the current reputation systems make little use of such information.

Using Telematic Technology to Build Trust

Examining other domains, we find a more detailed example in car telematics, which are based on computational scoring using IoT-based information to build

trust (Ma et al. 2018). In the literature, we find various terms, such as telematic traffic (Ma et al. 2018), usage-based insurance (Soleymanian, Weinberg, and Zhu 2019), or pay-how-you-drive auto insurance (Kantor and Stárek 2014). In all of these, insurance companies target the pricing to the actual driving behavior of their customers (Soleymanian, Weinberg, and Zhu 2019). To offer individually targeted price discounts based on each consumer's driving behavior, telematic devices measure some key elements of interest, such as the current time, acceleration, and position while driving with the help of sensors to detect speed, speed violations, braking, mileage, and traveling direction and to use this information to evaluate and build trust in a person's driving behavior (Ma et al. 2018; Soleymanian, Weinberg, and Zhu 2019). Typically, the data are not only used by the insurance companies but are also provided as feedback to the drivers (e.g., via a smartphone app; (Merzinger and Ulbrich, n.d.; Soleymanian, Weinberg, and Zhu 2019).

Studying the effect on driving behavior, Soleymanian, Weinberg, and Zhu (2019) mentioned that telematic tariffs have led to an improvement in driving behavior, resulting in safer drivers. In particular, they found that younger drivers improve their usage-based insurance scores faster than older drivers after usage-based insurance adoption and that females exhibit more improvement than males. They noted that economic incentives lead to greater improvements in driving behavior. However, in a study using telematic technology to measure driving performance, Choudhary et al. (2019) focused on nonfinancial incentives. In collaboration with the industry, they launched a smartphone app called DrivePower that aims to nudge safe driving using feedback on the driving behavior. In their field experiment, they found that even such nudges improved the average driving performance.

To a certain extent, the telematic system can be interpreted as a reputation mechanism in the sense of the work by Resnick and Zeckhauser (2002). In the case of car insurance, the price expresses the company's trust that the policyholder will not suffer an accident. The telematic system provides helpful information that the insurance company uses to determine whether clients are trustworthy drivers. The major aim of our work is to explore whether a telematic system can be used to build trust in the sharing economy. For this reason, we considered the possible benefits and concerns regarding using a telematic system compared to other reputation mechanisms. Next, we explore whether people might trust such a new mechanism, which is represented by the extent the information from a telematic system might influence their decisions.

Potential Benefits

Using telematic systems as reputation systems competes with other trust mechanisms, especially user ratings, as one of the most important mechanisms today. In the following paragraphs, we outline various benefits emerging from the use of telematic systems as a reputation mechanism. We focus especially on how telematic-based scoring systems can compensate for known weaknesses in user ratings.

Inflation of positive feedback. Even if no ground truth exists, user ratings often seem implausibly rosy (Filippas, Horton, and Golden 2018). Several authors have stressed that the bilateral reputation mechanism is often extremely positively biased (Nosko and Tadelis 2015; Dellarocas and Wood 2008; Resnick and Zeckhauser 2002). Horten et al. (2018; 2015) reported a similar phenomenon concerning the reputation system of a large online labor market. In addition, they indicated that the public rating scores increase strongly over time so that it is likely that the informativeness of reputation systems is eroding over time.

Several explanations exist concerning this discrepancy. Several authors have pointed out that the rating bias is the outcome of a reciprocity effect (Dellarocas and Wood 2008; Bolton, Greiner, and Ockenfels 2013; Horton and Golden 2015). Dellarocas and Wood (2008) assumed reciprocity expressed by a tit-for-tat strategy. This strategy represents an important driver of reporting behavior, fostered by the bilateral reputation system of eBay at that time. Bolten et al. (2013) pinpointed that reciprocal positive ratings help both buyers and sellers because it increases their reputations and reduces their transaction costs. By the same token, a negative rating harms the seller's reputation, triggering possible retaliation by also providing a negative rating. This leads to additional costs for both buyers and sellers. In addition, the whole platform suffers because low average ratings decrease the overall trust and increase the overall transaction costs.

Horton and Golden (2015) noted a second reason for reputation inflation. They found that positive feedback and not providing negative feedback take market penalty into account, which is associated with bad ratings. For instance, *The Guardian* reported that Uber bans drivers with bad ratings (Paul 2019). If a rating has a dramatic consequence for the person concerned, it increases the risk of retaliation, which could also have negative consequences for the rater. To avoid such consequences or express solidarity with the gig worker, not rating the worker or giving the worker a positive rating might be a better option.

The use of a telematic system could counteract the inflation of positive feedback because it is resistant to reciprocity and solidarity for better or worse. Moreover, automatic scoring can be an emotional relief for peers because the technology serves as a scapegoat. In the case of doubt, the blame for a bad rating is ascribed to the technology instead of a person.

Fake, paid, and promotional reviews. Fake, paid, and promotional reviews can deceive consumers into making suboptimal decisions and can increase mistrust in the entire reputation mechanism (Mayzlin, Dover, and Chevalier 2014). Therefore, this problem has recently attracted significant interest in the mass media, consumer protection organizations, and academia (Wu et al. 2020). *Fox Business*, for instance, reported that e-commerce platforms are flooded with fake five-star reviews (Henney 2019), *The New York Times* reported on a case in which a company posted fake reviews for years (Maheshwari 2019). Consumer protection organizations warn against trusting peer reviews. In addition, they often advise on what consumers should look for in peer reviews. The consumer center in Germany, for instance, has recommended relying on professional and independent testers that are funded with tax money and work according to transparently defined criteria (Verbraucherzentrale 2018). In academia, most research focuses on how fake

reviews can be avoided or at least identified. For instance, Ott et al. (2011) proposed a linguistic model to identify opinion spam presenting inappropriate or fraudulent reviews. Akoglu et al. (2013) suggested a network-based framework for opinion fraud detection in online reviews. Heydari et al. (2016) proposed a time-series based model for detecting review spam. Hooi et al. (2017) suggested a graph-based model to detect fraud.

Despite these efforts, fake and paid reviews will likely still be a problem in the future. Hence, additional reputation mechanisms are helpful even if frauds also try to exploit the vulnerabilities in telematic systems. As a second independent mechanism, it provides additional protection, which makes it more difficult for frauds to falsify both the telematic scoring and user ratings.

Rating fatigue. The rating ratio, defined as ratings per usage represents the desire of the user to rate the product or service. In the case of eBay, Bolten et al. mentioned that 70% of the traders leave a rating. Resnick and Zeckhauser (2002) noted a similar ratio of about 50% for buyers and 60% for sellers. In the case of YouTube, Chatzopoulou et al. (2010) found a rating/viewing ratio of 0.25% on average. No comparable studies on rating ratios for P2P platforms were found, but we expect a ratio somewhere between that for eBay and that for YouTube.

Several reasons exist for the users' unwillingness to report feedback. First, the rating means additional time and mental effort without any immediate benefit. Second, the evaluation also means the disclosure of personal information. Dellarocas and Wood (2008) also hypothesized that peers remain silent because they are afraid that reporting a negative experience will lead to retaliation by negative feedback. These reasons are reinforced by the fact that consumers are increasingly asked to evaluate products, services, locations, and so on, which can lead to rating fatigue.

Computer-based scoring can counteract such rating fatigue because it does not require any additional effort from users. Regarding the inflation of positive user feedback, for carsharing, considering all of the rides of a person, computer-based scoring becomes more balanced and reliable.

Discrimination. Ongoing evidence about everyday forms of ethnic and racial discrimination exists, especially regarding the labor market and housing market, but it also occurs in the service sector. Goddard et al. (2015) indicated that drivers pass black pedestrians without stopping more than twice the average rate, and black pedestrians wait longer than white pedestrians.

Concerning the sharing economy, Calo and Rosenblat (2017) stated that both service providers and service consumers face racial and other discrimination. Edelman (2017) found evidence that Airbnb guests with distinctively African American names were rated significantly less positive . They concluded that this penalty is consistent with the racial gap found in contexts ranging from labor markets and online lending to classified ads and taxicabs. Analyzing the data on a European carpooling platform using fictional profiles to ask for a ride, Carol et al. (2019) reported a similar result of ethnic and gender discrimination. Similarly, Tjaden et al. (2018) uncovered that drivers with an Arab-, Turkish-, or Persian-sounding name attracted significantly less interest in their offers (fewer clicks on the offer) than drivers with typical German names.

They concluded that these findings result from both taste-based and information-based discrimination. Regarding taste-based discrimination, the authors assumed that some consumers may not choose an offer because of stereotypes and prejudices. Regarding information-based discrimination, the authors assume that other consumers may not choose an offer because of security and safety issues. As there were no objective indicators on the platform, consumers might use the name of the driver as a cue for the perceived safety of a ride.

Intelligent systems are not free from bias, unfairness, and discrimination (Hacker 2018). To our best knowledge, however, telematic systems are not subject to the same types of discrimination as those described above. Therefore, telematic scoring might help reduce discrimination, especially information-based discrimination, because it can give an additional cue used by people to judge driving competence and the safety of a ride.

Sectorial trust of heterogeneous user groups. Although users of P2P platforms likely have basic interpersonal trust, it is conceivable that some might trust peer ratings more, whereas others have greater confidence in technical scoring. Providing an additional reputation mechanism can better consider this heterogeneity among users.

Moreover, because user ratings and telematic scoring examine the same subject from slightly different perspectives, people can triangulate these trust cues. If both systems measure the same directions, the two trust cues reinforce each other. An open question, however, is what happens when scores are opposing. In this case, it is reasonable that users create a kind of individual weighting of the scores, which reflects their personal sectoral trust. People who are more likely to trust other people are more likely to give a higher weighting to a user rating. In contrast, those who tend to trust technology are more likely to give higher weight to telematic-based scoring. Thus, telematic-based scoring should not replace the user rating but rather supplement it to consider the heterogeneity of the user group and support the individual, weighted triangulation of both trust cues.

Additional added value. In addition to these issues, a further added value of telematic-based scoring can be identified, which goes beyond the existing reputation assessment. Bossauer et al. (2020) examined the tension between trust and privacy using telematic systems in P2P carsharing by interviewing potential rentees and car owners. In contrast to user ratings, which provide an informational basis for decision-making, monitoring the car during the journey especially seems to promote trust on the car owner side. For example, some car owners specify the maximum speed of the car, which then can be controlled and reported by the telematic system in the event of a violation.

To build trust, the study further indicates that both parties should have access to the recording of the driving behavior and can use this data under the same conditions. For instance, in the case of litigation, telematic data can enable a more objective evaluation in the event of a dispute. In addition, under certain conditions, renters are willing to disclose information in specific situations if this promotes trust. For instance, the renter may be willing to share the current location because,

due to a traffic jam or other reasons, a renter may not manage to return the car in time.

Potential Concerns

Inappropriate trust. Telematic systems have so far only been used by insurance companies. Their scoring procedures are assumingly based on data-based risk analyses. However, to our knowledge, no independent evaluation of the procedures exists. Therefore, the extent telematic scoring reflects the true safety risk of a driver and accordingly conveys appropriate trust is unclear.

Moreover, the question about appropriate trust can only be answered from the ascribed meanings of such a telematic-based score. Due to the novelty of the concept, no knowledge yet exists on how much users trust such a score and whether it results in a lack of trust (not trusting a safe driver) or over-trusting (trusting an unsafe driver). Further studies are necessary to calibrate the trust cues to reconcile the perceived trust with the objective risk.

Privacy concerns. Telematic-based scoring requires that the renter's driving behavior is recorded by a telematic box or similar device. The driving data are used to determine personal characteristics (e.g. how safely people are driving). Hence, an implementation of the concept must be compliant with the General Data Protection Regulation (GDPR). The collecting, processing, and storing of the data are only used for the specified purpose, and the informed consent of the renter is needed. A qualitative study (Stevens et al. 2018; Bossauer et al. 2020) revealed that renters are willing to disclose such data in principle, if they obtain advantages (e.g. a more favorable rent and a higher probability of borrowing a car). However, it is an open question regarding the extent a telematic-based scoring concept would be accepted by users and how it could increase the likelihood to rent a car via a P2P platform, such as Getaround or Turo.

System accountability and the right to an explanation. The GDPR includes the right to "be subject to a decision based solely on automated processing, including profiling, which produces legal effects concerning him or her or similarly significantly affects him or her" (GDPR §21.1). Whether concepts such as telematic-based scoring fall under this paragraph is debatable because computational scoring should inform but not replace human decision-making. Nonetheless, for various reasons, computational scoring and reputation systems should provide a "right to [an] explanation" (Edwards and Veale 2017), making the scoring accountable (Jakobi et al. 2018; 2019) for both parties: the person being scored and the person who uses the score. Regarding this, the algorithms behind telematic-based scoring must be reviewable and traceable. Computational scoring should reflect common sense about what is considered a "good driver." In addition, the scoring system must not lead to unfairness and discrimination (Hacker 2018). We also need appropriate metaphors and visualization to make the computational

ratings comprehensible for both renters and car owners to increase trust in computational trust factors.

Ethical concerns. In addition to privacy and legal issues, computational reputation systems also raise the ethical question of how much decisions should be delegated to computers. The current development of social scoring in China, for example, and the dark side of the sharing economy (Calo and Rosenblat 2017) have raised the fundamental question of what influences reputation systems in general (both human and computational scoring) should have on social and economic systems. Moreover, in the sharing economy, online reputational mechanisms could but should not replace traditional service and work regulations, anti-discrimination laws, and inspection by public authorities (Ranchordás 2019). Even if someone voluntarily agrees to information disclosure, it remains an open question regarding whether computational scoring is ethically and socially acceptable for liberal societies (Landwehr, Borning, and Wulf 2019). For instance, the danger of unequal treatment concerning privacy exists, where rich people can own a private car, while poorer people must give up their privacy to rent a car.

Methodology

The previous section revealed that using telematic systems as a reputation mechanism would be far from perfect in various situations. However, these systems have the potential to compensate for some of the imperfections in other mechanisms, such as user ratings and user reviews. However, besides technical feasibility, users must accept and trust such new reputation mechanisms.

An acceptance indicator is that people trust in the information provided and that this information influences their decision-making behavior regarding identifying trustworthy persons (Resnick and Zeckhauser 2002). To verify this, we conducted a conjoint analysis experiment in which we compared the influence of a fictional telematic score with that of a user rating. As the computational scoring is quite novel and does not consider “soft” issues, such as friendliness or cleanliness, we expect that telematic-based scoring does not influence the behavior of the car owner as strongly as the user rating.

Procedure

We used a conjoint analysis as a common market research technique to measure customer preferences for new or changed features or prices for products and services and to guesstimate unconscious decision processes (Dobney, Ochoa, and Revilla 2017; Rao 2014). In contrast to identifying the importance of individual product attributes, conjoint analysis measures the acceptance of complete products, which are regarded as a bundle of attributes and their importance. This way, the

analysis can specifically uncover how respondents develop preferences and help to develop new products.

For the conjoint analysis, a special focus must be placed on the choice and definition of factors (also called attributes) and their levels (also called values) (Rao 2014). As we aimed to analyze the effect of computationally provided ratings compared to the established peer rating, our conjoint analysis focused on these factors but neglected other, self-provided information on the person, such as gender, age, photo, and so on. We also did not include peer reviews because it is difficult to define the manifold examples in a controlled way.

Table 1 displays the factors, levels, and corresponding scale values that we presented to the participants. In a pre-test, we determined that all of them are crucial for the decision of the user. The coinage of the term *trust score* was an evolutionary process. Various terms used in the insurance industry indicate that no term has been established to communicate the telematic concept to the customer. Our goal was to use a term that does not lead to under-trusting or over-trusting in the score. Initially, we used the telemetric score as a technical but neutral term. However, in our pre-testing, we became aware that people did not understand what we meant, so they tended to under-trust the concept. Therefore, we explained the term in the sense that we speak of a telematic score that aims to support trust in the driving skills of a renter. In these discussions, the term *trust score* has become established to express the goal of the concept instead of the technology to reach it. In our conjoint analysis experiment, we used this term, defining the rating of such a telematic system as the *trust score*, which, in principle, could also be used in reputation systems for other areas of the sharing economy.

Table 1. Factors and their levels used in the fictive profiles and corresponding scale values

Factor	**Levels**	**Scale Value**
User ratings	1 of 5 stars	1.0
	3 of 5 stars	3.0
	4.5 of 5 stars	4.5
Number of ratings	3	1.1
	20	3.0
	200	5.3
Trust score	1 of 5 stars	1.0
	3 of 5 stars	3.0
	4.5 of 5 stars	4.5
Kilometers driven	50	1.6
	500	3.9
	5,000	6.2

For the *user rating*, we used a five-star scale because this is common in platforms like Airbnb, Amazon, or Getaround. We chose three levels: 1 star, 3 stars, and 4.5 stars. The same scale and levels were used for the trust score to increase comparability. The star ratings for the factors *user rating* and *trust score* were

designed identically to make them easier to assess. Moreover, both factors used the same star visualization to avoid any effects caused by the presentation and not by the semantics of both factors.

We also included the *number of ratings*, which is common information in peer-based reputation systems, and correspondingly included *kilometers driven* as an additional factor in the computational reputation system (Table 1). For both factors, we used a log-linear scale to consider the psychometrical fact that a noticeable change is only perceived when the value doubles. In other words, a notable difference exists if someone has a driving experience of 100 km instead of 50 km, whereas the difference between 5,450 km and 5,000 km is negligible. We include three levels to represent low (three ratings [log: 1.1]/50 km [log: 1.6]), middle (50 ratings [log: 3.0]/500 km [log: 3.9]), and high (200 ratings [log: 5.3]/5,000 km [log: 6.2]) values.

The structure of the questionnaire has been divided into five parts. First, the participants receive an introduction and explanation of the trust score (Figure 1) to become familiar with the case.

What is the Trust Score?
Many peer-to-peer carsharing platforms use telematics. For this purpose, car owners are provided with a small box free of charge, which is installed in the vehicle.
- The telematics box records the driving style of the tenants whenever the vehicle is booked and used by the platform.
- In addition to braking behavior, speed and acceleration, external factors such as weather, daytime, location are also used to reliably record driving behavior - careful driving is rewarded with points via intelligent algorithms.
- If the tenant drives carefully, they receive a good trust score on the platform.
- If the tenant tries to manipulate the box, this is immediately recognized automatically and reported to the car owner.

Figure 1. Explanation of the trust score presented to the survey participants.

Second, the participants decided between two fictional profiles (Figure 2).

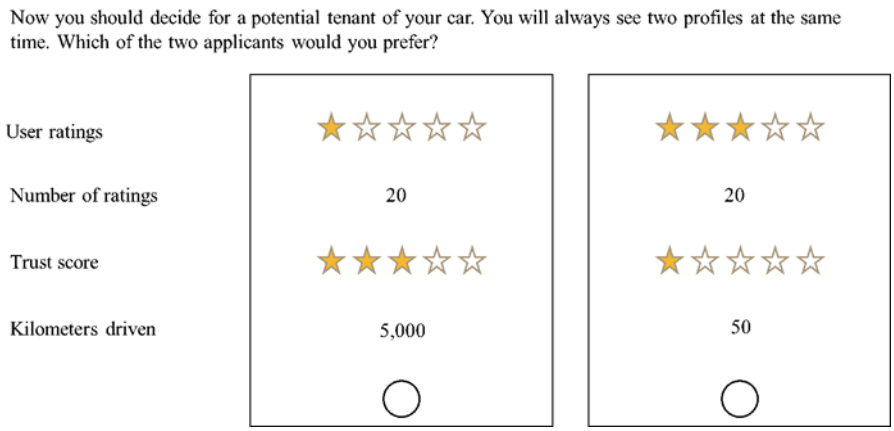

Figure 2. Example of the two fictive profiles of peers, in which the participant had to choose one (translated, the original text was in German)

Third, respondents were asked three questions about their trust in user ratings (interpersonal trust) and three questions about their trust in the trust score (technology trust), each based on the Likert scale. Fourth, to uncover the perceived helpfulness of the trust factors, the participants rated the helpfulness of the provided information from 1 (not helpful) to 4 (helpful). At the end of the questionnaire, general data about car ownership and demographical items were gathered.

Sample and Acquisition

During the period from May 6, 2019, to June 15, 2019, the survey was electronically shared via email at the Hochschule Bonn-Rhein-Sieg University of Applied Science in Germany and via social networks. Moreover, 77 people participated, including 43 women and 34 men. The average age was 30.6. In this sample, 88.3% of the respondents had a car, and the median car value was between 15,000 and 25,000 EUR. The median car age was between 6 and 15 years. Most of the respondents had a positive bond with their cars (mean: 3.5; standard deviation: 1.2; 1 (I do not care) to 5 (high bond).

Results

We analyzed the choice-based conjoint data using the multinomial logit model and the maximum likelihood method. We did not encode the levels by dummy variables (Baier and Brusch 2009) to estimate the part-worth utilities for each factor level but interpreted the factors as a metric.[1] For different factor levels, we used the scale values in Table 1. We estimated the factor coefficient using multinomial logistic regression (Starkweather and Moske 2011). The calculations were conducted using the *mlogit* package for R (Croissant 2012).

Table 2 summarizes the findings of the logistic regression. Both the likelihood-ratio test and McFadden's R^2 (Table 2) indicate a good model fit and predict significantly better than the null model. Respondents were only able to make their decision on the information provided in the profile. In a real-world situation, other factors that were not considered in this study also play a role. However, this indicates that the factors are relevant to the decision process and that the linear and log-linear scales approximated the "true" part-worth values quite well. This is also reflected by the fact that all trust factors are significant with a p-value of $< .001$ for the trust score and user rating, $< .02$ for the number of ratings, and $< .04$ for the kilometers driven.

[1] To cross-check the results, we also estimated the part-worth utilities using the dummy encoded method. This led to a similar result, especially for the same ranking of relevance of trust factors.

The result reveals that the trust score has a significant influence on the decision of the car owner regarding who should be allowed to borrow the owner's car. Moreover, our findings indicate that the coefficients of the trust score and user rating are quite close. This holds even when we consider the standard deviation of the coefficients. Compared to this, the trust factors of kilometers driven and the number of ratings are five times lower, which indicates that they are not more important than the other factors.

Our findings can best be interpreted by the odds ratio[2] given in the right column of Table 2, which is calculated by taking the exponential value of the estimated coefficients. Each star in the trust score increases the ratio of the probabilities (odds ratio) by a factor of 2.91. For instance, two users who want to rent a private car have the same profile except that user A has one more trust score star than user B. In this case, user A has a 2.91 times higher chance to be selected as a trustworthy person than user B. This is slightly more than the effect of an extra star in the user rating, where the odds ratio is 2.67.

Table 2. Coefficients and odds ratios of the trust factors used in the conjoint analysis study

Coefficient		**SD**	**Odds Ratio**
Intercept	0.01	0.15	1.00
Trust score	1.07***	0.12	2.91
User rating	0.98***	0.11	2.67
Kilometers driven	0.21**	0.10	1.23
Number of ratings	0.20***	0.07	1.23
Observations:	395		
R^2:	0.49		
Log-Likelihood:	-140.97		
LR-test:	265.45*** (df = 5)		
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$		

Table 3 illustrates how helpful the provided information was perceived as being by the participants to select a fictional profile. First, the table reveals that all information was rated as helpful (a value above 3 means helpful or very helpful). This confirms the results of the conjoint analysis finding that all factors are relevant to the selection decision. However, there are also key differences. For example, the differences in the rating of information usefulness are much smaller than the coefficients of the conjoint analysis. One explanation could be that they were all considered helpful and relevant. However, the four-point scale we used provides too little possibility to further specify the degree of helpfulness. Hence, the ratings become remarkably close to each other.

Table 3. Perceived helpfulness of the provided information to select the fictive profile

[2] For metric product properties, the odds ratio provides, *ceteris paribus*, the change in the odds when the metric property is increased by one unit of scale (*m -> m+1)* (Baier and Brusch 2009).

	Helpful information	
	Mean	**SD**
User rating	3.66	.68
Number of ratings	3.38	.74
Trust score	3.26	.86
Kilometers driven	2.99	.88
Note:	*1 = "Do not care"; 4 = "Very helpful"*	

It is also noticeable that, in the perceived helpfulness, the trust score did not reach the first rank as in the conjoint analysis. Moreover, it only placed at the third rank, behind even the number of ratings. Although it played only a minor role in the selection process, the participants consider it to be the second-most important information. In summary, it seems that a kind of perception-action bias exists in that, in the deliberate reflection, the relevance of peer-provided information seems to be rated higher than the actual influence on the decision-making.

Table 4 Measurement model for the sectoral trust

Factor	Items	Loadings[a]	Cronbach's alpha[b]	AVE[c]	CR[d]	Rho A[d]
Peer Trust	PT1	.925	.502	.651	.784	.652
	¬PT2	.668				
	~~PT3~~	too small				
Technology Trust	TT1	.810	.816	.731	.891	.816
	¬TT2	.877				
	¬TT3	.876				

Notes:
a. All item loadings > .5 indicates reliability.
b. Cronbach's alpha > .7 for a factor indicates reliability.
c. Average variance extracted (AVE) > .5 for a factor indicates convergent reliability.
d. Composite reliability (CR) and rho A > .7 for a factor indicate internal consistency.

We measured the sectoral trust regarding peer trust and technology trust using three items, each using a four-point Likert scale. Items PT2, T2, and T3 measured the factor negatively; hence, the scale was reversed before analysis. The factor loading of item PT3 was too small; thus, the item was dropped. The reliability of the remaining items was tested using composite reliability (CR); however, Cronbach's alpha for peer trust is quite low at 0.502. Therefore, the results must be handled with care (Table 4).

We estimated the influence of sectorial trust on the perceived usefulness of the information using structural equation modeling (SEM), which is illustrated in Figure 3.

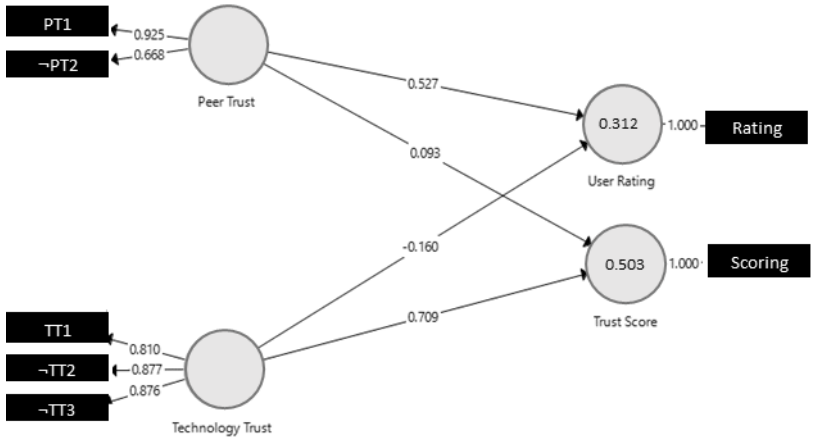

Figure 3 Influence of the sectoral trust on the perceived usefulness of the trust cues provided. Structural equation model together with the estimated path coefficients and R^2 (Calculations were carried out with SmartPLS v3.2.8. Ringle, Wende, and Becker 2015).

According to Henseler (2009), one of the main assessments of a structural model comprises the evaluation of the R^2 of the latent variables. Regarding the provided trust cues, R^2 indicates that the sectorial trust in peers and technology explains 31.2% of the variance of the perceived usefulness of the user rating and 50.3% of the variance of the perceived usefulness of the telematic-based scoring.

Sectoral trust influences the perceived usefulness to varying degrees. While peer trust loads strongly on the peer rating at 0.572, it loads only weakly on the telematic-based scoring at 0.093. This result can be interpreted to mean that the user rating is a more helpful reputation system for people with a high level of trust in others. The opposite is the case with technology trust. At 0.709, the technology trust loads strongly on the trust score but negatively affects the user rating. Hence, the trust score seems to be a more helpful reputation system for people with a high level of trust in technology.

This preliminary result indicates that telematic-based scoring should not replace but should supplement the traditional user rating because the scores address different user groups. Nonetheless, these findings must be handled with care because the findings are based on a small sample size, and our model neglects any moderating effects, such as the existence of generalized trust that might affect both interpersonal and technology trust.

Conclusion

Trust plays a key role in the sharing economy in general and in sharing a car with a stranger in particular. Reputation systems have become an established means to overcome the trust dilemma in the sharing economy. Today, reputation systems primarily rely on trust factors based on peer-provided information, such as peer ratings and peer reviews. In this paper, we suggested using additional trust factors that use computationally provided information because such information can be

collected automatically and evaluated using objective measures. We explored the adoption of telemetric-based scoring of driving behavior, which is currently used only by car insurance companies.

Our study aimed to determine (1) whether such a trust score influences the behavior of car owners in distinguishing between trustworthy and untrustworthy peers and (2) the extent of this effect. Both the findings of the conjoint study and the perceived helpfulness present the first indicator that telemetric-based scoring can be effective. Moreover, some evidence indicates that such scoring might have a critical role in future reputation systems and play the same role as user ratings. Thus, computational reputation systems using telemetric technologies have the potential to enhance the overall carsharing experience.

However, several limitations must be considered. First, all measured effects are statistically significant, but the sample is still relatively small with $N = 77$. In addition, the sample is formed by young people who are, on average, 33.6 years old. While this reflects a common finding in the literature that the sharing economy is particularly popular with younger people, the aim should be to motivate older people as well. It can be assumed that older people are more likely than younger people to own a car that they could make available to others. Therefore, the results should not be over-generalized.

In addition, our research design focused on the main effects only, and any moderation effects were excluded for the sake of simplicity (such as the interaction between the number of ratings and user rating and between the kilometers driven and trust score). This makes our model more parsimonious; however, in the future, moderation factors should also be considered.

Another important limitation is that most participants had no first-hand experience with the telematic-based scoring. It is quite usual for conjoint analysis to evaluate not-yet-existing product features; however, the fictional profiles limited the ecological validity of the experiment. Hence, the experiment reflects the projection of how people might interpret this factor in the future. Thus, our study demonstrates the potential of a telematic-based scoring for P2P carsharing, but to realize this potential, the socio-technical concept of using telematic technology for this purpose must be adequately implemented.

Moreover, two interrelated issues must be addressed critically. As outlined in the beginning, no calibration avoids under- or over-trusting in the information provided by a telematic-based reputation system. In our pre-testing, we became aware that the term *telemetric score* was too technical, and people had difficulty understanding the intention of the score. Thus, the danger that people could under-trust and ignore the score exists. In contrast, our study reveals that naming the construct *trust score* helps people consider this information in their decisions. However, future studies are needed to validate whether such a term avoids over-scoring and misinterpretation.

In addition, our study indicates observed perception-action where participants are unconsciously more influenced by the computational rating when they are aware of it. Hence, the danger of a non-reflective manipulation by algorithms exists, which is perhaps even worse because it takes place unconsciously and is largely concealed.

Our study has demonstrated the potential of a computational reputation system for the sharing economy. In the future, the concept should be elaborated in diverse ways. We require a better understanding of how decision-making works in practice when using the information provided by telemetric technology. For instance, we should study the situated actions of lending cars to others via carsharing platforms. An interesting question would be whether general interpersonal trust and technology trust influence trust factors. We should also explore the concept regarding other sharing areas (e.g. Does telematic-based scoring have a similar positive influence on the trustworthiness of Uber drivers?). Finally, to validate our findings, the concept should be implemented prototypically under real-world conditions. Regarding this, our work presents a pre-study showing both the practical relevance and theoretical foundation of using computer-based scoring as a mechanism that can compensate for some weakness in the traditional user rating.

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Notes

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Envisioning a Shared Checklist Display to Support Teamwork During Emergency Medical Care

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Abstract. Information technology and systems in healthcare are becoming increasingly complex and dynamic, requiring design approaches that consider not only providers' information needs and work practices, but also their perceptions and expectations about technology. In this paper, we describe an exploratory study conducted to assess the feasibility and impact of a shared checklist display for supporting teamwork during trauma resuscitations. Using the concept of technological frames, we explore how members of multidisciplinary emergency medical teams perceive current technology and what they expect from a future shared checklist display. Our results showed discrepancies in team members' perceptions of technology and its roles. Some care providers envisioned a shared checklist display as a tool for achieving a global view of the process, improving communication and maintaining situation awareness. Others perceived it as a point of distraction, where team members may be checking each other's work to ensure accuracy

of documentation. These requirements and limitations extend beyond the capacity of a simple checklist, while also shifting the privacy of work from individuals to the entire team. We conclude by discussing design implications for a future shared display and how shifting to a multi-display environment within a safety-critical context may transform work practices.

Introduction

CSCW research has long focused on designing socio-technical systems for complex work, including computer-mediated communication tools, decision-support systems, shared displays, and cognitive aids. To design these systems, researchers have applied user-centered approaches to study social, informational, organizational, and technical aspects of work (Abraham and Reddy, 2008; Delaney et al., 2012; Faraj and Xiao, 2006; Houben et al., 2015; Kaplan and Fitzpatrick, 1997; Østerlund, 2008; Robbins, 2011; Whittaker and Schwarz, 1999). Fewer works, however, specifically studied user perceptions of technology, long before this new technology was conceptualized. For example, Bardram et al. (2006) ran field studies to identify collaboration and awareness issues in a surgical ward, and then conducted a series of design workshops with clinicians by using white boards as an inspiration for the wall-display system AwareMedia. Similarly, Söderholm and Sonnenwald (2010), explored user perceptions while brainstorming features of a prototype 3D telepresence technology for emergency care scenarios during envisioning workshops with stakeholders. This type of an early understanding of user preferences about technology is especially important in medical domains where user adoption and smooth continuation of work practices are critical.

In this paper, we describe our efforts during the conceptualization phase of a new technology in the emergency medical setting of trauma resuscitation, where we focused on exploring trauma team roles' assumptions, expectations, and knowledge of technology through a series of envisioning workshops. We used an existing, tablet-based checklist in a regional trauma center to first elicit user perceptions about sharing the checklist content on a wall display during patient care and then applied technological frames (Orlikowski and Gash, 1994) to interpret the findings. Although the resuscitation domain provides many opportunities for innovation, designing computerized support for multidisciplinary, high-risk collaboration is challenging. Prior research has shown that introducing new technology in safety-critical medical contexts can improve task performance and reduce errors (Gonzales et al., 2016; Hart and Owen, 2005; Kulp et al., 2017, 2019; Thongprayoon et al., 2016; Wu et al., 2014). Similarly, past efforts to project technology onto shared displays have shown positive effects on teamwork, leading to improved communication in settings like operating rooms (Ong et al., 2015; Parush et al., 2011), trauma units (Faraj and Xiao, 2006; Xiao et al., 2001), and

Figure 1: An example trauma bay equipped with medical tools and instruments, large wall displays, and other artifacts.

emergency departments (Bjørn and Østerlund, 2014; Østerlund, 2008; Wu et al., 2011). These studies, however, implemented design solutions based on user observations or analysis of interaction logs, without first exploring user perceptions and unintended consequences of the proposed systems.

The envisioning workshops helped us develop an understanding of team members' (a) perceptions of technology and its role in their work, (b) reactions to shifting information privacy from an individual artifact to a shared display, and (c) expectations of how the shared information would affect team performance. We therefore make two contributions to CSCW: 1) an understanding of role groups' visions of a new technology and its implications for their work in a complex, high-risk medical setting, and 2) design implications for a future technology to support time-critical teamwork.

Background and Related Work

Teamwork and Artifacts in Trauma Resuscitation

Trauma resuscitation is a team-based medical process that requires rapid decision making and lifesaving interventions in a time-critical setting (Figure 1). Trauma teams are hierarchical and interdisciplinary, consisting of seven to 15 members, each having a specific role and set of responsibilities (Sarcevic et al., 2012). An attending surgeon, fellow, or senior surgical resident assumes the role of team leader (TL) to guide the team, make decisions, and formulate a care plan. During patient evaluation, the team follows a standardized protocol called Advanced Trauma Life Support (ATLS). The protocol consists of two surveys: (1) the primary survey rapidly evaluates the patient's major physiological systems like Airway, Breathing, blood Circulation, Disability or neurological exam, and Exposure

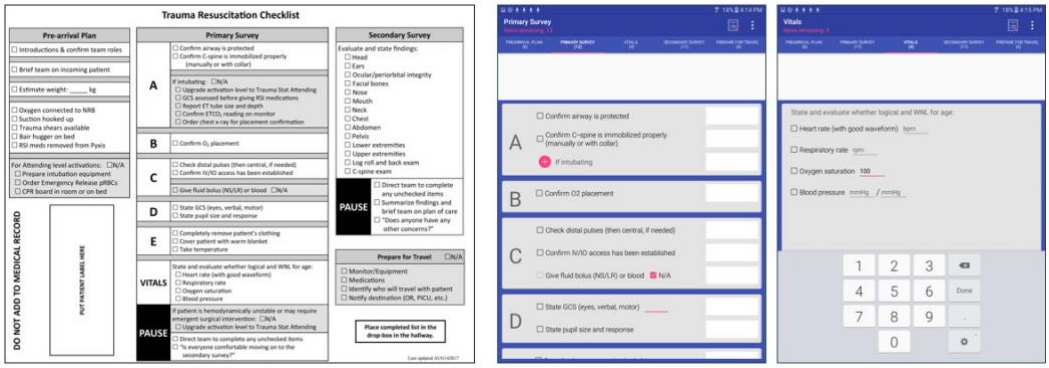

Figure 2: Paper checklist (left) and digital checklist interface for the primary survey (middle) and vital signs (right) screens.

assessment (ABCDEs), and (2) the secondary survey includes a head-to-toe patient evaluation to identify other injuries. To ensure protocol compliance and timely completion of all tasks, the leader administers a trauma resuscitation checklist that was designed for the leadership role only; no other role views or uses this checklist during resuscitations (Figure 2). This checklist is available in both paper and digital (tablet) formats, and team leaders can choose between the two based on their preferences. The checklist is not integrated with the official patient record and any information recorded on the checklist is not available to team leaders after they complete the resuscitation. The checklist has five sections: pre-arrival plan, primary survey, secondary survey, vital signs, and prepare for travel. Team leaders have been using this checklist during actual patient scenarios to check off items corresponding to resuscitation tasks, enter patient values (e.g., blood pressure), and take notes about exam findings (Kulp et al., 2019).

Other groups (team roles) include the Emergency Department physicians (ED), who assume the co-leadership role with surgical leaders. Bedside physicians (BP) perform the hands-on evaluation of the patient, reporting exam findings out loud for the team. Scribe nurses (REC) document the event, recording patient information, interventions and exam findings on a paper flowsheet. Medication nurses (MED) prepare medications, while the bedside nurses (BN) administer them. The nurses are drawn from the Emergency Department nursing pool and can rotate between roles depending on the nursing needs during resuscitations. Anesthesiologists (ANST) and respiratory therapists (RT) manage the patient's airway. Other specialists or staff may also be called, including neurosurgical, orthopedic, or pediatric intensive care unit (PICU) fellows, or radiology technician.

Trauma teams are ad hoc and team members may not know each other. To support coordination among roles, one of the first items on the checklist requires team members to introduce themselves and announce their role on the team. Teams also use several other tools and artifacts to facilitate teamwork, including the vital signs monitor (also projected on a large wall display), timers and clocks, the

i-STAT device for analyzing blood samples, a portable x-ray machine, the Pyxis system for dispensing medications, and a pager for notifications.

Approaches to Shared Display Design in High-Risk Work Settings

Shared displays have been introduced to improve collaboration and situation awareness in many team-based work settings, including healthcare. The approach to their design has varied from simple projection or input from an individual device (Hulfish et al., 2018; Wu et al., 2011), to ethnographic studies (Faraj and Xiao, 2006; Østerlund, 2008; Xiao et al., 2001), to design workshops with clinicians (Kusunoki et al., 2015), and to more advanced solutions that automatically capture information from sensors (Bardram et al., 2006; Parush et al., 2011). Hulfish et al. (2018), for example, simply projected a static paper checklist on the wall in a simulation setting to examine the effects of a shared trauma resuscitation checklist on task completion and provider mental workload. Although this shared checklist significantly decreased the number of omitted tasks, the display solution did not include any user studies to derive or design dynamic or interactive components. In contrast, our work explores how various team role groups perceive the value and importance of technology for their work and their expectations about the interactions with the technology. In an earlier study, we identified information needs of complex medical teams through interviews, video review, and design workshops, finding that a shared display could better support teamwork (Kusunoki et al., 2015). In this study, we envision this shared display by drawing on an existing technology (a digital checklist) that can provide dynamic information based on user input (e.g., patient status or team process) to support team situation awareness.

Others have also conducted field studies, observed work practices or interviewed clinicians to understand their information needs prior to designing systems (Bardram et al., 2006; Parush et al., 2011; Xiao et al., 2001). For instance, Parush et al. (2011) interviewed resuscitation team members to understand their roles, goals, and patterns of communication to create a conceptual design of a shared display for cardiac operating rooms. The concepts were evaluated through focus groups with healthcare professionals and iteratively designed based on feedback. An interdisciplinary team similarly conducted a field study to derive design directions for a shared visual representation of the neurosurgical symptoms to better support cooperative tasks of clinicians (Presnov et al., 2019). These previous studies have used a range of methods for designing shared displays to support teamwork, including understanding user needs and, in some cases, designing with users. In this work, we adapt the concept of technological frames to guide our envisioning workshops to both understand user assumptions and expectations while also prototyping initial system concepts with end users.

Technological Frames

Technological frames is a conceptual framework for studying the underlying assumptions, expectations, and knowledge that people have about technology (Orlikowski and Gash, 1994). Individual's technological frames have been shaped by past experiences or inclusion in social groups, forming their perception of the functionality and usefulness of technology for their work. These frames of reference may vary between key groups within organizations or roles within teams, posing challenges to technology design and development. When identified properly, however, technological frames provide a valuable lens for understanding how and why people interact with technology. In her classic study of the Notes groupware, Orlikowski (1992) applied technological frames to explore how technologists, managers, and consultants approached the introduction of new technology, finding incongruence between the groups' technological frames. For example, managers expected to see transformed business operations after technology was introduced, while users believed the technology was implemented solely to control their work processes. These insights resulted in three domains that characterize three different technological frames of the various groups: (1) the nature of technology, (2) technology strategy, and (3) technology in use. The results further suggested that recognizing differences in mental models about technology is important because cognitive habits that formed through initial exposure could be difficult to change later. Majchrzak et al. (2000) similarly studied the deployment and adoption practices around a virtual system for teamwork, identifying a shift in team hierarchy based on use behaviors, expectations, and adaptation over time. They found that collaborative technologies should include features that can adapt to the changing needs of users as their understanding of the technology evolves. We build on this work by understanding initial expectations of the technology and discussing potential adaptive features with various role groups to determine how the technology can best support collaborative work. We identify the information needs specific to each role group and derive design recommendations for a system that can support various user groups of a single collaborative technology.

Technological frames have also been used for evaluating deployed systems in medical settings, including Electronic Health Record (EHR) systems (Bardram and Houben, 2018; Jensen et al., 2009; Karsten and Laine, 2007), electronic medication prescribing (eRx) (Agarwal et al., 2010), and a 3D telepresence technology (Söderholm and Sonnenwald, 2010; Sonnenwald, 2013). Jensen et al. (2009), for example, studied how a group of physicians in two Danish surgery wards used a recently implemented Electronic Patient Record (EPR) system. Shortly after deploying the system, researchers conducted observations at each of the two wards, interviews, and a focus group with physicians to understand their sensemaking of the new technology. While physicians were open to the new system, they used it in ways that challenged its intended operation, which in turn created work-arounds that reinforced the old way of working. Although most prior studies applied

technological frames after system deployment, Orlikowski (1992) argued for understanding technological frames of different user groups prior to deploying a new technology to improve adoption rates. Early identification of where and why frames are incongruent or inconsistent can help preclude technology misuse, while also helping users understand the changes that may emerge with new technology. For example, Söderholm and Sonnenwald (2010) evaluated the benefits and feasibility of a prototype 3D telepresence technology for emergency care scenarios through a set of workshops. The authors defined three categories of technological frames in relation to the role groups who would be using the proposed technology; (1) physicians and nurses who would use the technology to provide services, (2) EMS managers who would manage people using the technology, and (3) IT professionals who would provide technical support for the technology. These workshops allowed the researchers to understand user perspectives on a new technology and its compatibility with current workflows, as well as to derive implications for system development and adoption.

Similar to prior studies, we chose to conduct the envisioning workshops before any prototyping or development of the shared checklist display had begun to understand the initial technological frames of different role groups within a multidisciplinary medical team. However, our approach differed because we had an existing, tablet-based checklist in regular use by a trauma team leader. We previously compared the impacts of this digital checklist and an earlier paper version on task performance, finding little difference between the digital and paper formats (Kulp et al., 2019). Now that we better understand the effects of this technology on task performance, we are further exploring how the checklist could support situation awareness for the entire team. We therefore used this artifact as a prompt and encouraged participants to consider what the future technology might look like, what information they expected to see, and how this new technology could fit into their workflow. Based on Orlikowski (1992), we also define the technological frames as different assumptions, expectations and knowledge of current and future technology. Using the workshop discussions, we extracted three frame domains that represent the individual technological frames of each user group and then identified areas of congruence and incongruence in each frame domain, which will now inform our design decisions.

Methods

To understand trauma team members' perceptions and expectations of a shared checklist display, we conducted four mixed-role envisioning workshops with participants representing different team roles (Table 1). The study took place at a level 1 trauma center in the U.S. mid-Atlantic region on four separate days between May 2017 and April 2018. The study protocol was reviewed for ethical issues and approved by the hospital's Internal Review Board.

Table 1: Summary of participant demographics per workshop, including team roles in each workshop and median years of their experience.

WSHOP #	**Team Roles**	**Experience** (median, years)
WSHOP#1	2 bedside physicians, 1 nurse	6
WSHOP#2	2 surgical team leaders, 2 ED physicians, 2 bedside physicians, 1 nurse, 1 anesthesiologist	2
WSHOP#3	2 surgical team leaders, 1 ED physician, 5 nurses	7
WSHOP#4	2 bedside physicians, 1 nurse	3

Participants

We recruited 22 unique participants (16 females and six males) representing six of the seven trauma team roles, including seven team leaders (three ED physicians and four surgical team leaders—three fellows and one senior resident), six bedside physicians, eight nurses, and one anesthesiologist. We intentionally planned for heterogenous (consisting of mixed role groups) workshops, ideally with all team roles represented in each to emulate the team makeup during an actual resuscitation. Because organizational power structures and team hierarchy play an important role in how people discuss and express perspectives in a group setting (M. J. Muller, 2002), we implemented several strategies to mitigate the effects of groupthink. For example, we started each discussion topic by first asking participants to independently perform a task (e.g., write responses on sticky notes, create an individual vision/sketch) and then share those responses as a group. Distribution of roles and participants varied between the workshops (Table 1), mostly due to the challenges in recruiting busy trauma team members. Team roles with significant representation included surgical and ED team leaders, bedside physicians, and nursing roles. We could not recruit a respiratory therapist and only one anesthesiologist participated in the study. Despite these challenges, we identified major technological frames and determined their levels of congruence between team leaders (surgical and ED), bedside physicians, and nurses—the three critical user groups for adopting new technology in this environment. All study participants are hospital employees and were compensated for their participation.

Data Collection and Analysis

We conducted the envisioning workshops in the hospital's emergency department, near the trauma bay, with some team members coming immediately after working the night shift and others beginning their work day. Each workshop was an hour long and consisted of individual activities, sharing individual work with the group, and group discussions. We started each workshop with an overview of the study, participants' rights, and introductions. Participants were then asked to recall the

most recent resuscitation they worked and write on a set of post-it notes how they obtained information about the patient when they arrived and throughout the event. Next, each participant shared their responses with the group. We followed with a series of open-ended questions focused on current use and perceptions of technology in the trauma bay, including the paper and digital checklists used by the team leader. All participants had an opportunity to explore both checklist formats during the workshops. Participants then envisioned how this individual checklist could transform into a shared display and discussed what information they expected to see on the display. This step included interactive components such as sketching and prototyping to visualize the layout and information distribution. Each participant presented their prototype to the group, explaining what information they expected to see and how the display would function. Reflecting on the prototypes of this shared checklist, participants discussed its potential effects on teamwork, privacy, and workflows. We concluded the workshops by asking each participant to think about the benefits or concerns of this future technology, write those on post-it notes and post them on the wall for group discussion.

Workshop discussions were audio recorded, and audio files were transcribed and then analyzed using a qualitative data analysis tool, Atlas.ti. We used a multi-step thematic analysis to understand different providers' interpretations of technology and identify frame domains. The data were first coded into six groups labeled by the trauma team role (e.g., team leader or bedside physician). For each team role, we then identified statements that reflected assumptions, expectations and knowledge of the current and future technology. We also examined statements across roles to determine common themes.

Results

We identified three frame domains that characterize trauma team members' perceptions and interpretations of current technology, as well as visions of a shared checklist display for supporting teamwork: (1) *importance of technology for work*—refers to the perceived importance of current technology for work and understanding of capabilities; (2) *private versus public work*—refers to the shift from managing individual information spaces to publicly sharing information on a wall display; and (3) *multiple roles of technology*—refers to understanding and expectations of the roles that a future technology may take and any consequences associated with use. The workshops provided an opportunity for identifying areas of congruence and incongruence between the roles' perceptions, expectations, and knowledge of information technology. For example, we observed divergence among team roles within the technology importance frame. Team role groups also differed in their expectations when discussing the shift from private to public information spaces, yet agreed that the introduction of a shared display would alter

information privacy. Although participants envisioned many functions for the display under the third frame, we observed overall congruence among roles.

Relative Importance of Technology for Work

In discussing participants' assumptions about current technology in the trauma bay, we found that technology plays an important role in performing medical work, but not all team members interpreted this importance in the same way. Rather, team members explained their technology use in distinctive ways, depending on their role on the team. Team leaders are responsible for guiding the team through the protocol in a timely manner, while ensuring that all tasks are completed. In doing so, they rely on a range of tools and artifacts, including the checklist (both paper and digital versions), vital signs monitor, timer, trauma flowsheet, real-time video transmission of a procedure, and wall charts. One surgical team leader (TL#1) explained the importance of the room timer to their work: *"I like the little clock that's timing things because it gives me a sense of how long I've actually been in the room so I can expedite things to get the kid out or finished."* Elapsed time since the patient's arrival is important information for leaders' work, as confirmed by prior research (Kusunoki et al., 2015). Because every minute matters, the leaders must ensure thorough yet efficient and timely performance of all tasks. The leader is positioned at the foot of the bed, overlooking the patient and team and facing the wall with the timer and large wall displays. No other team role mentioned the importance of the timer.

Another team leader highlighted the importance of a camera attached to the tube used to treat and manage the patient's airway. The team leader explained that the camera enables better training and confirms the outcome of the treatment:

> "Another piece of technology that not everybody interacts with is the camera attached to the endotracheal tube and we are able to watch other people intubate the patient, and I think that has provided huge levels of safety training as well as confirmation and has been instrumental in terms of ability to manage the airways." (TL#2)

In contrast to leaders who have an unobstructed view of the monitors due to their positioning, bedside physicians explained that they do not use the vital signs monitor or vitals projected on the wall display because they are standing next to the patient, turned away from the monitors:

> "I don't feel like I look at the monitors. I mean they [leaders] do, it's just our positioning in the trauma bay and we'd have to turn around and look behind to see the monitor, so I don't look at it…I look at the patient so personally in my role it's not as important." (BP#3)

> "For my specific role, I don't use a lot of technology and yes, there's a monitor but I don't even look at the monitor and other than the light [otoscope] to look at the eyes, my role is not heavily technology based." (BP#2)

A third bedside physician agreed that their role does not heavily rely on technology but also said that they would sometimes turn around to look at the monitor. One of the responsibilities of bedside physicians is to verbally report the

patient's vital signs during resuscitation, so looking at the monitor provides a quick reference before reporting the values.

The scribe nurses described that all charting work is still handwritten and paper-based, and that *"the only thing we would use electronically is the [vitals] monitor and the Pyxis machine to get the meds out."* The scribes use the vitals monitor to periodically record patient vitals on the multi-page paper flowsheet because patients may deteriorate at any time, requiring frequent reassessment and history of values. The medication nurse uses a paper-based reference guide to determine medication dosages and then retrieves those medications from the Pyxis machine. Although technology plays an important role in the workflows of many trauma team members, these results suggest that incongruences exist in how different roles perceive the importance of technology for their work.

Importance of the Checklist

Our workshop discussions also focused on the use of the leader's checklist because our overall goal was to assess the feasibility of designing a shared checklist display. Team leaders explained that the checklist mattered to their role but might not affect anyone else in the room because leaders are primary checklist users (e.g., *"I'm not sure it affects anyone other than us, that I know of," TL#2).* In contrast, other team roles thought of the checklist as a tool that supports the work of the entire team and not just the leader. A scribe, for example, offered this explanation:

> "My understanding from a nursing standpoint is that it's almost like the leader's version of the 3-page flowsheet and plethora of things that we fill out, to make sure that everything is getting done and we haven't forgotten a vital part of assessment or planning." (REC#1)

A bedside physician (BP#1) described the checklist as an assessment tool that helps reduce the cognitive load of the team:

> "It is a standardized way to approach [patient] assessment, but also a big component is taking the thinking out of it so everyone gets oxygen, everyone gets temperature control, and so on."

Participants also mentioned how the checklist facilitated information handoff from one team leader to the next, as explained by another bedside physician:

> "…if it's a trauma stat now or if someone is late, [the checklist] can help transition from team member to team member, someone else could pick up the checklist and take on that role until the actual team leader comes." (BP#2)

We have informally observed this handoff several times during our visits to the hospital. In one case, an ED physician filled out the pre-arrival section of the paper checklist and handed it off to the surgical team leader when they arrived. In a different case, the ED physician used a paper checklist for pre-arrival tasks and the surgical team leader continued with rest of the tasks using the digital checklist. One of the ED physicians explained how the checklist served as a tool to get updates about an ongoing resuscitation, especially when they arrive late:

> "I would say the simple checklist as technology is facilitating our processes. As the ED attending, when a fellow is running a trauma, I may just walk in and look over their shoulder, see where we are on the checklist, look at the patient, everyone seems like they got a handle on

> things and I just kind of step back. I don't need to say what's going on, where are we at when I hear the surgical junior say something." (ED#1)

The checklist has become an indispensable component of the resuscitation workflow because it reduces the team's cognitive load and keeps the team organized. Now that the checklist has moved to a digital platform, we can take advantage of its potential and project the checklist information on a shared display.

Perceptions of Private versus Public Work

Discussions about projecting the leaders' previously private work on the checklist for the team in real time showed how team members may interpret the changes in information privacy as it moves from an individual checklist to a shared display. Team members also suggested additional data points for the display, which may affect the privacy of information for other roles as well.

Views on whether the digital checklist is a private or public document differed among team roles. Some participants agreed that the checklist is only for the team leader because it contains their notes about the resuscitation process, patient status, plan of care, and other information. Some thought that the checklist is private because it contains patient information. Others believed that the checklist is used to assist the team and is therefore a public document, as stated by one bedside physician (BP#2): *"I view it as a document to help the entire team, so, public."* One of the ED physicians (ED#1) posed a question to the group: *"Do you think it would be different if [the checklist] was displayed up there versus private to the team leader?"* This question led to a discussion about the effects of the shared information on teamwork. Participants expressed a concern that the display could be distracting because roles assessing the patient would be checking if their verbalized findings were added to the display, as shown in this exchange:

> "Of course [it would be different] because then it's distracting to the whole team." (ED#2)
>
> "Then people are like 'oh we said this but you didn't put it up there.'" (BP#4)
>
> "Right, 'oh you didn't catch my abrasion I called out, I think it should be up there but it's not' […] some people are more focused on different things, have different concerns in your roles, and everyone should be concerned on the whole checklist." (ED#2)

Hearing this discussion, two bedside physicians commented that regardless of who can see the checklist, any information marked or written on the form is public because it was previously verbally called out or shared through reports. In other words, these participants thought that physically displaying the checklist information for the entire team would not change its already public status. What could change, however, is access to information by people outside the trauma team, which might lead to breaches of privacy. The resuscitation rooms are often frequented by other personnel and people, like social workers, patient family members, or police, who would now see the displayed information: "*It's all shared within the room, I mean it's shared verbally now, but I guess there's another*

question, now that we're displaying traumas in the social work area, you know, is that like a privacy issue?" (BP#4) This comment revealed a new concern related to shifts between public and private work that now involves not only leaders versus team, but also trauma team versus everyone else.

Displaying the checklist data on a shared display would allow the team to view the leader's interactions with the checklist in real time, including items being checked off, values entered, or notes taken. The participants' expectations of the display, however, exceed that of a single person entering information. One bedside physician proposed distributing the responsibility of data entry by allowing other team members to enter information. For example, the leader would be checking off the checklist items, the scribe would be entering vitals or patient values, and the medication nurse could enter administered medications using her interface:

> "In a way, I think it would be ideal if the checklist could be manned by several people, so the team leader does exactly what they've been doing on their checklist, which is just focusing on the surveys and then the med nurse would document medications and the nursing administrative liaison would document labs and consults, so people can still use it as a reference, but it's not one person in charge of everything." (BP#2)

A bedside physician from a different workshop explained the importance of the checklist to organize the room and all team members, and to distribute the preparatory tasks across the team prior to patient arrival:

> "My thought was to display a checklist of everything that needs to be done before the kid arrives so that everybody participates in making sure the oxygen is there, the suction is there […] I think that would help so we can see what's there and what's not because it's always sort of a shouting match and 'oh we forgot this' because not everybody can see that [check]list now." (BP#5)

One of the scribe nurses suggested that their data entry from the flowsheet, especially when it becomes electronic, could be coupled with that of the leader's entry from the checklist to contribute to the information on the shared display. As a counterargument, a bedside physician (BP#1) suggested an entirely new role for administering the checklist: "*I was even thinking as to who would do it, ED attending or I don't know, or should it just be a separate role in itself?*"

Implementing these ideas, whether feasible or not, may impact the team workflow. The leaders echoed this concern, explaining how they must focus on the patient and checklist, and any extraneous inputting of information would only distract them. Furthermore, with several roles inputting information for the shared display, more individual work would become public. Any errors or inaccurate information could change the team dynamic and affect patient care.

Multiple Roles of a Shared Checklist Display

Three distinct themes emerged during the workshops as we discussed user expectations of a checklist display: (a) display as an information source, (b) display as a tool to support communication, and (c) display as an awareness tool.

Display as an Information Source

While sketching and discussing the types of information expected on a shared checklist display, participants frequently came back to the idea of having checklist items automatically update on the display as they are checked off on the tablet. This portion of the display would show checked items and upcoming unchecked items, as well as highlight any items where the leader took a note because of an abnormal exam finding. Bedside physician #1 explained their sketch (Figure 3(a)) as follows: "*I'm envisioning ABCDE [steps] similar to what's on the tablet right now, that's scrolling going down to the secondary survey with highlighted any pertinent positives.*" The leaders suggested an activity summary with exam findings at the completion of the checklist, explaining how this information could help them remember the findings and formulate a care plan:

> "I think what would be useful at the end as a recap, if we had a final screen that popped up, here's the things we wrote down that were pertinent, cause the only things I write down, if pupils are normal I just check it, check the box, we did that, and then if there's seatbelt sign or significant abdominal tenderness, I'll write that over in the little box, and if those little things popped up at the end [on the display] when we recap, that would be helpful." (TL#2)

While many of the information items that were discussed already appear on the checklist, participants also expressed the need for several new types of information that are beyond the scope of the checklist. Prior studies of shared displays for supporting awareness in high-risk medical domains identified a need for information related to patient and process status (Bardram et al., 2006; Wu et al., 2011; Xiao et al., 2001). Our participants similarly mentioned the need for medication orders and administration times, consultations, and a process summary. Multiple roles also suggested a pre-hospital information summary at the top of the display. Although the current checklist does not contain a section about pre-hospital information, prior work has shown that leaders often write this information in the checklist margins (Sarcevic et al., 2016). An ED physician drew a sketch with constant information that is static, patient values that are dynamic and scrolling, and then a section for the existing checklist items that update in real time as the leader checks them off (Figure 3(b)). Bedside physician #1 had similar ideas for their sketch (Figure 3(a)) as well:

> "I'm envisioning the constants – whoever the patient is, medical record, age, weight, mechanism of injury, so it's a quick description that's not going to change, along with pre-hospital interventions or any meds, you know, CPR times 2, 20 minutes in the field, and then scrolling current vitals [points to top right], interventions and meds, again scrolling, and then possibly after secondary survey is done you get a patient summary, next steps, orders, chest x-ray, basic labs, again so everyone is on the same page as to what we're waiting for, and then possibly patient disposition at the bottom." (BP#1)

Participants also suggested showing trends in vital signs that would allow for quick assessment of the patient condition and rapid decisions. A team leader envisioned the role of this shared display as a visual aid for determining the care plan based on changes in patient vital signs:

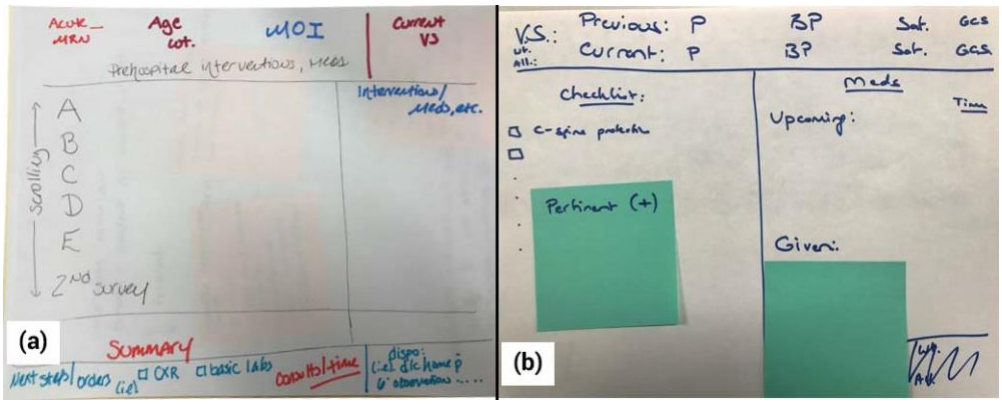

Figure 3: Sketches of the envisioned displays by bedside physician (a) and ED physician (b).

> "I think that the vitals trend is actually a really good idea because sometimes that alone is a really good visual indication of a patient that is very stable or very unstable. If you see a low blood pressure, you are like heart rate is slowly going up, you might not necessarily notice the end point value, but if you see a trend it's like a visual reminder." (TL #1)

Some participants voiced concerns about the fine line between the display providing necessary information and becoming a distraction point. The fear was that team members would fixate on the display instead of focusing on the patient, as explained by an ED physician:

> "I think there's an important downside of too much information up there, like vitals, are they stable, so I think it's like we're all looking up while we're supposed to be focusing on the patient, nurse is supposed to be focused on getting the blood pressure instead saying this is not pertinent, just needs to be focused on the patient." (ED#2)

Display as a Communication Tool

One salient theme throughout the workshop discussions was the impact of a shared checklist display on team communication. Trauma resuscitations are hectic and verbal reports are often missed or incomplete because of ambient noise and overlapping speech. Participants agreed that a shared checklist display could help improve teamwork and communication. A bedside physician commented: *"It could keep everyone on the same page. People tend to focus on their own roles, but it also pulls in a global view of where we are, what we need to do, and priorities."* (BP#2).

Another bedside physician (BP#1) and a scribe nurse (REC#3) saw the display's positive effects on team communication when team members arrive after the primary survey had started and ask redundant questions ("*A display would keep everybody on the same page and eliminate some of the redundancies of people asking if something has been done.*"). For scribes, the display could provide a reference for missed or incomplete information in the record:

> "When you're documenting all of this stuff is very easy to miss, what has been missed in all of the three pages […] it's almost like a second check to make sure we're getting all of our documentation done as well." (REC#1)

As with any technology deployment, there is an anticipation of the system malfunction and a need to revert back to the workflow prior to the use of a new technology. Our participants expressed concern that if the digital checklist or shared checklist display stopped working, they needed a quick way to revert back to the paper checklist, which could alter the team's communication or task coordination:

> "The situations when it [technology] goes down, we have to be able to get back to paper really quickly in a nimble way." (ED#1)

> "That's always an issue." (BP#4)

> "Yeah, always have the backup that's easy, and this is just one sheet of paper. […] Paper checklists are always in the room so it's easy to just pick it up and use." (TL#2)

> "As long as those [paper forms] don't go away." (BP#4)

Display as an Awareness Tool

The dynamic nature of trauma resuscitation requires team members to simultaneously work on several tasks. Because bedside physicians often need to verbally repeat the findings, they commented that a shared display would provide a quick reference for the progress in relation to the checklist: *"A one liner at the top so if people come in late they know at least the summary statement."* (BP#2) Another bedside physician suggested a simple display with only checklist sections and the status progress:

> "It would be helpful to have the display primarily for people who are coming into the trauma at different time periods, so if it was a chaotic situation where they weren't able to get a clear picture of what was going on, they could see 'oh they're on secondary, this is what has been done'…and in terms of the display I think because traumas are so fast-paced and there is a lot going on, it would be helpful to display the least amount of pertinent information as possible, so primary survey, 'check', has been done and if there was any intervention that would be helpful to make note of like, 'airway: intubated'." (BP#5)

One of the scribe nurses proposed a split-screen display that allows for detailed checklist items and pertinent findings, as well as a high-level summary of where the team is in the protocol:

> "Maybe it should be a split screen where one screen is an actual checklist and the other screen is a summary of what's been done so it can be like primary has already been done and if someone walks in they can be like 'ok we're at the secondary right now'." (REC#3)

Discussion

The results from our envisioning workshops with trauma team members showed that technology serves an important role in emergency medical teamwork and that a shared checklist could bring an added value to the team. We also observed role-based congruences and incongruences across all three frame domains. As such, our results fulfill Orlikowski and Gash's expectation (1994) that further empirical work

will expand the frame domains reflecting specific technologies in unique contexts. Below we discuss the challenges that the observed alignments and misalignments in perceptions of new technology pose for designing a shared checklist display for emergency medical care processes.

Designing for Misaligned Perceptions of Technology

Although technology serves a critical role in the work of many trauma team members, we observed differences in how team role groups perceived the importance of technology. One of the main incongruences between team roles that emerged early in the workshops was that bedside physicians do not use current displays for a visual reference because their focus is on the patient and hands-on evaluation. This initial assumption about technology suggested that bedside physicians would most likely develop resistance toward a future shared checklist display or simply not use it, even though fellow team members perceived the new technology as useful for the team. Later in the sessions, however, we observed a shift in bedside physicians' assumptions, when they envisioned new information types for the checklist display in their prototypes. These observations suggested that the initial frames about current technology evolved throughout the discussion, making the bedside physician role more open to the idea of a shared checklist display. Schubert and Röhl (2017) argued that in work environments, sensemaking consists of making, acquiring, maintaining and appropriating technology artifacts. These artifacts may initially become invisible as they become embedded into workflows, but as the purpose or materiality (e.g., wall display) of the technology shift, the technology may become more visible to the entire organization (or team). Forcing users to adopt a technology they do not perceive useful may lead to resistance or misuse of the system (Agarwal et al., 2010), making it important to not only understand the initial technological frames but also how they evolve over time. Orlikowski and Gash (1994) argued for tracking frames of role groups over time to better understand the underlying reasons for incongruence and identify appropriate points of intervention. Our findings confirm that recognizing user apprehension about technology and how the frames can change over time represent an important factor in conceptualizing the design of a new technology. This nuanced recognition of changes in user attitudes toward technology also has implications for the process of designing a new technology. For example, it is important to include all role groups in the design process in an attempt to understand the frames of different groups and meet their needs.

Although the leader's digital checklist is now fully incorporated into the trauma team workflow, the workshop participants disagreed on the purpose of the checklist. Team leaders saw it as a tool for keeping their own work organized, while other roles viewed the checklist as a tool that supports the entire team. For team members that acknowledged the importance of the checklist, this frame will likely

carry over to the new technology. To maintain this frame, the new design should preserve the information currently on the checklist since team members already perceived it as important for their work. For the roles whose frames of reference differed, we should first understand those differences and design to support them rather than to align them. As we prepare to proceed with the design of a shared checklist display, we must address the needs of each role rather than using a one-size-fits-all design. Our prior research has identified the information needs of trauma team members and can provide insight about the types of information important for each role (Kusunoki et al., 2014). Results from this study extend this prior work by providing an in-depth understanding of user expectations related to information on the checklist as identified in this study.

Previous work has described a "sensitizing concept" as a starting point for deriving design guidelines in a specific work setting (Blumer, 1954; Bowen, 2006). The workshop discussions reflected on how technology was being used for work and how additional technology could further support information needs and team situation awareness. In turn, the discussions sparked ideation and design thinking about the possibilities of technology in a complex work environment. By involving stakeholders, we now have a clearer understanding of how they perceive technology for their work and can build on this knowledge when proceeding with technology design and implementation.

Designing for Shifting Privacy of Information Spaces

Sharing the content of an individual checklist with the team will necessarily lead to changes in information privacy and access rights, as the information moves from a private device to a shared display. Team leaders view the checklist as their private work and decisions about what to record and when to check off items are solely theirs. Making the checklist information available to the entire team, and even to those outside the team, may disrupt this view because information will no longer be private to the team leader. Our results suggested that publicly displaying the checklist information may affect how leaders use the checklist. On one hand, leaders may become more compliant with the checklist because more people will be able to see their work in real time. Based on prior research, this change in use practices as a result of shared work is common. Wilson et al. (Wilson et al., 2006), for example, found that the availability of a large display for supporting information sharing during shift handovers encouraged physicians to write their summaries more neatly, thereby improving their work for the benefit of the team. On the other hand, sharing the checklist content may create tension between roles if people start checking the work of the leader. Similarly, the leader may start documenting less information in an effort to avoid their work checked. Team roles involved in patient evaluation and treatment were especially concerned about this effect; they thought the display would be distracting because they would keep checking if their reports

were documented. Other roles suggested multiple entry points for the display to allow team members to enter information specific to their work processes.

Several design implications emerged from these results. First, given the high-risk and dynamic nature of the resuscitation domain, the shared checklist display should be designed to keep the leader in control of what information gets shared and when. The leader would remain responsible for discerning the pertinent positives that might affect the plan of care and whether or not to share them. Even so, there are benefits in allowing others on the team to input information, as shown in prior work. Greenberg et al. (Greenberg et al., 1999), for example, evaluated a SharedNotes system that supports both private and public note taking, but once a private note is made public, its creator no longer owns it. This study suggested that a rigid distinction between private and public work was not realistic and recommended a system that would let people fluidly shift notes and other artifacts between personal to public spheres. Similarly, allowing other trauma team roles to own the information and input data for the checklist display could potentially lead to increased alertness to any incorrect or missing information.

The second design implication pertains to the effects of the display on team communication. Wilson et al. (Wilson et al., 2006) describe a shift between active and passive information seeking after a shared display was introduced in a hospital ward, noticing how medical staff went from actively seeking information to passively receiving it, as the information was now automatically presented to everyone. A similar shift can be expected in behaviors of trauma team members with the introduction of a shared checklist display, especially in latecomers' inquiries about the team status that were described as redundant and disruptive. A previous study on information needs of trauma team members suggested that providing pre-hospital information and history throughout the resuscitation could reduce redundant information and communication (Sarcevic and Burd, 2008). The shared display is an ideal mechanism for removing this negative redundancy, while still allowing for positive redundancy by continually displaying critical patient or process information. The shared-checklist display could therefore include a "one-liner" related to pre-hospital information or progress indicator for where the team is in the protocol, providing shared awareness for both team members in the room and those who arrive late.

Finally, we need to consider another shift in information privacy that may occur when the checklist information becomes public. Currently, the team is communicating verbally, reporting and discussing patient data and exam findings. This information, however, is only temporary until it is recorded on the scribe's flowsheet or the leader's checklist. With a shared display, the recorded information will move to a public sphere and will become visually available to anyone in the room, further eroding patient privacy. This shift then brings up an issue of how to effectively filter information on the checklist, while also providing an automatic and timely reflection of the leader's work. Rather than automatically sharing all of

the information, the design could allow the leader to filter out sensitive information. As Wilson et al. (Wilson et al., 2006) found, simply sharing information on a display encouraged more thorough review of the information. In contrast, other studies have found that setting a privacy filter ahead of time alleviates the cognitive load of the decision maker in a complex work environment (Won and Pipek, 2003). Adopting a similar solution in our context would allow the leader to project the status of their work without being concerned with revealing the sensitive and private information.

Designing for Dynamic Teamwork in a Multi-Display Environment

Participants mentioned other technology and artifacts that support their work in the trauma bay, including the vital signs monitor, wall charts, and other cognitive aids. Introducing yet another information display (a shared checklist display) will require determining what information remains helpful when redundant (e.g., vital signs) and what information becomes distracting if redundant (e.g., wall timer). These considerations may lead to a multi-display environment. Furthermore, our participants expected to see more information than what is currently available on the checklist. Items like pre-hospital information, medication orders and administration times are all related but extraneous to the idea of a checklist. A recent study of a hospital-wide implementation of an electronic patient record system showed that information needs of team members are often based on team and patient status rather than that of the process (Karsten and Laine, 2007). Given these and our own insights, we must consider whether the checklist is the right tool to fulfill these expectations. As the results from our study have shown, simply projecting the content of the current checklist will not suffice.

One solution is to use existing displays in the environment and add the checklist information to their contents. Research on multi-display environments (MDEs) has shown that participants use the shared display differently than their individual devices by taking a step back to see an overview of the group's progress, which offers communication grounding and synchronization of tasks (Wallace et al., 2011). Bardram and Houben (2018) suggested using portable, context-aware devices for accessing patient health records because this ecosystem of devices would better support the collaborative affordances of an EHR system. A multi-display environment in the context of trauma resuscitation could help improve team communication and situation awareness, but multiple displays could be distracting. An MDE for a complex-medical setting means not only several displays to view but also to manage in terms of what data to enter and when. Our results showed that participants welcomed the idea of multiple inputs for the shared display, and even multiple formats or screens for representing the information (e.g., one detailed view and one summary view). Another suggestion was to introduce a new role dedicated to inputting the information for the shared checklist display. A previous

study has made similar arrangements to evaluate the impact of a displayed checklist on trauma team performance in a simulation setting—an entirely new trauma team member was added as the checklist documenter to check off items on a handheld checklist when activities were verbalized by the team (Hulfish et al., 2018). As their findings showed, this addition of the checklist documenter decreased the workload of the team leader, who was now free to refer to the checklist display without the need to administer the checklist. However, it is unclear how the addition of the checklist documenter affected the work of the leader and team dynamics in general. Shifting the ownership of the checklist administration removes the leader's ability to make notes about the patient status and use the checklist as a memory aid. In our study, the scribe nurses compared the digital checklist to their multi-page flowsheets, explaining that the digital checklist could serve as an extension of the flowsheet. The flowsheet also has all of the additional information that participants envisioned for the shared checklist display. Even so, the same concerns and challenges we observed for the idea of projecting the leader's work would also apply to projecting the forms filled by the scribe nurses, including how people in the room might be checking the accuracy of data entry as it gets projected on the display. Despite all the risks, recent work on developing an MDE in the commercial flight deck that captures contextual interactions and collaboration during layered tasks shows promise that MDEs could improve complex, team-oriented task performance when designed and implemented in a manner that considers workers' assumptions, expectations, and knowledge of technology (Roesler et al., 2017).

Conclusion

We conducted envisioning workshops with team members working in a high-risk medical setting to understand their perceptions of technology and assess the feasibility and impact of a shared checklist display during medical emergencies. We applied the concept of technological frames to understand perceptions of technology for each team role group. We found that team members value technology differently based on their role and the nature of tasks they are performing. While our participants expected a shared checklist display to have positive effects on teamwork and communication, they envisioned a tool that exceeded the capacity of a simple medical checklist. These findings suggest different approaches to designing for high-risk medical collaboration, such as supporting differences in technological frames rather than aligning them, allowing users to shift their information between personal and public spheres, and providing an environment where information is effectively shared through multiple displays yet unobtrusive to teamwork. Although we conducted a single site study, our results generalize to emergency medical work in other U.S. trauma centers because of the similarities in team roles and standardized patient evaluation protocols. As we

continue this work, it will be important to track the frames of team roles over time to understand technology adoption and use behaviors for improved system design.

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Networks of Practices: Exploring Design Opportunities for Interconnected Practices

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Abstract. For over a decade, researchers from the practice-centered computing community are taking social practices as a unit of design. While the first generation focused on a social practice in isolation, more recent work argues for the (inter-)connections of mutually influencing practices as the primary unit of design. We discuss these current approaches to motivate the notion of a network of practices. Utilizing the case of food practices, we construct and analyze a network populated by the answers of 60 participants. Based on this network we suggest how to identify central elements and clusters as well as points for intervention within the overall network, but also within and in-between clusters of practices. Based on this, our work critically discusses how an understanding of practices as a network could improve practice-based research and design.

Introduction

Beginning with the turn from workplaces towards everyday life and culture (Bødker, 2006) evermore elements of social practice theory (SPT) find application within practice-centered computing research and design (Kuutti & Bannon, 2014). Starting off with studying single practices in isolation, at least since the special issue on sustainable practices, it became clear that, "it is not appropriate [for HCI scholars] to consider a practice individually, withdrawn from any other practice" (Disalvo et al., 2008). Since then, design research used multiple practice theoretical lenses to better understand the relation of different practices and their interconnection (Kuijer et al., 2013; Kuutti & Bannon, 2014) to derive design relevant knowledge (Prost et al., 2018).

To account for the complexity of interconnected practices (Schatzki et al., 2001), several frameworks (Entwistle et al., 2015; Ganglbauer et al., 2013; Ng et al., 2015; Terpstra et al., 2005) to structure practices have been proposed. However, these frameworks are rather simplistic by only focusing on specific aspects of practices, e.g. hierarchies (Ganglbauer et al., 2013), consumer lifecycles (Ng et al., 2015), or materials (Terpstra et al., 2005). This simplicity does not capture the theoretical connection of practices (Nicolini, 2009, 2012; Shove et al., 2012), as interconnected networks forming a 'rhizome' like structure. Nor do they account for the needs of designers, e.g. Kuijer et al. (2013) state that identifying overlapping elements of practices should be considered during design. Besides the point that the knowledge about central elements and the connection of practices is valuable for designers, it is also of interest for researchers, who work on a deeper understanding of how practices emerge, persist and mutually influence each other (e.g. (Gram-Hanssen, 2011; Kemmis et al., 2013; Shove et al., 2012)).

Aiming to advance models of SPT as a common resource for discussion and exchange between social scientists and engineers, Higginson et al. (2015, 2016) operationalize Shove et al.'s (2012) theoretical ideas of overlapping elements towards a notion of practices as networks. While their paper (Higginson et al., 2015) makes first steps toward a theoretically grounded visualization method, they abandon their theoretical foundation and level of detail in later work (Higginson et al., 2016) for the sake of simplification. Still, their research does not discuss networks from a practice-centered computing perspective and as a source for designers to understand practices. Nonetheless, they (Higginson et al., 2015, 2016) prove the general applicability of network theory combined with SPT.

Motivated by a further improvement of the method towards applicability in practice-centered computing research, to derive design-related knowledge from networks of practices and to construct such network, our work presents the example of a network of food practices (FP) based on 60 written-interviews, inspired by Higginson et al.'s survey (2016). The resulting network is exemplarily examined from different perspectives to demonstrate the methodological capabilities. As the focus is clearly on the method and the operationalization of practices as a network, FP are just used a case to populate the network. The

method itself is not limited to FP only, therefore we aim to discuss rather general ideas on the usage of such method, by exploring the example of FP.
We choose FP as our domain of interest for three reasons. First, it is already acknowledged by various research in practice-based computing that FP are interconnected and, although we do not fully understand the connections, relevant FP were identified (Ganglbauer et al., 2013; Ng et al., 2015; Terpstra et al., 2005). Second, there exist multiple frameworks for FP, from hierarchies (Ganglbauer et al., 2013), to lifecycles of consumers (Ng et al., 2015) to follow the food approaches (Terpstra et al., 2005), which offer material for comparison and show the relevancy of modeling this domain. And lastly, Human-Food Interaction is an emerging field in HCI (Altarriba Bertran et al., 2019, 2018), which might benefit from early involvement of a practice lens and a nuanced understanding of practice networks.
By discussing social practices as networks from a methodological perspective our work contributes to future practice-based research and design, by (1) introducing the perspective on practices as a network to the community of practice-centered computing scholars, (2) providing new means to identify central elements, their (dynamic) relationships and interconnections, that otherwise would remain unexplored, and (3) supporting the identification of opportunities for design by the means of network theory.

Related Work

Social Practice Theory

Attempting to "overcome existing dualisms between actor and structure, by finding ways to give voice to human agency without neglecting structural constraints"(Entwistle et al., 2015), practice theory is neither focusing alone on micro nor macro-social phenomena, like individualistic behavior or structural order, but inquire observable effects at both levels. Quite influential contributions to SPT are the ones of Schatzki (1996) and Reckwitz (2002), who understand practices as the "routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood"(Reckwitz, 2002). In Schatzki's (1996, 2002; 2001) initial work two central notions of practice are to be found, one being a linked or organized nexus of different elements ('practice-as-entity') and the other being practice-as-performances. Both are in a recursive relationship, as the performing of doing and sayings "actualizes and sustains practices in the sense of nexuses"(Schatzki, 1996). Another central distinction that Schatzki draws is between dispersed practices and integrative practices. While dispersed practices are generic, usually tacit practices that are spread across a realm of actions (e.g. explaining, following rules or imagining) and mainly need some form of understanding, integrative practices are "the more complex practices found in and constitutive of particular domains of social life"(Schatzki, 1996).

Building upon Schatzki's work Reckwitz describes practice as the emergent level of the social, "a routinized type of behavior which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge"(Reckwitz, 2002). Practices are defined by the existence and interconnectivity of these elements and cannot be reduced to any particular one of them. According to that, Reckwitz describes practices as a "block" or "a pattern which can be filled out by a multitude of single and often unique actions"(2002).
Shove and Pantzar draw upon Schatzki's and Reckwitz' formulations to develop a framework for empirical research (2005). In current research on SPT, the composition of practices from different elements is largely adopted, even though different authors introduce different key elements (Gram-Hanssen, 2011). Shove and Pantzar "work with the notion that practices involve the active integration of materials, meanings and forms of competence" (2005), which are interdependently related and equally connected. Shove et al. investigate the connections between these key elements and how these connections allow a practice to emerge, subsist, shift and vanish. The three components are described broadly so that different key features can be subsumed. 'Materials' include "encompassing objects, infrastructures, tools, hardware and the body itself"(Shove et al., 2012). 'Meaning' has been condensed from what Reckwitz has called mental activities, emotion, and motivational knowledge. For 'competences' several forms of understanding and practical knowledgeability have been summarized. Shove et al. (2012) distinguish between *practices, proto-practices,* and *ex-practices*. *Practices* are the well-established and unconsciously performed routines. *Proto-practices* are practices that are yet not incorporated by the person because relevant elements are not yet existing or are not yet linked. In contrast, *ex-practices* are practices that have been abandoned because of the breaking of one of the linkages (Shove et al., 2012).
However, there is still an ongoing debate about which key elements constitute a practice and how a practice is related to other practices via key elements resp. how the nexus between practice-as-performance and practice-as-entity can be described (Gram-Hanssen, 2011; Hui et al., 2016b; Kemmis et al., 2013). Blue and Spurling call for a theory of social practices that includes the "relationships between connections (interconnections)"(2016). They argue that although different descriptions of multi-practice compositions (like bundles, complexes, constellations, and systems) "are useful for understanding how one practice is connected to another, they are of less value in helping us understand relationships between the connections that hold practices together."(Blue & Spurling, 2016). For Warde, it is questionable what exactly can be determined in their examination as a constitutive part and where the boundaries of an integrative practice are drawn (2015). Harvey et. al. conclude that the answer lies in the form and focus of the research question being addressed. In studies of practices-as-performances researches narrowly determine practices, while practices-as-entities are investigated within loose, expansive boundaries of a certain bundle of activities to identify common elements that link practices (Harvey et al., 2012).

Interconnected Practices as a Unit of Design

Since Shove et al. first launched their manifest of practice-oriented design (2006), several researchers (Kuijer et al., 2013; Kuijer & De Jong, 2012; Scott et al., 2009; Wakkary et al., 2008) have used their framework as a basis for their design. In contrast to the understanding of product- or user-oriented design, Shove et al. (2007) highlight the importance of practices as the unit of analysis and the designability of the evolution of practices over space and time. Within these attempts, similar questions of central elements and (inter-)connected practices arise, not from a theoretical stance, but about the efficacy of interventions and a more integrated view on change.
Kuijer et al. (2013) suggest to deliberately introduce unfamiliar elements, e.g. 'Trigger-Products' that can cause what Reckwitz calls a "crises of routine" (2002). However, acknowledging that change in practice(s) is not a matter of technological transformation alone, they stress the connectedness of the investigated practice (Schatzki et al., 2001): *"Ideas of cleanliness or perceptions of the body for example, are not elements of bathing alone. Reconfiguration of bathing may require reconfiguration of a wide range of related practices."* (Kuijer et al., 2013). Although there is a theoretical debate about the key elements of practices and their connection, and well-known work in the practice-centered computing community, such as Shove et al. (2006) who already account for such relations of practices resp. their elements as well as the need to "identify[…] points for intervention", still there is need to work on the methodological means to identify these elements as well as their relations and interconnections. Similarly, Kuutti and Bannon (2014) call for a more holistic approach to practice(s), that does not focus on single aspects only, but rather tries to better understand the role of single elements resp. "computer artifacts in the emergence and transformation of practice"(Kuutti & Bannon, 2014, p. 8).

> *"Designing interventions requires a consideration of the complex nexus of interconnected practices (dispersed and integrated) that define food practices" (Ganglbauer et al., 2013).*

Considering the interconnectedness of practices is especially important for our example of FP, as e.g. Ganglbauer et al. (2013) suggest. To understand and structure the complex entanglements of FP, several constitutional concepts have been suggested:

Linear & Cyclic Structure

Some authors follow a kind of follow-the-actor (Latour & LaTour, 2005) approach, where the actor is not the human consumer, but the non-human, consumed food (Ng et al., 2015; Terpstra et al., 2005). Tracing the various FP has led to linear (Terpstra et al., 2005) and cyclic (Ng et al., 2015) models resp. Terpstra et al. use a linear model that "shows […] the route followed by food after its purchase by the customer" (2005). Such an approach proves to be beneficial to identify critical moments within FP (Terpstra et al., 2005), but it excludes different perspectives on practices, by focusing solely on the handling of food.

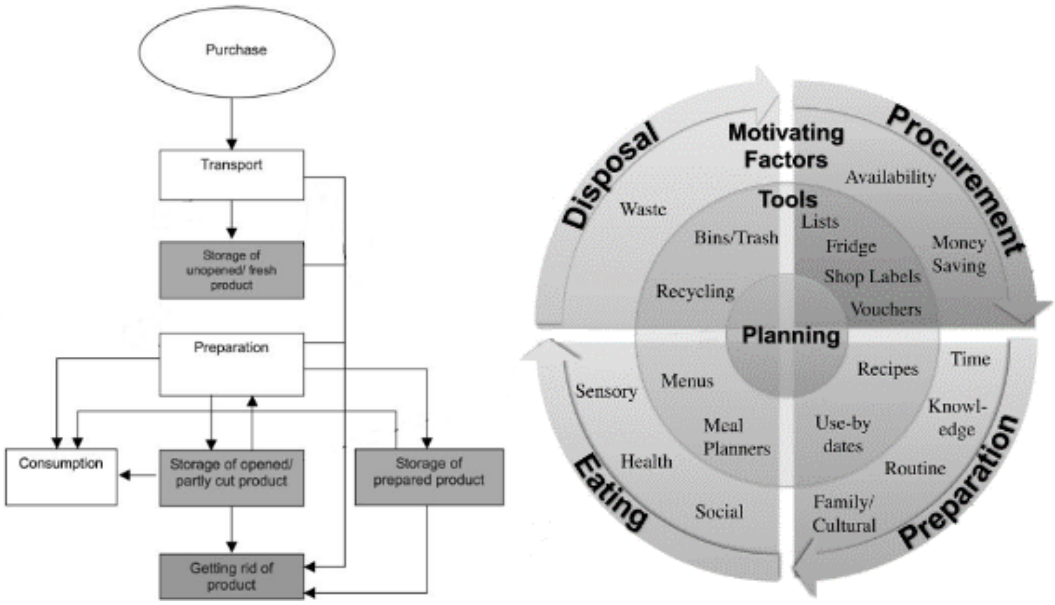

Figure 1 a) Linear (Terpstra et al., 2005) and b) Cyclic Model (Ng et al., 2015)

While their approach draws upon the relationship of practices as chronologically organized, they do not account for the key elements of a practice. Still using a following-the-actor approach, the food consumption lifecycle by Ng et al. (2015) already accounts for different entry points and the repetitive nature of food consumption (see Figure 1*b).* The incorporation of motivational factors in FPs, as well as the utilization of tools within different practices, are an advantage of their model. Besides, the model suggests that planning is the underlying central practice governing all FP: from procurement to disposal. This implies an individual agency making rational decisions and thereby neglects a fundamental notion of SPT, namely that an individual merely acts as the carrier of a practice (see (Reckwitz, 2003; Schatzki, 1996)). Such a view is insufficient because it considers food waste as a planned behavior, rather than an unintended result of interconnected practices (Ganglbauer et al., 2013).

Dispersed & Integrative Practices

Besides linear and cyclic approaches, Warde (2005) and Ganglbauer (2013) use the notion of dispersed and integrative practices, which suggest a hierarchical, tree-like structure of top- and sub-practices. Although they do not visualize their structure, their attempt aims to identify hidden interrelations and the inner logic of FP as a complex bundle. According to Ganglbauer et. al. integrative practices in the food domain are, e.g. “cooking practices and eating practices, where the embodied actions of the cook or the dinner are often habitual, informed by histories and cultures of performance, but also adapted to an unfolding social and environmental context” (2013). For Warde (2005) consumption cannot be considered an integrative practice but is rather a dispersed practice that is required and entailed in most integrative practices. Ganglbauer et. al. (2013) argue that food disposal, as non-consumption, is a dispersed practice as well. It is not by chance that Ganglbauer et. al. (2013) do not apply a follow-the-good-as-the-actor methodology, but use open-ended interviews to make use of people’s

competences to express relations among practices and to integrate experiences as well as to rank them into hierarchical order.

Excursus: Network Theory

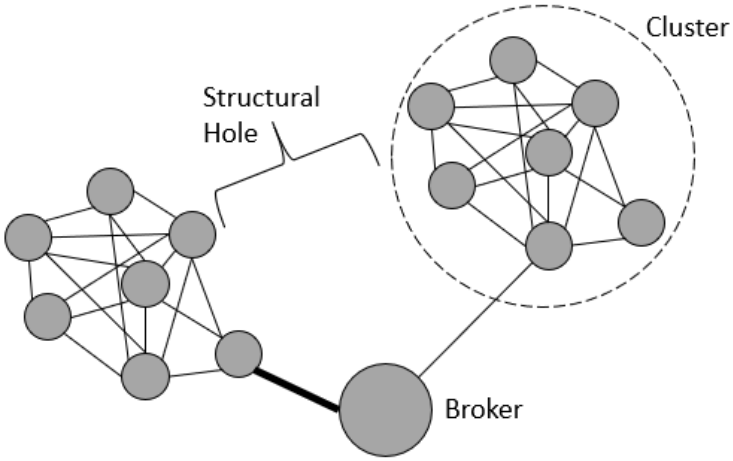

Figure 2 Simple Example Network

Before our work continues with an explanation of how SPT and network theory relate, we briefly want to give a short introduction on basic terms from network theory based on the work of Burt (2009) and Butts (2008). Figure 2 shows a simplification of a network. The grey circles are nodes, which represent entities in the network. Nodes are connected by edges, that have a varying thickness, which displays their degree of importance. The thicker they are, the more important and vice versa. When several nodes are closely interlinked with each other by edges they form a cluster. In our example network, the two clusters are connected by a node called broker, which creates a kind of bottleneck between both clusters. In this case, we can suggest that the broker has a high centrality, meaning a short average distance to all other nodes. Nodes have a 'degree', which describes the amount of edges connected to the node. For the limited connection between clusters, network theory refers to structural holes (Burt, 2009), where only little exchange between clusters resp. their elements exist.

Social Practices as a Network

Addressing the downsides of current modeling approaches on SPT, researchers (Bellotti & Mora, 2014; Higginson et al., 2015, 2016; Lawo et al., 2019) suggest a new method: The conjunction of network theory and SPT. Motivated by a deeper understanding of practices as well as the creation of models to improve the communication between engineers and sociologists (Higginson et al., 2015, 2016), a further discussion and refinement of their work might contain solutions for questions arising from practice-based design.

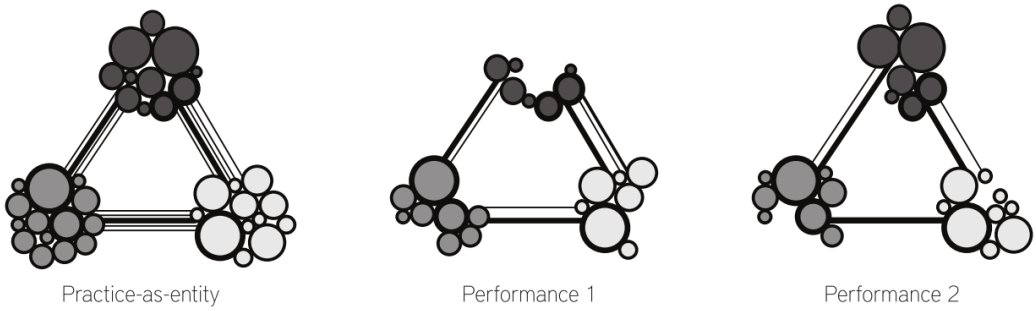

Figure 3 Adapted Practice Model by Kuijer (2014)

Shove et al. (2012) explore elements shared by different practices. Based on the example of driving and repairing they illustrate how masculinity is a shared element of meaning between both practices. While this perspective exemplifies the details of connections a more 'zoomed-out' perspective promises to see a network of practices forming an interconnected nexus (Shove et al., 2012). This perspective is also shared by Nicolini (Nicolini, 2009, 2012), who describes practices a forming rhizome like network structure, that is formed by connected elements, such a computer that is shared by the practice of manufacturing and using computers.

Slightly adapting the model of Shove et al. Kuijer (2014) visualizes variants of practices-as-performances, that built a partial "manifestation" of the practice-as-entity. The practice-as-performance is constituted by a sub-set of elements and therefore links connecting them. Kuijer draws upon the importance of certain links, by increasing their line strength. Strength reflects the importance of a link, whereby it is stronger when the connection is observable within more performances. Similarly, the size of the bubble represents the importance of a certain element (Kuijer, 2014).

Higginson et al. (2015) propose a different layout of the graph since the clustering of elements of the same type implies a certain proximity which does not necessarily exist. In their layout, the type of the element, either material, meaning or competence is given by color instead of position. To further increase the information gain by the means of visualization Higginson et al. suggest drawing the node size, based on its node degree (2015).

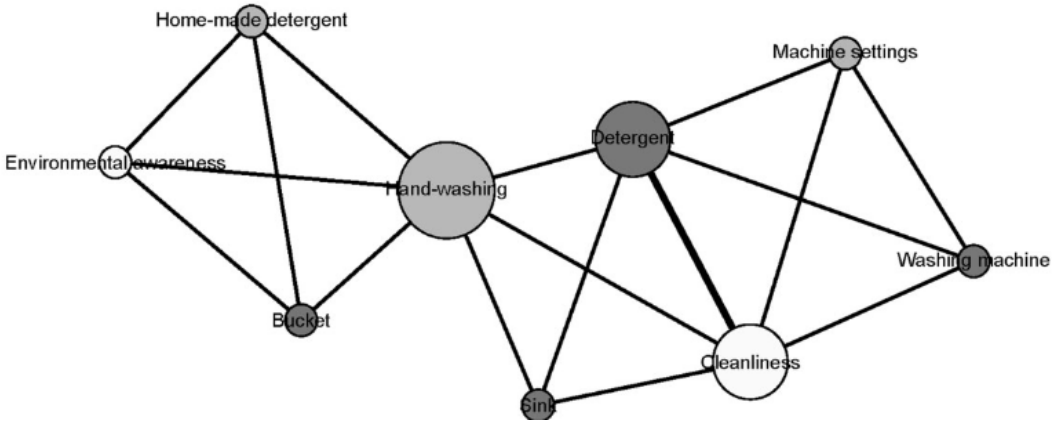

Figure 4 Example of Laundry Practices as a Network (Higginson et al., 2015)

In their first work Higginson et al. (2015) construct a network of a practice to identify central elements shared by the practice of doing laundry. The here investigated perspective very much refers to ‘zooming in’ as described by Nicolini (2009). Still, the comparison of different practices belongs to ‘zooming out’ for her. She ‘metaphorically’ highlights the importance of studying practices in detail, by recognizing the interaction of humans with artefacts, materials, and other humans. From this perspective, the ‘rhizomatic nature’ of practices is quite similar to Shove et al. (Shove et al., 2012). Still, shove goes a step forward in distinguishing between elements that constitute parts of the rhizome and how they have to be connected universally.
In further research on commuting as a practice, Higginson et al. (2016) take up on Shove et al.’s (2012) suggestion to ‘zoom out’, but abandon their theoretically founded ‘universal connection’ phenomenon, that implies that all elements of a practice are equally connected in constituting the nexus. Higginson et. al. (2016) move towards a follow-the-actor approach by chronologically connecting practices, that does not reveal hidden (inter-)connections of the nexus. However, despite these criticisms, their work provides the fundamental considerations to construct a network of practices. Therefore, there work more resembles the ‘zooming out by following intermediaries’ as described by Nicolini (Nicolini, 2009), that implies a stronger spatio-temporal dimension to the antecedents of practices, rather than a universal zooming out on shared elements as Shove et al. suppose (Shove et al., 2012).
In summary, we see how not different scholars attempt to operationalize the theoretical perspective on interconnected practices as network by mainly referring to Shove et al. (2012). Although there are differences in the meanings of what zooming in and out is about, we think that, in addition, to continuing to follow the path of Shove et al. (2012), the work of Nicolini (2009) is valuable to consider for a more nuanced understanding of perspectives.
Based on this inspirational corpus of ideas, our work tries to improve the method, adapt it towards applicability practice-centered computing and trigger design-related discussions.

Constructing a Network of Food Practices

Qualitative Online Survey

To construct a network of FP, we conducted an online-survey, similar to the survey of Higginson et al. (2016). We decided to follow the approach of Higginson et al. (2016) in conducting a survey, as this paper mainly focuses on the operationalization of practices as a network and as the method has shown to be fruitful in their research. Still, especially in the light of ethnographic research (Ganglbauer et al., 2013; Ng et al., 2015; Nicolini, 2009), we believe that it is necessary to consider other, probably more detailed methods in the future. Therefore, we discuss the choice of methods in more detail in the discussion section.

The survey of Higginson et al. (2016) was adapted to be more online and user friendly. We randomly assigned each participant to questions either about planning, procurement, storage, preparation, eating or disposal, which are most commonly used to structure FP (Altarriba Bertran et al., 2018, 2019; Ganglbauer et al., 2013; Ng et al., 2015; Terpstra et al., 2005). The questions encouraged the participants to describe the competences they use, the material context of the practice as well as the meaning of the practice. In total we asked 9 questions per practice, with 3 questions per elements category, either material, meaning or competence. For the example of cooking the questions were: "which tools / aids do you use for cooking?", "which techniques and skills do you use for cooking?" and "which (social, religious or self-defined) rules and norms influence your cooking?".
Our sample of 60 participants (10 per practice) has been recruited through an opportunistic sampling approach within the authors extended social network, to capture a variety of practices. We directly asked practitioners in our social media to participate. The resulting sample is characterized by the following socio-demographic structure:

- Age (18 – 80, Avg. 40, Std. 18.39)
- Gender (37 female and 23 male)
- Education (29 university degree, 5 trade school, 11 apprenticeship, and 15 high-school)
- Housing Situation (18 with a partner, 1 alone with children, 19 alone, 12 partner and children and 10 flat-sharing community)

The qualitative survey data were transcribed and analyzed[1] with Catma[2]. We used the practice-theoretical lens of material, competence, and meaning (Shove et al., 2012; Shove & Pantzar, 2005) to mark the elements for our later network within the given answers. After each iteration of coding, we discussed the current coding template (King et al., 2004) to ensure reliability.

Network Construction

Analogous to the first attempt of Higginson et al. (2015) we treated the occurrence of each element within the coding of the individual survey result as equally important for the constitution of a practice. We followed this perspective as it is grounded on the perspective of Shove et al. (2012). Following the work of Kuijer (2014), we weighted the importance of connections and elements based on their number of occurrences in the complete survey. To further explain our operationalization, we imagine the following example: A single practitioner answers that s/he for cooking uses a pan (material), his/her cooking skills (competence), and follows the meaning of health.

[1] The elements identified in the interviews were translated from German to English. The coding was done by a native speaker based on the German original survey answers.

[2] https://catma.de/

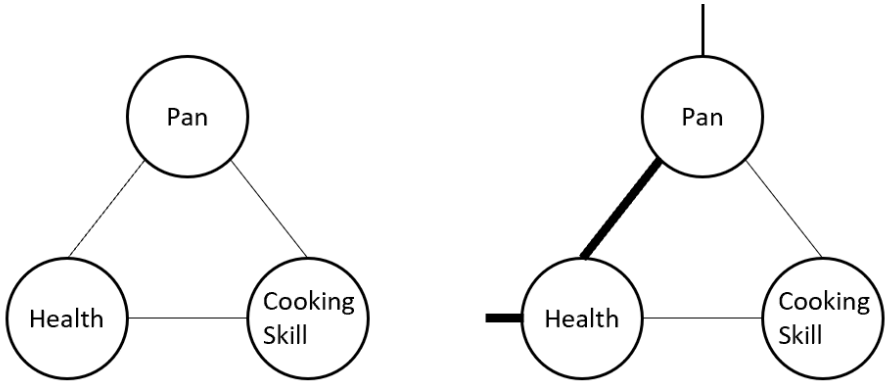

Figure 5 (Left) Example Network for One Practitioner; (Right) Same Example Network for Multiple Practitioners

As Figure 5 (left) shows for this single practitioner all elements are equally connected with no specific weight for the edges. If we now add answers of other practitioners, that among other elements, name the pan and health, the weight is adjusted to highlight the importance of specific connection (see Figure 5 (right)).
Analyzing our survey results, we filled out a matrix (159 elements on the x-axis and the 60 participants on the y-axis) with an one (if an element is mentioned) or a zero (if not). With the help of a Python script, we imported the results in Gephi[3], an open-source graph exploration software. This resulted in a Graph of 159 nodes (89 materials, 41 meanings, and 29 competences) with 2759 edges (weight between 22 and 1).
In line with Higginson et al. (2015) we ranked the size of each node according to its degree and then applied the force atlas 2 layout, to pull highly connected elements into the center of our network and form clusters of highly interwoven elements. However, we choose a different measure of distance, which addresses the original criticism of Higginson et. al. (2015) concerning Kuijers (2014) approach, that the three key elements of practice are resp. not necessarily strongly tied to themselves. While Higginson et. al. (2015) solve this issue by rearranging the network with the help of a force atlas algorithm, we additionally distinguish between the elements by color, according to the respective practice that has been inquired. To distinguish between the key elements, we use ‘M’ to tag meaning, ‘S’ for material and ‘C’ for competence in brackets behind the name, e.g. Food (S).

Food Practices as a Network

Examining networks of practice with a theoretical focal point in mind and visualized by the means of network theory, we will interpret and discuss certain perspectives on the network of FP to define methodological capabilities and raise questions for further research.

[3] https://gephi.org/

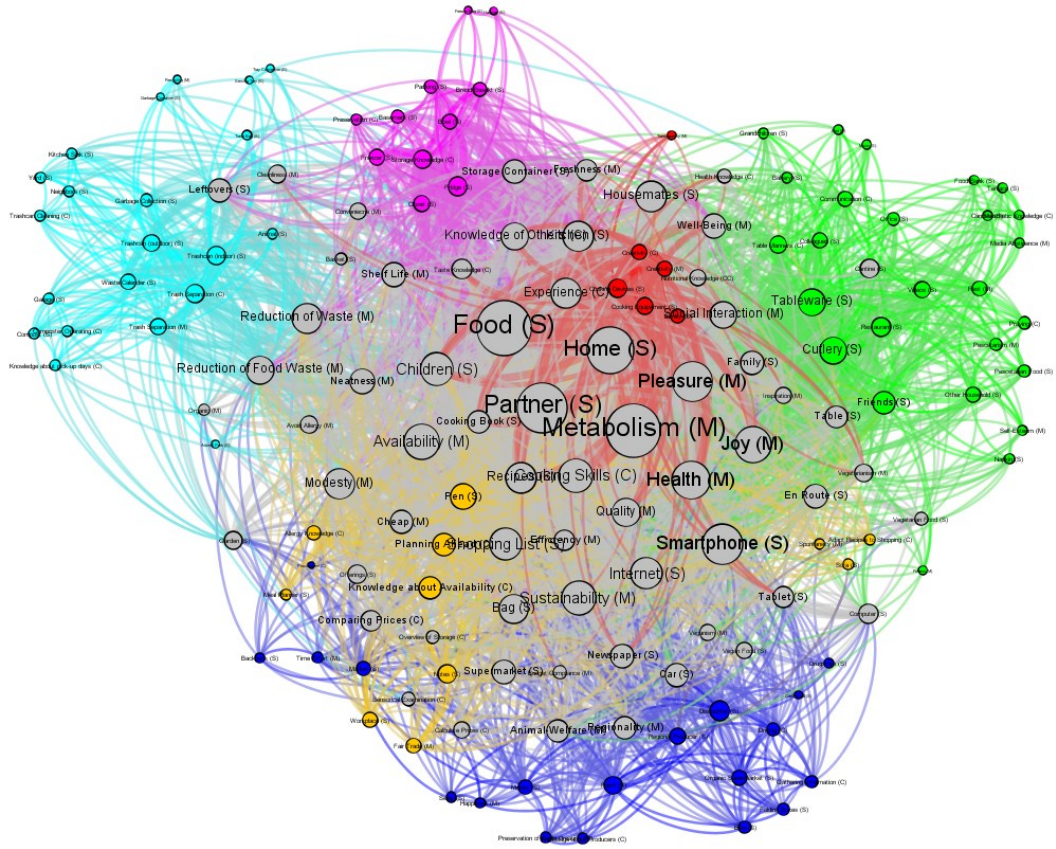

Figure 6 Network of Food Practices (Cyan=Disposal, Purple = Storage, Yellow = Planning, Blue = Procurement, Green = Eating, Red = Cooking, Grey = Multiple Practices)

Zooming Out

When 'zooming out' we are able to first identify the overall arrangement of practices, by analyzing the clusters (practices) separated by their respective color and second the central elements of the overall network. While we mainly follow the perspective of Shove et al. (2012) when zooming-out as means to see the relation of practices, still, this is similar to what Nicolini describes as "Zooming out by following the relationships among practices" (Nicolini, 2009).
In Figure 6the elements are colored according to the practice, that they constitute. When an element constitutes multiple practices, we colored it grey.

Arrangement of Clusters within the Network

When observing the network of practices from a 'zoomed out' perspective, we first see how practices, given by their clusters of elements, are separated and visualized by color as a measure of distance. The practices all include several elements that are colored by their unique given color and therefore are essential to this practice only, while other elements (grey) are constitutive for several practices. With a further look at the overall arrangement of practices within the network, we can see that practices of eating (green), procurement (blue), planning (yellow) and storage (purple) group themselves around the practice of cooking

(red). Besides the red elements of the cooking practice, a cluster of shared elements, strongly connected to cooking, as visualized by the edges, is located in the center. Those elements, such as *Food (S)*, *Partner (S)*, *Metabolism (M)* or *Home (S)* are shared by several practices. These elements are represented with the biggest nodes, based on the frequency of being mentioned. Therefore, they can be seen as central to the overall network of FP. The constitutive elements of the practice of disposal are connected to the practices of planning and storage, but in general not central within the overall network of FP.

Central Elements – Central Clusters

Besides the whole cluster of elements of disposal practice, single elements of other practices are placed in the peripheral area around their respective practice. Higginson et al. (2015) state within their reflection on core and peripheral elements, that "[c]entral elements are defined as 'core' to the practice; those which appear at least once in each variant and are shared by all variants. Marginal elements are 'peripheral'; they are herein defined as those elements which are unique to a single variant. Elements that do not fall into either the 'core' or 'peripheral' groups logically form a third group, which is referred to as 'intermediary'. These elements are shared by some, but not all, variants."(Higginson et al., 2015). At this point we want to extend the corpus of analytical lenses on the network of practice, by defining central and peripheral clusters. We define central clusters as those, being 'core' to a network of practices, resp. those contributing to the overall doing of the practices. Peripheral clusters are similarly not important for the network of observed practices, in a way that the incorporated doing of several (inter-)connected practices might be possible without this specific practice (depicted as a peripheral cluster).
After describing the overall structure of the network and how clusters are arranged, as well as defining the ideas of central and peripheral clusters resp. practices, we now want to have a further look on those central grey elements, having a high node degree. While *Food (S)* as a central element is quite an expected result, as already mentioned by follow-the-actor approaches (Ng et al., 2015; Terpstra et al., 2005), other elements such as *Metabolism (M)*, have not been mentioned in attempts to structure FP. Especially when utilizing the lens of dispersed and integrative practices (Ganglbauer et al., 2013; Warde, 2005) to interpret the importance of the cluster constituted by the central 'meaning'-elements *Metabolism (M)*, *Joy (M)*, *Health (M)* and *Pleasure (M)*, we see the notion of consumption as a dispersed practice. Thereby consumption is not constituted by any competences, at least no competences mentioned by our participants, but the food as the material to be consumed and several meanings that are attributed to the (prospectively) consumed material by the participants.

Zooming In-Between

When zooming in but remaining on a perspective on the whole network of practices, to which we refer as 'zooming in-between', we are able to identify elements that connect practices and therefore function as intermediaries. This

zooming on intermediaries originates from Nicolini (2009) but is used in a more immediate sense rather than overtime in our work.

Elements and their Connections

From a practice-centered computing perspective, the central role of the smartphone is interesting to see (*Figure 6*). To follow the links of the *Smartphone (S)* we colored the smartphone red and its adjacent nodes pink. Other elements are dark grey. This, on the one hand, shows how many direct neighbors the smartphone has, and on the other hand how it is linked to nearly the entire network. The smartphone being centered between the practices of cooking, eating, procuring and planning, shows how digital technologies integrate whole parts of FP, by e.g. allowing to write a shopping list on the smartphone, using it whilst shopping, searching recipes on the smartphone or even using them as a starting point for planning and finally watching videos during mealtime or sharing photos of food with others.

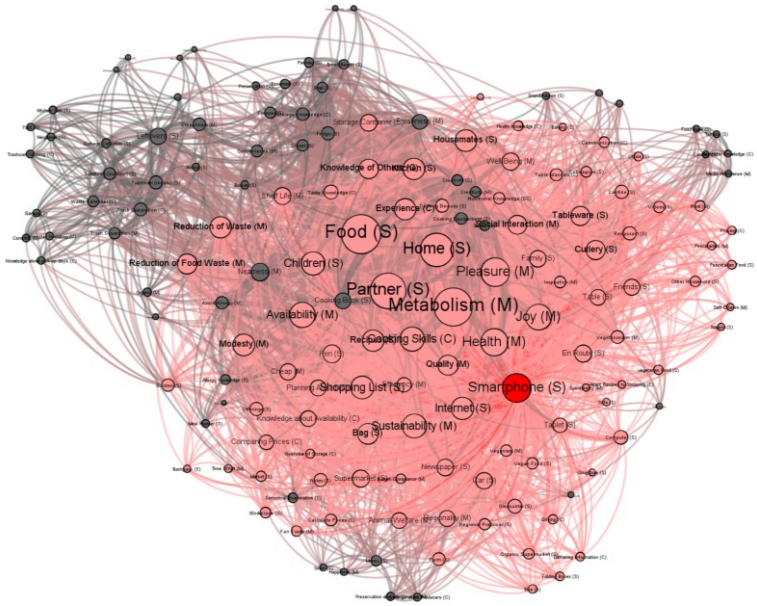

Figure 7 Smartphone Connecting Practices

Apart from that, we see how the smartphone is not central for practices of storage and disposal yet. These practices remain excluded from data exchange, at least from a digitally mediated data exchange, through the use of smartphones.

Practices and their Connection.

When having a look at the overall arrangement of practices, the question of *why disposal is not equally connected to the highly connected cluster of cooking resp. to the rest of the network* arises. To answer this question, we 'zoom in-between'. By doing so we are able to reveal the links between disposal and the other practices in detail. To do so, elements only belonging to disposal are colored in light blue, elements shared with another practice are colored according to the practice (purple = storage; blue = procurement; green = eating; dark grey = multiple practices).

Although disposal practice is in general only loosely connected to the main cluster, its elements are linked to some of the central elements of FP, e.g. the food itself, the kitchen and residents of the household. Those connections are quite expected, due to shared household activities and the food, being the material that is thrown away. Similar to the element *Kitchen (S)*, eating is connected to disposal due to the *Cantina (S)* as a shared location of eating and throwing away food.

Besides those obvious links, is the linkage between two thematic clusters worth having a look at. First the cluster of '(Food) Waste Reduction', constituted by elements such as *Reduction of Waste (M)*, *Reduction of Food Waste (M)*, *Sustainability (M)*, *Modesty (M)* and *Neatness (M*); and second the cluster of 'Unspecific Food Competences', constituted by elements such as *Experience (C)*, *Taste Knowledge (C)* and *Knowledge Taught By Others (C)*. Those links show how disposal is, in the mind of the participants, not meant to be a part of FP, but a practice whose performance has to be minimized. However, the competences, besides *Taste Knowledge (C)*, do not indicate a clear strategy, despite the trust in one's own experience. *Taste Knowledge (C)* as a competence describes the knowledge about one's own as well as flavor and ingredient preferences of others. This seems to be a method of ensuring the procurement and cooking of meals that are not in danger of being thrown away caused by the mismatch of preferences and characteristic flavors. Interestingly participants mentioned other skills belonging to disposal, such as the cleaning of the trash can, the knowledge about the pick-up days and the operation of a composter. While the first two and the meaning of *Cleanness (M)* indicate a strong connection between disposal and other cleanness-related practices, e.g. laundry practice identified by Higginson et al. (Higginson et al., 2015), the operation of the composter indicates a connection to gardening.

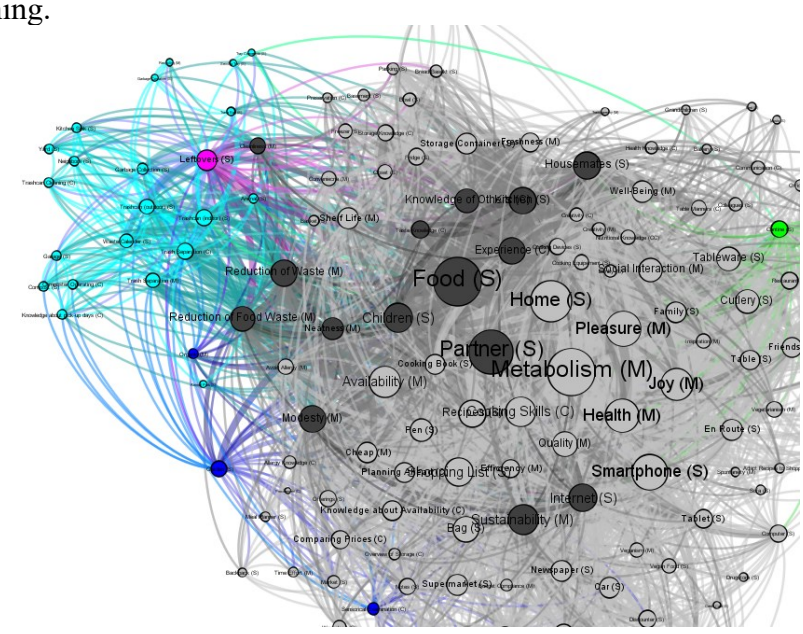

Figure 8 Zooming In-Between Disposal

Having a look at the links towards procurement (blue elements) the connection to gardening becomes more obvious. Especially the meaning of *Organic Food (M)*

as well as the *Garden (S)* as a place to procure food, show how disposal might be connected to the overall cluster in the sense of a lifecycle. However, gardening to grow one's own food is not a common practice (Church et al., 2015). Therefore, this connection is not strongly tying disposal to procurement. Besides *Gardening (C)*, procurement and disposal share the competence of *Sensorial Examination (C)*. Food is examined according to certain sensorial characteristics when being bought, but also when the decision of whether to keep or dispose of food or leftovers. Besides the dark grey elements, *Leftovers (S)* as an element shared with the practice of storing food, has the highest degree (node size). This element indicates the change of perception on the food, so it becomes another material: The food which was previously integer becomes a leftover because it was once prepared and meant for eating or was partly not needed during food preparation.

Zooming In

When 'zooming out' we were able to recognize the central position of the cluster of elements of cooking practice. To further understand its centrality, we should 'zoom in' this cluster of practice itself to have a more detailed look. To observe a specific practice, we have chosen a coloring that fade out elements not belonging to the practice, as well as gradually coloring those elements constituting the practice according to their centrality for the practice itself (see Figure 9). This helps visualizing central elements of the overall network, based on the size of the nodes, as well as the centrality of the elements for the practice itself, based on the gradual coloring. While elements central to the overall cluster, such as *Food (S)*, *Home (S)*, *Metabolism (M)* or *Partner (S)*, are of minor interest here. Nodes, such as *Cooking Skills (C)*, *Recipes (S)* and *Cooking Devices (S)*, as well as *Cooking Equipment (S)* are more interesting. Based on the coloring we can see how *Cooking Skills (C), Cooking Devices (S)* and *Cooking Equipment (S)* (small Nodes above Home) are equally colored, which means, that they are equally central for the practice of cooking, but their node size is different, which means, that they are of different importance to the overall network.
Furthermore 'zooming in' shows how *Cooking Books (S)* and *Recipes (S)*, which are less central to cooking, based on our network, are central to the network of food practices. Examining their connections suggests how the knowledge about cooking, either informal or as a formalized recipe, is used during planning and procurement practices.

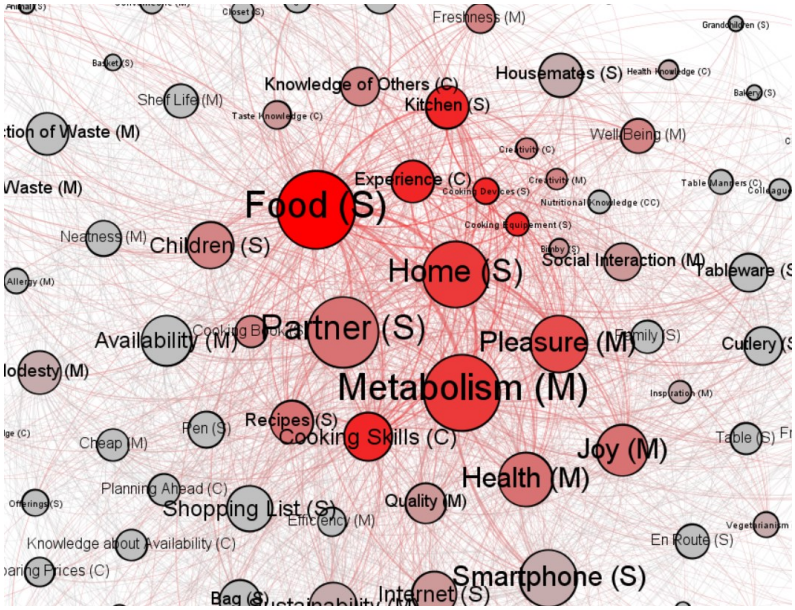

Figure 9 Zooming In Cooking

Discussion & Critical Reflection

Informing Design through Networks of Practices

Our example of FP as a network as well as Higginson et al.'s (2015, 2016) work present the analytical capabilities of the approach to visualize practices using network theory. However, still, there is a need for discussion about how the method enhances our understanding of practices and what kind of implications resp. incentives it provides for design. We argue that networks of practices provide the means to identify opportunities for intervention as well as new methods to evaluate design, both through the visualization of static and dynamic networks of practices.

Identifying Opportunities for Intervention

Our example network indicates two different opportunities for intervention: first, the identification of, what network theory calls 'structural holes' (Burt, 2009; Butts, 2008) and second the identification of elements that are central to the overall network, meaning that they are connected to several other elements and practices.

Regarding *structural holes,* the food network reveals that there is a hole between the practice of procurement and the practice of disposal. While our network already indicates possible connections through *Gardening (C)*, the practice of growing one's own food is not widespread anymore (Church et al., 2015). The identification of such a structural hole might provide opportunities for intervention, e.g. the (re-)introduction of a practice to fill the hole and tie practices together more strongly or implementation of other mechanisms or

technologies to connect the elements of the practices through a, for the lack of a better word, broker-technology. 'Brokerage' (Butts, 2008) indicates the role of a certain node as a connector of different clusters. In our example, such broker-technology might e.g. connect a competence of the procurement practice, such as *Sensorial Examination (C)* to disposal practice, so that food is more commonly examined by the status quo of edibility and not by the narrow definitions of food regulations, e.g. the best-before date. Identifying opportunities for such brokerage might be especially valuable for technology probes (Ganglbauer et al., 2015; Hutchinson et al., 2003). They could act as a means to fill the gaps and explore opportunities for a (re-)connection. While traditionally, probes focused on reflection on and changing of practices, brokerage in this sense offers a new opportunity for restructuring and recombining whole networks of practices.

In order to facilitate digital support for practices, practice-centered computing researchers can find the means to widen the field of investigation in an network-theoretical approach to everyday (food) practices especially by investigating digital artifacts (the smartphone) with regard to connected elements (competences, meanings and other materials), the connections to different practices, its comparable importance to a particular cluster and the overall network, and the relationship of these connections (interconnections). Thereby practice-centered computing research can evaluate how a design intervention can influence other elements, practices resp. their nexuses, and in particular how storage and disposal can be included in the development of integrative systems to support FP.

Regarding *central elements and clusters,* our network shows how central and widespread certain elements are. For example, the *Smartphone (S)* is connected to several practices of the FP network, expected storage and disposal practices. Similarly, *Cooking Skills (C)* (formal or informal), as well as the cooking practice itself, are central to the network. The identification of such elements for intervention is quite alike to what Shove et al. call "points for intervention" (2006). These points might enable change within a network of practices, reaching more than one practice alone, but several connected practices. Within our example, an intervention focusing on the central role of *Cooking Skills (C)* might influence other practices next to cooking practice. Being able to cook healthier might for example lead to more healthy procurement practices. Likewise, the whole cooking practice might bring change to FP as a whole when being influenced by an intervention. However, our work provides no answer on how a change in a central practice effects the nexus of other practices.

A network of practices overcomes the focus on a particular practice (or its central element), towards "an emphasis on the interdependencies, connections and configurations that are central to the constitution, reproduction and transformation of social life"(Blue & Spurling, 2016). In this way, design interventions can be examined for their effects on other practices or their nexuses. Before interventions are initiated, they can be diagrammed in different network graphs representing the distinct nexuses of practices based on different intended interventions. Furthermore, the current stage of interventions, somewhere between proto-practice and practice can be analyzed. By these means, researchers and designers can discuss and evaluate design decisions.

Networks of practices can support practice-centered computing research in the development of design interventions and decisions by giving it access to previously unexposed information, in particular, to illustrate interconnections. We were able to show that a 'zooming in' is possible in the form of representing a practice within a nexus by visualizing both, the relevance of a central element for the practice and the nexus. In the ‘zooming in-between’ the different connections to a central element or a cluster of a practice, in our example, the smartphone or food disposal were presented. Likewise, in ‘zooming out‘ the connection between clusters of practices become investigable. In the study of these different forms of connections, the understanding of the relationship between connections (interconnections) can be extended.
As Kuijer et al.(2013) already suggest, central elements are not a ‘magic bullet’. They bear the danger of making interventions more difficult and complex due to the need for a reconfiguration of other practices as well. In line with their considerations, networks of practices help to identify the interconnectedness of these elements and therefore raises the awareness about how difficult and complex a certain change might be as well as which practices and other elements an intervention should consider, too.

Evaluation through the Dynamics of Practice Networks

Both network theory and SPT are not only interested in static representations but challenge the understanding of dynamics. This is especially interesting to understand how complexes (of practices) change (Shove et al., 2012) and how spatio-temporal patterns arise (Nicolini, 2009). While network evolution supports the approach of Shove et al. in an analogous way, processes might be applicable for observing certain elements or clusters as they move through a network of practices. Processes are comparable to the notion of ‘threading through’ which is a term in an open discussion within the social sciences in order to find a theoretical framework for how “an object or a practice, can move or advance through the nexus of practices, thereby linking the practices through which they pass or to which they are connected”(Hui et al., 2016a). For the practice-centered computing community, these approaches promise to give valuable insights into the course of hardware, technical devices, and other artifacts through daily usage. An exploration and elaboration of such dynamic diagramming of networks of practices is open to future work.
While some short-term interventions allow measuring certain key-values, such as the amount of food discarded (Altarriba et al., 2017; Farr-Wharton et al., 2014, 2012; Ganglbauer et al., 2015) or the amount of organic food purchased (Zapico et al., 2016), sustainable, long term practice change, especially when it is still in a phase of transition, requires other means for evaluation. Networks of practices allow for such evaluation of interventions, concerning the dynamic of social practices (2012). Although our work did not capture two or more different networks of FP in terms of time, that could be compared, the example of the smartphone indicates how appropriation and access of an intervention could be analyzed. Comparing a depiction of a network of food practices, captured before the invention of the smartphone, could reveal how such a widespread technology might have influenced and changed the interconnected FP. Further research could

draw from our results by looking into the influence and change in certain clusters of practices and the rearrangement of connections between certain elements.
However, as we have seen in our example, the smartphone is central, but not reaching disposal and storage practices so far. Comparing our network with another empirically captured network after a smartphone-based intervention, that focuses on storage practice, might help to understand how the practice has changed with respect to its elements and their connections. Additionally, side-effects on other practices and the overall network, as well as barriers for appropriation, can be analyzed. Having such a measure at hand might, therefore, support more sophisticated and integrated evaluations of design.

Gathering Data & Constructing Networks of Practices

Lastly, our work wants to critically reflect on the method of creating a network of practices from different perspectives.

Avoiding the Trap of Oversimplification

Although our research, so far, presents the opportunities of this new approach from quite an optimistic point of view, networks of practices similar to any other modeling of social life may be too condensed. Any trivial representation of a nexus runs the risk of undermining the complexity of elements and their connections if these connections themselves are just another element. Schatzki debates practices cannot be modeled or simulated without jeopardizing the irreducible complexity and dynamism of social affairs (Schatzki, 2012). Shove et al. (2012) already considered the danger of their model falling “prey to the scientific urge to build simplifying, diagrammatic models of social life”(Schatzki, 2002, p. 12). Also, Higginson et. al. bring into the debate, if the approach of diagramming social practices into one graph can fall into the “trap of reducing the insights of SPT so significantly as to undermine their contribution”(2016, p. 16). However, the possibility of that trap should not prevent us from researching new means to make SPT more accessible for empirical research agendas and thereby scaling up its impact on design. Shove et al. (2012) argue similarly, when they state that their approach helps them to gain insights into the conceptualization of stability and change as well as into the recursive relation of practice-as-performance and practice-as-entity. While we have not evaluated our method towards its capabilities to support insights gained in a real-life design case so far, we see from a methodological point of view how a condensed network approach supports the identification of certain characteristics of connected practices.
However, these potential benefits do not liberate us from the awareness of the boundaries and downsides of social practice modeling and the task to critically scrutinizing our own method as well as to improve it in regard to accuracy and precision. Higginson et al. argue that “thinking critically about how one might model practices and experimenting with different approaches is in itself a valuable aim”(2015, p. 3). The very difference in the level of detail between Higginson et al.’s (2016) work and our approach shows how little advanced the discussion about networks of practices is and how much networks of practices

have to be created and analytically used to understand the capabilities and barriers of the method.

Empirically Populating a Practice Network

While our work has adapted the survey of Higginson et al. (2016) such that people not familiar with SPT can answer the respective questions, we have not questioned the procedure in general. This might be less important for our example network due to the methodological contribution of this paper but is a key question for the applicability of network theory in future design-oriented work.

Considering the unequal distribution of material, competences, and meanings, that have been gathered with our survey, the question of how to gather as many nodes and their connection as possible arises. While Higginson et al. (2015, 2016) and our work uses a qualitative survey, that needs interpretation and coding of the results to identify the elements of the network, other SPT based research uses a broad variety of methods, e.g. qualitative interviews (Ganglbauer et al., 2013) or ethnography with a sense cam (Ng et al., 2015) as well as closed-questions quantitative surveys (Warde & Hetherington, 1994). In our view, the use of other empirical methods could also be applicable to networks of practices. However, our work does not provide an answer on which method to use to gather empirical data for the construction of a network of practices. Here, further research should focus on a better match between the collection of data and the visualization. Using a deeper ethnographic inquiry might allow for thicker data sets and elements that remain hidden when directly asking the participants.

However, ethnographic research is time-consuming and often relies on smaller samples, and networks of practices require some kind of quantification by definition (Dorogovtsev & Mendes, 2002), e.g. to determine the edge weights before letting the layout algorithm run. Kuijer (2014) already laid the basis for edge weights depending on the importance of a certain edge resp. the number of occurrence within the sample (Higginson et al., 2015), but we so far do not know how big our samples need to be to identify the weights of the edges. correctly. Furthermore, the occurrence of all performances and their elements as well as their connections is a matter of quantity, if researchers want to prevent ‘anomalies’. One example of such an ‘anomaly’ in our food network is the competence *Allergy Knowledge (C)* which seems to be misplaced. Although the competence could be applied in several food-related practices, such as eating, procurement, and cooking, it is, however, only present in planning practices. This ‘anomaly’ occurs due to our small sample size and the random assignment of the probably only allergy suffering participant to the survey on planning.

Without wanting to take up the old discussion of qualitative and quantitative research (Halkier, 2011; Schrøder, 2012), we still want to raise awareness about certain issues. Networks with a higher degree of detail or a more explorative character might be created by ethnographic methods, while a stronger quantification is needed for more robust networks with more causal significance. Especially when choosing smaller qualitative samples researcher should be aware of outliers and probably other yet unidentified phenomena that are not correctly visualized within such networks.

Analysis – A Matter of Distance

Methodically our approach uses, in contrast to Higginson et al.(2015, 2016) in particular their later work, color to visualize the distance of nodes instead of reducing their connectivity. While they (Higginson et al., 2016) argue that they reduced the connections, since they observed a low tendency to cluster as well as less obvious geometries, our results show that clusters and geometries of the overall network can be visualized, although nodes are highly connected. From our perspective, this difference is based first on the means of visualization and second on a distinction between practice-as-entity and practice-as-performance.

Regarding the *visualization,* our coloring approach shows how practices are forming quite homogenous clusters, although all practices resp. clusters despite disposal are closely tied together. The introduction of the additional layer of color is however not only helping us to identify overall geometries when 'zooming out' but due to the versatility of coloring, we were able to visualize and therefore provide more detailed explanations. A gradual highlighting of nodes and edges, e.g. when 'zooming in or in-between', allows to clearly trace the connections of certain elements or the importance of a particular element for a certain practice and the network of practices as a whole. Therefore, with regard to the discussion about oversimplification, we argue that networks of practices should not simplify reality, but adapt towards the complex social life and therefore provide means that might at first glance be complex as well, but upon further observation are more helpful when researchers want to apply SPT to inform design.

Regarding the *distinction between practice-as-entity and practice-as-performance,* our work indicates that practices-as-performances form clusters, that represent practices-as-entities. From our perspective, the network of Higginson et al. (2015) shows the same tendency to cluster, although they (Higginson et al., 2016) argue that there is a low tendency. Attempting to capture different variants of laundry practice, their (Higginson et al., 2015) network, visualizes different performances of doing laundry. Those performances cluster towards one entity, that then does not allow for differentiation between the different performances. Within our results, the gathered performances of one practice (e.g. cooking) form a practice-as-entity cluster as well. Within this cluster, we are not able to distinguish between the performances or 'variants' of performances as well. Here it might be interesting to see which additional measures of distance, e.g. layer of color, could visualize those categories to allow for an even more detailed 'zoom in'. Generally speaking, we disagree with Higginson et al.'s (2015, 2016) observation that practices do not cluster but argue for more adaption of the method towards a higher level of detail. This means that research on a practice-as-entity level needs distance measures that are less selective than research on a practice-as-performance level within the entity clusters.

Conclusion

Adapting the approach of Higginson et al. (2015, 2016) our work introduces the combination of network theory and SPT to the practice-centered computing

community. Furthermore, we attempted to improve the method to address, what we have identified as downsides in current approaches. Based on the constructed network of FP we identified design opportunities and benefits of an understanding of practices as interconnected networks.
Rather than focusing on practices in isolation our work indicates the chance for interventions by a focus on structural holes and central elements through what we call 'broker-technologies'. Nonetheless, we argue that this focus is not a 'magic bullet', that changes practices towards desired outcomes. However, an understanding of how practices are interconnected might support understanding barriers of intervention as well as barriers of appropriation over time.
While our work contributes to SPT based practice-centered computing research by introducing, adapting and discussing a new research method, we are aware of the still unanswered questions. Limited by a small sample of 60 participants and no application in a real design study, many of our thoughts remain theoretically and more questions arise than have been answered. We especially want to encourage researchers to contribute to the discussion about networks of practices, research methods to empirically gather elements of practices as well as to evaluate its usage in real design studies.
With our work, we intended to create a deeper understanding of the methodological capabilities of network theory applied to SPT and an understanding of practices as a network. This paper offers the potential to inspire designers and researchers to engage and contribute to the discourse about networks of practices.

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Model-Based Systems Engineering (MBSE) as computer-supported approach for cooperative systems development

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Abstract. With rising globalization and a trend towards Cyberphysical systems (CPSs) as well as smart products the demand for cross-company and interdisciplinary collaboration increases. To handle the complexity of these systems and products Model-Based Systems Engineering (MBSE), as an enhanced form of Systems Engineering (SE), has emerged in engineering and is adopted by many companies. While this approach tries to cope with the current complexity trends, it does address the collaborative aspect of product creation only in a small scope. This paper shall address the combination of MBSE and collaboration in engineering to form a computer-supported approach for collaborative systems development.

Intro

Products have become more complex in recent years (Lindow et al., 2011). For coping with the rising complexity, companies establish joint ventures as well as other forms of cooperation and use development approaches for product creation that are more sophisticated, covering modern processes, methods and tools.

As most of the modern products can be seen as 'systems', which in the sense of engineering are defined in (ISO 15288, 2015, p. 9) as a 'combination of interacting elements organized to achieve one or more stated purposes', Model-Based Systems Engineering (MBSE) is one of the approaches that is gaining more attention in recent years. Even though, Systems Engineering (SE) as foundation of MBSE is meant to be ' [...] a transdisciplinary and integrative approach [...]' (INCOSE, 2019), it's current state is not yet as transdisciplinary and integrative as it should be. Huldt and Stenius (2018) for example pointed out that the system engineering tools used for SE tasks do not connect and integrate different domains and thus keep the benefits of MBSE inside the SE domain.

Goal of this paper is taking a closer look at MBSE as a computer-supported approach for collaborative systems development. It shall give a brief overview of MBSE as well as cooperation and collaboration in general and then focus on some current challenges as well as possible solutions for these challenges. These possible solutions shall give some research topics for further investigation.

State of the Art

Model-Based Systems Engineering (MBSE)

Model-Based Systems Engineering (MBSE) has yet no internationally converged definition (Huldt and Stenius, 2018). The most widely used definition is from the International Counsil of Systems Engineering (INCOSE), is one of the largest organizations focusing on systems engineering and has defined MBSE as:

> '[...] the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.' (INCOSE Technical Operations, 2007, p. 15)

This definition covers multiple aspects. The mentioned activities and the consideration of all life cycle phases refers to the SE-part of the term MBSE, which focuses on enabling the realization of a system from stakeholder needs to the final system or solution. While the activities described in the mentioned definition have been done document-based in the conventional SE, the 'Model-Based' aspect of the MBSE definition means to use models as artifacts for these activities. While models have been used in document-based SE for specific

aspects and analysis, MBSE aims to create a holistic model of the overall system that integrates the various models within itself and the various modeling activities, mentioned in the MBSE definition above, into SE (Friedenthal et al., 2012, p. 45). This model-based approach, which is used in some specific domains like software engineering (e.g. Unified Modeling Language (UML) models) and mechanical engineering (e.g. Computer-aided Design (CAD) models) for quite some time, is meant to replace the document-based approach (INCOSE Technical Operations, 2007, p. 15), as it has multiple benefits (INCOSE, 2015, p. 189):

- multiple perspectives on the system model and thus an easier analysis
- improved product quality due to consistency, correctness and completeness evaluation possibilities
- knowledge reuse by using standardized capturing of information
- possible reduction of cycle times due to standardization and reuse
- easier maintenance and synchronization of information compared to document-based approaches.

The holistic model of the overall system is called system model. It '[...] consists of model elements that represent requirements, design, test cases, design rationale, and their interrelationships' (Friedenthal et al., 2012, p. 17). There are different approaches to connect the elements of the system model. Stark and Schulze (2010) pointed out three forms of linking system model elements, presented in figure 1:

1. inter-linkage between system elements
2. inter-linkage through a meta-model
3. inter-linkage of partial system results

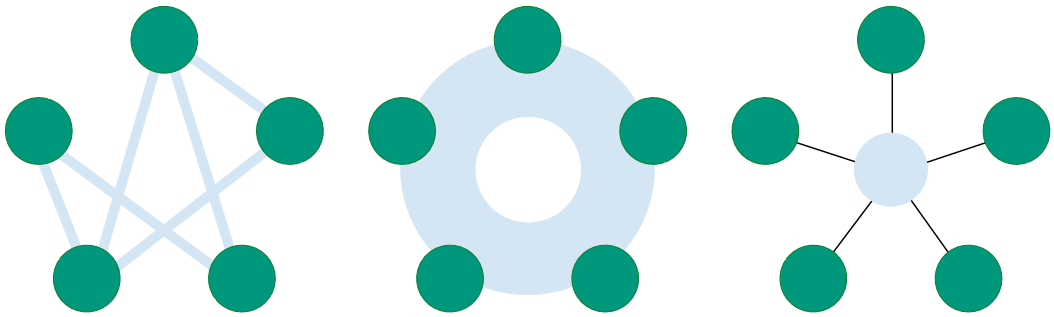

Figure 1. System modeling approaches presented by Stark and Schulze (2010) left to right: inter-linkage between system elements, inter-linkage through a meta-model, inter-linkage of partial system results.

An example for the inter-linkage between system elements is a direct link and exchange between a requirement, a test case for the verification of that requirement and a component inside the product structure that needs to fulfill that requirement.

To allow this link a standardized interface is required. In that way, this approach allows a tool-independent linking and usage.

The inter-linkage through a meta-model is the typical approach of modeling tools like PTC Windchill Modeler, Eclipse Papyrus, IBM Rational Rhapsody or Cappella. They use modeling languages like Systems Modeling Language (SysML) to model various elements and store them in a model repository (Haskins, 2011). These tools create and manage a meta-model in their backbone, which stores the interconnections of these modeled system elements.

The third form presented by Stark and Schulze (2010) focuses on the inter-linkage of results. In that way, the stakeholders can model and simulate all partial system elements independently and the other system elements solely interact with their results. Therefore, key parameters have to be linked dynamically and the results of, e.g. the domain-specific simulations, can be exchanged, without influencing the internal modeling of other system elements and without unwanted exposure of internal knowledge. An example is the Smart Hybrid Prototyping (SHP) approach of Auricht et al. (2012), where they have linked results of the behavior model to the output of a haptic feedback device and to a Digital Mock-Up (DMU), to allow an interaction with a physical prototype.

The mentioned inter-linkage between the model elements can be associated with the term traceability, which has been adapted from the software industry. Traceability is defined in ISO 29110 (2016), which is currently in publication, as description of an '[...] association among two or more logical entities, such as requirements, system elements, verifications [...], or tasks [...]' (ISO 29110, 2016, p. 10). It has been topic in multiple research work, as for example Königs et al. (2012) and Sünnetcioglu et al. (2017). They all deliver feasible approaches to enhance traceability but focus only meta-models and tool integrations for traceability handling. In contrast, Eckl et al. (2015) uses SysML as modeling language for a meta-model but does rely on Open Services for Lifecycle Collaboration (OSLC) as well to allow an inter-linkage of model elements with domain specific models like CAD models through a standard interface. We value the tool-independent approach as more promising, as there already exist approaches for semantic web in other domains, as for example Kim and Chung (2005), Jacobs et al. (2014) as well as Wang et al. (2018). For further research, this tool-independent approach shall be favored.

As MBSE has been defined as '[...] formalized application of modeling [...]' (INCOSE Technical Operations, 2007, p. 15) in the definition above it is neither a process nor a methodology in itself. To give the users of MBSE some kind of guidance for the application of MBSE multiple methodologies have been developed. Methodology means a combination of methods, processes and tools used for that objective (Estefan, 2008). Estefan (2008) list IBM Telelogic Harmony-SE, INCOSE Object-Oriented Systems Engineering Method (OOSEM), IBM Rational Unified Process for Systems Engineering (RUP SE) for Model-Driven Systems Development (MDSD), Vitech MBSE Methodology, JPL State Analysis (SA) and Object-Process Methodology (OPM) as examples of

current methodologies. Roques (2016) additionally presented the Architecture Analysis and Design Integrated Approach (ARCADIA) method with its Domain Specific Modeling Language (DSML). Until today none of these methodologies has emerged as standard in MBSE.

As we want to avoid tool-dependency, a rough overview on the basic activities in MBSE shall be given using the V-model of Fraunhofer IPK and TU Berlin as a possible process approach. It is based on the V-model as used in the VDI 2206 (2004) methodology for mechatronic system development and has been further developed by Beier et al. (2014) on the left side V-model and Buchholz et al. (2018) by forms of prototypes on its right side. Figure 2 depicts the adapted V-model presented by Buchholz et al. (2018).

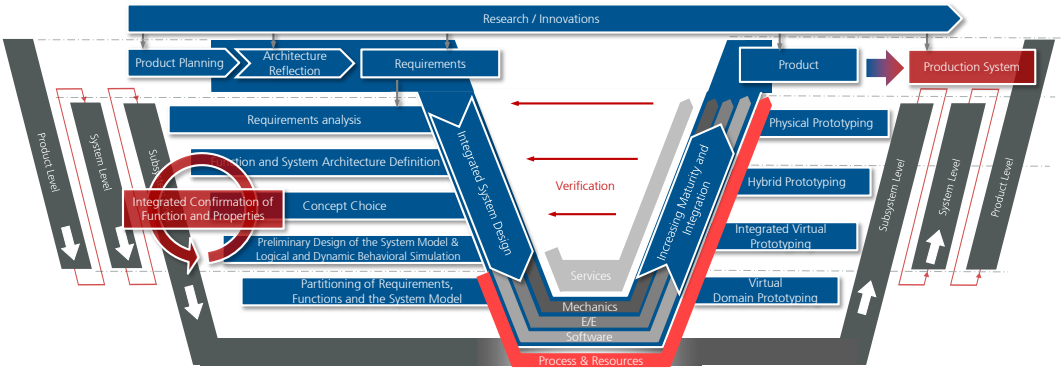

Figure 2. MBSE-process model presented in Buchholz et al. (2018).

The MBSE-process model, presented in figure 2, considers the complete development procedure from product planning as first step to a product with respective production system as output. According to Beier et al. (2014) and Buchholz et al. (2018), the process comprises the following activities:

1. **Product definition:** (*Product level only*) This point includes the first 3 aspects from 'Product Planning' through 'Architecture Reflection' to the 'Requirements'. While most development processes, as for example VDI 2206 (2004), start with the requirements as input, this approach considers them as output of previous tasks.

2. **Requirement Analysis:** (*all levels*) The product requirements defined in the previous phase have to be analyzed and checked for formal correctness and quality. In MBSE this is done with an authoring tool that allows to store the requirements in a formal requirements model and possibly automate this analysis.

3. **Function and System Architecture Definition:** (*all levels*) With the correct requirements, the functional architecture and the system architecture are defined. These are structured combinations of either functions or systems in a decomposed form based on the requirements. An example could be 'store

energy' as a function and 'photovoltaic power station' as a system for an requirement 'the system shall store 20,000kWh of energy generated by an photovoltaic power station'. On lower system levels of the development procedure, the system architecture can include components as well.

4. **Concept Choice:** (*all levels*) In this phase, the system architecture and the functional architecture have to be mapped to each other. As the 'photovoltaic power station' of the previous system example cannot be mapped to the function 'store energy', alternative and additional systems and solutions have to be considered, e.g. 'battery system' and 'hydrogen storage'. These have to be integrated into the system structure, checked for incompatibilities and mapped to the respective functions.

5. **Preliminary Design of the System Model & Logical and Dynamic Behavioral Simulation:** (*all levels*) In this phase, the system model is designed by connecting the functions, components and a related behavior with each other, and then simulated to test the logical and dynamic product, system and subsystem behavior. The key of this step lies on checking if some aspects are missing or have been modeled badly. Additionally, it can be used to examine first rough parameters for the chosen concepts. When the simulations have been executed successfully and delivered the expected results, the procedure is started over from step 2 for the system and for the subsystem levels.

6. **Partitioning of Requirements, Functions and the System Model:** (*Subsystem levels*) When all phases have been gone through for the product, system and subsystem level, a partitioning of requirements, functions and the system model in general is done on the subsystem level as lowest level in this process. Common domains for the partitioning are Mechanics, Electronics and Electrics (E/E) and Software for mechatronic systems, expanded by services as well as process and resources in the shown process, to make this process applicable to the previously presented systems as well. In the domain-specific design, each domain is working on its own solution within given boundary conditions and with the respective interfaces defined by the system model.

7. **Prototyping:** (*various levels*) In the integration phase on the right side of the V-model, various prototypes are created. Each domain designs virtual prototypes as last step of the domain specific design phase. These prototypes are continuously integrated until the interaction can be tested on a physical prototype. In this way, the product can be tested virtually considering all development aspects.

This process is iterative, which means the activities influence each other and are refined in the development process. The users has to chose the form of modeling these activities. It can be used full tool suites like IBM Rational or PTC Windchill

with tools integrated tools e.g. for requirements management (2) and modeling of use cases and system architectures (3) or independent tools for the activities, e.g. Eclipse Papyrus for the architecture definition (3). Same goes for possible modeling languages like SysML, MECHATRONICS UML (Schäfer and Wehrheim, 2010), that tried to already address the mechatronic system design or the language of Systems Modeling & Management Tool (SysMT), in which Königs (2012) tried to address some weaknesses of SysML. This is the foundation for an integrated MBSE approach. Independent of the used tools and modeling languages a overall system model has to be created in one the forms presented by Stark and Schulze (2010). We want to avoid the limitation to a specific modeling language or tool and therefore consider these references as valuable input but do not use one of them exclusively.

A rather new approach of handling systems engineering is the Advanced Systems Engineering (ASE). In addition to the previous aspects of SE and MBSE, ASE '[...] gives human considerations a central place in the integrated design and development of systems throughout their whole life cycle' (Albers and Lohmeyer, 2012, p. 413). This human-centered development is an important topic in today's research and should be considered in further research on this topic.

Collaboration and cooperation in engineering

Cooperation and collaboration are often mixed in terminology, while actually addressing a different depth of working together. Cooperation is '[...] the practice of people (or greater entities) working in common with shared resources and methods, instead of working alone or competitively' (Lu et al., 2007, p. 22). Collaboration '[...] aims at achieving a common goal and collective results that individuals would be incapable of accomplishing alone. In other words, collaboration requires a team of individuals to work on tasks that not only have shared resources (as in coordination) and shared outcomes (as in cooperation), but, most importantly, a shared common goal' (Lu et al., 2007, p. 22). As MBSE is focusing on the realization of one or more successful systems, there is a common goal that cannot be accomplished by an individual and thus highlights the required consideration of the collaboration aspect of MBSE.

Even though MBSE is a transdisciplinary approach for handling the realization of complex systems and INCOSE (2015) states the integration of all disciplines as one mayor point of SE, MBSE does not handle collaboration by definition. INCOSE Technical Operations (2007) even pointed out that

> 'Collaboration support capabilities for pervasive high performance, geographically distributed teams, would complement the integrated process support environment above by providing more empowerment for individual systems engineers and better collaboration support for performing team activities.' (INCOSE Technical Operations, 2007, p. 29)

New approaches like ASE try to address this topic by focusing more on the human (Albers and Lohmeyer, 2012). The computer-supported cooperative work (CSCW) community addressed the problems of cooperative work for a long time. Wang and Tang (2005) focused on collaborative work with computer-aided technologies (CAx) software, mainly for product design. Jia and Zhang (2007) developed a Web Service to integrate control model, mechanical model and hydraulic servo model. More recently, Cyberphysical systems (CPSs) as defined by Tomiyama et al. (2019) have been topic of CSCW research, e.g. in De Carvalho et al. (2018) and Hoffmann et al. (2019). They investigated CPSs as a mean for knowledge and expertise sharing in industry. Wouters et al. (2017a) evaluated their observations concerning a collaborative systems engineering scenario and pointed out five challenges:

1. A shared vocabulary is required. This challenge is based on the observation that the stakeholders have to share their data, which implies an agreed vocabulary.

2. Orchestration has to be provided to manage sequential tasks and inter-dependencies.

3. The Exposition of data has to be controlled meaning that not everything has to be exposed and most stakeholders want to keep their knowledge due to industrial know-how protection.

4. Consistent data is required and constrained by domain rules, which means that the data is heterogeneous due to the various domains.

5. The collaboration is typically part of a network of collaborations and has to be handled as such.

In Wouters et al. (2017b) they addressed the challenge of a shared vocabulary by semantic projection of one stakeholder's data to another stakeholder and thus allowing a common understanding, while each stakeholder may use its own vocabulary. The other challenges, that have been been investigated in their prior work, have not been addressed.

Lu et al. (2007) investigated similar problems in their work and comprised them to three main challenges: shared definition of the problem (common understanding), requirement for a same set of information and the understanding of rules for decision making. They have developed a framework for collaborative engineering based on investigations made in industry. Lu et al. (2007) define collaborative engineering as 'a new sociotechnical engineering discipline, which facilitates the communal establishment of technical agreements among a team of interdisciplinary stakeholders, who work jointly toward a common goal with limited resources or conflicting interests.' (Lu et al., 2007, p. 27). In their work, they designed a collaborative engineering process consisting of four phases that have to be addressed for an appropriate collaboration. Figure 3 depicts these four phases.

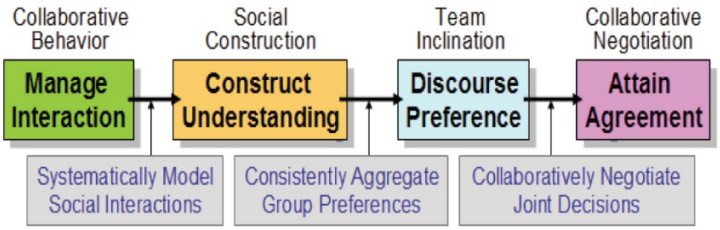

Figure 3. Engineering collaboration process by (Lu et al., 2007, p. 31).

The first phase presented in figure 3 is the management of social interactions. This includes the definition of stakeholders, goals, resources and workflows. The second phase is the construction of a common understanding. Herein, the goal understanding has to be synchronized for all stakeholders. Thirdly, a group preference has to be established instead of multiple individual stakeholder preferences. In the last phase, the team agreement has to be attained, which involves relevant negotiation activities (Lu et al., 2007, pp. 31ff.).

Stark and Stöckert (2009) have investigated another research approach in collaborative engineering. They examined errors created through virtual product creation (VPC), which denominates the usage of CAx for product development as computer-supported design activities (Albers and Lohmeyer, 2012). In the process of investigating errors, they defined interfaces in VPC that can be seen in figure 4, and discussed virtual collaborative engineering, also known as frontloading. As root causes for errors on the interfaces depicted in figure 4 Stark and Stöckert (2009) pointed out four issues:

- Domain-specific issues
- Technical issues
- Organizational issues
- Behavioral issues

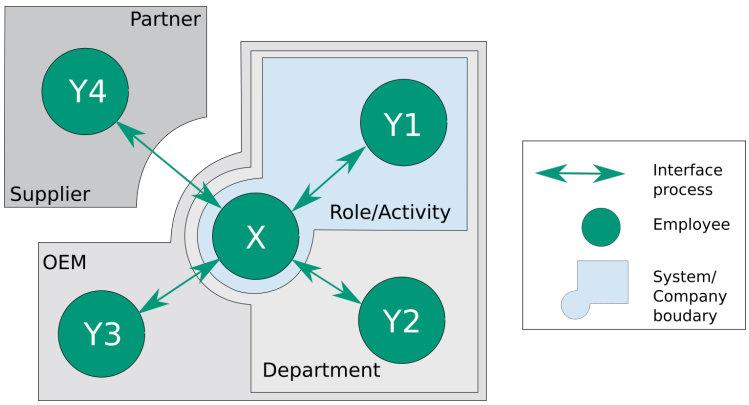

Figure 4. Interfaces of collaboration presented by Stark and Stöckert (2009).

The domain-specific issues mainly focus on the kind of project that can be defined for example by project size and depth of subcontracting. The technical issues refer to IT-problems and organizational issues for example on the processes. Behavioral issues refer for example to role and motivation conflicts.

Considerations for collaboration in MBSE

Based on the state of the art, multiple challenges for collaboration in general and in SE in particular could be identified. Table I gives an overview of the identified challenges and adds the reference that mentioned these challenge.

		1	2	3
C1	shared language/vocabulary	•	•	•
C2	management of interactions	•	•	
C3	exposition of data	•		•
C4	consistency of data	•	•	
C5	large collaboration networks	•		•
C6	system compatibility			•

Table I. Overview of identified challenges with • highlighting the sources of the challenge. References: 1 - Wouters et al. (2017a), 2 - Lu et al. (2007) and 3 - Stark and Stöckert (2009).

What can be seen in table I is that most challenges have been addressed by multiple researchers. As the column '1' referencing Wouters et al. (2017b) is explicitly focusing on MBSE the further references on the same challenge show that this seems to be a common challenge in collaboration and not only due to MBSE. In the following sections, these challenges shall be addressed with regard to MBSE and possible solutions shall be pointed out. It shall be mentioned that all considerations are meant as starting points for research approaches and have to be refined and tested in further research.

Used example

To depict the challenges in a demonstrative way the development of a Mars rover shall be used. As a Mars rover is a complex product in whose development multiple domains have to be integrated, this an appropriate example for the application of MBSE in a collaborative environment. The prostep ivip e.V. developed a SysML-model for the purpose of Cross-Discipline Lifecycle Collaboration (CDLC) (prostep ivip e.V., 2019), which is licensed under Apache license version 2.0 and therefore perfectly suitable for the current purpose. It is currently still under development by prostep ivip e.V. and thus neither fully translated nor complete.

Considering the process illustrated in figure 2 the product has to be defined in the first step. This can be compared to the second phase of collaborative engineering

process of Lu et al. (2007), labeled as 'construction of a common understanding' in figure 3. The SysML-model of prostep ivip e.V. uses a block definition diagram (bdd) as context diagram for this step, which can exemplary be seen in figure 5.

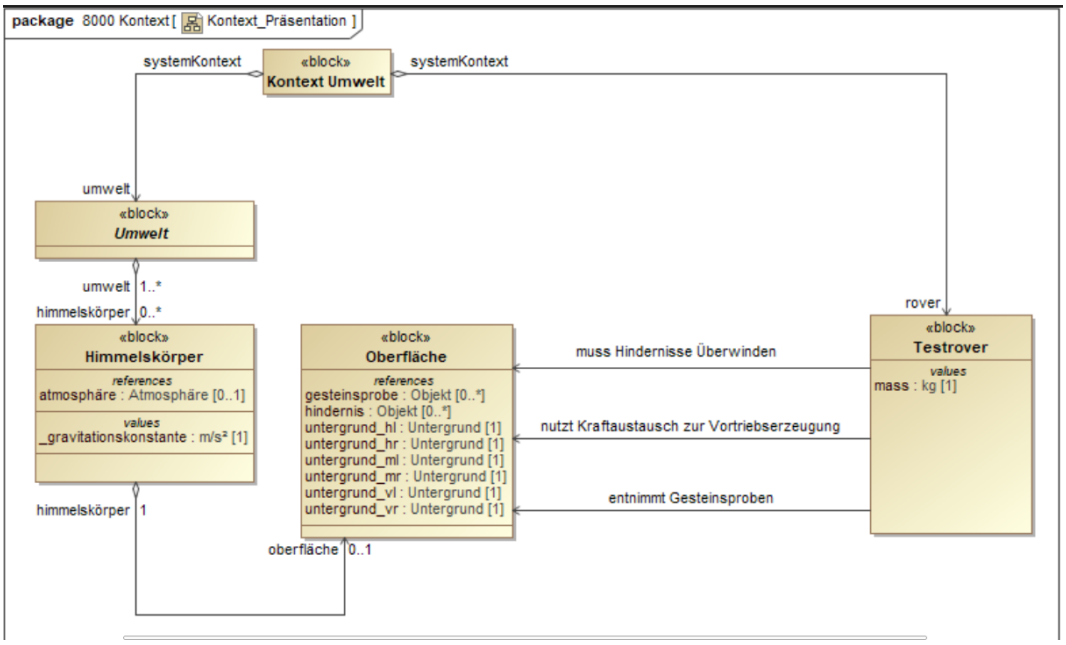

Figure 5. Mars rover Context Diagram.

This figure depicts the context in which the Mars rover shall be used in his operational time. It shows different objects it has to interact with as well as possible interaction with one of these.

In this figure, the first challenge **(C1)** is addressed in two ways: SysML as a graphical modeling language in MBSE can be used as a shared language between the various domains. The usage of models in this phase additionally supports the consistency of data **(C4)**. However, SysML as well as other graphical modeling languages in that area still have some lack in understandability. This is at first the graphical modeling language itself that has to be learned by the involved stakeholders and the written language in form of vocabulary, which is used inside the various blocks. As mentioned earlier, the SysML-example of prostep ivip e.V. is currently developed in German and might not be understood by foreign stakeholders. This can be especially challenging considering a large collaboration network **(C5)**. Here, the usage of different terms for the same element or the usage of the same term for different elements might be problematic, considering different language and domain languages. Wouters et al. (2017b) tried to handle this problem by semantic transfer of modeled information.

To manage the network of collaborations, a stakeholder overview can be modeled as well. This is presented for the SysML-model of the Mars rover in figure 6.

The shown diagram brakes down all stakeholders as actors from single roles to complete departments. When interconnected with further artifacts, the stakeholder

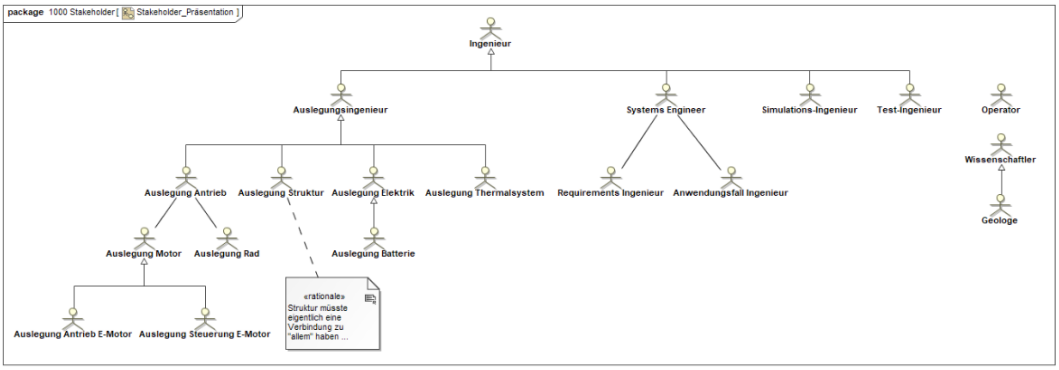

Figure 6. Mars rover Stakeholder overview as block definition diagram (bdd).

management (**C2** as well as **C5**) can be supported by MBSE and system model elements.

When going further in the process of figure 2, in the subsystem level and at the bottom of the 'V' the different stakeholders model their specific elements of the system which are required to build the complete product. This can be any models used in model-based engineering, may it be models of the control unit of the rover, SysML models of the subsystem architecture or CAD models of its physical parts. With respect to the large collaboration network of **C5** with every stakeholder in the collaboration using its own systems and its own internal knowledge, the exposition of data **(C3)** and the system compatibility **(C6)** become crucial factors. Eckl et al. (2015) have already addressed the system compatibility as they mentioned standard interfaces like OSLC for the exchange of information. This enables additional CSCW practices as for example the usage of web service and thus supports collaborative system development. The exposition of data **(C3)** can be controlled by combining the system modeling approaches of Stark and Schulze (2010) presented in figure 1. When the system elements relevant for intellectual property are linked only via their results (third form), only the relevant elements would be shared. This can be combined with the currently as ISO 10303-243 developed standard for Modelling and Simulation information in a collaborative Systems Engineering Context (MoSSEC) which can be found in more detail in Murton and Pollari. In such way, all relevant data can be shared without exposing confidential intellectual property. This is equal to delivering a component of the Mars rover with an appropriate user manual that list boundary conditions of usage but does not expose the inner functionality of the component.

The right side of the V-Model process for the development of the Mars rover faces the same issues as presented on the left and bottom part of the process.

In total, the six challenges of table I could be confirmed as well potentially solved on the example of the Mars rover model. In the following, they shall be summed up.

(C1) Shared language/vocabulary: The first challenge has been tackled in the Mars rover example by using a common graphical modeling language for the data exchange. By using this graphical modeling language, there occur the new problems of learning the modeling language as well as understanding the used vocabulary in sense of foreign language. This is confirmed by Königs (2012), who pointed out, that a broad knowledge of the language is necessary but has for example not been available to many employees in the automotive industry. Domain- and company-dependent vocabulary might be challenging as well. Königs (2012) for example mentioned that the high modifiability of UML and SysML leaves much room for interpretation and thus it might be even more difficult to understand the meaning of the diagrams. Transferring this to different languages and models it is hard, to reach a fully shared vocabulary. One approach has be provided by Wouters et al. (2017b) as they transformed the semantic information from one domain to another. Additionally, there exists much research on ontology, which could be used to reach this semantic consistency. For further reference, see Robinson and Bannon, Aslan et al. (2011) or Graves (2012).

(C2) Management of interactions: The orchestration is handled in the Mars rover example with a stakeholder diagram in SysML. It breaks down the different stakeholders and has to be interconnected to role and workflow concepts of other tools to regulate the interaction management defined by Lu et al. (2007) and Wouters et al. (2017b).

(C3) Exposition of data: This challenge becomes crucial when the stakeholders begin to include their knowledge into the system development, which is mainly the case in the subsystem and domain level. Apart from the method of transferring a reduced model to collaboration partner, which breaks with the philosophy of a system model as Single Source of Truth (SSoT), the modeling of the system model can be handled in the third form of Stark and Schulze (2010) by linking the results of the system elements. In that way, the intellectual property can be kept and the system model stays consistent. ISO 1030-243 will bring additional approaches by giving a standard for exchanging collaboration data with these models (Murton and Pollari).

(C4) Consistency of data: the system model as SSoT directly addresses the consistency of data. Research on and industrial implementations of new traceability approaches allow even better suspecting of inconsistencies and changes. While most of the time, the software solutions for the modeling with graphical modeling languages like IBM Rhapsody have their own tool-set for traceability integrated, there is some work on semantic web technologies, for example Wang et al. (2018), who addressed change propagation analysis making use of Web Ontology Language (OWL). This allows even more collaborative approaches, as the stakeholders are not bound to use the specific tools.

(C5) Large collaboration networks: The large collaboration networks mainly influence all other challenges, because the network multiplies the challenges of a single collaboration with the additional collaborations of the network. This challenge might not be addressed on its own, but shows that the solving of one of these challenges may influence further collaborations positively.

(C6) System compatibility: The system compatibility is an essential aspect in the subsystem and domain-specific phases. But even in the top-level phases it might not be possible for everyone to use the same tool to actively model into the system model. Standard formats (e.g. Requirements Interchange Format (ReqIF) for requirements) and standard interfaces (e.g. OSLC) are required to allow the participation of all stakeholders and are currently supported by a rising number of tool vendors.

Possible approach for handling current problems in collaborative MBSE

In this section, the challenges shall be fully addressed in one conceptual approach, which can be used for further investigation.

At first, a stakeholder overview is modeled in any desired modeling language. This stakeholder overview is used to design workflows and manage access rights of the various stakeholders. It shall be stored in a model repository, which is accessible for all stakeholders, such that they can view the defined interaction rules and can request or suggests changes easily through the model. To avoid incorrect modifications, the model should be made read-only to most roles in the collaboration network changes should be requested through a change management or issue tracking system. Only the interactions of the stakeholders inside the main collaboration should be managed inside this overview. Further collaborations of a collaboration network should be kept internal to not expose data that is not required for the collaboration. (C2, C3, C4 and C5)

In this model repository, a data model for ontology as well as the top-level requirements, functions and architecture elements should be stored, so that every participant of the collaboration can link the partial system elements to them. In that way, the shared system model takes a central role and can be send to communicate and manage all relevant information for a collaborative system development. The ontology data model for example can be extended with own definitions of all stakeholders such that the available definitions can be used, to translate domain- or company-dependent terms automatically. Wouters et al. (2017b) approach might be usable based on the input of this data model and thus support the shared vocabulary (C1 and C4).

When modeling further in the development processes the artifacts should be included into the system model, which does not imply the usage of a meta-model but the linkage with an approach of Stark and Schulze (2010) presented in figure 1. The systems architecture as well as functional architecture may be modeled with SysMT and further artifacts, e.g. the behavior of a systems element, modeled in

some other tool like MATLAB and only the results are then linked via OSLC. This approach supports the consistency of the system model while enabling a great system compatibility as well as avoiding an exposure of intellectual property (C3, C4 and C6).

SysMT of Königs (2012) is mentioned here instead of SysML due to its capability to display thumbnails with additional information as representations of the various elements. In the currently developed SysML v2 3D representations shall be included as well (Weilkiens, 2019), which will support the comprehensibility for all stakeholders drastically. This should be an important factor when choosing a modeling language, as 2D and 3D visual representations are most of the time more self-explanatory than blocks with text as used in most modeling languages, and thus support the common understanding (C1).

In general, as further system elements are created they should be added to the system model, by linking them to their relevant system elements. OSLC might be a good approach, as multiple tools, like IBM Rational or PTC Windchill already adapt to this standard. When this standard is used not just to link the tool suits directly to each other, but to link the artifacts to a system model with the approaches of Stark and Schulze (2010), the model can be used as consistent system data container comprising all relevant information for the development of the system of interest (C4 and C6). Figure 7 depicts this integration of all modeling parts in the system model via OSLC links.

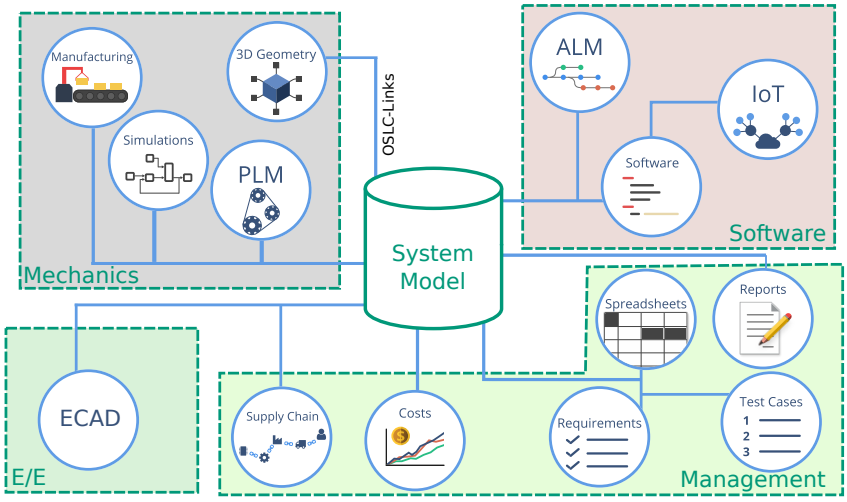

Figure 7. OSLC usage for MBSE adapted from OASIS (2019).

The depicted system model in the middle of figure 7 has not to be a meta-model, but may be any form presented by Stark and Schulze (2010) and shown in figure 1. The model elements of the different data sources around the system model, that are exemplary linked via OSLC-links to it, are connected to other system elements of the system model and thus include themselves inside of the overall system model. The linked data can then be used in any required form, e.g. as input for calculations and simulations or requirement refinement, which enables

current CSCW techniques as web services and Human-Computer-Interaction (HCI). To visualize this information in the best way, the combination of 3D objects and the accessible system information shall be investigated for feasibility in upcoming research.

With this MBSE-based approach a collaborative system development can be supported and enable further CSCW potentials. The system model itself can be seen as computer-supported means as well, as it requires computer-technology for proper functionality in this scenario. Thus, this approach can be seen as a computer-supported approach for collaborative systems development.

Conclusion and Outlook

The paper was intended to investigate collaboration in engineering and the potentials of MBSE as a computer-supported approach for collaborative systems development. To address this topic at a collaboration community like the European Conference on Computer-Supported Cooperative Work (ECSCW), an overview about MBSE as a transdisciplinary approach to develop complex systems in general has been presented followed by the state of the art for collaboration in cooperation in both MBSE and CSCW research.

The insights of the state of the art have been used to point out general challenges in collaboration for systems development. These challenges have been projected onto the example of a Mars rover's development.

Based on that, a development approach has been presented, that uses insights of the state of the art to address these challenges. The key element of the concept is the usage of the system model as central element of the systems development and the combination of the three approaches of system modeling presented by Stark and Schulze (2010) and shown in figure 1. With this MBSE-based approach, collaborative system development can be supported and the application of CSCW techniques can be enabled. Thus, it can be seen as computer-supported approach for collaborative system development.

In further research, this approach shall be prototypical implemented as well as tested and analyzed based on the mentioned challenges by combining the various approaches of system modeling and interconnecting different system infrastructures. 3D visualization shall be investigated in its applicability as well, as it is seen as a mean for better communication.

Acknowledgments

The authors want to acknowledge prostep ivip for licensing their Mars rover model under Apache license version 2 and thus allowing research to improve and use it properly.

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Conversational Crowdsourcing for Older Adults: a Wikipedia Chatbot Concept

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Abstract. Based on our research on the Wikipedia interface and crowdsourcing with older adults, we propose a conversational interface to streamline Wikipedia editing, engage new contributors and increase their well-being. The use of a conversational interface may mitigate the problem of a steep learning curve for new contributors to encourage more people to contribute to Wikipedia, and thus, little by little, make it more accurate, consistent and democratic. This solution can also negotiate some of the barriers apparent in older adults' interaction with the Wikipedia interface. To achieve these goals, we conceptualized a friendly chatbot called "Gizmo" which inverts the human-chatbot interaction paradigm by making the user be the one to aid the chatbot. In doing so, we explored some of the requirements and challenges associated with the design of a conversational interface to enable Wiki contributions. These include the choice of the appropriate task to crowdsource, in our case the infobox translation verification, the initiation of the conversation as well as the motivational component with key disaffection indicators. At the same time, we discuss some opportunities within the domain of CSCW related to the design and applications of novel conversational crowdsourcing interfaces.

Introduction

Demographic trends show a constant increase in the share of older adults in the western world, and the long term 2015 EUROPOP projection predicts this pattern will continue. Thus, it is increasingly important to encourage more older adults to remain active, both mentally and physically to foster their well-being, as in Morrow-Howell et al. (2003), and at the same time to contribute to the society and feel needed, even while staying at home, for example through engaging with crowdsourcing platforms. Crowdsourcing projects may benefit from older adults' experience, including their native language proficiency, as shown in Skorupska et al. (2018). Another such opportunity is engaging with Wikipedia, which is the largest crowdsourcing project, averaging 591 new English articles per day, with, according to data from Wikipedia.org (2020), over 39 million registered users on the English site. While all of these users have the technical possibility to contribute only a minority of them do so regularly, and those, as proven by Lee and Seo (2016), set the tone and focus of the content.

This is due to multiple reasons, including the complexity of the process, accessibility issues and motivation. As shown in our previous research by Nielek et al. (2017) on editing Wikipedia with older adults, these barriers are especially prominent for them, as they may have lower ICT skills and do not enjoy regular crowdsourcing tasks, as visible in a study by Brewer et al. (2016). Moreover, some older adults lack confidence in their ability to contribute valuable knowledge and insights in technology-mediated contexts as shown in Kopeć et al. (2018), which may also be amplified by a rich set of Wikipedia community guidelines[1] and senior editors who sometimes may stop new editors from becoming regulars, as noticed by Halfaker et al. (2013). To overcome these challenges we propose a chatbot for crowdsourcing Wikipedia edits, that would negotiate the editing complexity for the user, break the editing tasks into smaller chunks which are more likely to be accepted, and encourage a stream of new contributors thanks to inhabiting IM platforms.

Khan and Das (2018) defined chatbots as computer programs that "process natural-language input from a user and generate smart and relative responses that are then sent back to the users", thus, there is a focus on assisting the users. The proposed chatbot inverts the human-chatbot interaction paradigm, by being the one to gather information from the users. Our chatbot seeks assistance from the users, and acts as an intermediary for crowdsourcing Wikipedia contributions. Its dialogue structure hides the steps of content creation behind a simple conversational interface for new editors - one that can be accessed with many devices, such as a smartphone, a Smart TV or even a smart speaker via voice interaction, which is a promising venue as shown in research by Kowalski et al.

[1] New editors are encouraged to read pages such as: https://en.wikipedia.org/wiki/Wikipedia:Guidance_for_younger_editors (accessed on 28.01.2020, revision ID=937682704) or https://en.wikipedia.org/wiki/Wikipedia:A_primer_for_newcomers (accessed on 28.01.2020, revision ID=933431927) which may discourage potential contributors, especially if they are technology-shy.

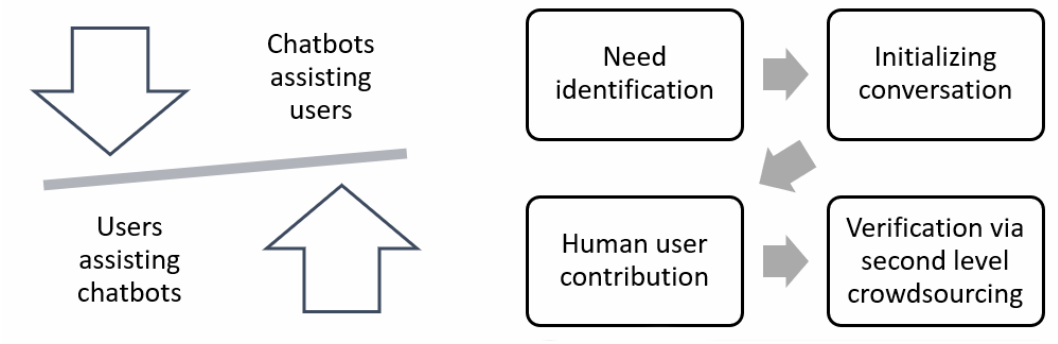

Figure 1. Inversion of the human-chatbot interaction paradigm and proposed chatbot-streamlined contribution process.

(2019). This implementation follows the logic on how chatbots are used to ease interaction with computers by shifting the weight of cognitive work of performing tasks from users to conversational agents. Morrissey and Kirakowski (2013) identify two main strategies that aid in this application, i.e "naturalness of interaction and sharing knowledge space". Hereby, it is easy to conceptualize that chatbots may also negotiate many circumstances in which it is necessary to learn artificial conventions, including crowdsourcing. The chatbot also embraces the idea of Chatbots for Social Good explored by Følstad et al. (2018). They point to the need to make various services more accessible via chatbots for the benefit of the users, such as increasing their opportunities for education, autonomy as well as their feelings of social relatedness. But in our case the user also gives back to the society by assisting in incrementally raising the quality of Wikipedia entries.

So, the aim of our chatbot is twofold: it explores the potential of employing a conversational interface for crowdsourcing with the use of micro-tasks, and in particular, it makes Wikipedia editing more accessible to everyone, but especially to older adults who, in general, do well with text and voice-driven interaction, and who may benefit from engaging in online volunteering, especially based on their inherent knowledge and skills.

Related work

Wikipedia and crowdsourcing

Apart from Wikipedia's status as a massive crowdsourcing effort in itself, there are also some indirect ways its content can be edited via separate crowdsourcing projects. For example, workers can help to validate the credibility of editors. Suzuki and Nakamura (2016) developed a system of rating contributors based on their historical edits in which vandalism can be predicted based on a database of labeled pairs of sentences. Another type of micro-tasks on Wikipedia is related to

verification of information. Redi et al. (2019) described the problem of missing citations and references in articles and had workers check or add requests for references assigned to sentences or articles. With the help of DBpedia, a queryable linked dataset based on Wikipedia, preparing such micro-tasks can be even easier.

There are few studies with older adults and Wikipedia and the existing ones, for example by Nielek et al. (2017), show problems with the accessibility of the interface including the colors, coherence and feedback. Such problems were also identified by Vora et al. (2010) who conducted a qualitative study with first-time editors. Additionally, Wikipedia is suffering from a decline in new editors, not only because senior editors discourage them, as noticed by Halfaker et al. (2013), but also a myriad of other interaction-driven problems, including two large categories related to confusing policies (overwhelming amount to read before one can start with no help) and technical difficulties (poor visual editor, having to use markup, lack of automation), as noticed by the Wiki community themselves. [2]

In this light, a chatbot seems like a perfect intermediary for editing Wikipedia, and solving some of its problems, which can be translated into micro-tasks and done without prior knowledge, especially for older adults, who often appreciate the ease and the social aspect of conversational interaction, as explored in Atay et al. (2016) and voice interaction, as in Kowalski et al. (2019)

Older adults

Volunteering is linked to improved physical and mental health, as shown by Lum and Lightfoot (2005), as well as well-being, which was explored by Morrow-Howell et al. (2003) and Greenfield and Marks (2004) with older adults. But for older adults to benefit from crowdsourcing tasks, some barriers to their participation need to be overcome, and these include lack of or lower ICT skills, lack of motivation due to unclear personal benefit or unsocial and repetitive nature of the tasks, as on Mechanical Turk study by Brewer et al. (2016). To encourage older adults to contribute Japanese researchers created a platform for proofreading scanned books as described by Itoko et al. (2014) and Kobayashi et al. (2013). They also researched different ways of motivating older adults to engage with it in a following study by Kobayashi et al. (2015). But the motivation of older adults is usually studied in context of physical exercises as in Schutzer and Graves (2004), or as in a study by Navarro et al. (2007), learning as in Kim and Merriam (2004) or work by Kanfer et al. (2013). Most of these works refer to the classic types of motivations, such as intrinsic and extrinsic, so ideas need to be adapted for chatbots. As for crowdsourcing tasks, researchers in Singapore, namely Yu et al. (2016), created a mobile application where older adults could tag historical photos. In general, older adults are willing to complete crowdsourcing tasks when the

[2] A full community analysis of this still relevant problem can be found here: https://en.wikipedia.org/wiki/Wikipedia:Why_is_Wikipedia_losing_contributors_-_Thinking_about_remedies (accessed on: 01.02.2020, revision ID=888559458). Similar issues are also touched upon in an MIT technology review article here: https://www.technologyreview.com/2013/10/22/175674/the-decline-of-wikipedia/.

system is more engaging and interaction more familiar to them, as shown in Skorupska et al. (2018). To address the lack of ICT-skills Hiyama et al. (2013) tested a question-based passive interaction model for gathering knowledge from seniors, which also inspired the design of our chatbot.

Chatbot design

Brandtzaeg and Følstad (2017) concluded that unlike other devices and software, chatbots ought to be created as "tools, toys and friends" at the same time. The friendship arc is explored in two scenarios by Lee et al. (2019) where people cared for, or were supported by, Vincent to increase their self-compassion in a study that may indicate human-chatbot relationships have the potential to affect users' well-being. Fichter and Wisniewski (2017) point out that two key aspects of chatbots are using friendly language, and the ability to handle failures in "an endearing manner" and increasing their acceptance by lowering expectations as in Broadbent et al. (2009). To aid in this Reshmi and Balakrishnan (2016) proposed an inquisitive chatbot "aware" of missing information and able to retrieve it by asking follow-up questions. Further repair strategies are explored by Ashktorab et al. (2019), who point out that misunderstandings ought to be acknowledged, repaired with user understanding and control, as well as adaptive to individual preferences. In their research Richards et al. (2016) explored ways to feed chatbots knowledge and noticed that the user satisfaction level is "proportional to the amount of fact knowledge" of the chatbot, which is likely connected to their efficiency within the domain in which they operate. To ease this process, Kobayashi et al. (2015) proposed an efficient way to extract question and response pairs from online forums to supplement chatbot knowledge. On top of this Morrissey and Kirakowski (2013) postulated four dimensions for evaluating the quality of conversations with chatbots: conscientiousness, originality, manners and thoroughness. Furthermore, Clark et al. (2019) identify key elements of a successful conversation to form design recommendations for chatbots which (or who) can move beyond task-oriented agents, even into the realm of being seen as community members, as postulated by Seering et al. (2019).

Still, the main challenge with human-computer interaction via text or voice conversational interface is natural communication. Moore et al. (2017) deems it necessary to overcome this challenge to increase user well-being and adoption of chatbots in everyday life. One thing that can help with that is the presence of response delays, which as Gnewuch et al. (2018) show ought to be dynamic (often created unnecessarily) to positively affect users' perception. Users then feel that other humans generate the responses. Also the visual aspects can change the perception of the conversation - a study by Candello et al. (2017) explored the use of a more robotic typeface which made the users more likely to evaluate a conversation with an advisor as bot-like, while a handwriting font did not show an opposite effect. The use of animated avatars potentially may also help humanize interactions by displaying emotions. Nevertheless, Ciechanowski et al. (2018)

show that in contrast to hardware robots, text, or voice bots without face are perceived as less dangerous and uncanny, and sometimes voice-only interaction or a humorous avatar is preferred to a human seeming one, as in Wang et al. (2019).

All of these considerations influenced the design of our "Gizmo" chatbot and can be summarized in the following set of recommendations:

1. Focus on their function as an interface to increase the users' productivity while satisfying interpersonal interaction needs.
2. Provide vast knowledge of the "inhabited" domain.
3. Ensure context awareness and retain key information about the user.
4. Allow more pre-defined dialogue choices and open-ended replies to increase naturalness.
5. Create a consistent and polite personality to grant positive social interaction.
6. Ensure careful and levelled emotional expression to match the shared narrative, as in Lee et al. (2019).
7. Avoid "the uncanny valley" by not using a human-like avatar.
8. Aim for amusing, endearing and entertaining demeanour.
9. Humanize the interaction with the use of dynamic response delays.

Conceptual design

While the best-case scenario would involve the possibility to generate all content for Wikipedia also via the chatbot interface, there are some practical considerations to take into account. First of all, Wikipedia is not a new project, but it has been around since 2001, as such, there is little need to elaborate on articles drawing from common, or easily accessible, knowledge in the most popular languages. Areas where there is largest need for contributions are translating the database of knowledge from English into local languages, which is still a massive task as examined by Wulczyn et al. (2016), and local interest information into other languages and verifying scientific and historical accuracy of existing articles, which may be lacking due to progress in the field, as shown by research reviewing articles in the Astronomy category by Thelwall (2016), bias or political agendas.

On the side of the users, there is preference for using their skills and knowledge that are immediately accessible to them without additional research and searching for references, which could break the immersion of interaction with the chatbot and make the task more work-like.

What these have in common are two large areas of concern: **translation and evaluation**, which address both the needs of the Wikipedia project, as well as make it possible for anyone to contribute without much research or specialized knowledge. These two aspects are what we will focus on.

Possible crowdsourcing tasks

In principle, the information that can be crowdsourced via a chatbot ought to come in chunks, so that it can be broken into micro-tasks, and be easily identifiable as the answer sought after. Examples of such tasks are listed below:

- **Historical information:** Knowledge about local history of the area, especially relevant in small towns and villages, including the history of institutions such as schools, churches or museums.
- **Local information:** Information about local attractions, buildings, museums projects, or people who are important locally, such as activists and officials.
- **Contested information:** Conducting surveys on the credibility of contested information, where the users can aid the chatbot to locate credible sources.
- **Sentiment verification:** Asking the users if information follows the guideline for the neutral point of view, or if an edit may have been an act of vandalism.
- **Meta-data:** Deciding on the classification of the articles, or aiding in the disambiguation as well as providing candidates for internal links within Wikipedia articles.
- **Tagging articles for clean-up:** Voting whether certain articles, perhaps from their pre-selected categories, need to be restructured or if they are understandable.
- **Translation verification:** Verifying translated chunks of information after machine translation, for example originating from infoboxes.

Pilot crowdsourcing task

Infoboxes are fixed-format tables in Wikipedia. They are most commonly used to display article summaries and navigation between pages. Each infobox consists of pairs of key/value. Infoboxes are very helpful for the automatic creation of knowledge graphs in the DBpedia project. Many categories of articles require the use of an infobox template as they ensure brevity and clarity of information. Wikipedia[3] has lists of categories and articles without infoboxes in multiple languages. These lists are a reference for users who want to expand Wikipedia, as many of these articles have equivalent pages in other languages which contain infoboxes. As this issue is common in multiple languages Zhang et al. (2017) introduced machine translation of values found in such tables and mechanisms for assigning keys in infoboxes. Doing this automatically would increase the internal consistency of information between the many languages of Wikipedia. Now, even in articles on neutral subjects, such as dog breeds[4], there are minor inconsistencies

[3] This Wikipedia article: https://pl.wikipedia.org/wiki/Kategoria:Artykuły_bez_infoboksu (accessed on 15.01.2020, revision ID=49749209) lists articles without an infobox for Polish.

[4] The exact search term used was "Golder Retriever, and the resulting url for Polish was: https://pl.wikipedia.org/wiki/Golden_retriever, accessed on: 1.02.2020, revision ID=58293665, and for English: https://en.wikipedia.org/wiki/Golden_Retriever, accessed on: 1.02.2020, revision ID=938596709).

Golden retriever

Golden retriever

Inne nazwy	Yellow retriever, Russian Retriever
Kraj patronacki	Wielka Brytania
Kraj pochodzenia	USA[1]
Wymiary	
Wysokość	56 - 61 cm (psy), 51 - 56 cm (suki)[2]
Masa	29 - 45 kg (psy), 24 - 29 kg (suki)
Klasyfikacja	
FCI	Grupa VIII, Sekcja 1, nr wzorca 111
AKC	Sporting
ANKC	Grupa 3 - Gundogs
CKC	Grupa 1 - Sporting Dogs
KC(UK)	Gundog
NZKC	Gundog
UKC	Grupa 4 - Gun Dog
Wzorce rasy	

FCI • AKC • ANKC • CKC • KC(UK) • NZKC • UKC

Golden Retriever

Origin	Scotland, United Kingdom

Traits		[hide]
Weight	Male	65–75 lb (29–34 kg)[1]
	Female	55–65 lb (25–29 kg)[1]
Height	Male	22–24 in (56–61 cm)[2]
	Female	20-22 in (51-56 cm)[2]
Coat	straight or moderately wavy	
Colour	any shades of gold or cream	
Life span	average 10-12 years	

Classification / standards		[hide]
FCI	Group 8, Section 1 Retrievers #111	standard
AKC	Sporting	standard
ANKC	Group 3 (Gun dogs)	standard
CKC	Group 1 – Sporting dogs	standard
KC (UK)	Sporting dog	standard
UKC	Sporting and fishing	

Domestic dog (*Canis lupus familiaris*)

Figure 2. Side by side comparison of infoboxes about the Golden Retriever from the Polish and English Wikipedia. Information such as coat, colour and life span are missing in the Polish version.

between the content, as can be seen in Figure 2. With machine translation and consistent format of infoboxes in multiple languages the verification of information and updates could also be easier across many languages. **So, in our pilot implementation we propose the design of a micro-task to verify machine translations and information management in infobox migration from the English to the Polish version of Wikipedia.**

Stages of task execution - first interaction with the chatbot:

1. Algorithm downloads available categories and presents them to the user (from such topic classifications as for example: entertainment, food and drink, sports or people)

2. User selects one interesting category and a subcategory according to their interests (for example: "film" from "entertainment")

3. System pulls articles for editing (finds a similar page in English with an infobox) and categorizes them by difficulty level (based on number of keys and value types).

4. The system creates a shortlist of articles, starting from the easiest difficulty (to provide an early success and increase motivation).

5. The user chooses an article from the shortlist. (for example: the page for the "Forbidden Planet" movie)

6. The user can edit each of the rows. They can remove optional parameters, edit translations, skip the task and move to the next one or finish.

Initiating interaction

Establishing the best method of initiating interaction is a significant problem which is not only related to the question of when the users are most open to contributing to crowdsourcing, but also when they are willing to engage in either text or voice (or both!) conversations with a chatbot on regular basis.

So, there is the question of choosing the appropriate trigger and pattern of interaction. In case of integration with Wikipedia it could be entering the Wiki page which has some needs associated with it, for example it lacks an infobox, or the Wikipedia as a whole. In other cases it could be exiting an application on the device, location-based (coming back home in the evening) or using Messenger. One of the key strengths of chatbots populating the popular IMs is the fact that no additional software needs to be installed for the chatbot-user interaction to be possible. Thus, chatbots may avoid a massive barrier to quick adoption of new solutions.

The initiation of the conversation also has to come at a right time for the users to contribute, based on their habits and preferences. It also ought to be initiated between their regular activities, so that they can commit to a new activity. Gizmo will be able to predict a good time to propose the interaction with the user. It could also happen based on the preferences of the users who could invite the chatbot to ping them at the time of their choice.

Currently, however, none of the voice assistants are allowed to initialize conversation without user input. The user only can initiate interaction via text or voice with a specific phrase (for example: "Ok, Google. Talk with Gizmo"). We resolve the technical problem of initializing the conversation by implementing push notifications with an encouragement to run the voice assistant. Each user will have a unique ID number. The central server would send notification to the user device at the predicted best time for interaction based on historical user data.

Additionally, the assistant can offer to finish the interaction by suggesting a break if it detects a decrease in the response pace or quality. Then it can offer a suggestion to continue at a chosen time.

Recovery techniques

The more complex the task, the more likely it is that the conversation may fall flat. For this reason, since apart from crowdsourcing, the chatbot aims to increase well-being of the users it must offer appropriate recovery techniques. In this case the recovery techniques ought to aid users in finding a task they can complete to help them feel good and to satisfy their need for cognitive closure. So, when the communication breaks depending on the type of failure there are a couple of techniques which can be used to get back on track:

- an apology and polite request to rephrase
- a switch to a different category
- a switch to an easier task
- a switch to a verification task
- a switch to a different rich response type
- planning a break and next interaction date

Chatbot evaluation

Designing successful HCI interactions is both about the numbers and the reasons behind them. For example, DialogFlow analytics consist of usage data, NLU Data: showing the frequency of use of "intents", the exit percentages of users, and response time. These can aid in finding problem areas, however, key measures for us are related to the user engagement and satisfaction with the conversation, and only then the number of successful contributions to Wikipedia and its relation to the previous two measures.

To evaluate these we intend to look at chat logs and hold individual IDIs with our pilot users once Google Home Hub is available in Polish. It is of key importance for us to deliver a pleasant experience, which could enrich the lives of older adults and aid them in making meaningful and visible contributions online, which they could share with others. We also expect that as the chatbot becomes more successful at encouraging contributions, the users may come to expect of it to also provide a pleasant social interaction outside of its main domain. This can be achieved by analysing the logs and, for example, evaluating the social dimensions of the attempted conversations, as in Aiello (2020). Finally, participatory design workshops with older adults could provide insights into the interaction patterns desired by them as well as key areas of needs that the chatbot could attempt to answer.

Design components

Our pilot implementation focuses on verifying machine translation of infobox contents. The choice of this implementation is partly inspired by our research, described in Skorupska et al. (2018), with older adults, who detected errors in subtitles, of which some were machine translated. It is evident that to evaluate the naturalness and logic of a translation it is often enough to know the target language, and older adults are confident in their native language abilities. On the other hand infoboxes are good candidates for machine translation verification tasks, because of their straightforward build of short key and value pairs. This implementation consists of the following modules:

Chatbot module

This module handles the full conversation flow, user contributions, including successful task switching and recovery and later feedback handling, as the motivational component. The module ought to allow for autocomplete to aid with typing, but also make use of different communication formats and allow multimodal interaction.

Design framework and communication formats

Leading tech companies have worked on launching chatbots since the dawn of smartphones. Siri was launched by Apple in 2010, and Google followed two years later with Google Now. Cortana and Alexa both appeared in 2015, followed by Google Home. Meanwhile chatbot frameworks were being developed alongside, with Wit.ai leading the way, followed by Api.ai bought by Google and renamed to DialogFlow, and Luis.ai. These frameworks provide HCI researchers with an amazing opportunity to use cutting-edge AI and ML algorithms in their studies. Without the need to develop these solutions from scratch on their own, they can focus on creating a specific chatbot for their research purposes. For this research Google's DialogFlow was chosen as a free tool that can be trained, without the need to create own NLP algorithms, as observed also by Mitrevski (2018) and which can be used with IM platforms whose popularity surpassed social networks as noticed by Pereira (2016).

The communication formats available on DialogFlow partly motivated our choice of the design framework, as they match the needs of the project and allow for multimodal communication with a touchscreen, which is important as some older adults encounter difficulties with typing or using a mouse. Here also voice interaction comes handy, but not in isolation. Voice-only communication relies on good memory and not much context, which is why it ought to be supplemented by a screen as shown by Kowalski et al. (2019). Chatbots, other than standard hardware voice assistants (smart speakers), offer many response types. Hybrid interfaces (for example: Google Smart Hub or Google Home) built into smartphones allow to generate visual responses, which are integral to voice

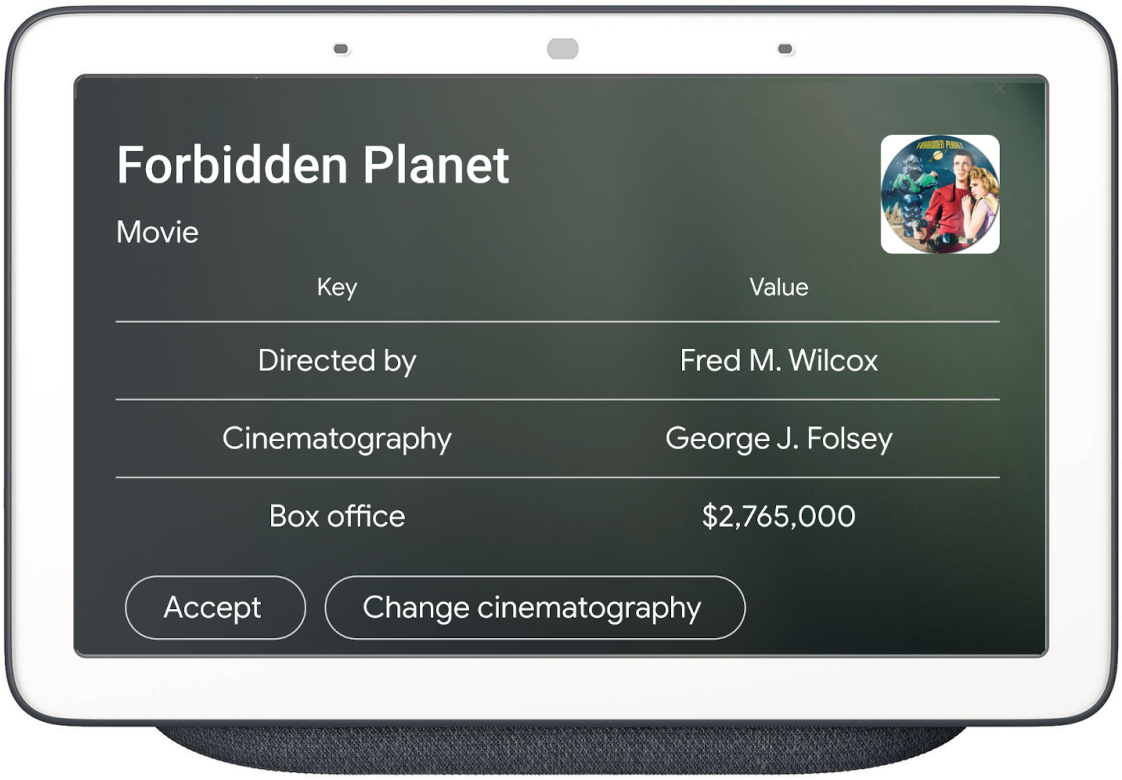

Figure 3. Gizmo on Google Home Hub. Sample screen showing the process of infobox editing. DialogFlow has predefined styles for tables so the table design is visually different from the standard infobox on Wikipedia.

commands. Dialogflow provides a few rich response types very useful for our pilot implementation of infobox translation verification:

- **Basic cards**: a bordered box with heading, text, optional image, and button. Excellent UI to summarize information about an article edited or display short Wikipedia information.
- **Browsing carousel**: a list of boxes with heading, text and small pictures. This component is useful for selecting categories.
- **Suggestion chips**: all of the responses can be decorated with many small buttons - suggestions of replies. This type of response is needed in the onboarding process. New users often do not have information about the list of acceptable responses for the current context. Secondly, chips are the best interface for closed tasks. At the same time chips ought not to block any other voice responses, as they are only suggestions.
- **Media responses**: a chatbot can play music and video as a response to the user request which is useful because Wikipedia has media content.
- **Table cards**: displaying tabular data is helpful for editing infoboxes or other structured data on Wikipedia, as seen in Figure 3

A chatbot using rich response types may offer multiple ways of continuing the conversation, either via voice, or by allowing the users to select one (or more) out of many responses with the use of voice, touch, mouse or keyboard, which can be imbued with multimedia elements. Devices such as Google Home Hub or Amazon Echo show added screen support to voice assistants. It is an impressive combination. Each voice command can be accompanied by a visual message (tables, pictures, etc.) This flexibility of possible communication formats makes modern chatbots uniquely accessible.

Wiki edition module

This element gathers the needed contributions from DBpedia or MediaWiki API such as missing information from charts, citations, meta-data or candidates for internal links and collects the needs related to vandalism detection and human verification of a neutral point of view. In our pilot implementation it handles the verification needs related to machine translations of infoboxes. It also handles the input information verification and the resulting Wiki edits as well as controls the generation of the feedback for the user, which includes reminders and statistics on the views of the page/pages the user helped edit to keep their motivation high.

Motivation and well-being

Building a solution that will have a real impact on Wikipedia's quality requires addressing the problem of encouraging users to interact more often.

Based on our previous studies we have identified a handful of heuristics that may work for older adults in this particular use case:

- **competition** – Gizmo: *With 63 corrected errors you are among the top 10 most active editors in Warsaw*"
- **self-imposed (or social) obligation** – Gizmo: *How many articles would you like to edit this week? / You wanted to correct 7 articles and so there are 2 more left for the week.*
- **sense of being useful** – Gizmo: *Last week, 245 people read an article you corrected. Thank you! / Can you improve the article about ...? On average, over 500 people read it every week.*
- **not wanting to be a burden** – Gizmo: *Cognitive training will allow you to enjoy good health for longer. Would you like to correct one more article?*

The above examples of chatbot motivating older people to edit Wikipedia articles show that one can reasonably refer to the main types of motivations known in psychology. However, the effectiveness of this solution will depend on the selection of the right arguments for each person and some of these may be shortlisted during participatory design workshops. Discussion on the detailed methods of automatic selection of the right approach to motivation, however, goes beyond the scope of this article.

To prevent users from betting frustrated and bored while they interact to help increase their well-being it is necessary to monitor indicators that can help formulate relevant, correct, and fast responses and aid the users in completing their goals. We list such disaffection indicators below:

- **Average response time** - an increase relative to the average may suggest boredom, which can lower accuracy - then Gizmo can suggest a category change, or an inappropriate choice of task difficulty, which Gizmo can then correct.
- **Abandoning tasks** - the user can interrupt the conversation at any time. Analysis of the timing (in a conversation, or relative to the time of the day) and task difficulty and category can reduce the abandonment rate.
- **Correct answers** - if the user provides irrelevant/wrong answers (in tasks where verification is possible) then Gizmo can decrease the task difficulty or suggest a break in conversation.
- **Response types** - The user can respond via voice, insert text, or choose predefined responses (chips). In the following tasks and conversations, the bot should not require non-preferred response types for this user.
- **Sentiment Analysis** - Each conversation may be logged and analysed to detect emotional overtones, both in terms of text content as well as speech as in Tashev et al. (2017). Based on this analysis Gizmo can adjust its own tone, suggest a change of category or encourage the user to take a break.

After identifying disaffection, the system can display tasks requiring verification. The user then can verify the correctness of the solution. These tasks can come from historical data of current and other users. This is recommended as Gadiraju et al. (2017) indicates that users of crowdsourcing systems in which the self-assessment system has been implemented solve the tasks 15% more accurately. Secondly, users can be quite interested in verifying the validity of other users work, as in Skorupska et al. (2018).

Additionally, assessing users' emotional reactions is important in HCI since well-being and lack of frustration are necessary to ensure the frequent use of non-essential applications. In chatbot communication, especially outside of the lab, measuring emotional states is challenging as sentiment analysis is limited to text and the collection of hard data (eg. from biometric sensors) is difficult. A unique method of measuring this is the mobile emotion wheel proposed by Warpechowski et al. (2019), which could appear after the conversation with Gizmo concludes. A screen-supported voice interface is an excellent environment to implement this solution.

Example conversation

An example conversation on how the chatbot interacts with the user is given below. The user first chooses the category and subcategory that interest them, and then dives into a specific task. In this conversation about the infobox for the movie

"Forbidden Planet", or "Zakazana Planeta" in Polish, the user corrects the common mistranslation of the word "cinematography" as "kinematografia" to the value of "zdjęcia" that is "pictures", which is the natural way to say it in Polish in this context:

- Gizmo: Greetings! Can you help me with fixing Wikipedia?
- User: Sure
- Gizmo: Great! Tell me a bit about your interests? Are you interested in entertainment, food and drink or people?
- User: entertainment
- Gizmo: Okay, and more specifically, perhaps dance, film, or music?
- User: film
- Gizmo: I have something for you. Look at this infobox about the movie "Zakazana Planeta". Do we need to change anything? [The chatbot displays the infobox on Google Home Hub, see Figure 3]
- User: Change the "kinematografia" to "zdjęcia".
- Gizmo: Okay I did - take a look. Should I change anything else?
- User: No, it is great.
- Gizmo: I saved your changes. Do you want to check another article in this category?
- User: Not today, I have no time.
- Gizmo: Thank you for helping. When would you like to talk again?
- User: Tomorrow morning is fine.
- Gizmo: Okay, I will catch you then. Thank you and bye!
- User: bye

Discussion

In this section we discuss the proposed approach in the context of opportunities related to co-designing such HCI solutions for older adults as well as the growing importance of this area of crowdsourced-based interaction and contribution.

Older adults and conversational crowdsourcing

Many studies have been conducted at the intersection of HCI and ageing, but according to Vines et al. (2015) they largely focus on stereotypes related to health, socialization and technology instead of looking for opportunities for ICT to, for example, tap into the older adults' potential increasing their well-being. One such opportunity is related to improving the accessibility of ICT-based solutions via chatbots; especially ones which allow older adults to remain active, both physically and cognitively which is a determinant of successful ageing, as in the

study by Lum and Lightfoot (2005) on how volunteering helps combat depression and slows negative effects of aging.

Despite the fact that older adults are a very heterogenous group, there are some things many of them have in common. For example, crystallized intelligence, which is largely measured through general world knowledge and language tasks, according to Baghaei and Tabatabaee (2015), may stay the same, or even benefit from aging as indicated by McArdle et al. (2000) as well as Wang and Kaufman (1993). So, older adults may be well-suited to provide contributions which hinge on the understanding of texts, as also the ability to conceptualize and grasp the high level meaning is shown not to degrade significantly with age, as shown by Radvansky (1999) and in some cases to increase. So, they are a good target to verify the logic of information presented in infoboxes in their native language.

At the same time, the fact that interaction with chatbots, especially multimodal interaction supported by touchscreens, allows to see the context of the conversation and does not overload short-term memory is very beneficial for older adults, as much of the cognitive capacity change in ageing happens in this realm. Another benefit of chatbots as interfaces for older adults is that there is no need for the users to learn artificial conventions of communication, as noticed by Morrissey and Kirakowski (2013), such as hard to navigate menus, to achieve their goals of interacting with computers and engaging in online projects, such as contributing to Wikipedia. This solution attempts to map the interaction with the system into natural conversations between people, in which they ask and answer questions. Because all people engage in conversational social interaction the barrier to entry to engaging with a system mirroring this interaction pattern is much lower, and they are encouraged to engage right away, as they learn-by-doing, without the fear of breaking anything.

Participatory design of conversational interfaces for crowdsourcing

One unique opportunity of designing text-based interaction is its potential to co-design it with users, without the need to explain UI elements to facilitate participation, as it was done in a study of participatory design during a hackathon with older adults by Kopeć et al. (2018). Because the text conventions are familiar to everybody the barrier to entry to actively take part in co-design workshops is lower, and there are multiple approaches to co-design that have been applied with older adults, as reviewed by Duque et al. (2019). Such workshops can be conducted in two parts as a mix of multiple activities inspired by the SPIRAL method of enabling user participation, after Kopeć et al. (2018), including:

Part 1 - Ideating and prototyping

- round-table discussion about Wikipedia to evaluate the appearing attitudes,
- quick presentation of Wikipedia, crowdsourcing and some areas of needs as user empowerment

- brainstorming key areas of interest for editing Wikipedia and collecting them as post-its (to fidn out what topics the chatbot could suggest first),
- affinity diagramming the received responses (to decide on "themes" the teams could work on),
- work in teams of older adults and designers to design the interaction flow (for the applications and topics identified above)

Part 2 - (Re-)designing and evaluating

- work in teams to write out possible responses for the elements of the interaction flow,
- using "Wizard of Oz" techniques to verify the ideas between different teams and find problematic areas,
- creating Mad Libs tasks where the users fill out some incomplete conversations with problematic dialogue elements left blank according to their preferences and doing these between teams
- discussing what feedback about their contributions the users would like to receive and how often and voting on the most attractive mode of receiving feedback (eg. every participant gets five star stickers to give out to different options)
- brainstorming the best time and method of initiating interaction with users based on their habits

During these workshops the potential users can co-design the interaction flow and the personality of the chatbot, to best fit their preferences.

One current limitation is that the screen interface implemented in Google Home Hub can not be co-designed, as it is not fully customizable for developers. Still, for this application an HTML box to render formatted Wikipedia articles with infoboxes would be very helpful, as it could print the outcome of the changes made thanks to Gizmo. Additionally, Home Hub does not have all the languages of Google Assistant on Android devices available, which is extremely important, as, at least in Poland, few older adults know foreign languages at a level that would allow them to converse with Gizmo if it is not available in Polish.

Yet, even in their native language selecting the users who would be interested in this form of spending free time can be a challenge, but participatory design workshops can help with making the solution more appealing to older adults. Still, the lower the barrier to entry, the larger the potential that more users will stick and continue to contribute, despite some of the possible problems. This solution is not a universal one for every user, or every older adult, but it aims to be a viable alternative to the Wikipedia's graphical user interface, which has been shown to be confusing, in particular, in a study with older adults by Nielek et al. (2017).

Overall, it is possible to take some issues Wikipedia is facing and attempt to translate them into a conversational interface mediating contributions, which has the potential to simplify and streamline crowdsourcing for some groups of older

adults who would like to contribute, but find it too difficult now, especially if they have the chance to co-design this solution.

The raising importance of making human verification accessible

Wikipedia is the largest repository of knowledge, and due to its simplicity, comprehensiveness and the massive size it is used not only a reference and a source of knowledge for individuals, but also companies, the media and governments. Over the years it has gained trust and expanded significantly. Because of its place in our lives it sets the tone of more than everyday debates, and with increased internet access more people flock to it for information, but often as passive users, without the know-how (eg. new internet users) or technical ease (eg. using mobile devices) to easily contribute their story. Because of the increased volume and readership without the increase in editing volume in the past 10 years, as described by Mandiberg (2020), Wikipedia's inequality in terms of who produces the content in contrast to who consumes it is even more profound.

This is why making Wikipedia editing more accessible to all user groups is a genuine concern, as the most active editors, and the most motivated individuals with greatest resources not only set its tone, but also choose what is worthy of being described, expanded upon or even mentioned.

While it is relatively easy to do remain objective when stating scientific theories or bare facts about someone's life, sections such as Controversies or Critical Reception are more problematic. So, on one hand it is curated by a select group of individuals, while on the other, because of inherent unconscious bias, even the best editors may produce subjective content.

So, making Wikipedia more accessible, by allowing alternate ways of interacting with the editing system and more reliable by aiding in data verification and evaluating if the content is accurate and/or free of bias is important. Especially at a time that organized online campaigns may be used to vandalize or skew information in support of a certain worldview or an interested party.

Although, the proposed solution is not a global Wikipedia editor for hybrid interfaces we recommend this method for verifying infobox translations. This application is in line with one of key areas of needs of Wikipedia, as infoboxes are difficult to maintain, not only due to the many languages where they may appear in different formats, but also because of the need to manually synchronize them with the contents of the article, whenever the article is updated with key information which ought to appear in the infobox.

Conclusions

Our solution reaches promising ground in conversational interface applications for collaborative work, and we believe that the CSCW domain is moving towards the emerging Web 5.0 with its focus on tailored emotive interaction accessible to more users. After all, one of the key benefits of chatbots as interfaces is that there is no

need for the users to learn artificial conventions of communication Morrissey and Kirakowski (2013). Thus, **chatbots hold great potential for simplifying interactions, especially when complex systems and designs arise incrementally, as was the case with Wikipedia or other collaborative environments**. However, there exist multiple challenges to enabling crowdsourcing contributions via conversational interfaces such as the identification of appropriate tasks, in which the need and expertise areas of both the system and the users have to meet, the monitoring of disaffection indicators and finally maintaining the interest and motivation of the users.

To verify these, as a next step we are planning to conduct tests with older adults once Google Home Hub supports the Polish language or with the use of "Wizard of Oz" techniques, if this support does not come in the nearest future. The users will interact with the chatbot and share their experience with the researchers conducting IDIs and analysing raw dialogue data to fine-tune the interaction to be more friendly, intuitive and motivating to also increase older adults' well-being. Additionally, we are looking into organizing participatory design workshops to further adjust the interaction with our chatbot towards what our potential users may expect.

Another aspect for further study are the contribution types which the chatbot could facilitate in connection with what the older adults would be interested to work on, and what other needs of the Wikipedia project, or other crowdsourcing projects, can be addressed with conversational crowdsourcing. Especially in the context of the emerging Web 5.0, we believe conversational crowdsourcing interfaces are an exciting area of inquiry for the CSCW community in the years to come.

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How the local domestication of a teleconsultation solution is influenced by the adoption of a national policy?

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Abstract. Telemedicine is presented by the French government and regional authorities in France as key to guaranteeing equal access to healthcare. Research on telemedicine has highlighted how it impacts the work practices of healthcare professionals and how its adoption is challenging. In this context, we are interested in understanding how the discourses and policy on equal access to healthcare are implemented and how they impact the deployment of telemedicine solutions in practice. We are currently studying the deployment of a teleconsultation solution for nursing homes inside a group of hospitals in Northeast France. On the basis of on-site visits at four nursing homes and interviews with the different stakeholders, we analyzed the domestication of the teleconsultation solution. Our first results highlight that the defined policy is useful to support the deployment of the technology but does not appear as sufficient for its incorporation into regular work practices. Our hypothesis to understand this obstacle is that nursing homes would need to endorse a new role to engage in further incorporation and later stage of domestication, which may be prevented by their existing ecosystem.

Introduction

Telemedicine in France was officially introduced in the health legislation in 2009. Then, in 2016, a law for the modernization of the health sector presented telemedicine as a way to ensure and equal access to healthcare independently of the social conditions and the territories[1]. September 2018 marks a milestone for the development of telemedicine practices, with the "DECRET 2018-788" that formally recognizes telemedicine as one of the regular medical practices in the French health insurance system[2].

Telemedicine is presented by experts and healthcare authorities as a major opportunity to address the demands for healthcare across a rural and underserved territory in a context where existing health professionals are overwhelmed, and newcomers are reluctant to settle in rural areas. Telemedicine is envisioned as a way to ease access to healthcare and to allow a better follow-up of patients, which could prevent emergency situations from arising.

The research that we present in this paper was conducted in this context where the East regional health agency (East-RHA), in partnership with the main hospital from one department of this region envisions telemedicine as an opportunity to improve the accessibility of healthcare by residents of nursing homes.

In fact, in France, nursing homes are not considered as healthcare providers, but rather as an accommodation and living service. Their staff usually includes a part-time coordinating doctor (most of the time, a general practitioner who could be retired from private practice), and nurses. A recent report from a commission of the French National Assembly points out that, on average, nursing homes have a ratio of 6 full-time nurses for 100 residents (Commission des affaires sociales, 2018). Moreover, a lot of nursing homes are settled in suburban or rural areas, which limits the availability of medical resources and competencies and then leads to the need for transportation of the residents to consult specialists. Telemedicine is then seen as an interesting solution to avoid moving patients. However, deploying telemedicine requires nursing homes to endorse a new role beyond solely supplying accommodation services. Indeed, allowing teleconsultation means becoming a genuine partner of the healthcare system, playing an active part in the medical care of their residents.

The current implementation and deployment of telemedicine solutions appear as complex and challenging, intertwining social and material issues (Orlikowski, 2007; Bjørn & Østerlund, 2014; Mathieu-Fritz & Gaglio, 2018). Projects of telemedicine deployments are hindered by numerous hardware and networking problems, and issues related to the appropriation of technology by organizations and professionals (Pols, 2012; Gaglio et al.,

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1 (*LOI n° 2016-41 du 26 janvier 2016 de modernisation de notre système de santé*, 2016)

2 (*DECRET n° 2018-788 du 13 septembre 2018 relatif aux modalités de mise en œuvre des activités de télémédecine*, 2018)

2016). In this context, we identify a gap between the high-level discourse in health policy related to telemedicine, and the technical and organizational issues at stake when dealing with its deployment in practice. Implementing new technology in a work setting is always an effort, but the conditions that support the organizations and professionals to engage in the effort of making their work practices evolve are still unclear. Our research is interested in examining the role of policy and the ways the stakeholders that promote and implement in the success of the deployment.

The questions we are dealing with are the following: How does the high-level discourse on equal access to healthcare impact the current deployment of a telemedicine solution? Does this policy support the adoption of teleconsultation? And at which step of the deployment process does it have an impact?

In order to account for the adoption of the telemedicine technology that was deployed in the project that we are following, we have chosen to adopt the perspective of domestication (Roger Silverstone & Haddon, 1996). Indeed, this framework supplements technology appropriation (Balka & Wagner, 2006; Draxler & Stevens, 2011) and allows us to consider the steps that are occurring before, during, and after the technology is introduced. The lens of domestication also provides a shared longitudinal model that allows for comparison across several organizations. Therefore, it is useful for addressing the relationship between policy discourses and technology implementation and highlighting the role of policy at different stages.

Through a field study of the deployment of a teleconsultation solution between a local hospital and four nursing homes (Aube department – NorthEast France), we had the opportunity to observe the contrasted reception of the solution at different sites. Since 2017, with the support of regional funding, the local hospital has developed (in partnership with a local software company) a teleconsultation solution that allows nursing homes to schedule teleconsultation appointments for their residents with specialists from the hospital. Forty-six nursing homes have been equipped with a dedicated teleconsultation solution. At an operational level, the knowledge and understanding of the different domestication situations across nursing homes could help the hospital to better accompany the deployment of the teleconsultation solution.

In this exploratory paper, we present preliminary results of the contrasting cases of four nursing homes, which are at a different stage in their domestication of teleconsultation. By so doing, we aim at contributing to the research questions listed above, in line with the CSCW research challenge of better addressing the relations between healthcare policies and practices raised by (Fitzpatrick & Ellingsen, 2013).

Related work

Telemedicine and Teleconsultation in Nursing Homes

Telemedicine, or telehealth, appears in the literature as an umbrella term that covers a wide range of medical activities with specific challenges in terms of technology, organization, and care relationship development (Pols, 2012). These medical activities range from collecting physiological measures at the patient home to enabling the patient to consult a health professional through a video-call (Larsen & Bardram, 2008), or supporting distributed medical teams to organize meetings at a distance (Robertson et al., 2010). Despite its focus on a mediated practice, the telemedicine term does not mean that all the care to the patient will be provided at a distance through networks without any face-to-face contact. Its deployment in practice often consists of providing a supplementary channel for care provision between a patient and health professionals, partly occurring in physical presence at one point or another (Islind et al., 2019).

In France, the legal framework distinguishes five categories of medical activities that can be performed at a distance and so be accounted for the health insurance system (Simon & Acker, 2008): “telemonitoring” which is the act of gathering medical data from outside a medical structure (for instance at home); “Tele assistance” which is a request for help to a peer doctor when performing a medical act, “regulation” which covers the existing practices for emergency medical services (EMS); “tele expertise” which is a request for advice and counseling between two health professionals; and, “teleconsultation” which involves a meeting at a distance between a patient and her personal general practitioner (GP) or a health professional appointed by her GP. In this paper, we focus on the deployment of a teleconsultation solution, but tele-expertise can be mentioned as a follow up of a medical consultation with a patient.

Among the few detailed studies of teleconsultation in practice, (Esterle & Mathieu-Fritz, 2013) and (Mathieu-Fritz & Esterle, 2013) have looked at its impact on articulation work and have shown that teleconsultation as a situation (Goffman, 1974) involves work at four different levels (or framings): a technical or material level which is especially concerned with the setup of the communication channels and camera; an organizational level in which one needs to gather the proper patient’s health records, register the teleconsultation event, and follow-up in the information system; a social level to stage proper introduction of the teleconsultation and initiation of the exchanges between the participants, as well as the interaction work for closing the exchanges; a clinical level in which medical care is achieved and good practices in the medical examination have to be attained. These authors have observed how the lead doctor in charge of the teleconsultation project had to define and negotiate the work to be done at these four levels in order to successfully routinize the practice of teleconsultation (more than 1500 teleconsultations had been carried out as of September 2012).

The "progressive routinization" (Esterle & Mathieu-Fritz, 2013) at the different framing levels and the adoption of teleconsultation come with the partial transfer of knowledge and responsibilities from the lead doctor to a nurse trained as an assistant in telemedicine. Thus, as observed elsewhere with the training of specialized paramedics for tele-EMS (Stevanovic et al., 2017), the successful deployment of telemedicine appears as a socio-material achievement that has an impact on articulation work.

Teleconsultation has also been studied in the context of nursing homes (N. Salles et al., 2013) with the aim to reduce the need to transport patients to health organization and to ensure a better quality of care (secondary preventive care) to reduce the request to Emergency Medical Services (EMS). The reported results of the experiment in the context of nursing homes are positive, and learnings for implementation have been gained (Nathalie Salles, 2017).

This existing work on the impact of telemedicine on work provides important insights on how to enable the successful implementation of teleconsultation in other settings, but few is known about the role of policies and political discourses, and how they can impact the adoption of a teleconsultation solution in a region-wide context.

The Domestication of Technology

The domestication approach of technology adoption allows us to account for the deployment and use of ICT as a consumption process (Roger Silverstone & Haddon, 1996), binding material, symbolic, and as such social dimensions of living with a technology artifact. The model supplements research on the appropriation of technology in practices (Balka & Wagner, 2006; Draxler & Stevens, 2011) as it accounts for steps before the technology is available in the field site, and enables to address the relationship between discourses and the deployment of the technology.

The domestication model has originated in the analysis of ICT adoption in homes from a media studies perspective (R. Silverstone et al., 1992), and provides an analytical framework to account for different stages in the adoption of technology artifact. This longitudinal model offers a structure to bring the trajectory of adopting a technology artifact together again.

* **Appropriation** deals with the circumstances of acquiring the technological artifact, moving it from the external public sphere to the setting. It focuses on the process of getting or buying it, the issues of funding and associated technology providers.

* **Objectification** is interested in the way the technology artifact has been set up and installed in the setting. This setup is as much about the configuration of the technology itself, as the connection to the network than with the change involved in the environment, like finding a proper physical place for the artifact in the setting and accessibility.

* **Incorporation** is concerned with the effective and attempted uses of the technological artifact and the changes in the users' daily routines and practices. Successful incorporation in the users' daily routine is challenging and may lead to abandonment, especially when the cost of making use of technology passes the benefits for the setting activities.

* **Conversion** addresses the value and symbolic meaning of the technology artifact through the way it is displayed to others, through discourses or presentation, outside the setting. Of course, not all adoption processes reach this phase, where technology impacts the identity of a setting, moving back the technology artifact from the setting to the external public sphere.

The focus of the domestication analysis framework was originally household adoption, but the model authors' intention was not to bound the applicability of their model to other contexts (Roger Silverstone, 2005). Several studies on technology domestication have been conducted on small businesses (Harwood, 2011), work organization (Pierson, 2005), and healthcare as well (Chamberlain & Craig, 2016; Gaglio et al., 2016; Kivits, 2006; Östlund, 2017).

This model is of special relevance for our study for its synthetic purpose, allowing us to gather and make sense of the very different adoption stories of the different nursing homes we are following. It also allows us to address the issue that not all nursing homes have reached the same stage with the teleconsultation solution.

Context

In this section, we introduce the context of the "MyGHT Télémédecine" project that is dedicated to the development and deployment of a teleconsultation solution allowing nursing homes to access specialists from the hospital. We first introduce the French telemedicine context, which allowed the implementation of MyGHT Télémédecine. Then we present the Groupement Hospitalier de Territoire (GHT), which gathers the medical organizations in the Aube and Sezannais region around shared healthcare aims and policies, and which has initiated the project. We then present the onset of MyGHT Télémédecine, the developed technical solution, and the current status of its deployment in the region nursing homes.

As a foreword, we would like to mention that the authors of the paper have been invited by the leader of the MyGHT Télémédecine project to follow its deployment as a follow-up of previous research projects. Indeed, we have not taken part in the design or the implementation of the teleconsultation solution. We have responded positively to the invitation following our interest in the case.

The evolution of the population demographics these last twenty years in France has led to a rising concern from health authorities and the population about the lack of available medical resources and trained staff, especially in rural areas. The notion of equal access to

healthcare has been reasserted in the framework of 2009 (July 21st) French law related to patients, health, and territories. This law has shaped telemedicine in France with the categories of medical activities introduced above (Simon & Acker, 2008). From 2014 to 2018, experimentations have been allowed locally under guardianship and funding of the Regional Health Agencies (RHA)[3]. RHAs are in charge of applying national policy orientations at the regional scale.

To address territorial inequalities, "Groupements Hospitaliers de Territoire" (GHT) has been defined (Healthcare modernization law, October 2016) as an organizational model gathering several hospitals on the territory, in order to develop a territorial approach of healthcare that would improve cooperation and coordination among its members.

The GHT Aube/Sézannais was officially created on the 9th of July 2016 with the support of the East-RHA and is a compound of 6 hospital organizations (figure 1).

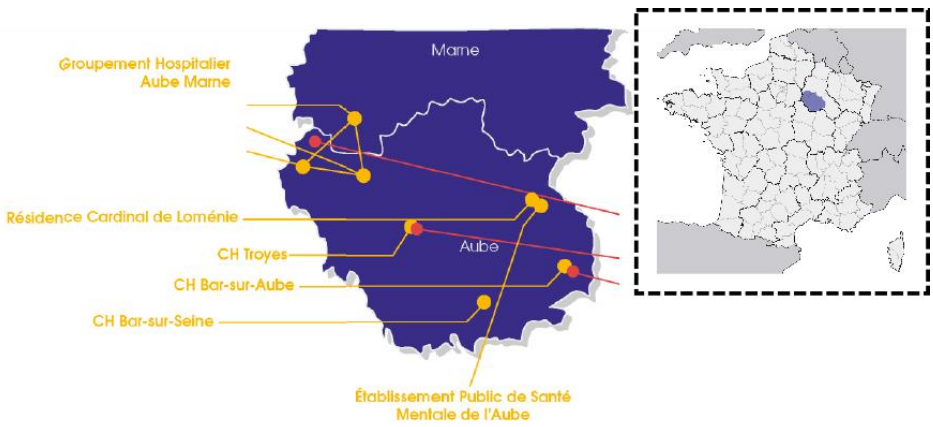

Figure 1. Location of the six institutions of the GHT (thumbnail: location of the GHT in France)

In this context, a project has been defined and agreed upon by the different members of the GHT for the 2017-2022 period. This project promotes a digital and ICT strategy to address the lack of available medical resources and to implement equal access to healthcare policy. On the side of elderly persons' care, the project's policy aims at easing the access to specialist doctors and at preventing the transportation of patients from nursing homes to the local hospitals. The project also aims at creating specific care pathways for a defined population (e.g., elderly residents with diabetes) with the support of telemedicine, as well as providing support to healthcare professionals for the use and integration of ICT in their practice. In this context, MyGHT Télémédecine was born in 2018, partly funded by East-RHA. The motivation behind this telemedicine project is based on the observation that nursing homes residents are experiencing a lack of medical follow-up, despite being the most at risk of experiencing chronic conditions and multiple pathologies. The main reason

[3] Article 36 du Projet de Loi de Financement de la Sécurité Sociale (PLFSS) 2014.

being the cost and the iatrogenic risk associated with transportation to the hospital for access to specialists. As explained by the leader of the MyGHT Télémédecine project:

> "most of the elderly residents are not able to book and consult diabetes' specialists from the hospital, apart from the occurrence of a critical event that will justify the cost for transportation and hospitalization".

This means their diabetes is mainly followed at the nursing home through general practice, which may not be up to date with the last medical protocols, if not at all. Diabetes by itself is not the main source of the request to EMS by a nursing home, but its association with other pathologies, for instance, with neurodegenerative conditions, and bad diabetes follow-up makes the residents at risk of experiencing a critical emergency, especially in the summer heatwave.

Several specialists from the GHT have accepted to take part and to open time slots in their calendar for teleconsultation on four domains: wound healing, diabetes, sleep apnea, and geriatrics. The nursing homes taking part in the experiment are then able to book teleconsultations for their residents with MyGHT Télémédecine (fig 2). On the defined day of the teleconsultation, the resident is accompanied by the nursing home coordinating doctor and/or a nurse to reach a dedicated room and have a consultation with the specialist through the Internet.

Figure 2. An example of the MyGHT Télémédecine teleconsultation software interface, before the start of a teleconsultation between a 74-year-old patient and a dermatologist.

The teleconsultation solution is an off-the-shelf laptop computer with a good quality camera and a printer. The chosen solution does not include any connected medical or physiological measurement device in order to keep the system simple. Health professionals are supposed to use the video-call channel to share physiological measures and information. The software solution provides secure video communication with scheduling and waiting room on the server-side and has been chosen to be able to run on any professional-grade computer as those used by the hospital.

After six months of experimentation and more than 200 teleconsultations, East-RHA validated the success of the pilot study and its interest in the solution. This early success has allowed the GHT to get funded for expanding the solution to the other nursing homes in the territory (n=49). As of September 2019, forty-six nursing homes have been equipped.

Despite this successful coverage, and the East-RHA attempting to incentivize nursing homes to use telemedicine, only some of them are regularly requesting teleconsultation. For a nursing home, fifty teleconsultations between September and December 2018 would have permitted to receive more funding, but several have not done much more than the test required by the East-RHA to get reimbursed from their investment.

In the remaining parts of this paper, we present the qualitative approach that we adopted in order to get a better understanding of the reception of the MyGHT Télémédecine solution at different nursing homes in terms of domestication of technology.

Participants and Methods

Given the distributed character of such telemedicine applications, our approach is inspired by multi-sited ethnography with the aim of "following people, connections, associations, and relationships across space (because they are substantially continuous but spatially non-contiguous)" (Marcus, 1995).

At the onset of our inquiry, we had conducted two one-hour long interviews with the doctor who leads the MyGHT project. These interviews focused on the context and history of the teleconsultation project, the motivation for the project regarding health policy and the organization of healthcare in the region, the current deployment status at the hospital and in nursing homes, as well as the cases identified as successful or not from his point of view. The documents shared among the different stakeholders of the projects and the presentations made to the public are also part of the material that we have collected.

From May to July 2019, the first author has conducted visits at four different nursing homes where the teleconsultation solution has been installed. The visits have been arranged with the support of the doctor in charge of the MyGHT project, who has provided us with a contact person in charge of MyGHT Télémédecine at each institution (the head of the nursing home or a coordinating doctor, depending on the case). Through observation and interviews, our visit allowed us to gather information about the reception of MyGHT Télémédecine following its installation and the current working status and material arrangement of the teleconsultation solution.

The topics addressed in the interviews were the history of the teleconsultation project at the nursing home (project enrolment and local needs), the installation and technical configuration of the solution, the current use by the staff (i.e., how is the decision of practicing teleconsultation made? Which pathologies are concerned? How is a teleconsultation scheduled and conducted?), as well as the future evolution of telemedicine

in the nursing home. In one case, we were able to follow a teleconsultation with the agreement of the patient and staff.

The visits lasted from thirty minutes to two hours. Detailed field notes have been written just after the visit, or the following day.

As mentioned already, the four nursing homes (figure 3) among the forty-nine in the GHT territory have been chosen after discussion with the doctor who leads the MyGHT project with the willingness to include both nursing homes in which the deployment is considered successful (VSB and ASA in table I), and nursing homes in which few or no teleconsultation have been conducted so far (BSS and BSA in table I).

Figure 3. The localization of the Troyes hospital (in red) and the four visited nursing homes (nursing homes attached to a local hospital are figured in yellow).

Table I. The visited nursing homes (TC = teleconsultation).

Nursing home name	Size of the institution (in beds)	Contact person role	Is close to a local hospital?	Date of the 1st TC	Number of TC in 2018
VSB	72	Head of the nursing home (former nurse)	No	2018-04-30	47
ASA	108	Head of the nursing home (non-medical staff)	No	2018-11-20	1
BSS	205	Coordinating doctor	Yes	--	0
BSA	130	Coordinating doctor	Yes	2018-07-17	1

VSB

Situated 36 km East from Troyes, Vendeuvre-sur-Barse is a 2300 inhabitants' village. The nursing home is part of an international for-profit private group (102 institutions in France, 10 in Italy, 11 in Spain, 2 in China). Twenty-eight among the 72 accommodations in this nursing home are dedicated to people with advanced dementia (ADRD: Alzheimer's disease and related disorders) and 4 to short-term stays. The first floor is called "the Village center", with some tables imitating a sidewalk cafe and a free to use coffee maker is available for everyone (residents, families, workers).

We started with a thirty-minute semi-structured interview with the general manager and the telemedicine referent nurse in a meeting room. Then, we attended a 23 minutes' teleconsultation for a non-healing pressure ulcer. Third, the general manager showed us the institution around.

ASA

Situated 37 km North from Troyes, Arcis-sur-Aube is a 2800 inhabitants' village. The nursing home is an independent public institution composed of 108 accommodations, including 14 for ADRD. Furthermore, it includes a service that delivers nursing care at home (46 beds). Nurses and assistant-nurses go to patient's homes to practice everyday nursing care.

A 35-minute semi-structured interview with the nursing home's general manager was conducted in his office. No telemedicine consultation occurred when we met, so he just showed us his telemedicine equipment.

BSS

Located 32 km South-East from Troyes, Bar-sur-Seine is a 3000 inhabitants' town. Including ten short-term beds, 22 long-term and rehabilitation beds, and two nursing homes with 205 beds (counting 21 ADRD beds) that are public institutions. Bar-sur-Seine hospital, which is part of the GHT, is key for the local healthcare infrastructure. This hospital only works with healthcare practitioners with a private practice. It is a classic operating mode for small hospitals that cannot afford permanent practitioners. Because of this organization, the nursing home has issues finding available practitioners for their residents.

A 46-minute semi-structured interview took place with the coordinating doctor and one of the two health managers in the health manager's office.

BSA

Located 60 km East from Troyes, Bar-sur-Aube is a 5000 inhabitants' town. The local hospital offers 30 long-term care beds, 30 rehabilitation beds, a 130 beds nursing home (including 14 ADRD beds), an Emergency and Resuscitation Mobile Service, a conventional radiology unit, and offers a wide range of external consultations (cardiology, neurology, general surgery, ORL…).

A 20-minute semi-structured interview with the coordinating doctor took place in his office.

Findings

In what follows, we use the four stages of the domestication framework to present the reception of MyGHT Télémédecine at different nursing homes. It is worth noting that the design and the deployment of the teleconsultation solution did not consider the specific work practices of the nursing home we have followed.

Stage 1: Appropriation

As a follow-up of the success of MyGHT Télémédecine experiment, the local government, and the Regional Healthcare Agency (RHA) funded the nursing homes to be equipped with the "MyGHT Télémédecine" technical solution.

The process is the following: the nursing homes which decide to put in place teleconsultation contact the MyGHT Télémédecine service provider to order the equipment and set up the system. Among the four nursing homes we have studied, two of them have spontaneously requested to join the project (VSB, BSS). The other two (ASA and BSA) have accepted to join the project after the leader of the MyGHT Télémédecine project insisted on their interest in joining the project.

The RHA gives 14k euros for each nursing home participating in the project. After purchasing the equipment (that costs less than 5k euros), the nursing home receives half of the amount (7k euros), and the RHA gives the second half at the end of the year at the condition that the nursing homes have scheduled 50 teleconsultations.

The number of 50 teleconsultations is an unrealistic goal (see Table 1) that was not clear for the nursing homes before they engaged in the project. As the coordinating doctor of BSS puts it:

> "We had to start the experiment very quickly to get funding from the RHA. Besides, the proposal was not honest: we were given full funding on the condition that we would carry out 50 TCs between April and December!"

VSB nursing home is situated 40km away from Troyes hospital, an area that lacks medical care. Therefore, they saw the telemedicine project as an opportunity for better continuity of care for their residents. Besides, two of its three general practitioners (GPs) were about to retire, and the general manager did not find new ones for patients' follow-up and prescriptions, thus, she asked spontaneously to join the project. As the head of the nursing home of VSB puts it:

> "We started (the teleconsultation project) out of need. In mid-2017, out of the three general practitioners following our patients, we knew that two had planned to retire in August 2018. We would, therefore, have one general physician and a half-time coordinating practitioner left. We had heard about a telemedicine project in preparation with the hospital of Troyes; we went to meet them. "

As ASA nursing home has similar geographic limitations, the leader of the MyGHT Télémédecine project offered them to join. They were not lacking GPs but specialist doctors, so they agreed to try out the solution.

BSS and BSA are two nursing homes linked to their own local hospitals. General practitioners with private practice and specialists from the local hospital can see the nursing home's residents when needed. Therefore, the heads of these nursing homes have expressed few needs for the teleconsultation service offered by Troyes' hospital (apart for dermatology for BSS).

All the nursing homes bought (with the financial support of RHA) the basic package including a laptop with an integrated microphone, a couple of webcams, antivirus software, and a printer.

Stage 2: Objectification

In VSB nursing home, telemedicine consultations take place at the infirmary or at the resident's room. To ensure privacy, nurses place a warning sign "teleconsultation in progress, do not disturb!" on the door. Wi-Fi connection issues occurred, so a 4G Internet dongle has been installed that allows telemedicine consultations everywhere in the nursing home.

ASA followed the same strategy as VSB, but we noticed when we came to visit the nursing home that the trolley for the telemedicine equipment was in storage for medical furniture, behind a vacant desk.

BSS and BSA both dedicated a room to telemedicine consultations. The residents must come to the "digital medical office" for their teleconsultations. Some of them needed a nurse with a stretcher-bearer to bring them to the room.

Stage 3: Incorporation

In 2019, VSB organized 92 teleconsultations (47 in 2018), ASA only 2 (1 in 2018), and BSS and BSA only one (in 2018, 0 for BSS and 1 for BSA). Thus, VSB was finally the only nursing home we have seen, which has succeeded in routinizing teleconsultation and completing the incorporation stage.

We are now going to describe a case that we observed in VSB: A patient was suffering from a not healing pressure ulcer after two weeks of care. A nurse then decided to launch a telemedicine consultation with a surgeon from the hospital: She then scheduled an appointment directly into the surgeon's digital calendar. On the morning of the appointment, the nurse switched on the laptop, tested the connection and the equipment, and ensured that the surgeon accepted the appointment (or did not cancel it). On the 28th of May 2019, we attended this teleconsultation. The patient was sitting on a comfortable armchair in the infirmary, in front of the laptop (placed on a trolley). Waiting for the surgeon in an online waiting room, two nurses and a student were discussing the workflow of the teleconsultation. The referring telemedicine nurse said: "Before the surgeon comes in, you have to remove the bandage and read the medical record. Even if she can read it online, she always asks you to introduce the patient". The consultation lasted for 23 minutes, which included several connections and webcam troubles, and only 9 minutes of actual consultation time. The surgeon gave some recommendations on how to improve the healing of the pressure ulcer and added these recommendations to the medical record of the patient. Nurses ended the consultation and put back the bandage while administering the surgeon's advice. The nurses booked another teleconsultation for monitoring purposes in three weeks.

In the case of ASA, to accommodate the potential teleconsultation, the nurses have changed the organization of their work so that two nurses are always present in the nursing home during the day, whereas only one is there during the night. Then, if a teleconsultation happens, one of the two nurses can participate while the other one can still take care of the residents. However, for ASA's general manager, the telemedicine project rolled up too quickly with low quality but expensive equipment, so the telemedicine consultations did not become a daily practice. For him, the equipment is "absolutely not ready". We should prepare ahead for teleconsultations as the computer takes one hour to turn on and the update of the system is too complicated.

In the case of BSS, where two nursing homes are attached to a small hospital, a room has been dedicated to the teleconsultations. So, as we mentioned, a nurse is supposed to help the patient to reach the consultation room and to stay in the room for the whole teleconsultation. However, when the coordinating doctor of the nursing home saw a nurse using a stretcher-bearer to bring a patient to the "digital medical office" for teleconsultation he decided to stop the experiment saying, "this is not her job!". This simply ended the nursing home tentative to incorporate the teleconsultation solution.

Finally, in the case of BSA, a nursing home attached to a small hospital, a room next to the emergency service was dedicated to the teleconsultation, as the teleconsultation is planned to avoid the transfer of the patient to the major hospital in Troyes. This organization also requires carrying the patient to the consultation room.

In the case of BSS and BSA, the nursing homes share medical health actors with their attached hospitals. Thus, in both cases, the interviewees mentioned the lack of medical time (mainly nursing time) necessary to engage in the teleconsultation. For the interviewee of BSS (Coordinating doctor)

> "We are already running out of medical time... Also, the doctor has to be present during the teleconsultation, which is a considerable waste of time. There is no protocol."

From the beginning, BSS and BSA have stated that the service does not match their demand: Troyes' hospital offers telemedicine consultations while BSS nursing home would prefer telemedicine advice (tele-expertise: where a doctor asks for another doctor advice for a patient's case). As the coordinator doctor of BSS puts it:

> "the specialties offered were not aligned with our needs: we needed teleconsultation in dermatology. For 5 minutes of consultation (physical, classical), there is one hour and a half of preparation. It is necessary to write a letter to the dermatologist to explain what we need, but we are not in front of him, we cannot speak directly with him. So, we thought it would be more comfortable with telemedicine. "

Once a month, a dermatologist, a neurologist, and a surgeon come to BSA's hospital, so the nursing home does not need teleconsultations with specialists from Troyes' hospital. the coordinator doctor of BSA highlights this fact:

> "The problem is that the telemedicine offers duplicates to our advanced hospital consultations. The benefit is unclear. We are a local hospital with an imaging service (radio, echo, mammography), a Mobile Emergency and Reanimation Service, a mother/child center, a psychiatry unit, a planned day hospital, and a network... Here we are not an isolated nursing home."

Once again, the service does not correspond to the need. When we asked the coordinating doctor in BSA if we can have a look at the dedicated consultation room, he answered: "I don't even know where the key is!". Incorporation in those nursing homes failed for the moment.

Stage 4: Conversion

The fact that the project improved access to specialists from Troyes' hospital but not to general practitioners, VSB nursing home joined another telemedicine project using the same technology. They also responded to a call for projects from the RHA to become a public access center in which fragile people living at home could come for teleconsultation, instead of having to go to the hospital for a face to face consultation. They wrote a proposal, but the RHA did not agree to fund it, so the project stopped.

ASA is also considering the opening of the nursing home to the public so that any citizen could benefit from the teleconsultation service, but the general manager would like to buy a better laptop or even a tablet and accessories. For now, because of an internal reorganization, he stopped working on this topic. For now, BSS and BSA are waiting for a need's analysis. They have put the project on pause because MyGHT Télémédecine does not fit their current needs.

Discussion

Observing these different situations, we are interested in examining how does the high-level discourse on equal access to healthcare impact the current deployment of a telemedicine solution, and in particular, to look at the role of policy in supporting the adoption of teleconsultation.

In terms of the domestication process, the four nursing homes we have observed have reached the objectification stage, which highlights that the RHA-East and GHT policy and funding supported the nursing homes in acquiring and installing the teleconsultation solution. However, only one of the four nursing homes we have studied (VSB) is regularly organizing teleconsultations.

Our findings show that the policy of equal access to healthcare triggered the initiation of the domestication process of the teleconsultation. In fact, for East-RHA, funding nursing homes to join MyGHT Télémédecine was a way to locally transpose the national political discourse about equal access to healthcare. Furthermore, The East-RHA tried but failed to force the incorporation and conversion steps by conditioning the payment of half of the funding with the execution of fifty teleconsultations in three months for each nursing home.

We argue that each case differed based on how the discourse of the policy promoted by the GHT resonated with their ambition to be part of the healthcare system.

Nursing homes mainly offer residential services for fragile people. Placing the telemedicine technology at the nursing home requires that the role of the nursing home evolves so that it becomes a partner in the provision of healthcare. Thus, while nurses in the nursing homes are used to take care of medical issues by organizing transfers to emergency services or by organizing specialist consultations, they never take part in any way in the medical act. However, with the use of telemedicine technology at the nursing home, they start playing this active role in the medical act, in our case, the consultation.

As we described above, the deployment of teleconsultation was conducted in a top-down manner, starting with expectations of East-RHA to improve healthcare in nursing homes. These expectations required nursing homes to adapt their work organization, which impacted the process, practice, and space. In ASA, the nurses changed the shifting organization, in the four places, nurses faced additional tasks like accompanying the patient the whole time of teleconsultation or helping the patient to reach the consultation room (in

BSS and BSA). In BSS and BSA nursing homes, a room was created for teleconsultation to take place.

Our findings also show that the need for teleconsultation is not homogeneous and depends on the local organization of healthcare. For instance, in VSB, they lack general practitioners. In contrast, in ASA and BSS, they rather lack specialist doctors, mainly dermatologists, and psychiatrists (not currently covered in MyGHT Télémedecine). Moreover, for BSA, the current offer of teleconsultation seems redundant with the service they already offer to their residents.

The use of the domestication framework allows us to analyze the difference in the effort put into integrating teleconsultation in the four cases. Initial observations suggest that there may be a link between the political discourse about the access to healthcare and the reception of the teleconsultation solution by the nursing homes.

In the case of VSB, the actors do not consider themselves as healthcare providers. They perceived the policy that promotes equal access to healthcare as a way to offer new services to their residents by becoming a partner for healthcare. Using telemedicine at the nursing home allows them to be proactive with solving the problem of accessing care and thus suffering less from being located in a rural area. This vision incentivized them to provide the necessary effort and thus to domesticate telemedicine. The head of the nursing home of VSB insisted in the interview that:

> "nursing homes are evolving to become a new "hub" in the territories (like the post offices used to be before they closed) and that (telemedicine project) it is an essential step for them to become local health and medico-social relays".

The head of the nursing home endorses the idea that teleconsultation gives access to healthcare, and his willingness to open his institution to the public emphasizes that this nursing home is becoming a genuine partner for healthcare, going beyond providing accommodation services solely and acting as a proxy for healthcare. This vision aligns with the political discourse on equality of access to healthcare.

In the cases of BSS and BSA, the main invoked reason for not using the teleconsultation solution is the lack of relevant specialist doctors. However, as the other nursing homes are also facing this issue, we hypothesize that being attached to a local hospital did not lead them to envision the use of teleconsultation as a way to become more effective as a partner for healthcare. The professionals in these nursing homes already consider themselves as part of the healthcare system, as they already work across the local hospital and the nursing home.

Finally, in the case of ASA, more time is needed regarding their ambition to become a public center for teleconsultation as they have joined the project lately.

In summary, in terms of domestication process, the four nursing homes we have observed have reached the objectification stage, which highlights that the RHA-East and GHT policy and funding supported the nursing homes in acquiring and installing the teleconsultation solution. However, only one of the four nursing homes we have studied (VSB) is regularly organizing teleconsultations.

Indeed, in this case of successful domestication, the head of the nursing home is convinced by the idea that teleconsultation gives access to healthcare, and his willingness to open his institution to the public emphasizes that this nursing home is becoming a genuine partner for healthcare, going beyond providing solely accommodation services.

These preliminary findings start contributing to the CSCW literature on the appropriation of technology as "the way in which technologies are adopted, adapted and incorporated into working practice" (Dourish, 2003, p. 466). Our contribution is related to the first step of the domestication process, and the importance of policies in the future incorporation of technology in existing work practices. This work will, of course, go on. Still, our preliminary results of this region-wide deployment of a teleconsultation solution in nursing homes already contribute to the study of the complex interplay between policy, technical systems development, and social practice (Jackson et al., 2014; Centivany, 2016).

Conclusion

The research work reported here deals with the relationship between healthcare policy and technology adoption, and to what extent they impact and influence each other. The MyGHT Télémédecine solution has been developed within the context of a policy aimed at providing equal access to healthcare by providing a way to ease access to specialist doctors through teleconsultation. In this paper, we have presented preliminary results of our observation of the domestication of MyGHT Télémédecine in four nursing homes. These are the first steps in enlightening the way a healthcare policy can incentivize the use of a teleconsultation service.

MyGHT Télémédecine continues its deployment, and our study and fieldwork are ongoing. In the next steps, we plan to expand our fieldwork with several other nursing homes. We want to investigate further the link between policy and technology domestication, not only from the perspectives of the head of nursing homes but also from different professions' perspectives (in particular the nurses and orderlies). For instance, the doctor in charge of MyGHT Télémédecine presents teleconsultation and easier access to specialists as a way to initiate a shift in practices towards a more preventive approach to healthcare, which could avoid the request to costly emergency care. We will also investigate the teleconsultation practices of the specialist's doctors at the hospital.

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A system design to support outside activities of older adults using smart urban objects

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Abstract. During outside activities, elderly people encounter different challenges than young people. Those difficulties impede their motivation to pursue outside activities. To counter this problem from a human-computer interaction perspective, we propose a support system for seniors to improve their motivation and subjective safety while undertaking outside activities by coordinating smart urban objects. Drawing from an extensive empirical requirements analysis, we identify typical barriers experienced by seniors for which networked smart urban objects may provide assistance. We discuss a conceptual description of an activity support system: the system aggregates user profile data with information about the urban space to suggest possible activities, the elderly user chooses an activity and receives navigational assistance to increase their motivation and feeling of safety while undertaking the chosen activity. Finally, we discuss our approach regarding challenges such as user autonomy, privacy and real-world deployments, which need to be considered in future implementation and evaluation phases of the system.

1 Introduction

When pursuing activities outside their home, older adults have considerations and requirements towards the urban space that young, able-bodied people may not be aware of, such as shorter distances between seating opportunities or the inability to climb steps. When perceived as safety issues, these requirements may severely constrain seniors' outside activities, to the extent that some senior citizens stop leaving their home at all (Generali Deutschland AG, 2017). In the *UrbanLife+* project, we are currently exploring various approaches for encouraging and fostering self-directed activities outside the home in older adults. This entails overcoming many kinds of barriers, both objective and subjective.

To increase the safety of outside activities for seniors, we are developing an activity support system that provides navigational assistance as well as motivational support based on gamified interactions tailored towards the needs of seniors. This paper provides some context based on our requirements analysis, summarizes our system design, provides an example scenario to illustrate the vision behind the idea, and outlines several challenges that we are facing in ensuring that giving our users' needs the highest priority. Eventually, our goal is to extract the lessons learned from designing and deploying our systems into design recommendations for IT systems aimed at seniors that are deployed in the urban space.

2 Related work

A few research approaches have been made into supporting seniors in outside navigation. Teipel et al. (2016) give an overview with a focus on systems geared towards dementia patients. While the target user group's physical needs are closely related, our approach differs in that we focus on senior users who do not suffer from cognitive deficits, at least not to such an extent that it would impair their daily life.

Krieg-Brückner et al. (2015) provide a review of approaches for augmenting personal mobility devices, e.g. wheelchairs, using navigation assistance technology, partly addressing the same problems as the system detailed in this article. The biggest design difference is that *UrbanLife+* aims to install technological assistance into the public urban space itself, rather than focus on personal devices.

An example of a broadly related project that uses statically placed devices to assist seniors experiencing the space is presented by Kempter et al. (2014); however, this and similar systems are only concerned with indoor use.

Another interesting research area related to assistance of daily routines are workflow management systems, which have seen considerable research in the field of Computer Supported Cooperative Work (CSCW). These systems manage and coordinate tasks in business processes by enabling an automated flow of tasks between the participants and supporting the participants during the activity accomplishment (Galler, 1997). The task management and workflow coordination contain similarities to our required support for seniors as they support work

activities by providing information to the employee for orientation, e.g. about the process status, task description or other involved employees. However, they focus on different kinds of activities: computer-based activities, indoor activities, business process related activities. In contrast, we are aiming to provide motivation and support during outdoor activities for elderly people, while the activities are not computer-based or business process related.

We believe the outdoor installation of innovative activity support technology for seniors to be a novel research approach.

An essential aspect of technology development is its high acceptance of the target group for which the technology is designed. As seniors are a special target group, there is some research in how to measure and estimate the acceptance by seniors by applying, for example, a *Senior Technology Acceptance & Adoption Model (STAM)* (Renaud and van Biljon, 2008) with the following aspects:

- User context: demographic variables (e.g. personal factors like age and functional ability, social influence)
- Perceived usefulness: "extent to which person believes that using the system will enhance his or her job performance" (Venkatesh et al., 2003)
- Intention of Use: influenced by user context and perceived usefulness
- Experimentation and Exploration: the first usage of the technology and first impressions of the ease of use
- Ease of learning & use: combination of perceived ease of use and final decision about ease of use
- Confirmed usefulness: usefulness of the technology for the user measured with the features the user can learn to use
- Actual use: predicted by the outcome of experimentations and leads to ease of learning & use

Renaud and van Biljon (2008) identify the components *ease of learning & use* and *perceived usefulness* as fundamental factors for the elderly's acceptance or rejection of new technology. As the paper focusses on mobile phone accceptance, it still needs to be verified whether or which of those aspects are relevant when it comes to smart cities and technology in the urban area. However, the STAM may be used for evaluation purposes of our activity support system with a detailed look at those two most relevant acceptance factors of technology for elderly.

As *UrbanLife+* is a multi-year project involving several institutions, a number of early and intermediate infrastructural elements are already available or within planning distance. Chiefly, the project is concerned with the development of smart urban objects (SUOs), devices that can be installed in public or semi-public urban spaces and that provide personalized functionality using networked digital technology (Kötteritzsch et al., 2016; Aleithe et al., 2017; Fietkau et al., 2016; Zimpel and Hubl, 2019). Utilizing stationary devices in the urban space as opposed

to personal mobile devices means that interaction surfaces can be larger, the devices cannot be forgotten at home, and retaining battery charge is not an issue.[1]

Among the devices being developed, there are:

- Information radiators: a class of devices that broadcast ambient information visually, ranging from large touch screens to small LED information devices (Koch et al., 2017)
- Adaptive lights: public light installations that can adjust their color and brightness according to user preference or other pertinent criteria (Aleithe et al., 2018)
- Smart park benches: public benches for seating that are outfitted with sensors and actuators to facilitate e.g. advance reservation or subtle nudges to remind users to make room for approaching seniors (Hubl, 2019; Hubl et al., 2018)

Skowron et al. (2019) provide an overview and categorization method for the SUO design space.

The approach of using SUOs to increase seniors' safety was previously mentioned by Kötteritzsch et al. (2016), who describe interactive information radiators as one specific category of SUOs, discuss the topic of a *comfort zone* and how this zone can be extended. The information radiators are either large information displays or micro information radiators with LED lightning or sound signals. Every SUO has a different functionality, but all of them have the aim of increasing the safety of seniors by giving support and information, consequently seniors feel more comfortable in the urban area. For example, a macro information radiator is a large multi-touch-screen containing information about events and activities in the neighborhood or small information radiators can be positioned at, for instance, a traffic light where sound is played to attract the senior's attention and showing a signal with an arrow pointing towards the next barrier-free intersection (Kötteritzsch et al., 2016). The small information radiators are flexible in position and deployment scenarios, while large information screens enable an overview and easy touch interactions for the senior.

We have also published a proposal for how the SUO network could be harnessed to provide seniors with a gamified system to promote outside activities (Fietkau, 2019). We endeavour to keep the repetition of content from that article to a minimum, but will briefly explain our approach as applicable in sections 4 and 5.

These SUOs are connected to a number of backend services for various tasks: SUO enumeration and cataloguing, providing accessibility information about the urban space, storing user profile data etc. This paper proposes an additional *activity support service* to model outside activites undertaken by users and to coordinate pertinent data exchanges between SUOs and other services, whereby seniors can be

[1] These advantages come with the caveat that *UrbanLife+* implements user identification at the SUOs via Bluetooth, for which users (or their caretakers) are expected to install an app on their personal mobile device. Users do not need to actively use their device to interact with SUOs, but merely carry it in their pocket. This approach also allows them to easily switch off the tracking whenever desired.

supported during their whole activity accomplishment. Details on the design can be found in section 4.

3 Requirements

The *UrbanLife+* project has picked the german city of Mönchengladbach (population: about 260,000) as its location for analysis and evaluation. The city was chosen for test deployments within the project and an extensive survey among seniors was carried out in two specific districts (one within the city center – Hardterbroich – and one in a more remote and rural area – Rheindahlen). We defined our target user group as seniors aged 65 and up, who are physically and mentally capable of planning their own everyday activities in- and outside their home and then executing their plans. These criteria exclude some seniors, such as people who are entirely bedridden or who are suffering from advanced cognitive decline to an extent that they can no longer make their own decisions regarding their daily activities. The rationale behind these criteria is that systems to assist outside activities can only benefit users who are capable of deciding on and undertaking such activites.

Through a cooperation with the local governments, all residents aged 65 or older and living in those specific areas were contacted – 6,170 surveys were sent out in total. Of those, 1,302 were complete enough to be evaluated. Subtracting a small number of non-deliverable surveys and unusable return questionnaires, the return rate was 21.5%. The survey covered a number of areas including general demographic data, household and family constellations, health and lifestyle, general IT use, mobility and activites, mobility barriers and perceived obstacles. See Leukel et al. (2017) for a detailed description of the study, and the project website[2] for a summary of the overall results. General implications of the survey results are further discussed in other project publications (Schehl et al., 2019; Schehl, 2020; Schehl and Leukel, 2020). In this article, we will focus on the data items that are directly relevant for our design, which are the responses on mobility aids and perceived barriers for outside activity.

Mobility aids: The most common mobility aid used by the target user group is the walking cane, which is used at least somewhat often by 17% of respondents. Walking frames are almost as common at 13%. Other mobility aids such as wheelchairs are less common. While a very strong majority of respondents does not regularly make use of any mobility aids, the user groups that do use them are far from negligible, especially when viewed as a whole. This means that systems aiming to support seniors' outside activities must incorporate various kinds of mobility aids into their design and cannot assume that their users will be able-bodied, capable of climbing steps or steep inclines, and able to fit through narrow spaces.

[2] https://www.urbanlifeplus.de/2017/09/ergebnisse-der-buergerbefragung-jetzt-online/

Perceived barriers: The survey asked seniors how much several different possible barriers prevented them from going outside. When looking at the percentage of people responding "moderately" or higher, the most common responses in descending order are: 1. lack of public bathrooms (45%) 2. fear of assault/violence (44%) 3. dangerous footpaths (38%) 4. not enough lighting (34%) 5. too few opportunities to rest (32%) 6. distances too long (26%) and 7. too many traffic-related dangers (24%). While our system is unable to fix any of the root causes for these perceptions, they offer valuable guidance for what specific paths or roads need to offer in order to be perceived as safe. Assisting users in finding the benches and public toilets that do exist, and taking care to make use of well-lit public paths wherever possible, are design goals that may help seniors feel more confident about being active outside their home.

4 Activity support

Taking part in activities outside the home necessarily entails navigating to and from the location where the activity takes place. To provide pedestrian navigational assistance to seniors, to account for personal needs on the way (e.g. stops for rest or toilet use) and to foster motivation by as many available means as possible, we aim to utilize a wide variety of networked SUOs which are installed in the urban space, as detailed in section 2. Additionally, data needs to be aggregated from central sources such as the profile service, the SUO management service, and the routing service. As this is a centralized task, it makes sense to implement it as an additional central backend service.

We call this service the *activity support service*. It is connected to the other *UrbanLife+* backend services (for user profiles, SUO data, routing etc.) and it can interface with specific SUOs via the SUO management service. Those connections of the activity service and other components are displayed in the architecture diagram shown in figure 1, containing the *UrbanLife+* backend, SUOs and personal or connecting devices.

Users of the *UrbanLife+* system may view a variety of recommended activities at any large information radiator. As the SUOs can identify an approaching user (provided they have installed the project's mobile app and registered an account or they carry an iBeacon close to them), personalized recommendations can be provided from a pool of available activities in- and outside the neighborhood. To help foster motivation, we also aim to provide a variety of tasks and rewards which are modeled after the "quest" metaphor commonly found in role-playing video games, such that users would be enticed to attempt new activities and offers by small material rewards. See Fietkau (2019) for more details regarding this approach. For the purpose of this article, it is sufficient to know that the activity support system is intended as the central infrastructure to facilitate choosing outside activities, tracking individual progress and managing personal rewards.

When a user has decided to start an activity, the activity support service coordinates smart urban objects and data from other services to provide as much

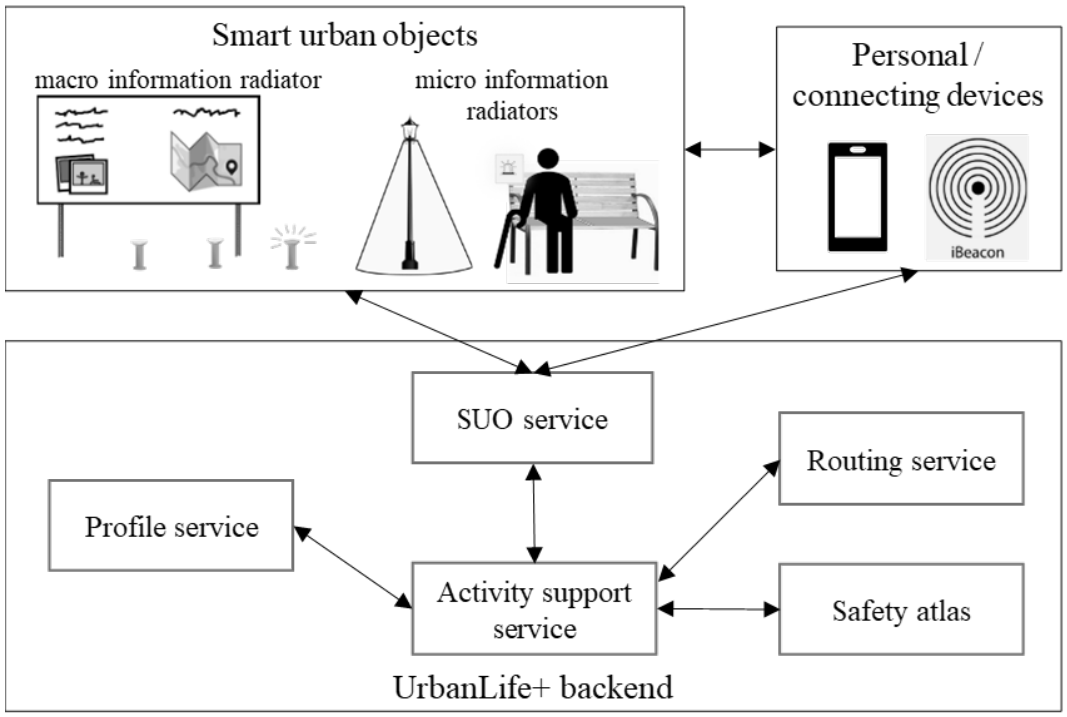

Figure 1. Activity support service architecture diagram with connected components..

support as possible to the user while they navigate to the activity through the urban space, partake in the activity, and then navigate to the next location or back home.

Any action taken by the service is based on a known or suspected *intent* of the user. In our model, "intent" is defined as follows:

- An intent is a mental plan held by a user for a future activity.
- Intents may range from very precise ("be at the dentist at 4:00pm this Thursday") to very loose ("spend some time in the sun this weekend").
- Intents can cover different timescales, e.g. "I want to go buy groceries right now" vs. "I want to check out the new restaurant some time this month".
- An intent may or may not be self-motivated. Some outside activities are entirely voluntary, such as taking a walk, others (e.g. medical appointments) can be externally imposed.
- One user may have several intents at the same time, each one having a different priority and urgency.

This intent model was developed iteratively based on internal correspondence with project members, including experts for elderly care. We started with a minimal model in which one user would have exactly one goal at any time, and then gradually expanded to accommodate ways in which we conjectured that real users would make plans for activities. The intent model has not been specifically validated and, if found lacking, is subject to change.

The activity support service attempts to determine and model user intents. Ideally, the user signals their intent to the *UrbanLife+* system directly, for example by tapping "I want to visit the restaurant right now" at the large information radiator or by sharing their appointments with the *UrbanLife+* system via an as-yet undetermined process. Avenues to infer user intents indirectly may also be explored, although this will be much more difficult to do reliably and in a way that does not confuse or patronize the user.

4.1 Example scenario

Margot Nowak[3] wants to leisurely spend a few hours before dinner. She looks at the large information radiator at the Hardterbroich seniors home for some ideas for what to do. She sees that the Textiltechnikum (a local museum) is currently open and touch-drags the offer into her personal area for immediate use.

The information radiator notifies the activity support service that Margot intends to visit the Textiltechnikum right now. The service queries the routing service to determine the path that Margot is likely to take, and then requests a filtered list of smart urban objects located on or near this path from the central SUO management service. It calculates her expected arrival time based on her expected walking speed (determined heuristically or from previous tracking data, stored by the profile service) and sends an event to all affected SUOs reading something like "Margot Nowak is on her way to the Textiltechnikum and will likely pass by on foot in x minutes". It may also send an email to Textiltechnikum staff letting them know that a person requiring mobility assistance is on the way.

The SUOs along the way can react to this new event in whichever way they deem appropriate: smart park benches may start a timely seating reservation process, lights may adjust themselves to Margot's needs and preferences, small information radiators may prepare to show symbols for navigation assistance, etc. Whenever new information about Margot's location becomes available, updated events may be sent – especially if Margot changes her mind about the activity and turns around to go back home.

Independent of user intents, SUOs may continue to offer their general functionality, such as small information radiators displaying dynamic warnings for hazardous areas like steps that get slippery after it has rained.

5 Discussion

Setting aside the technical and organizational challenges in getting the *UrbanLife+* platform to a functional stage, we view the evaluation from an HCI perspective as the most significant challenge. The goal is to strengthen seniors' participation in

[3] Margot Nowak is the name of a fictional persona – one of several – which *UrbanLife+* uses for scenarios and usage models. Her demographic data and assistance requirements are an example for a person living in the senior housing residents in the city where the project is being conducted.

the urban space and to make it easier and safer for them to take part in activities outside their home. Possible measures for success could be an increase of such activities, but it would be unrealistic for the scope of *UrbanLife+* to perform a wide-area deployment to allow organic, unsupervised use of the platform. To evaluate our approach, we instead run long-term deployments of individual SUOs in semi-public areas in combination with time-limited, closely supervised installations in public spaces – say, deploying a number of small information radiators along the street during daylight hours for a few days to perform usability tests. Our specific constellation of circumstances prompts us to engage with a number of different challenges.

Firstly, we need to take care to design for user autonomy and self-determination. The activity support system aims to assist users and to open up new possibilites – our intent is to leave all decision making competence in the users' hands. Designing all user interactions to respect this principle will be challenging. For example, users might perceive an arrow that signals them where to go next as a restriction as opposed to an assistance. Our interactions will need to be designed and evaluated to ensure that users are always aware that they are free to change their mind without penalty and to diverge from the provided recommendations whenever they want.

Within our constraints, we can definitely test the usability and user experience of the direct user interactions with the technology. However, determining whether it can have a positive long-term effect is much more difficult. To gauge whether our platform could actually help seniors be more active outside their home, we intend to rely mostly on self-reported results from interviews and questionnaires (e.g. "On a scale from 1 to 10, with 10 meaning "absolutely confident", how confident do you feel about outside activities when using this system?", "On a scale from 1 to 10, with 10 meaning "absolutely confident", how confident do you feel about outside activities when going on your own without technology?"). The reliability of self-reported data in terms of predicting future behavior is limited. We attempt to bridge this gap by evaluating users' observed behavior when interacting with our system – such as their level of engagement and their willingness to continue using it – and drawing an inference from *increased motivation for repeated use of networked SUOs for outside activity support* to *increased motivation for outside activities*.

Furthermore, although more of an engineering than a user research problem, we are faced with the challenge of respecting and protecting our users' personal data. The data that users are asked to provide includes not only personal data commonly considered non-confidential, such as name and age, but also data about users' specific physical abilities and needs for assistance. Even though we are not interested in actual medical data, many users may consider information about their eyesight or walking abilities (it could be considered "health-adjacent data") particularly private. It goes without saying that we follow best practices about minimizing data collection and that all personal data is deleted as soon as it is no longer needed or the study has concluded. But beyond that, we also need to design our systems to minimize the potential for privacy violations. In practical terms, an

important design guideline for *UrbanLife+* is that each distributed component of our system only has access to the minimum required personal information about each user, as opposed to a naive "every component can access any data" approach.

At the time of writing, implementation work on our system is ongoing and empirical evaluations are being planned. At the beginning of 2020, we were planning to perform several short-term deployments of SUO networks in the spring and summer, which would be combined with long-term SUO installations that are already in progress. This would give us the opportunity to verify whether the activity support system can help seniors discover and take part in new outside activities. Several of our planned experiments would center around the gamified motivational support described in Fietkau (2019) and will verify the effectiveness of the activity support system as a matter of course, although we expected to gather feedback from other evaluations of networked SUOs conducted in the scope of *UrbanLife+* as well.

Regrettably, as of the writing of this article's final version, the COVID-19 pandemic has rendered most of our plans infeasible. We are currently unable to ascertain when and how evaluations and observations of our deployments with senior users in public will be able to be conducted safely. We are exploring new avenues for validation studies, but it seems certain that evaluations in the final year of *UrbanLife+* will look entirely different than anticipated.

6 Conclusion

In this paper we have given an overview over the *UrbanLife+* activity support system and described some of the research and design challenges we face. The concept of the presented activity support in this paper contains a central service to determine and model intents of seniors (a mental plan for a future activity) and supports the accomplishment of activities by providing information and guidance through distributed and connected SUOs in the urban area. In our implementation we respond to the identified challenges by ensuring trust in our service in respect to personal data handling and by considering an interface, that signals user autonomy and self-determination to the senior as we do not want our supported guidance to feel like an obligatory rule. In our evaluations so far, the need and interest for higher safety of elderly people was consistently confirmed. Whether our activity support service helps increasing safety feelings of seniors will be evaluated in upcoming and ongoing deployments, to whatever extent circumstances permit.

As the field of HCI involving seniors grows, we are hopeful for continued community discourse around the questions discussed herein. We aim to incorporate current and future best practices into our research.

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Time Matters: Flexi-time and women's retention in the 24/7 workplace

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Abstract. Historically, the ability to exercise agency over the scheduling of working-time has shaped women's retention in the workforce. Therefore, policies such as flexi-time, that claim to give employees control over the scheduling of working hours, should be beneficial to the retention of women in paid employment. The digitally-mediated service sector is considered family-friendly partly because of the rhetoric that work can be carried out anytime, anywhere. Literature in the CSCW tradition has focused on the design and use of technology to facilitate collaboration. The issue of how workers' agency over the scheduling of working-time plays out in practice and its implications for workforce participation have not been explored. I argue that flexitime is a situated practice embedded in a complex adaptive socio-technical system. By studying time practices of women who have returned to work after maternity leave in the Indian software services sector using Rob Stones' strong structuration theory as a framework, I hope to contribute conceptually to the CSCW tradition by providing insights on the role of the agency of the worker in the processes that shape temporal patterns in collaborative work. These insights may be used to indicate possibilities for designs that enable greater worker agency over time.

Introduction

The parameters of an ideal worker, particularly in jobs providing higher than average wages, job and income security and social protection, have historically been constructed based on the common characteristics of a man, who typically did not have domestic responsibilities. Thus, the ideal worker was expected to give precedence to the demands on his time made by his professional needs over his personal or domestic requirements (Acker, 1990; Ballakrishnen, 2018; De Neve, 2012; Hays, 1996; Hochschild, 1998; Stone, 2007). A key characteristic of this construction is that it is based on a sharp

demarcation between professional time and domestic/personal time. Historically, such a rigid demarcation has led to the exclusion of women from the workplace (Edgell, 2012; Stone, 2007; Kellerman,1989). Exponential increases in the speed of computers and telecommunications and their use in the workplace has increased the possibility of blurring boundaries between professional time and personal time and led to claims of creating family-friendly work.[1] These claims are especially strong in the digitally-mediated service sectors.[2] Central to the claim is the argument that the use of ubiquitous technologies, that can help in accessing information anytime and from anywhere and therefore give the worker flexibility of time and place in the delivery of digital services, has made work family- friendly. Following the same argument, flexi-time policies in digitally-mediated service industries, have been articulated as a measure to make the workplace more inclusive of workers with non-work demands on their time. I define flexi-time as "a working time arrangement in which employees can choose their preferred work schedule i.e. starting and finishing times of work each day within specified limits" (Messenger, 2018, pp.17-18). Employers often grant flexibility in working-time schedules to retain valued workers who desire greater control over the scheduling of their working-time (Kalleberg and Epstein, 2001).

Women with domestic responsibilities, particularly those with young children, are commonly considered as targets of such policies. Much like the "situatedness" of the notion of the ideal worker that is based on "specific qualities, knowledge, skills, personal conduct and behaviour that characterize an ideal employee in a particular work organization and cultural context" (Peterson et al., 2017, pp.56) there is also a culturally shaped ideal typical construct of motherhood. Sharon Hays coined the term "intensive mothering" to describe the historically constructed ideology of appropriate mothering that "advises mothers to expend a tremendous amount of time, energy and money in raising their children" (Hays, 1996, pp. xi). She argues that while the ideology of intensive mothering that expects selfless love and care from the mother is at odds with the competitive ideology of the market that presupposes that an individual is guided by self-interest, the ideology of intensive mothering is subscribed to as much by working mothers as by stay-at- home mothers (Hays, 1996). Blair- Loy (2003) in her study of women executives in America uses the term "family- devotion schema" to describe the cultural model that is based on the notion of "intensive-mothering" i.e. mothers should spend a lot of time with their children (Blair-Loy, 2003). In her study based on in-depth interviews with forty employed mothers Karen Christopher finds that mothers navigate the "intensive mother" and "ideal worker" ideologies by constructing scripts of "extensive" mothering which involves "delegating caregiving tasks while remaining ultimately responsible for children" (Christopher, 2012, pp.91). An analysis of accounts of 24 middle and upper middle class African American mothers employed in professional careers points to how shared histories and cultural expectations can shape ideologies of mothering – these mothers assumed that they should work outside of the home, be self-reliant, and use kin and community members as child caregiver, an ideology the author terms as "integrated mothering" (Dow, 2016, pp.180). Thus, given the time demands of a professional career, the strategies that mothers adopt to manage time to ensure that the needs of their children are met is culturally shaped. A recent study of Italian and British mothers who

[1] In this paper, for the purpose of brevity, I use the term work to denote paid employment unless otherwise specified

[2] By digitally-mediated services, I refer to services that can be delivered digitally. This excludes work that is mediated digitally but delivered physically for e.g. location-based services enabled by digital platforms such as Ola, UrbanClap etc.

are experiencing low or reduced incomes suggests that intensive mothering discourses still dominate European and American parenting cultures (Cappellini and Harman, 2019). While there are studies that point to how fathers have also increased the amount of time doing childcare, there are also studies that point to how mothers are almost always present when fathers are with their children (Palladino, 2014). Moreover, mothers usually perform childcare tasks that have to be done on schedule (e.g. feeding, dressing, transporting) while fathers engage in tasks that can be more irregular and time flexible (e.g. playing, reading) (Craig, 2006). All these accounts, largely from the U.S., point to the nature and strategies of allocation of time as a crucial aspect of the construction of "motherhood" and of the negotiation between the roles of the "ideal worker" and the "ideal mother". Additionally, there is also evidence to show that the pressure to negotiate between these two roles can shape women's career ambitions (Meeussen and Laar, 2018). According to a World Bank study, women in urban India with at least one child under the age of six have a reduced likelihood of being employed (Das and Žumbytė, 2017).

I choose to look at how digitally enabled flexi-time that claims to give the worker control over the scheduling of her working-time, gives her agency in negotiating formal and informal rules determining working-time and how this agency shapes her retention in the workforce after maternity. The term agency has been used in varied senses. I draw on Naila Kabeer to understand agency as the "ability to define one's goals and act upon them" (Kabeer, 2001, pp. 21). Agency is exercised when individuals are able to choose between alternatives and act upon their choices, this action having significant consequences for their lives. Agency is therefore exercised when human beings have the "capability" to act upon their intentions (Giddens, 1984). The particular case that I focus on is that of women engineers in the software services sector in India – a digitally-mediated sector that provides higher than average wages, job and income security and social protection.[3]

Digitally enabled flexi-time is a computer supported collaborative temporal working arrangement. There is a sizeable literature in the Computer-Supported Cooperative Work (CSCW) tradition that takes into consideration the temporal aspects of collaboration in the design of technology meant to enable collaborative work (Edwards and Mynatt, 1997; Palen, 1999; Hudson et al., 2002; Fisher and Dourish, 2004). There is literature that has looked specifically at how to design digitally enabled systems for distributed work that makes cooperation possible between workers located at different places and/or with different time schedules (Ambe et al., 2016; Hinds et al., 2015; Dangelmaier et al., 1997).[4] A majority of this work has considered a smoother collaboration between workers as the end goal of the design of systems. There is also literature that specifically talks about socio-cultural aspects of collaborative work such as power differences based on geographical location (Hinds et al., 2015 ; Matthiesen et al., 2014) homophily leading to better task completion rates (Kandappu et al., 2017), relation of deep level diversity with creativity in virtual ideation teams (Ye and Robert. Jr, 2017), trust issues in distributed teams (Duysburgh et al., 2014; Robert Jr., 2016) etc. In recent times the CSCW community has encouraged discussions on the need to incorporate feminist approaches in

[3] In India corporate managers, professionals and associate professionals receive wages which are 1.9 to 4.3 times higher than average earnings (ILO, 2018). For my research I consider software development work as providing higher than average wages, job and income security and social protection (ILO, 2018).

[4] The references mentioned are not exhaustive as the literature is too extensive to be accommodated here. I have cited relevant work in the CSCW tradition in the past 5 years.

computing (Fox et al., 2017; Steinhardt et al., 2015). Lindley (2015) has argued that technology can play a role in both "shaping temporal infrastructures and shifting reified temporal patterns" (Lindley, 2015, pp.1442). Making such temporal patterns visible can lead to "temporal reflexivity or the recognition that reified temporal patterns are flexible and changeable" (Lindley, 2015, pp.1448). Such an argument points to the scope for enabling agency to modify existing temporal structures. My study draws heavily on Lindley's argument regarding the agency to modify existing temporal patterns.

I argue that there is a need to explore the role of digitally-mediated flexi-time in giving workers agency over working-time and therefore supporting the creation of a workforce that is inclusive of workers with non-work demands on their time. In understanding the implications of digitally-mediated flexi-time for the agency of individual workers it is pertinent, even within the CSCW tradition, to look beyond the design of technology. Ethnographic studies over the years have acknowledged that there is an asymmetry between the design of technology and the "situated and contingent unfolding of action" (Blomberg and Karasti, 2013, pp.376). Much of the work that looks at the design of technology as the 'solution' to social issues suffers from what Ackerman terms as the "social-technical gap" i.e. "the divide between what we know we must support socially and what we can support technically" (Ackerman, 2000, pp.179). This is because it is difficult to predict the vagaries and contingencies of human social activity and incorporate the same in the design of technology. A more useful approach would be to acknowledge that flexi-time is a situated practice that is embedded in a complex adaptive socio- technical system, which evolves through interaction of sub-systems (Kaplan and Seebeck, 2001). Insights regarding processes that occur in natural situations in this socio-technical system can contribute theoretically to CSCW research by providing an understanding of the processes that go into creating temporal patterns in work practices and the role of individual agency in these processes. These insights may then be used to "steer evolution" (Kaplan and Seebeck, 2001, pp.373) or suggest "general characteristics of potential technologies" (Kaplan and Seebeck, 2001) considering workers agency over working-time as an end goal. I argue that the strong structuration theory proposed by Rob Stones (2005) is a useful theoretical framework to study how women exercise agency over existing temporal structures through the practice of flexi-time.

This paper is structured as follows: In Section 1, I begin with a historical overview of the literature on women in paid employment to show how agency over the scheduling of working-time has shaped women's participation in the workforce. I then invoke existing empirical studies and theoretical standpoints to argue for the importance of taking into consideration the issue of the agency of women. Next, I analyze existing studies on the nature of working-time in the software services sector focusing on how it shapes the experiences of women. I point to how literature on women's participation in the workforce, including that on the Indian software services sector, often points to structural factors but does not give equal analytical weightage to the agency of women. Finally, I briefly discuss some of the insights from the literature on time and technology and argue for the need to recognize that temporal experiences are subjective and technological structures are emergent in human practice through the recursive interaction between agents and structures. I draw on Giddens (1984) work to conceptualize agents as reflexive, knowledgeable actors (Giddens, 1984). In Section 2, I discuss in detail the theoretical framework of "strong structuration" (Stones, 2005) arguing for why it is suitable for understanding the agency of women over working-time. In Section 3, I lay out my research methodology. In Section 4, I argue that flexi-time is a situated practice and it is the socio- technical context in which it is enacted that determines whether it gives agency to workers.

This socio-technical context may be characterized as a complex adaptive system that evolves through interactions between sub-systems and cannot be 'forward engineered' very easily. It is therefore necessary to look beyond the design of technology as a solution to provide workers with agency over working-time and instead try to understand processes that go into creating temporal structures through work practices and the role of individual agency in these processes. By describing how agency over working-time shapes the nature of workforce participation in digitally-mediated work, I hope to provide the grounds from which possibilities for design that encourages worker's agency over working-time can be devised.

Section 1: Related Literature

Participation of women in the workforce

I begin my discussion with the factory system of mass production as it has been widely accepted as a period during which changes in the organization of work shaped the nature of women's participation in the workforce. This system of production replaced the family wage with the wage for the individual worker and given the pre-existing patriarchal family structure established the male-breadwinner model of the family (Hartmann, 1976; Nicholas and Oxley, 1994). Optimistic perspectives on how the factory system of production shaped the participation of women in the workforce attribute a crucial role to technology. According to these accounts, the introduction of machinery reduced the need for physical strength and offered women more and better paid jobs than agriculture and domestic service (Nicholas and Oxley, 1994). Alternative perspectives suggest that it exacerbated job-segregation by sex and reduced the participation of women in paid employment (Hartmann, 1976). The women who did enter waged work in the factory system of production did so on "persistently less favourable terms than men" (Kabeer, 1994, pp.45). The exclusion of women from the sphere of paid employment on equal terms as men was exacerbated by the introduction of standard working hours. Women were actively engaged in earlier small-scale craft-based production systems where there was greater flexibility of time (Hartmann, 1976). With the introduction of standard working hours, the pre-existing sexual division of labour which associated women with domestic tasks and men with acts of production for the market, was extended to the wage labour system (Hartmann, 1976; Kellerman, 1989). Men's time was used for the production of commercial products and services, while women's time was associated with the creation and maintenance of lives and in related domestic services (Hartmann, 1976; Kellerman, 1989).Time was measured by the clock, recorded, interchangeable and had "exchange value".[5] E. P Thompson, while describing the temporal structure of the industrial society characterized by the factory system of mass production, demarcates the temporality of women's domestic work and the work of the mother of young children from that of the industrial worker. The women engaged in care work and domestic work, according to him, have not yet moved out of the pre-industrial sense of time and have an "imperfect" sense of clock time, attuning their schedule instead to other human needs (Thompson, 1967).

It has been argued that such gendering of working-time was aided by social sentiments against women especially married women, working outside the home (Hartmann, 1976). Marxist feminists,

[5] Ratio at which a commodity exchanges against others is called exchange value (Jary and Jary, 2000, pp.663)

such as Mies, have propounded the idea of "capitalist patriarchy" which denotes "patriarchal civilization as a system, of which capitalism constitutes the most recent and most universal manifestation" (Kabeer, 1994, pp.50). The feminist theorist Joan Acker conceptualizes the gendered division of labour in terms of the gendered social differentiation between the production of material goods or commodities (considered as male domain) and the daily and intergenerational reproduction of people (considered as female domain) (Acker, 1992). This differentiation was evident from the common form of the capitalist workplace which did not integrate activities like childbirth, sleeping, eating and other daily maintenance activities within its boundaries (Acker, 1992). Even in cases where women did participate in the labour force, the gendered division of time persisted in the domestic division of labour where most women carried out a disproportionate share of household chores – what is referred to as "the second shift" (Hochschild and Machung, 1989). Thus, it may be argued that the standardization of working-time and the underlying forces of patriarchy were two critical factors that discouraged the participation of women in the industrial production labour force in equal numbers and on equal terms as men.[6]

The transition from standardized mass production to flexible production was brought about by the crisis of productivity and the crisis of profitability of the Fordist system of production in the 1970s (Edgell, 2012). Flexible production involved the capacity to deploy or redeploy production resources, including labour, efficiently as required by changes in the environment (Duguay et al., 1997). The flexible system of production was characterized by promises of temporal self-determination i.e. the ability to divide and shape working-time in coordination and synchronization with other needs of life (Nowotny, 1994). Unlike standardized mass production, flexible production, in principle, appeared to give greater autonomy to workers to complete their tasks (Duguay et al., 1997). It was suggested that in systems of flexible production, the exchange between working-time and free time was no longer derived "from the linear and continuous working biography of the male employee" (Nowotny, 1994, pp.108) implying therefore that increased employee autonomy over working-time should encourage the greater participation of women in the labour force. Another strategy adopted to deal with the crisis of the Fordist system of production was internationalizing production by relocating it to countries with availability of lower wage labour (Edgell, 2012). These strategies were also adopted in the services sector where the introduction of digitally-mediated work reinforced claims of female-friendliness. I discuss the literature on women's participation in the digitally-mediated service sector at some length because this sector is projected as particularly conducive to participation by women.

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[6] The principle of control over employee's time and its standardization are found in systems of mass production such as in scientific management and the Fordist principle of production. The principles of Scientific Management, devised by Frederick Winslow Taylor, were implemented in industrial production in America in the 1920s.To scientifically determine the optimum way to complete a task Taylor performed 'Time Studies' that involved the use of a stopwatch to time a worker's sequence of motions with a goal to determine the one best way to perform a job. Thus, workers were given prescribed times within which they had to complete the tasks assigned to them. Henry Ford applied the principles of scientific management to automobile production. His employee policies reflected adherence to the male breadwinner model (Edgell, 2012, pp.97). He implemented a complex profit-sharing scheme divided into two components: a basic wage paid to all workers and a profit-sharing element that was only available to those who had worked for Ford for at least six months, married men "living with and taking good care of their families", single men aged over 22 "who are of proved thrifty habits", and young men under 22 and women "who are the sole support of their next of kin" (Edgell, 2012, pp. 92).

of labour became almost synonymous with female-friendly) nature of digitally-mediated work is the proposition that digital mediation has altered the organization of work, overcoming the "negative features of industrial capitalism" and creating a society "organized around knowledge and information in which creativity, equality and the prevalence of high-skilled knowledge work would replace alienated and exploited labour" (Sandoval, 2015, pp.42). While the factory system of production was based on the separation of the sphere of paid employment from the domestic sphere, digital mediation allows production to happen "anywhere" (Flecker, 2016, pp.1). According to post-industrial theory, working from home "offers the freedom of self-regulated work and a reintegration of work and personal life" which will lead to "more sharing of paid and unpaid domestic labour , as men and women spend more time at home together" (Wajcman, 1991, pp.40-41).

Research points to how flexible work arrangements are instrumental in achieving a healthy work and family balance (Felstead et al., 2002; Hill et al., 2010; Valk and Srinivasan, 2011). Work-life balance leads to greater employee retention (Downes and Koekemoer, 2011) particularly for women with domestic responsibilities (Cox et al., 2014; Srinivasan et al., 2013). By this argument, flexible work arrangements give rise to greater retention of women with domestic responsibilities. Literature also points to how work-family balance has been largely treated as a woman's issue (more specifically married women) because of the perception that catering to the needs of the family is a woman's responsibility (Smithson and Stokoe, 2005).

There is literature that counters the claim that digitally mediation leads to greater work-life balance. The counter argument is that flexible work timings can lead to an encroachment of work into personal lives or what Melissa Greg refers to as 'presence bleed' (Greg, 2011) and does not necessarily lead to greater work– life balance (Downes and Koekemoer, 2011; Eldridge and Nisar, 2011 ; Whittle and Mueller, 2009). Digital mediation enables after hours telecommuting which can lead to longer working hours and reduced work-life balance (Duxbury et al.,1992). This is exacerbated by the 24/7 economy and its "demands for around the clock availability for labour market activity" (Presser, 2003, pp.1- pp.2). The 24/7 economy is shaped by the global capitalist relations of production that have expanded in reach with increase in the speed of communications technology. Additionally, the use of these communication technologies in the context of paid work has given rise to the "autonomy paradox" i.e. on the one hand it has enhanced the worker's sense of control over the timing and location of work while on the other hand it has led to workers using it everywhere/all the time thus reducing their autonomy in practice (Mazmanian et al., 2013). Both CSCW and Human-Computer Interaction (HCI) literature has focused on the role of digital interactive technologies in managing time and "mediating work/life tensions and boundaries, documenting the skilled use of digital tools, its collaborative aspects, and the assemblages of physical/digital resources in non-professional spheres such as volunteering and leisure as well as in professional domains" (Ciolfi and Lockley, 2018, pp.3). Research also points to the complexity of individual strategies, professional demands, and life situations in navigating work-life boundaries (Ciolfi and Lockley, 2018; Cousins and Robey, 2015; Sadler et al., 2006). Therefore, historically and in more recent narratives, agency over the scheduling of working-time and management of work life boundaries has played a central role in accounts on the nature of participation in the workforce. In the next section I cite historical instances of how workers have used informal means to exercise agency over working-time and argue for why particularly for women it is important to consider the issue of agency.

Agency over working-time

Historically, there have been instances of workers' exercising agency in the face of temporal constraints, with implications for the nature of their participation in the workforce. For instance, to break the monotony of extra-long workdays for six days a week, a group of factory machine operatives resorted to "an ordered series of informal interactions"- some of them were verbally articulated by the group as coffee time, peach time, banana time etc. while others were not always verbally recognized such as window time, pick up time and other times used for horseplay (Roy, 1959, pp.161). These informal interactions increased the endurance of the workers to work in situations bereft of creative experience (Roy, 1959). Similarly, women with children working in small workshops in the Tiruppur garment cluster in South India, took up jobs close to their homes and used their informal relations with the workshop owner (they referred to him as their brother) to ensure that there was flexibility in their work schedules so that they could come home whenever required during the day to complete domestic chores (De Neve, 2012). Inability to exercise this agency would have led to them dropping out of the workforce. Through observations and interviews with mobile knowledge workers who engage in digitally-mediated work, Erickson and Jarrahi show how actors construct—either individually or collectively—"a bricolage of material, mental, social, and cultural resources to adapt to seamful situations and advance accordingly" thus revealing the "competence or ingenuity of actors" (Erickson and Jarrahi, 2016, pp. 1325). Thus, workers have displayed instances of agency over working-time, through informal means. It is important to recognize such informal means of exercising agency as they can have significant implications for workforce participation.

It is especially important to consider the question of agency of women to counter the traditional association of the feminine with "lack of free will" and "lack of capacity to live a self-sufficient life" (Hutchings, 2013, pp.16). Inability to take into consideration the analytical category of the agency of women has been viewed as a significant gap in the literature on innovation and regional learning which perpetuates the image of the innovator as a "disembodied ideal worker for whom work is primary and the demands of the family and personal life insignificant" (Al, 2018, pp.7). In the CSCW tradition, the issue of time has been addressed in the design of technology meant to enable collaborative work (Edwards and Mynatt,1997; Palen, 1999; Hudson et al., 2002; Fisher and Dourish, 2004) and more specifically distributed work that makes cooperation possible between workers located at different places and/or with different time schedules (Ambe et al., 2016 ; Hinds et al., 2015; Dangelmaier et al., 1997). However, the gender identity of the user is not taken into consideration in these accounts. The feminist approach in CSCW, "catapulted by formative work in HCI" (Steinhardt et al., 2015, pp.304) suggests that the "ungendered construction of the user" (Bardzell and Bardzell, 2011, pp.678) or "abstract individuation" (Bardzell and Bardzell, 2011, pp.679) should be replaced by a recognition of the individual as being embodied in interpersonal, historical and physical context because abstract individuation denies the "agency and subjecthood" (Bardzell and Bardzell, 2011, pp.677) of the individual. This approach suggests that given that design is an intervention i.e. an intentional effort to bring about change, it has the potential to ensure that gender remains "a relevant axis of investigation" (Bardzell and Bardzell, 2011, pp.677). Writing about the history of feminism in India, Maitreyee Chaudhuri argues that agency is always "enacted within specific structures of constraints" and sometimes these structures do get "redefined" (Chaudhuri, 2012, pp.29). Her argument resonates with Anthony Giddens' proposition that all structural relations of dependence are sustained through similar social practices that "exist across varying spans of time and space" (Giddens, 1984, pp.17). These relations of dependence "offer some

resources whereby those who are subordinate can influence the activities of their superiors" (Giddens, 1984, pp.16). Individual agency may be exercised through everyday practices which can, in principle, bring about changes in structural relations.

In the next section I discuss the existing literature on the nature of working-time in the software services industry and its implications for women employees pointing to how analytically the issue of the agency of women has been understudied.

Nature of working-time in the software services industry

Increases in the speed of computers and telecommunications, increased expectations for the immediate availability of products and services and the competitive nature of the global market (Orlikowski and Yates, 2002) have created pressures to reduce "time to market", leading to the need to shorten project cycles which in turn lead to a demand for longer working hours (Shih, 2004). For instance, in Silicon Valley's high-tech industry, working-time is unstructured and based on "project" time - employees are given a deadline and expected to reach it without being instructed on how to allocate time to complete it (Shih, 2004). Thus, while hours are flexible, they are also often very long and erratic.

In the software industry, the need to work for long hours is reinforced by equating number of hours worked with productivity. Frederick Brooks, writing about software engineering for large programs in 1975, mentions how the unit used in measuring the size of the job is man- month i.e. the product of the number of men and the number of months (Brooks, 1995). Perlow, studying software engineers in the U.S, who worked in cubicles and labs in their office and did not have the option to work from home, found that they spent excessively long hours at the office in order to meet their delivery deadlines (Perlow, 1995). Managers used number of hours worked as a criterion for ranking these engineers (Perlow, 1999).

There is work in the CSCW tradition that focuses on distributed teams (Dong et al., 2016; Duysburgh et al., 2014; Hinds et al., 2015; Robert Jr. 2016) and some that deal specifically with globally distributed teams engaged in software development (Ambe et al., 2016; Guzzi et al., 2015; Matthiesen et al., 2014) to name a few. In these studies, managing time has been treated as an important aspect of collaborative work and in some cases control over scheduling of working-time has been considered as a manifestation of power relations - for example, in globally distributed teams, "higher status sites, such as headquarters, or teams with high status individuals have more influence when negotiating times to meet" (Hinds et al., 2015, pp.865).

Like the literature on the global software services industry, the literature on the Indian software services industry also points to the centrality of time, both in terms of organizing the work and in the evaluation of its workers. Much like their global counterparts, the Indian software services firms bill clients based on hours or days of work (Upadhya and Vasavi, 2006). Indian companies usually bid for projects in terms of man-days based on an eight-hour workday (Upadhya and Vasavi, 2006). These predictions often underestimate the man-days required following which engineers are required to work much longer (Brooks, 1995; Upadhya and Vasavi, 2006). Moreover, regardless of the accuracy of estimation, unexpected problems often crop up at the last minute and the entire team is usually expected to put in extra hours to solve them (Brooks, 1995; Upadhya and Vasavi, 2006). Thus, not only are work hours long, they are unpredictable.

India has been termed as an "outpost" (Upadhya and Vasavi, 2008) of the global software industry - an "enclave economy" that is closely linked to the global economy with few linkages to local, regional and national economies (Upadhya and Vasavi, 2006).The Indian software services industry

draws the majority of its revenues from clients located outside India, predominantly the US.[7] Similar to any firm that is located in a time zone different from its client, interactions with the client may need to be carried out on the basis of the local time at the client's location which could be odd hours in India.[8] However, interactions with the client can be carried out via a virtual medium, thus not making it mandatory for the employee to be in her/his office.[9] This possibility for the decoupling of time and space, along with the possibilities for flexi- timing, has led to claims of the software services industry being a sector that enables "women to pursue a flexible career at their 'critical biological stages' and return to full time employment seamlessly" (Srinivasan at al. 2013). While such claims are not specific to India, how such claims play out in practice is determined by the political, economic and cultural background of the Indian context. In the next paragraph, I describe the time practices of the Indian software services industry as captured in existing literature and how it shapes the experiences of its women employees.

The Indian software services industry is characterized by the norm of long and uncertain working hours and frequent and unplanned travel (D'Mello, 2006; Peterson et al., 2017; Poster, 2008; Radhakrishnan, 2011; Upadhya and Vasavi, 2006) which contradicts the claims of flexi-time on the basis of which arguments are made about its female-friendly nature. While flexi-time, in theory, gives employees the freedom to choose their working hours, in practice it means that they have to work as long as necessary to finish the tasks at hand (Upadhya and Vasavi, 2006). Moreover, most companies usually have 'core hours' during which everyone must be in the office – a policy that further contributes to the long working hours (Upadhya and Vasavi, 2006). Thus, the time practices in the software services industry are not different from those of the factory system of production on account of two features - control over worker's time and the need to complete tasks within a stipulated time. However, unlike the factory system of production there is greater unpredictability about the length of daily working hours that the software engineers have to put in to complete the task in the stipulated time.

Women in the Indian software service industries work less hours than men (Upadhya and Vasavi, 2006). This is because married women have domestic responsibilities while un-married women face parental disapproval as well as occasional resentment from male colleagues, if they stay back after office hours (Upadhya and Vasavi, 2006). Women are often not allowed to work at night after business hours which becomes exclusionary when crucial meetings are held during this time in which women are not included (Poster, 2008).

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7 According to data published by NASSCOM in 2018, 51% of industry revenues come from services. The predicted revenue from exports in 2019 is USD 135.9 billion while predicted domestic revenues are USD 41 billion. The report can be accessed at https://www.nasscom.in/sites/default/files/Industry- Performance2018-19-and-what-lies-ahead_0.pdf

8 The outsourcing of the software development process to different countries gives rise to what Robert Hassan terms as 'network time' or 'connected a-synchronicity' i.e. "breaking up the uniform and universal linearity of clock time into a billion different time contexts within the network" (Hassan, 2007, pp.51). India, as an outpost of the global software industry, is part of the time of this network. Hassan opines that "network time" is disrupting but has not yet displaced the all- pervasive clock time (Hassan, 2003).

9 According to data published by NASSCOM in 2018, 51% of industry revenues come from services. The predicted revenue from exports in 2019 is USD 135.9 billion while predicted domestic revenues are USD 41 billion. The report can be accessed at https://www.nasscom.in/sites/default/files/Industry- Performance2018-19-and-what-lies-ahead_0.pdf

9 In some projects which involve sensitive data that cannot be accessed from home networks due to security issues, working from home is not an option.

Historically, middle class women have acted as "idealized markers of Indian national culture" and have been "a key mode" through which "modernity gets reconciled with a perceived authentic culture" (Radhakrishnan, 2011, pp.49). The new Indian middle class woman is exemplified by "upwardly mobile professional women" who "must simultaneously reinforce the values of the nation while legitimating the integration of the new cultural and economic influences of global capital" (Radhakrishnan, 2011, pp.50). This middle-class feminity, that Radhakrishnan refers to as "respectable feminity", emphasizes the role of the woman in preserving "good families" (Radhakrishnan, 2011, pp.50) which implies prioritizing family over professional work. Women, especially those with domestic responsibilities, working in the Indian software services sector are subject to these cultural expectations and the practices that they engage in must be analyzed in this context.

Women returning to work in the software services industry after a maternity break must negotiate between the time demands of the industry such as long working hours and frequent travel and the time demands of motherhood. A study based on interviews with employees from a large software service company in Chennai reveals that women with children prioritize their responsibilities towards their children over their work and career (Fuller and Narasimhan, 2008). The policy allowances that the IT industry makes for women with children makes the low percentages of women in upper management seem to be an outcome of choices made by women (Radhakrishnan, 2011). In practice however, the temporal expectations from the ideal worker in the software services industry remains intact and is therefore detrimental to the professional interests of its women employees, particularly those with domestic and caring responsibilities. For instance, women in the Indian IT industry who opt for flexi-time after childbirth "find themselves side-lined when it comes to promotions" and "individual managers may block the implementation of flexi-time in their teams due to the pressures of work and the discontent it creates amongst (male) team members who do not use flexi-time" (Belliappa, 2013, pp.117). Even in the software sector in Silicon Valley where many companies have family-friendly policies,[10] there are reports of the prevalence of the norm of long and gruelling working hours.[11]

Thus, existing literature points to how structures of working-time in the software services industry are not conducive to the participation of women with non-work responsibilities. Drawing on Giddens' concept of the dialectic of control that suggests that "all forms of dependence offer some resources whereby those who are subordinate can influence the activities of their superiors" (Giddens, 1984, pp.16), I argue that all structures are sustained through similar social practices and individuals engaging in those social practices help to sustain those structures. Therefore, analytically, there is a possibility for individuals to change social structures through their practices. I argue that this possibility has been underexplored in the existing literature. In the next section I argue for the need to study flexi-time as a situated practice to understand the question of the agency of women over working-time.

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10 For details see https://www.freeenterprise.com/silicon-valley-benefits/, https://qz.com/work/1568480/amazon- competitors-with-backup-childcare-google-facebook-apple-microsoft/

11 For details see https://medium.com/@bobwyman/back-in-the-1970s-when-i-first-got-in-the-software-business-i-remember-there-being-a-much-higher-f70e8197fbd9, https://www.nytimes.com/2015/04/08/upshot/silicon-valley- perks-for-some-workers-struggles-for-parents.html., https://www.wired.com/2017/06/silicon-valley-still-doesnt-care- work-life-balance/

Flexi-time as a situated practice

Lucy Suchman argues that every action is "situated" i.e. it "depends in essential ways upon its material and social circumstances" and therefore should not be abstracted "away from its circumstances" and represented as a "rational plan" (Suchman, 1987, pp.50). The approach should rather be to “study how people use their circumstances to achieve intelligent action” (Suchman, 1987, pp.50). Drawing on her claim about the fundamentally situated nature of activity, Julian Orr through his study of the work of photocopy machine repairers shows how “service work” is “situated practice” (Orr, 1996, pp.10). A situated practice is an action that must be understood with reference to the situation of its doing (Orr, 1996). Policy and technology designed to manage time is often predicated on the notion of “circumscribed time” that does not recognize the situatedness of time practices and considers time as “chunkable, single-purpose, linear, and ownable” (Mazmanian et al., 2015, pp.1453). The problems with understanding time as an objective phenomenon that exists independently of human action and can be designed to regulate human action can be attributed to the vagaries of interpersonal relationships as well as the contingencies that arise when performing tasks according to pre-determined time schedules. Ethnographic data based on lived temporal experiences point to how time is subjective and “porous” (Mazmanian et al., 2015, pp.1453). For example, Barnett and Gareis (2000) found that long work hours are not universally distressing for individuals, and therefore using an absolute number of hours measure alone has limited utility in understanding human action as experiences of time are subjective (Dugan et al., 2012). Even within organizations and institutions that operate within the logic of “circumscribed” time, individuals adapt to the fluidities of time by resorting to informal means (Mazmanian et al., 2015). It may however be argued that time is not constructed completely through human action. While people play an active role in “shaping the temporal contours of their lives”, their actions are also “shaped by structural conditions outside their immediate control” (Orlikowski and Yates, 2002, pp.684). Not all temporal experiences lend themselves to articulation or scheduling because they cannot be assessed due to external contingencies (e.g. travel time) or they cannot be anticipated (e.g. creative phases) (Mazmanian et al., 2015). It may be difficult to account for these temporal experiences in the design of technology structures. As Lindley argues, "efforts to design for temporal experience must do more than simply build desirable temporal models into technologies" - there is a need to address the broader practices of which these technologies are a part (Lindley, 2015, pp.1449). Moreover, I argue that there is a need to recognize that technology structures are “constituted recursively as humans regularly interact with certain properties of a technology and thus shape the set of rules and resources that serve to shape their interaction” (Orlikowski, 2000, pp.407). Technology structures are therefore emergent through situated practices and not embodied in technologies (Orlikowski, 2000). In the next section, I provide an outline of the theory of strong structuration highlighting why I consider it suitable to study the agency of women over working-time and s implications for their retention in the workforce

Section 2: Theoretical Framework -The strong structuration theory

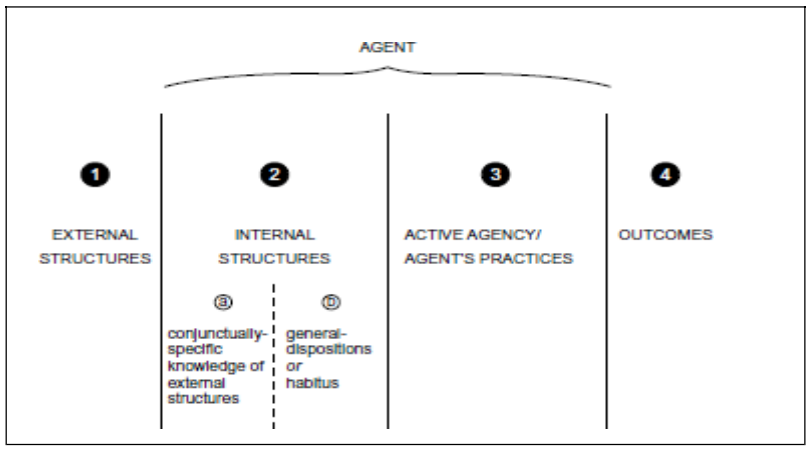

Figure 1: The quadripartite nature of structuration (Source: Stones, 2005, pp.85)

In understanding how flexi-time as a practice shapes women's agency over working-time, I draw on Rob Stones' strong structuration theory which builds on Anthony Giddens' theory of structuration. Stones modifies Giddens' concept of duality of structure. Giddens used the term 'duality of structure' to indicate the dual role of structure as both medium and outcome (Stones, 2005, pp.5) - "the structural properties of social systems are both medium and outcome of the practices they recursively organize" (Giddens, 1984, pp.25). Structures serve as the 'medium' of action as they provide, through memory, the bases upon which agents draw when they engage in social practices (Stones, 2005, pp.16). Stones proposes instead a quadripartite nature of structuration. This framework connects individual psychology to practice, with implications for structures and is more amenable to analysis of "specific processes involving structures and agents in particular, situated, contexts" (Stones, 2005, pp.13). One of the critiques of Giddens' theory is that it considers structural power as a negotiable outcome of routine interactions whereas some forms of structural power may precede individual action and be relatively enduring (Jones and Karsten, 2008). This critique is relevant in the context of the history of women in paid employment which points to enduring structures such as patriarchy that have shaped women's agency over working-time. Some basic features of patriarchy have endured. While Giddens does talk about constraints placed by the context of action on the range of choices available to individuals (Orlikowski, 2000) i.e. their agency, he does not explicitly link it to his conceptualization of structure. This criticism is also pertinent when considering the material features of technology. Giddens argues that structures do not have a material existence outside of human action, they exist only when instantiated in human action (Orlikowski, 2000; Jones and Karsten, 2008). Rob Stones argues instead that structuration involves both internal, virtual structures and external, objective structures, social action being always mediated by the former (Orlikowski, 2000). Ontologically, therefore, there is a distinction between a structure that

resides in a material artefact and a structure that is instantiated in action (Orlikowski, 2000). This conceptualization has significance for distinguishing between features of technology that are instantiated in practice and those that remain as external, objective structures – the latter forming a part of the context that places limits on the range of options available to actors. Some of the key theoretical concepts used by Stones are:

1. External Structures: these are conditions of actions that have an existence autonomous from the individual. These can exist at the abstract ontological level or at the "conjunctural level of particular participants" (Stones, 2005, pp.84).
2. Internal structures: exist within the agent and can be analytically separated into general dispositional structures or conjuncturally specific internal structures (Stones, 2005, pp.85).
3. Active agency: ways in which the agent either routinely and pre-reflectively or strategically and critically draws upon her internal structures (Stones, 2005, pp.85).
4. Outcomes: these could be external or internal structures or events. The effect of agents' practices on structures could involve change or reproduction of existing structures (Stones, 2005, pp.85).

Stones' theory of strong structuration provides a useful framework to understand agency as defined by Naila Kabeer. The notion of active agency is analytically aligned with the "intangible, cognitive processes of reflection and analysis" (Kabeer, 2001, pp.21) that Kabeer refers to in her understanding of agency. This conceptualization of agency is essential to understanding the processes through which women take decisions regarding their participation in the workforce. The situatedness of knowledge and action that informs my conceptualization of flexi-time as a situated practice is explicated in Stones' use of the term 'conjuncture' in his framing of the notions of external structure and internal structure. The term conjuncture points to the specific circumstances of the actions of agents and others as well as the "bounds of agents' knowledgeability in the shifting contexts of time and space" (Stones, 2005, pp.71). In the next section I describe my research method, justifying the use of the same in the context of my study.

Section 3: Methodology

My primary research objective is to understand how flexi-time shapes the retention of women after a maternity leave in digitally-mediated work embedded in a 24/7 economy. I address this objective through the following sub-questions-

a) How does flexi-time shape the agency of women over working-time in digitally- mediated work embedded in a 24/7 economy?
b) How does this agency over working-time shape the retention of women after a maternity leave?

I focus specifically on the experiences of women who have returned to work after maternity leave in the software services sector in India and have at least one child below 6 years of age. There is research which shows that in urban India women with at least one child under the age of 6 have a reduced likelihood of being employed (Das and Žumbytė, 2017) and existing literature points to how lack of agency over working-time reduces the probability of women's employment in paid work. Following this logic, agency over working-time should help in the retention of these women. Given that statistically these women have a reduced likelihood of being employed, I find it particularly important to analyze the situations and therefore identify underlying processes through which these women are able to participate in paid employment and the role of flexitime i.e. agency over the scheduling of working hours in shaping their participation. Since my interest is in identifying the processes through which agency is exercised, I will be analyzing situations under which the same

woman is involved over a period of time. This method is referred to as situational analysis in which the "choice taking of actors is given due weight as against the concentration on the institutional framework" (Mitchell 2000, pp.168) i.e. selection by the individual in any one situation from a variety of possible relationships - which may themselves be governed by different norms (Mitchell 2000, pp.142). The particular relationships and norms selected are likely to vary in regard to "the same individuals from one situation to another and in regard to similar situations from one individual to another" (Mitchell, 2000, pp.143). This method requires the researcher to observe the different naturally occurring situations, the activities and interactions women engage in over the course of a period of time. Therefore, since March 2020, I am working as an intern with the Human Resources department of an Indian software services firm in Bangalore. As part of my fieldwork, I will be observing the time practices of women who have returned from maternity leave to this software service firm over the past 5 years.[12] I will be supplementing the observations with semi-structured interviews with these women and others who were involved in the situation to understand their perspectives on the same. The firm I am interning with has 30.6% women in their workforce and a female attrition rate of 22%. Given that an examination of the claim that digitally-mediated flexi-time is family-friendly (which as discussed before is considered synonymous with female-friendly) is the starting point of my research, I choose to focus on firms that are considered as female-friendly. Accordingly, I will study only those firms which at least one third-party has certified as female-friendly. For instance, the firm that I am currently interning with has been certified as one of the 25 best workplaces for women in the year 2019 by a reputed global organization that certifies firms on the basis of workplace culture. It is difficult to a-priori predict the number of subjects and firms and the duration of my study in each firm (a minimum of three months) and will depend on when I reach data saturation i.e. the point at which no new themes are observed in the data collected with respect to my research questions.

While I have spent about 2 weeks familiarizing myself with the field (before lockdown was made effective), due to the global pandemic and the implementation of work from home for all employees I have not yet been able to effectively begin my observations. Prior to commencing my fieldwork, I had carried out pilot interviews with women in the software services sector to understand how agency over working-time shapes the nature of their participation in the workforce. Excerpts from some of those interviews are presented in Table I:

Table I. Agency over working-time and participation in workforce: Pilot Interviews

Details of participants	Agency over working-time
Case 1: A female software engineer, one month after returning to work to an Indian	"They are not willing to give me time off to feed my child. I have to attend review calls from 7 AM-12 PM which sometimes coincides with the feeding time of the baby. The requirements for review can be easily e-

12 I have shared the details of my research and have been given permission by the concerned authorities to conduct the research in the firm on the grounds that I will anonymize all data I gather from my fieldwork. I will also be seeking permission from the individual respondents and research participants before conducting observations and interviews. In case I am unable to conduct observations because of the COVID-19 pandemic and the resultant directives to observe social distancing, I will conduct diary studies and follow-up interviews with the women on a daily basis.

software services company after a maternity leave. She has changed her job since then.	mailed to me and I can work on it in my own time, but my manager doesn't agree. I have complained to the HR, nothing has happened. I am really wondering whether I should continue" ... (She mentioned later in the interview that for her, nursing the baby and not giving him expressed milk was an intrinsic part of being a good mother as well as essential for bonding with the child).
Case 2: A female software engineer, who returned to work after a maternity leave of 13 months	"When I joined back, I didn't give too may interviews, maybe 1-2 telephonic rounds. Then I got a call from my previous client and got a job. They told me that they would give me less salary than the time I went on break. I negotiated and got at least the same salary that I was getting. For me the first priority is work-life balance. They allow me to leave at 5 PM and are okay with me not taking any calls from home" ... (She also mentioned that she had very understanding team members - all unmarried men- who willingly agreed to such an arrangement)
Case 3: A female software engineer who quit her job after returning from maternity leave and has been on a break for the past one month.	"When I rejoined, they gave me only one option- a project which had night shifts, that too rotational. I had gone through an ectopic pregnancy and my child was very small. I was okay with any other shift except night shift. I had to quit".

In the first and the third case there is a clear relationship between inability to exercise agency over working-time and the decision to quit (the firm in the first case and the workforce in the third case). In the second case agency over working-time clearly shaped the decision to continue working. One enabling condition seemed to be the composition of the team. However, as literature suggests unmarried men may not under all circumstances be willing to accommodate the needs of women with children and even when they do there are processes that shape their decisions. This points to a need to analyze situations in which women are able to exercise agency over working-time over a period of time to be able to identify underlying processes that can be abstracted beyond empirical cases. These processes could involve relatively enduring external structures such as patriarchy that look at childcare as primarily a woman's duty or conjuncturally specific external structures such as a firm's policies regarding working-time as well as internal structures such as a woman's beliefs regarding motherhood.

Section 4: Anticipated Contribution

I problematize the claim that digitally-mediated flexi-time, under all conditions, makes work more conducive to participation by workers with demands on their time outside those of paid employment. I argue instead that retention of such workers in the workforce is shaped by the extent of their agency over working-time. Flexi-time is a situated practice and it is the socio- technical context in which it is enacted that determines whether it gives agency to workers. I choose to study women with children up to 6 years who have returned to work after maternity leave because there is research that shows that in urban India women with at least one child under the age of 6 have a reduced likelihood of being employed (Das and Žumbytė, 2017). Moreover, historically, control over the scheduling of working-time has been an important factor leading to greater retention of women with domestic responsibilities. Literature on Female Labour Force Participation (FLFP) has looked at structural factors but analytically not given equal weightage to the agency of women. In the CSCW tradition, while most of the literature looks at designing technology for improved collaboration between technology users as abstract genderless ahistorical entities, the feminist tradition (which draws on feminist HCI) calls for a need to recognize the user as a historically embedded gendered individual with personal goals and life-worlds. Technologies designed to coordinate work activities do not consider providing the worker with agency over working-time as the primary end goal. I argue that a way to create a workforce which is inclusive of workers with demands on their time outside of paid employment is to give them greater agency over the scheduling of their working-time. This, when combined with other enabling conditions, could shape greater retention of these workers in the workforce and prove beneficial for the firm in the long run in terms of encouraging diversity of thought as well as reducing the costs associated with attrition. The first step to do this is to ensure "temporal reflexivity" (Lindley, 2015) i.e. recognize the constructed nature of reified temporal patterns. The next step would be to use situation analysis to describe the processes through which workers exercise agency over these temporal patterns in a particular socio-cultural context. I argue that flexitime is a situated practice that is embedded in a socio-technical system. This socio-technical system could be viewed from a "complex adaptive systems viewpoint" (Kaplan and Seebeck, 2001, pp.372). A complex adaptive system contains "component sub-systems interacting such that they co-evolve" (Kaplan and Seebeck, 2001, pp.359). 'Forward engineering' complex adaptive systems can be challenging, especially when its complexities are not accounted for (Kaplan and Seebeck, 2001, pp.373). 'Reverse engineering' through identifying processes occurring in naturally occurring situations is very effective in "uncovering the stories that explain the how and why of socio-technical systems" (Kaplan and Seebeck, 2001, pp.373). These insights may be used to "steer evolution" i.e. reuse design tricks that worked earlier and recombine or extend these tricks (Kaplan and Seebeck, 2001, pp.373). While some frameworks have been suggested that can help to codify these design tricks they are always contingent on practical experiences, local context and skill of the practitioner.[13] Alternatively, as Schmidt has argued, insights from research may not provide "specific design recommendations for specific systems" (Schmidt, 2000, pp.145) but contribute to the "conceptual foundation of CSCW" (Schmidt, 2000, pp.146) by uncovering "the practices through which the myriad distributed and yet interdependent activities are meshed, aligned, integrated, because it is the very practices through which such orderliness is accomplished that must be supported" (Schmidt,

[13] For a detailed discussion refer to Kaplan and Seebeck (2001)

2000, pp.145). In my research I intend to uncover the processes that go into creating temporal patterns in work practices and the role of individual agency in these processes. The role of individual agency has not been sufficiently addressed in the existing literature. By describing how agency over working-time shapes the nature of workforce participation in digitally-mediated work, I hope to indicate possibilities for design that can be incorporated to encourage agency over working-time. The question of providing agency over working-time to all workers has become even more relevant now, in view of the current COVID-19 global pandemic and the ensuing change in work practices where a majority of the working population have had to take up work-from-home options leading to a blurring of physical boundaries between work and home.

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Social Icebreakers Everywhere: A Day In The Life

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Abstract. Developing systems to spark face-to-face interactions between strangers is a recurring challenge that may benefit from drawing together inspiration from many different creative fields. This paper presents a design fiction that makes accessible over 50 diverse examples of objects and environments that might help foster new social encounters. Unlike most design fiction, this narrative is not about the future, but about an alternative present. The designs discussed are all real objects - either functional prototypes or interactive exhibits. The fiction is that these already existing artefacts are a commonplace, and not particularly remarkable part of the everyday. Thus the strange is made familiar by unusual designs being presented as a universal normality. Each individual element is "real" in that it has not been invented for the purpose of this review, however the overarching story uses a fictional frame to place all this work in the same world. We hope immersion in this narrative can enrich perspectives and debates around designing to support social interaction.

1 Introduction

1.1 CSCW and supporting new encounters

The field of Computer Supported Cooperative Work (CSCW) has become increasingly interested in the development and application of systems that attempt to strengthen the social side of the workplace through supporting the initiating of new relationships and other informal exchanges. Such projects include circulating photos

photos through shared proactive displays (McCarthy et al., 2008) and encouraging the snatching of unique image files from colleagues (Mentis et al., 2012), tangible interfaces to enliven access to company information in coffee corners (Fachry et al., 2007), and online conversational agents to provoke offline gossip (Foucault et al., 2007).

A more challenging but potentially highly valuable arena for CSCW related research is the development of systems for public and semi-public places with the aim of supporting or even initiating collaboration and sharing between individuals who may not have previously established relationship with each other. A range of devices and platforms has been explored in this respect for supporting or establishing collaboration or shared experiences between people engaged in leisure activities such as backpacking (Axup et al., 2006), patronizing coffeehouses (Yoon et al., 2004) and even whilst motorcycling (Esbjörnsson et al., 2003). Others have addressed how collaborative behavior can be induced through the ad hoc sharing of digital files such as photos (Kohno and Rekimoto, 2005), music (Håkansson et al., 2007), playlists (Baumann et al., 2007) and song selections (Seeburger et al., 2012).

Most of these endeavors, like the workplace sociality and plethora of electronic badge (e.g. Paradiso et al. (2010) and other conference social support systems e.g. Oh and Lee (2012) aim to strengthen existing ties in terms of shared interests, mutual employers, or connection to a conference's subject matter respectively. A far greater challenge to developers is initiating positive encounters between individuals who have no such ties, but just happen to be occupying or passing through the same place.

In this paper we aim to contribute to addressing this challenge by enriching understandings of designing to support new encounters. We present a vision of a world in which all artefacts and environments have been designed to support social interaction and collaboration. The concepts that populate our narrative are drawn from an ongoing design space review of creative work concerned with how objects and environments can help foster social interactions.

1.2 Going forward by looking around

Various authors have made useful contributions in reviewing interventions to support new social encounters – most notably a recent systematic review of collocated interaction research by Olsson et al. (2019), Hespanhohl and Dalsgaard's analysis of interactive media installations (Hespanhol and Dalsgaard, 2015) and recent work from Dagan et al. concerning social wearables (Dagan et al., 2019). However, most such reviews overwhelming have a focus on a particular media, and in particular (Dagan excepted) an emphasis on visual displays.

Artists, designers, architects and inventors have proposed all kinds of means to help social icebreaking. However, despite many years of concept generation and experimentation, both within and outwith academic research, there has not been huge progress in the overall endeavour of designing to support collocated new

encounters. As Katherine Isbister recently noted, even though many leading experts in human computer interaction have turned their attention to supporting collocated encounters: 'somehow, this work is not making its way in a sustained fashion into the everyday fabric of technologically enhanced life, nor into the sustained public perception of what technology can do for us as human beings' (Isbister, 2019, p.2).

One factor in this lack of progress could be the apparent absence of any systematically presented collection of relevant design examples drawn from across a full range of different disciplines and media. To address this, we have been conducting an extensive design space review examining examples of both high and low-tech efforts for sparking social interactions. This is an attempt to systematise a still growing corpus of over 1000 design examples (as described in Mitchell and Olsson 2017, but see also Mitchell, 2019, and Mitchell and Olsson 2019).

We contend that enabling a broad and deep cross fertilisation from different fields and media is beneficial for designing to support social encounters. However this is troublesome to disseminate. It is not easy to entice readers to cross disciplinary fields to inspect designs from radically different traditions. And page limits, and other scholarly conventions make it difficult to convey a breadth of possible inspiration in an easily accessible format. Thus we have begun to explore less traditional routes to synthesising and making accessible insights and inspiration from our corpus, and turned design fiction.

1.3 Design fiction and speculating upon alternative presents

Telling stories and tales purposefully, through tools like design fiction, has become a valuable way to explore and understand complex ideas, and situate work in human experiences and contexts. Within HCI, design fiction is an approach that has consistently challenged the narrative conventions of academic articles. The uses of fiction within the academic literature are as varied as the definitions attributed to it. But most influential has been Bruce Sterling employing Kirby's notion of 'diegetic prototype' (Kirby, 2010) as technological artefacts that function within the context of a story. Sterling defined design fiction as 'the deliberate use of diegetic prototypes to suspend disbelief about change' (Bosch, 2012).

Emphasizing the central role of narrative in design fictions, Theresa Tanenbaum et al. stressed that 'Design fiction uses narrative elements to envision and explain possible futures for design' (Tanenbaum et al., 2012). Precisely in terms of challenging narratives, design fiction has been used to critically explore the functioning of abstracts (Blythe, 2014b), full papers (Lindley and Coulton, 2016), and even conferences (Kirman et al., 2018). However our concerns here are not methodological but provoking readers' engagement with the designs we present. Thus of particular relevance for this paper, is how design fiction may be used to critique technological scenarios such as Weiser's (Blythe 2014a, Linehan and Kirman, 2019). Together with Blythe we acknowledge how narrative descriptions of technology in the form of scenarios such as Weiser's often hide

social conflict and struggle (Blythe, 2014a). In this, we ally ourselves with James Auger who identifies how design proposals based on existing technology can conjure up 'alternative presents' to ask questions about the current state of the world (2013). Such 'speculative' designers create artefacts to provoke the re-thinking of existing technologies, ideologies and practices. Our aims are similar, but instead of design proposals we are interested to see what happens when many different contemporary artefacts can be combined through a simple narrative into a coherent, but open-ended vision.

1.4 Entering a design space through entering a design fiction

As an experiment in bringing our design space review to life, and provoking reflection, dialogue and exchange between different kinds of experts and other stakeholders, we present a 'day in the life' narrative populated by examples from our corpus of social icebreaking designs. This narrative was originally made for a oral presentation/performance as a highly visual keynote lecture.

The examples featured in this paper comprise around five percent of the total corpus. The criteria that motivated selecting these examples were threefold. Firstly, it was important to populate as many different contexts from a typical day as possible. Some contexts in the narrative feature many more design examples than others. This is broadly representative of our corpus of design examples – for instance, we have seen many more relevant installations and artefacts explicitly designed for places like bars and cafes where socializing with strangers is generally considered to be more likely. Many designs have been created for gallery and museum exhibition. Seeing museums as social places, we inserted these artworks into the more typically convivial contexts in the story.

Secondly, designs were selected for inclusion in order to represent the breadth of the design space review in terms of media, scale, sources, and design approaches. By design approaches, we mean the strategies or logic whereby the design might support social ice-breaking. For instance, the narrative includes examples of a wide range of different strategies to boost reduce barriers to social interaction such as various means of filtering interpersonal space (Mitchell and Olsson, 2017) a range of ways to lubricate social proximity (Mitchell, 2019), exploiting temporal aspects of collocated actions, and providing reasons to initiate an interaction (Mitchell and Olsson, 2019).

And thirdly, drawing upon a background in presenting science communication events and cultural production, the first author attempted to craft an emotionally engaging sequence of design examples. The intention was to take the original live audience for the narrative on a journey that alternated between moments of repetition and variation, and recognition and shock. Instrumental to crafting a sequence of such qualities was reflecting upon commonalities in how previous audiences had responded when exposed to different portions of the corpus. His earlier facilitation of over a dozen design workshops, conducting several focus groups and many expert interviews, plus presenting at a number of design talks

and teaching events, gave a good basis for anticipating the likely reactions to different examples. This supported selecting examples to provoke a full range of audience responses, spread across a hypothetical daily routine.

Translating the fiction from oral to written form may reduce the vivacity of the narrative, but we contend that this loss is counterbalanced by gains in allowing a reader to take their time in apprehending each example. A document more easily allows revisiting and thus affords the reader to dip in and out and more readily make comparisons between different designs from different episodes of the day. And of course, this document also serves as a reference list for the featured designs. So we recommend that you will gain most from the scenario if you have someone read it out loud to you. Or if you read it out loud yourself directing your words towards one or more humans. in any sectors of the CSCW matrix (Johannsen, 1998) of your choosing. I.e. your listeners maybe collocated or remote, and they might hear you synchronously or asynchronously. Taking it turns with a reading partner to verbalise a paragraph each can also work well. But whatever the format, one thing is beyond doubt: after you share a reading out loud, you will have lots to talk about together. The topic is social, so it would be fitting that you encounter the text without being entirely solitary.

In our narrative we playfully appropriate Mark Weiser's 'Sal' scenario (Weiser, 1991) to present a vision of a world in which nearly all objects in a domestic, workplace, urban and leisure environments appear to have been designed in order to address an interpersonal priority that differs vastly from most existing typical artefacts and environments. The designs discussed are all real objects - either functional prototypes or interactive exhibits. The fiction is that these already existing artefacts are a commonplace, and not particularly remarkable part of the everyday. Thus the 'strange is made familiar' by the unusual qualities of these designs being presented as universal normality. Unlike most design fiction, this narrative is not about the future, but about an alternative present.

In line with criticisms of Weiser's Sal scenario, our main character is not given an identity. Instead, the 'flatness' of design is 'broken' through the narrative being conveyed in the second-person form so that 'you' the reader are the protagonist. The story puts the reader into the role of an able-bodied, urban dwelling character with an office job, but leaves other characteristics such as gender, nationality etc. entirely open. The empowered individuality depicted in Weiser's vision is deliberately challenged. Instead of the 'disappearing computer' in his vision, we have a faceless, nameless character whose individuality disappears into their relationship with other individuals. Are you sitting comfortably? The narrative is about to begin. You can also begin to read whilst laying down, just like the protagonist.

2 A Day In The Life

The day begins like every other day with you lying down with your eyes closed. You are awoken by your alarm clock. You jump up quickly, because you know that your clock has taken control of your mobile telephone. Instead of a snooze button, if you don't get up within 3 minutes your alarm clock tells your telephone to call a random number in your telephone's contact list (figure 1) (Wang, 2009).

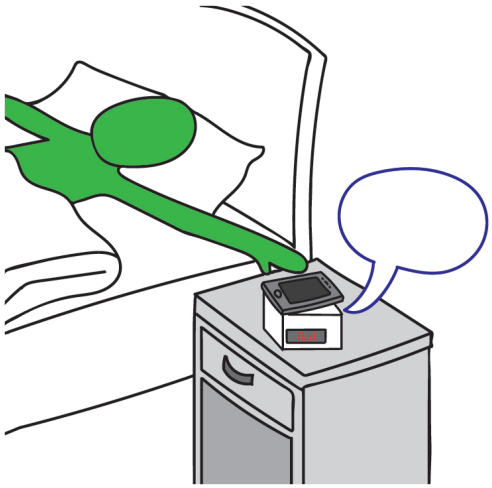

Figure 1. Tyrant by Alice Wang.

NOW YOU ARE AWAKE! Great! Because today like every other day, is not about telephone conversations or other remote communication. No! It is about same place, same time, social experiences. So you stumble to your bathroom... you are so happy that your social toilets are gender neutral and classic in design. They are just an identical pair of standard sit down western-style flush toilets half an arms length apart - with no barrier or screen separating them (figure 2).

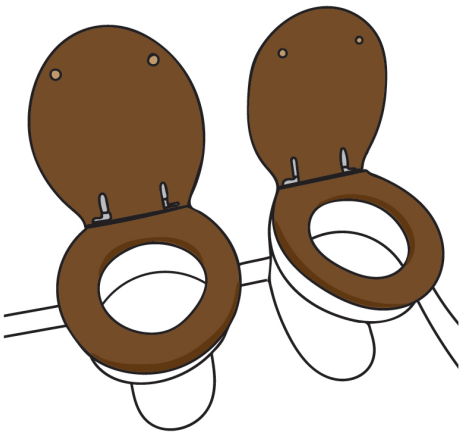

Figure 2. A double toilet, spotted in a South London pub by Prusikloop.

These are a wonderful improvement on your much less inclusive previous twin toilets. Although these consisted of one female and one male urinal, they were mounted on either side of a wall, so the main social aspect was seeing the bodily fluids mixing as they dribbled down a shared drain (figure 3) (Schweder, 2009).

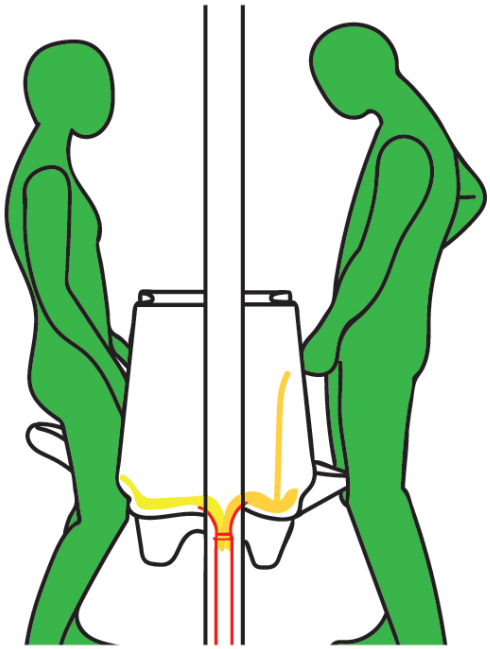

Figure 3. Plumbing Us by Alex Schweder.

What is next? Washing your hands of course. You really enjoy that you are not able to accomplish this by yourself. Instead, to get water flowing through your taps, you must ask a companion to grip the water pipe with you (figure 4) (Nakamura, 2015).

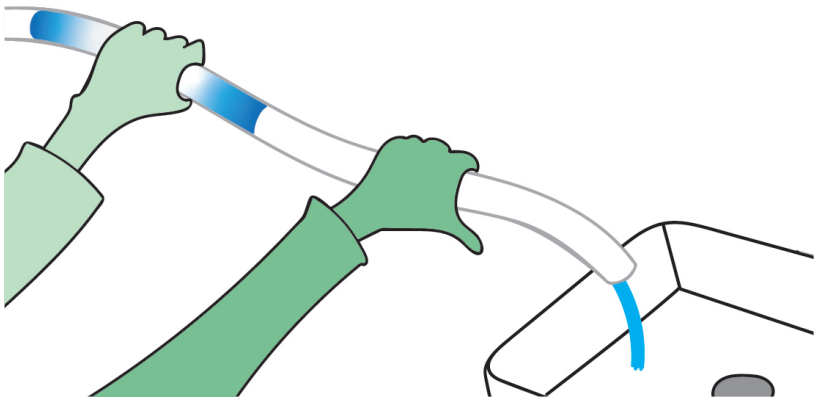

Figure 4. Touchy Tap by Nanami Nakamura, Elena Garcia de la Fuente, Emma Berlekovity, and Asger Bøgh Lautrop.

And after going to the toilet, that is the best time to weigh yourself isn't it? So you step onto the bathroom scale and ask for assistance to read the numbers. The load measured by your weighing machine is displayed on a panel inset into a sidewall of the device (figure 5) (Wang, 2009).

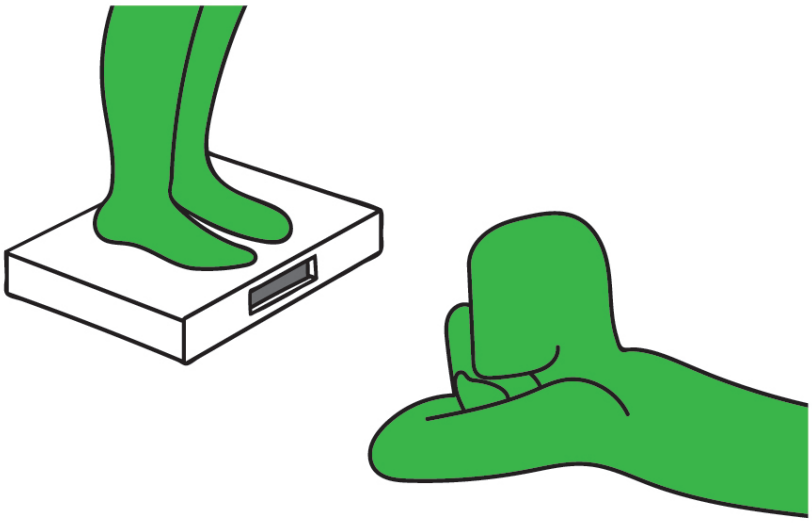

Figure 5. Half Truth by Alice Wang.

This (almost) face-to-face design is a great upgrade on the earlier version which sent your weight to someone else via SMS (figure 6) (Wang, 2009).

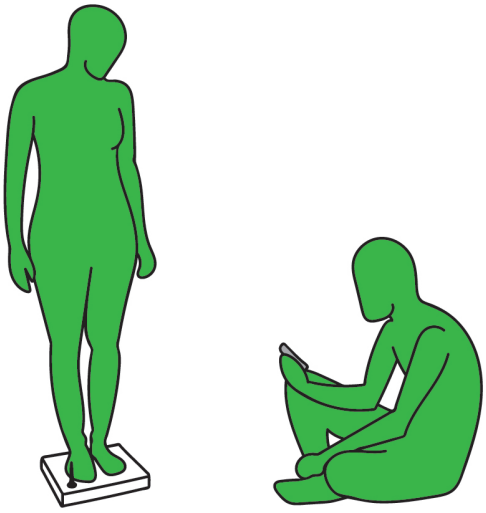

Figure 6. Open Secrets by Alice Wang.

Making best use of your large electric toothbrush also requires a co-pilot. The handle is so heavy and the controls for the brush are so far away that a companion is needed to operate the device for you (figure 7) (Schlegel, 2009).

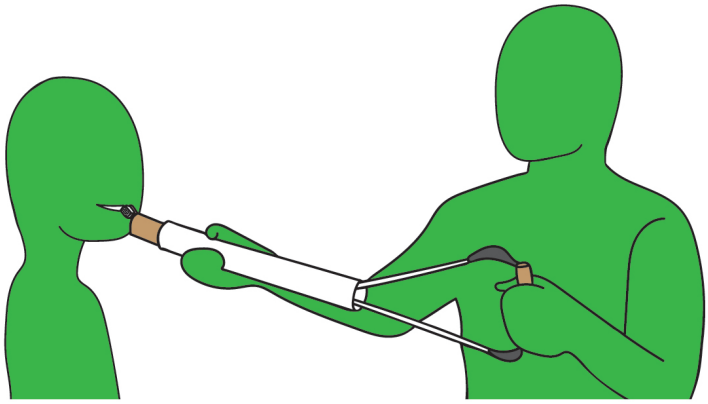

Figure 7. Toothbrushes for Two by Allison Schlegel.

As normal, you enjoy a quick simple breakfast, you and your companion feeding each other with one-metre-long spoons, in the bath (figure 8) (Balina, n.d.).

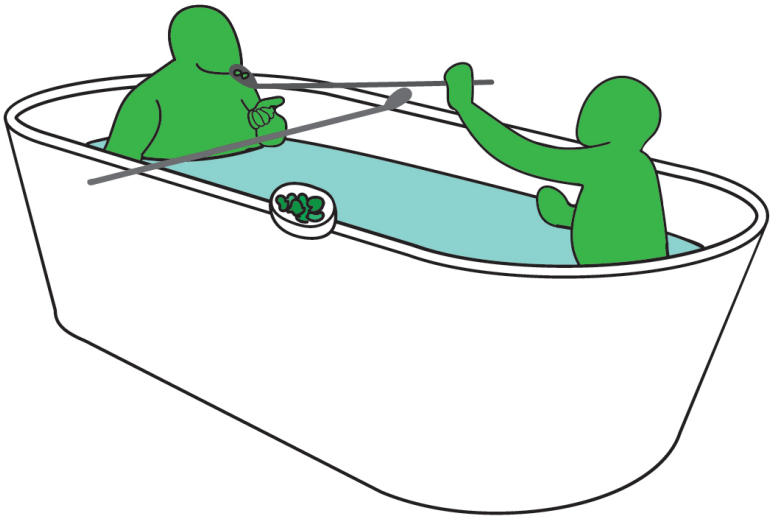

Figure 8. When I Will Grow Up (Long Spoon) by Arta Balina.

2.1 Getting dressed

Then it is time to deal with what you have been worrying about ever since your alarm clock sounded. WHAT ARE YOU GOING TO WEAR TODAY? You take a look in your cupboard...

It is not easy is it? Your eye catches your silversmith designed armature that provides elbow supports angled so as to encourage the wearer's arms to continuously adopt an open and approachable posture. But you grew up wearing things like this, so for you to appear friendly, you need little help from this kind of aluminum prosthetic-like apparatus (figure 9) (Youngblood, 2013).

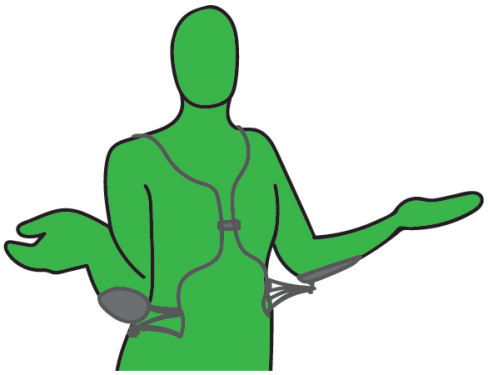

Figure 9. Unguarded Gestures 3 by Jennifer Cupri.

Nevertheless, signaling that you are listening closely to someone also has its advantages, so you pause to consider whether to put on your headset of silicone cast hands. Held in place by a band over the top of the head, the life size silicon hands are cupped around the ears so that the wearer can hear better in the direction that they are facing (figure 10) (Borland, 2011).

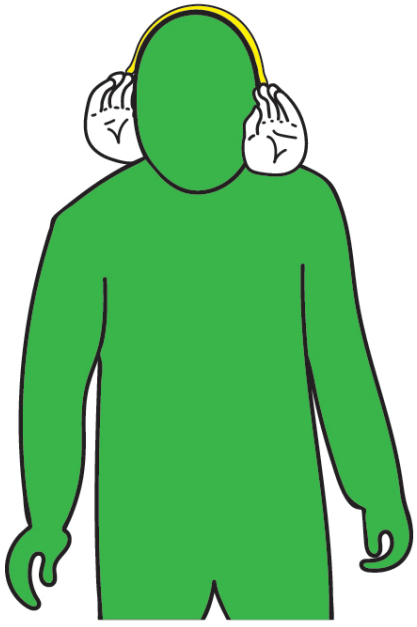

Figure 10. Handy Ears by Ralph Borland.

But in regards to fashion today your mood is classic and minimal. So you opt for wearing powerful magnets underneath your everyday clothing. When you get quite close to another person wearing the same thing, these super strong magnets will pull you towards them. But you need to be careful because depending on the poles, magnets also repel (figure 11) (Moriwaki, 2011).

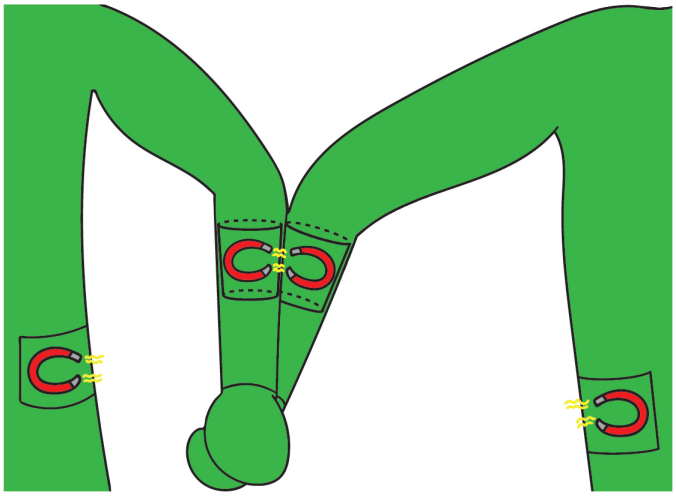

Figure 11. Recoil by Katherine Moriwaki.

Since you are not the tallest person in the world, you wear your usual footwear - your smartphone controlled, adjustable level platform shoes. This mechatronic footwear means you can be eye-to-eye with anyone taller than you (figure 12) (Marom, 2011).

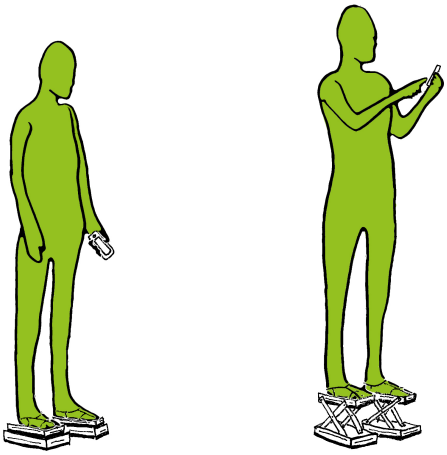

Figure 12. SHORT++ by Adi Marom.

And of course, since like many people, you are concerned about how attractive you look, you will need a sensor to monitor how upright your posture is, and respond with haptic feedback and annoying sounds when you slouch (Ryan, 2009).

2.2 Into the world

You are the kind of person who appreciates the healing power of human-to-human touch, but sometimes you feel a bit too shy to ask for it. So as you leave your apartment you are really relieved to see that the anonymous hugging wall in your street is fully operational. A pair of shoulder-length gloves is incorporated into vertical fabric surface. This means a person on one side of the wall can wear the gloves and thus give mutually unsighted hugs through the textile membrane (figure 13) (Dixon, 2008).

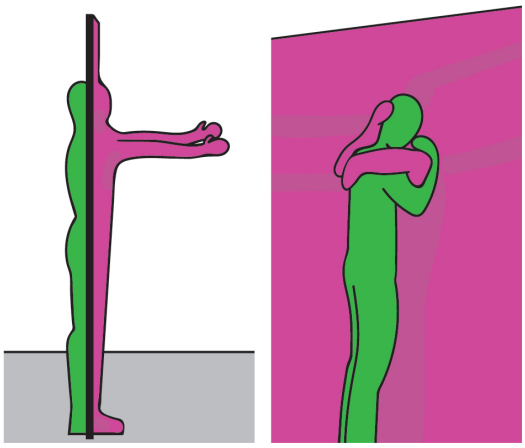

Figure 13. Anonymous Hugging Wall by Keetra Dean Dixon.

At the bus stop, you have these lovely repositional seats. The seats rest on a bed of marbles so after you start talking to other passengers, you can easily glide a bit closer to them without standing up and changing seats (figure 14) (Niedderer, 2007).

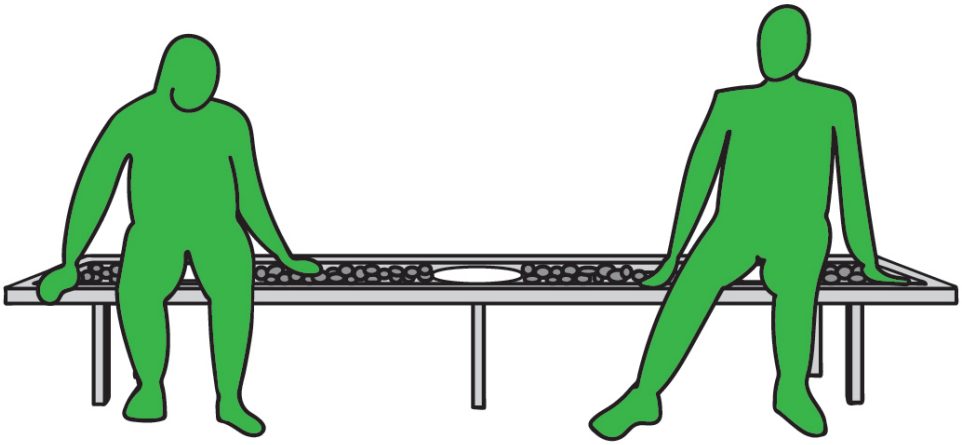

Figure 14. Come A Little Bit Closer Bench by Nina Farkache / Droog.

Getting on the bus, of course you rush for the new seats that are clearly marked as reserved for strangers who wish to become acquainted. Even though you are not the kind of a person who needs help with deciding what to do talk about, you appreciate that these seats come with a reliable supply of post-it notes suggesting conversation starters (figure 15) (Biscoitos Zezé, 2014).

Figure 15. Alimentando Amizades by Mark+.

After getting off the bus, you take a shortcut down an alleyway towards your workplace. You find it really easy to meet and greet new people here because of the stretched fabric that funnels pedestrians together (figure 16) (Coles et al., 2009).

Figure 16. The Meeting Place by Aspect Studios.

2.3 At work

As you enter your office you take a moment to look at the floor projection of recent footsteps. These projected white footprints provide a useful way to estimate who might be in the building and which office is occupied (figure 17) (Monastero and McGookin, 2018).

Figure 17. Traces by Beatrice Monastero.

Your organisation has recently been taken over by a rival, so there is a bit of tension at your workplace. These days a powerful way to help starting to heal conflicts is still performing the ritual of handshaking. However not everyone is ready to actually squeeze each other's flesh. In such instances, a glass vitrine containing a pair of thick stiffened gloves plays a useful role. At opposite ends of the glass case, is an opening that allows insertion of a hand into one glove. The fingers and fists of both gloves are interlocked in a handshake position so that the gesture of handshaking can be performed without direct physical contact (figure 18) (Wilcox, 2010).

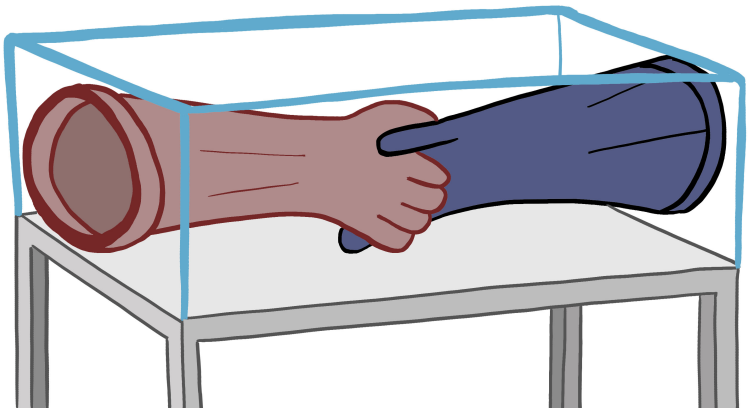

Figure 18. Pre-Handshake Handshake Device by Dominic Wilcox.

During meetings, you and your colleagues choose carefully where to sit, in order to achieve the right balance between assertiveness and humbleness. The main options are between chairs largely similar in appearance. However one design has a seat that is rather too narrow, and through tightly squashing its user's legs together, makes its users more likely to adopt a meek or subservient looking posture. By contrast the other chair has a very generously wide front that fosters more relaxed, or confident, dominant looking poses. This chair has a slightly broader backrest, but the arms of the chair are angled, opening away from the backrest so that the seat cushion is an isosceles trapezoid shape (figure 19) (Toretti, n.d.)

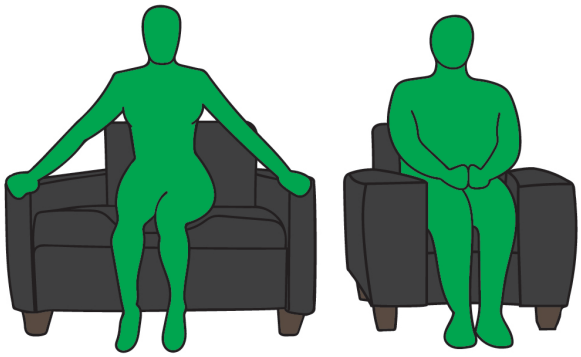

Figure 19. Gender Subverting Chairs by Judy Toretti.

Your office vending machine is the same as vending machines everywhere. It sells bottles of drink that can only be opened by using the bottle of another person to unscrew the lid (figure 20) (Monllos, 2014).

Figure 20. Friendly Bottle by Leo Burnett.

But you prefer a hot drink. Intertwined colorful ribbons are tied between pairs of cups around a circular table. The short length of the interconnected ribbons means that drinkers perform a bowing like gesture to the people opposite them. Although a particularly intense collaboration is required with the drinker at the opposite end of your ribbon, all the hot drinks are loosely connected so you are very happy to spend your coffee break entangled with a few colleagues from other departments (figure 21) (Mitchell, 2013).

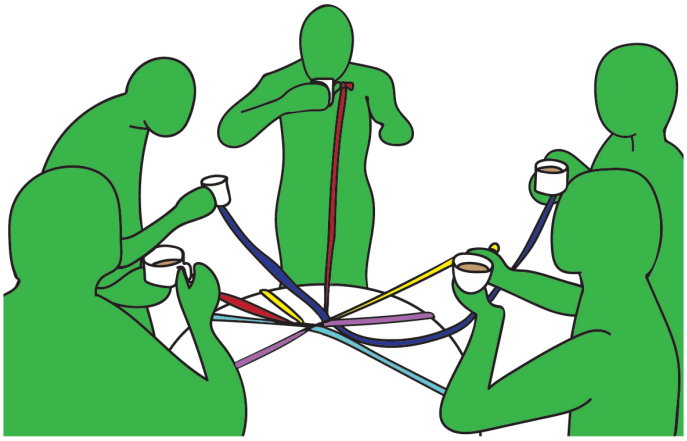

Figure 21. Cuppa Hoop by Robb Mitchell.

2.4 Lunch

But anyway, soon it is lunchtime. YAY! One of your favourite cafés, features tables cut in half. So that half the table is in the cafe. And the other half is on the other side of the glass, actually inside the cafe (figure 3). This means that it is really comfortable to share a table with a stranger, because although you are very close, you are not really in the same place (figure 22) (Ha, 2015).

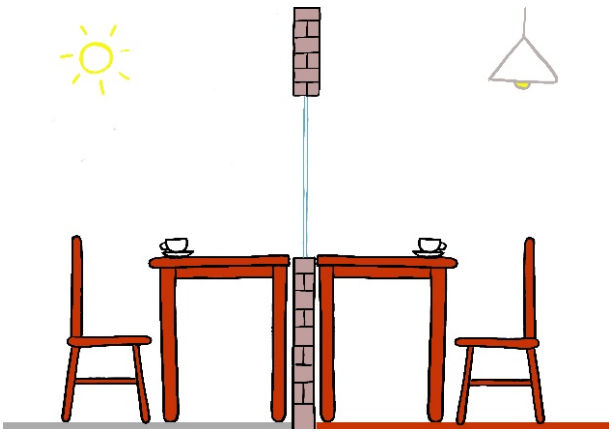

Figure 22. Table for Two by Shani Ha.

But you actually really fancy going to that nice sushi place. Here, like in all takeaways nowadays, in order to open the food box, several people need to pull a string each, in different directions, but at the same time (figure 23) (Chen, 2008).

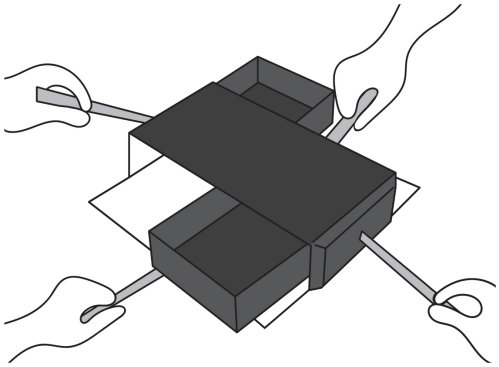

Figure 23. Share by Stephanie Chen.

Soya sauce makes you a bit thirsty, so you join another collaborative string pulling activity. This room-filling contraption is much larger than the sushi-boxes, but despite the size, it dispenses refreshment much more slowly, and is designed for use by two people, taking it in turns to moisten each other's palette. So you alternate between imbibing and dribbling drink into another person's mouth. This is much more hygienic than it might sound. With your mouth open, you stand, facing up beneath a ring of pipettes. Each pipette is connected to a different hanging rope that you cannot reach. Thus you are dependent on an ally to pull a rope and release some drops of drink into your mouth (figure 24) (Vogelzang, n.d.b).

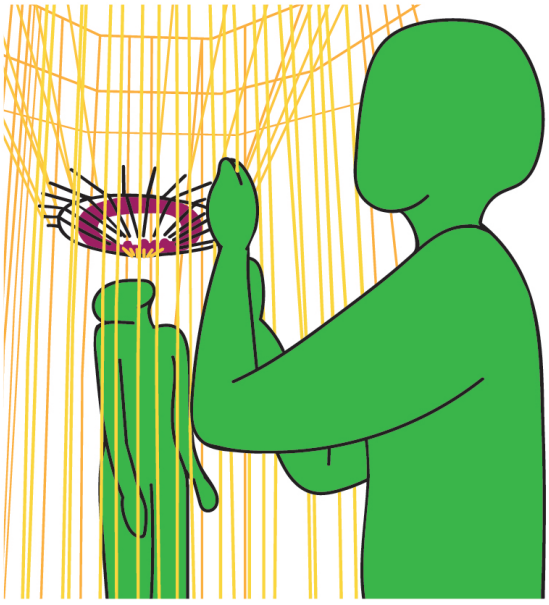

Figure 24. TEARDROP by Marije Vogelzang.

2.5 A walk in the park

It's a nice day, and you have time for a short walk in the park. You enjoy seeing two different kinds of benches that encourage people to sit closer together. Both are of a similar material and scale to classic timber park benches from the 20th century. One provides encouragement to increase interpersonal proximity via interactive lighting. This furniture has the form of a classic park bench, but features embedded sensors and various shapes of LED lamps discretely mounted in the backrest. The sensors detect where people sit on the bench. When two people are seated far apart, arrow shaped lights pointing on the backrest are turned on. These arrows point towards the other person. When two people are sitting close together in the centre of the bench, red heart shaped lighting appears either side of them on the backrest (figure 25) (Dekel et al., 2005).

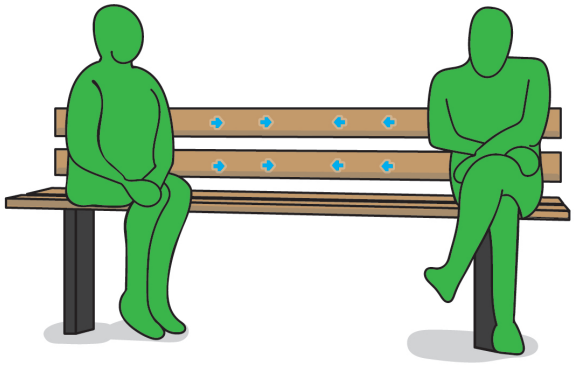

Figure 25. Intimate Bench by Yoav Sterman.

The other kind is more low-tech. The legs and backrest of this bench also resembles that of a classic bench. However, when viewed face on, the seating surface resembles the curve of a smile, sloping inwards from each end so that people sitting on the bench find themselves gently sliding together into the dip (figure 26) (Hein, 2013).

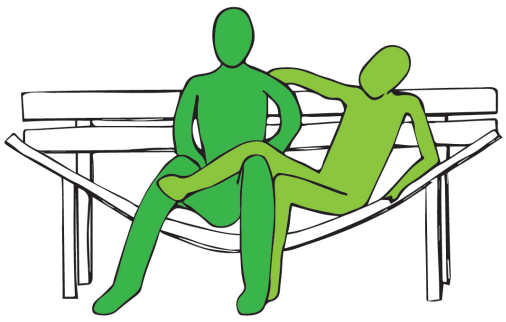

Figure 26. Modified Public Benches 3 by Jeppe Hein.

Other picnicking folk prefer to sit on the grass facing each other. Nevertheless, they enjoy similar reliance on their dining partner as the users of the seesaw benches. Here the two people form the legs of a table with their bodies, so that they suspend a lightweight, but potentially unsteady surface by draping each end around their shoulders (figure 27) (Chan, 2016).

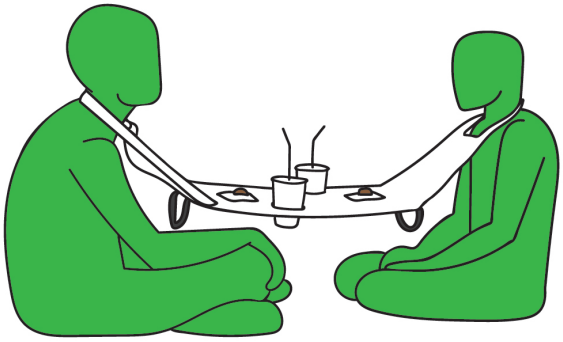

Figure 27. Napkin Table by Hung Lu Chan.

You also see some furniture similar to your usual bus stop bench that gives people opportunities to move close together. In the park is some seating that offers some related benefits but fosters inter-dependency between its users. This bench has a central sturdy metal post supporting two metal beams. The beams are independently horizontally rotate-able and on each is mounted two plastic seat tops. Both beams are horizontally jointed halfway along their length, so that there is a seat either side of the joint. Furthermore, the seat bases themselves can also rotate approximately 180 degrees. A user sitting on one seat can apply pressure on the ground to attempt to adjust the orientation of their seat and its distance to other seats. But each individual's control of seating position and orientation is dependent on if, and how other users are also attempting to manoeuvre their own seats (figure 28) (Mitchell, 2019).

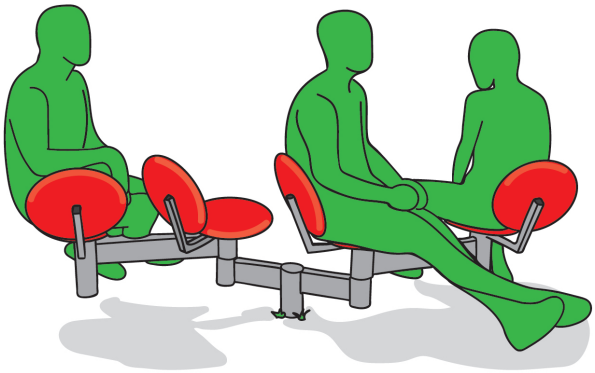

Figure 28. Public benches of Troyes, France.

The inscription on a low stone plinth offers amusing photo opportunities that brings some strangers together. This knee high truncated rectangular pyramid displays on one side the text: 'We don't know each other, we're just hugging for the picture. When we're done, I'll walk away quickly'. This provides a caption for anyone or anything that chooses to stand on this platform. This text thus indirectly and humorously provides the suggestion for people unacquainted with each other to share a hug on the platform (figure 29) (July, 2009).

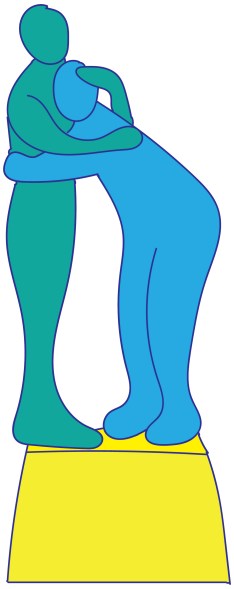

Figure 29. Pedestal For Strangers by Miranda July.

Water drinking fountains are also arranged to bring people into closer awareness of each other, even though it can be hard to make eye contact or converse when your mouth is full. The drinking fountains are spread out across the top of an arrangement of waist high concrete walls (figure 8). Each fountain has multiple waterspouts around its basin, and the fountains are distributed so that on sunny days, nearly anyone who bent over to quench their thirst, would be closely facing another person gulping water (figure 30) (Blum, 2005).

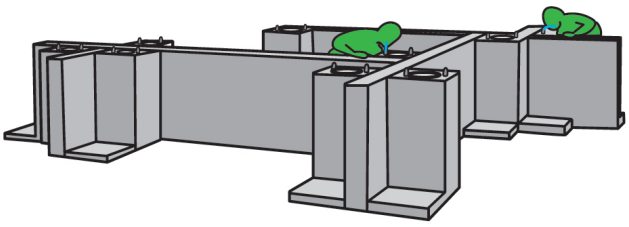

Figure 30. Drink Sleep by Andrea Blum.

2.6 Kids today

You leave the park and on the way back to your office, you pass a high school and notice lots of noise and action around a cluster of wobbling schoolyard benches. You remember reading about the new equipment that might be exciting these young people. Namely, loosely encircling an unusual looking lamppost are five backless benches. These long seats wobble because instead of solid legs, each bench rests on standard playground equipment springs. Motion sensors installed in each bench control different properties of the dynamic and kinetic lamp atop the central pole. Furthermore, wiggle motions detected in one bench can also output as vibrations felt by people sitting in one or more of the other benches (figure 31) (Tieben et al., 2014).

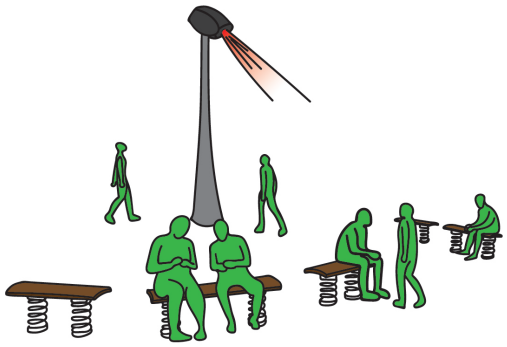

Figure 31. Wiggle The Eye by Rob Tieben.

And looking over the fence of the kindergarten next door, you catch a very brief glimpse of some intense multiplayer action. It is much clearer what is happening here. A bunch of kids are clambering over a 3m tall replica of the classic Atari joystick. They interact with onscreen video game action by collaborating to push the enormous stick and stamp or jump on the giant push button (figure 32) (Flanagan, 2006).

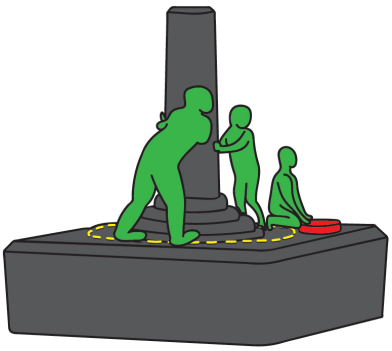

Figure 32. giantJoystick by Mary Flanagan.

2.7 Evening

After work, you look for more mingling to relax. But by this time, the batteries for your platform shoes are running out. Actually, the batteries in the shoes are fine, it's the phone controller that is low on juice. So you make your way to a bar that provides and requires its patrons to wear non-adjustable vertical footwear extenders. This means that each bar goer wears a pair of platform shoe inversely proportional to their own height, so that everyone present is equally tall. So the shortest people totter on huge platforms, whereas the very tall wear flat-soled shoes (figure 33) (Smith, 2010).

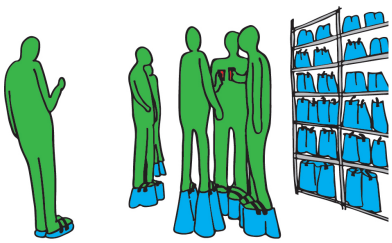

Figure 33. Level by Hans Hemmert.

However, being on the same level doesn't solve all challenges to social interaction, does it? So you move on the next bar.

Making and keeping eye contact is uncomfortable for some people (IT CAN BE LIKE LOOKING INTO A FIRE). And it seems some people much prefer looking at themselves. So this bar offers many opportunities to combine images of self and other. Seeing your face mixed up with the face of someone else can be a good way to give at least some attention to the other person. You enjoy both the digital and non-digital forms of this experience. The simplest version is sitting across from another sitting person and looking at each other through a frame that alternates strips of mirrors with equal sized gaps. So when both of you are positioned at a similar distance from the panel of mirrored slats, you both view the illusion of a single face that half looks like yours, but half looks the seated person on the other side of the frame (figure 34) (Exploratorium, 2015).

Figure 34. Your Father's Nose by Exploratorium.

Mixed up video group portraits are also displayed on wall monitors. Face-tracking technology records, aligns, cuts up and joins images of visitors' faces, to dynamically combine headshot segments of different patrons (figure 35) (Levin, 2010).

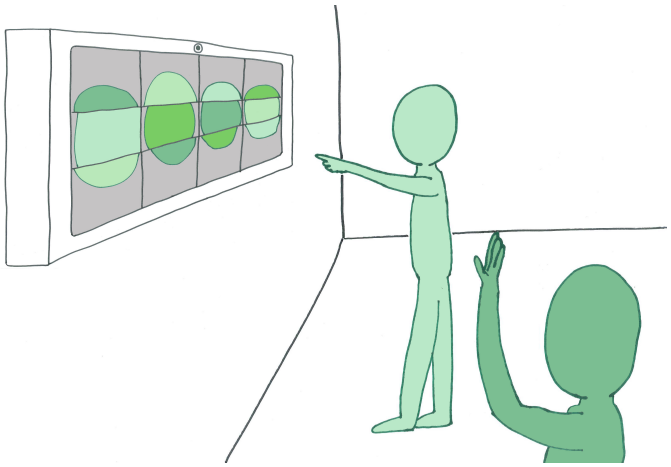

Figure 35. Re:Face by Golan Levin and Zachary Leiberman.

Feeling slightly peckish, you head towards a set of mirrors which features only one round gap, near its centre. You enjoy how attention to your own reflection can be increased further when there is this gap in the mirror around where you might expect to see a reflection of your mouth. And someone on the other side is spooning food through this opening into your actual mouth (figure 36) (Vogelzang, n.d.a).

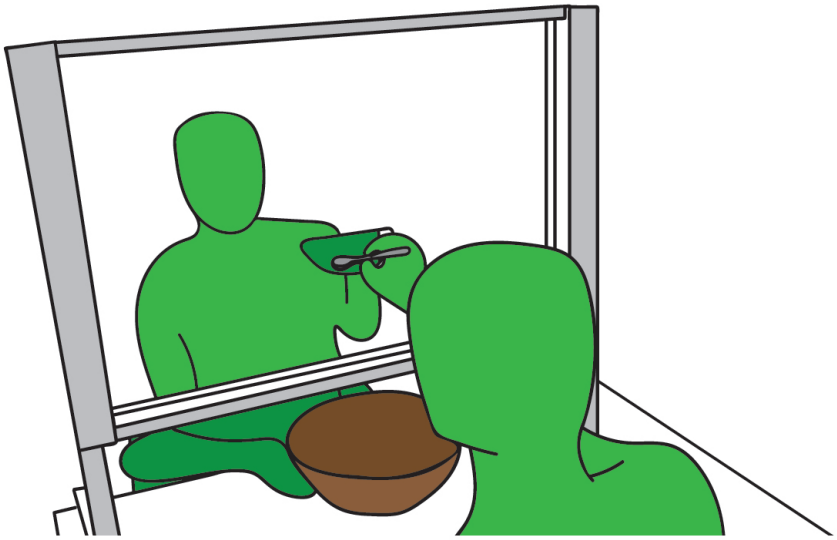

Figure 36. Edible Reflections by Marijie Vogelzang.

2.8 Piazza people

After you leave the second bar, you hear some strange music in the distance. You follow the sound to the piazza. Here a small crowd has gathered on both sides of a large canvas screen. Bodily contact on either side of the opaque and stretchy canvas triggers musical samples. This enables getting acquainted through exploration of music and intimate cooperation. The closer people on opposite sides of the screen are to touching the same point on the canvas, the more rewarding the audio feedback (figure 37) (Boerdonk et al., 2009).

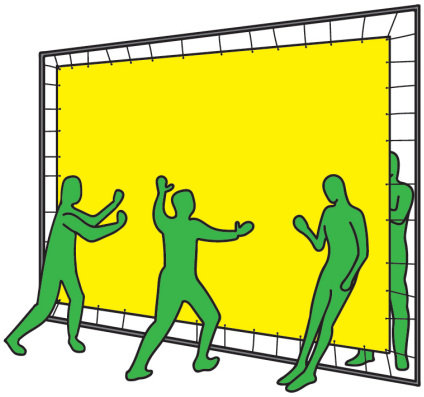

Figure 37. Touch Me Dare by Boerdonk et al.

There are no public telephone booths in this urban environment. But in a corner of the piazza, a pair of timber-walled, one-person booths provide a different kind of opportunity for shyer people to converse unseen by each other. The booths feature comfortable cushions to encourage lingering. They are positioned so that lattices in their side-walls are close enough together for conversation to flow between the two structures. People using the booths are visible to passersby, but not to their conversational partner in the adjacent booth (figure 38) (Naido, 2010).

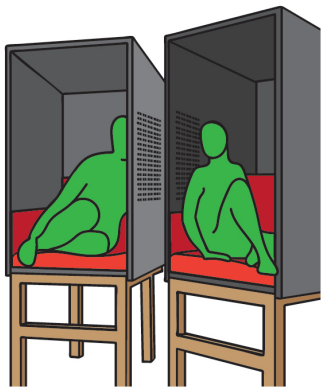

Figure 38. Contemporary Domestic Confessional by Arik Levy.

In another corner of the square, is an opportunity to explore mutual attraction, regardless of appearance, gender, voice or language. Using only the sense of smell. you stand on one side of a wall. Plastic tubes connect your nose with the smellier parts of someone else's body on the other side of the wall. And SNIFF, breathe in and breathe out, and breathe in.. And breathe out... (figure 39) (Auger Loizeau, 2009).

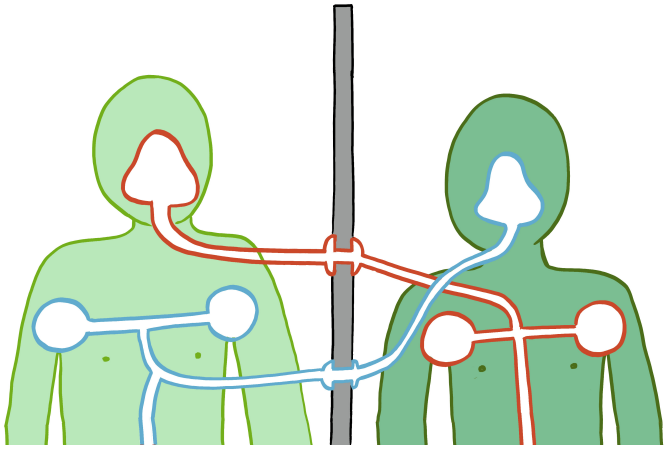

Figure 39. Smell+ by Auger Loizeau (Auger Loizeau, 2009).

Speaking of smellier parts of the body, you realize that you have not been to the toilet since before breakfast. The doors of the nearest public toilets feature digital displays showing gender icons like the doors of yesteryear. However every five minutes the displayed gender icons switch sex to help break down this artificial divide (figure 40) (Carpenter and Høbye, 2008).

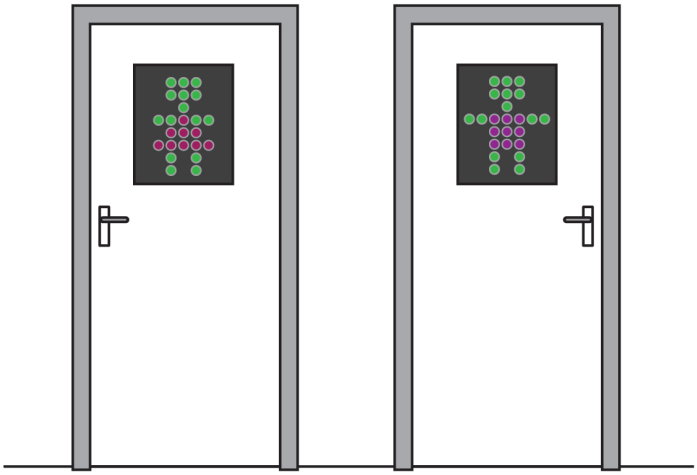

Figure 40. Ladies and Mens Room Mix Up by Daniel Brynolf, Mads Hobye, Nicolas Padfield and Vanessa Carpenter.

2.9 One more bar

Time for another drink? In the next bar alas, there are no platform shoes provided. However, a very large, wooden revolving door offers some help in equalising different sizes and strengths. The door stands in the centre of the room like a giant turnstile fringed by a near continuous ring of chairs. The panels of the door pass very closely over the knees of people seated around it. The closer you are to the centre of the circle, the heavier the door is. But people sitting down can push the wooden panels very easily, almost effortlessly. The seated and the standing people are linked through a continuous game of peekaboo, as neither knows who might be revealed. Those standing can also find themselves helping or obstructing each other. So people can be collaborating even if they do not realise it. In the old days, you might go to a bar and hide in a cosy corner and not meet anybody new. Here there are no corners, the changing shape of the space, means people are continuously mixed up (figure 41) (Mitchell, 2009).

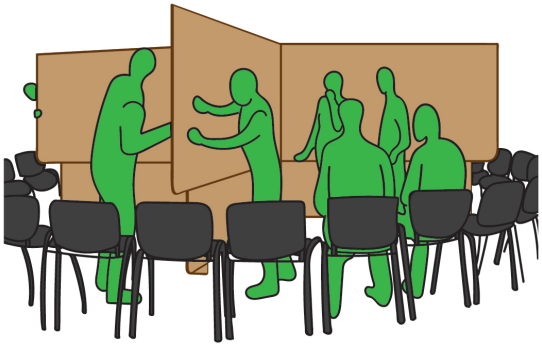

Figure 41. Blender by Robb Mitchell.

In this bar, the drinks are served in metallic containers that have bases shaped like half an egg. So they are very wobbly. This means that in order to rest your glass, you need to put it down next to another glass so that they can interlock and balance each other (figure 42) (Niedderer, 2007).

Figure 42. Social Cups by Kristina Niedderer.

2.10 Okay, this is really the last bar

The furniture in your next bar attempts to offer moments of intense interpersonal focus. You can stick your head up into various structures.

First you try a inflated fabric construction, hung at shoulder height and designed for two people. On the underside at each end of this balloon like form are two openings which you can unzip and stick your head into. The zeppelin-like shape is maintained by electric fans continuously pumping in air. Although the thin textile of the structure does not offer any sound proofing and it is only semi-opaque, the bubble gives a feeling of isolation and thus focus towards any other person whose head is inserted (figure 43) (Attias, 1999).

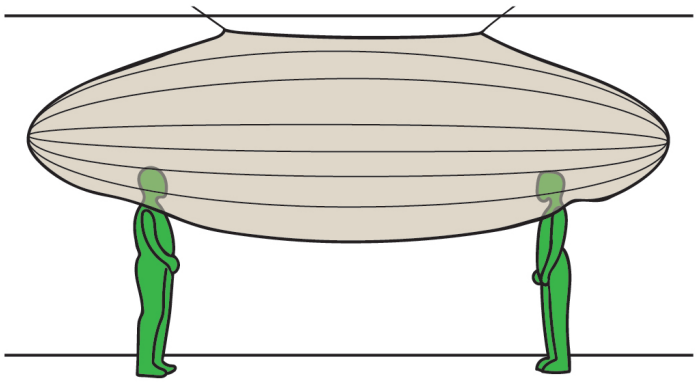

Figure 43. La Parole by Pablo Reinoso.

Another version is a slightly lower hanging cylinder shape made of black lycra and fiberglass poles. This one has four head sized holes spread spaced across its lower horizontal surface. The opaque stretchy material means this is a place to meet new people without being too aware of their clothes, their body shape, and even their height, or if they are in a wheelchair (figure 44) (Mitchell, 2013).

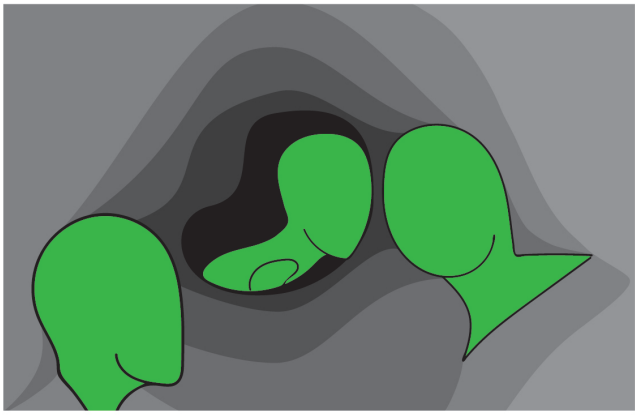

Figure 44. Lycra Headspace by Robb Mitchell.

2.11 Nightlife

You have been in the pubs for a while, so when you are back on the street it is night time. You join the crowd whooping, hollering and clapping in front of the church. They are energized by the dynamic projection on the exterior of the ecclesiastical building that changes in response to the sound made by the crowd. The system detects difference in cadence, pitch or rhythm. Under the cover of darkness, it is not easy to tell whose input is creating which visual effects (figure 45) (Haque, 2007).

Figure 45. Evoke By Usman Haque.

This anonymity is very liberating. So you scream and shout for a while - at the church. Now you feel ready for a nightclub...

Upon entering the club, the first thing you see is an abstract representation of yourself on a big screen. (Yes that is you. Nice and large). This interactive projection is tracking your movements real me. BUT THEN IT GETS EVEN BETTER. On the screen a bold line is now displayed, linking your avatar to that of a stranger near you. Increasing your awareness of each other, and offering an excuse to play (figure 46) (Hespanhol et al., 2011).

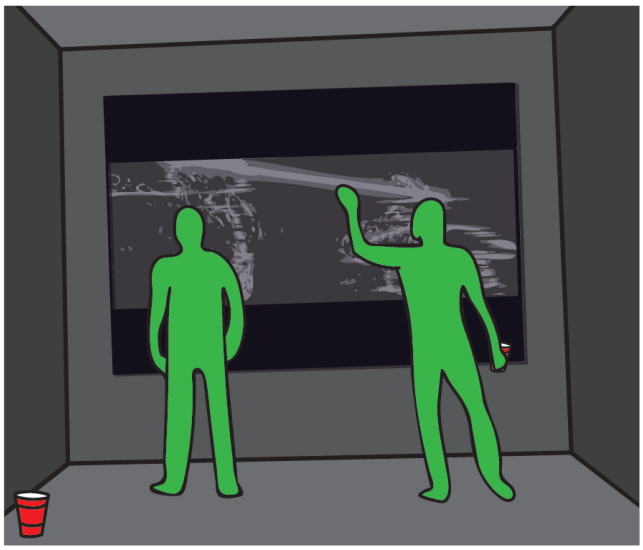

Figure 46. Liquid Light by Luke Hespanhol.

Above the main dancefloor is a grid of 64 hula-hoops cable tied together. Most of the time you hardly notice them, apart from the circular shadows they cast on the walls. But at the climax of the party, the grid of hula-hoops is dropped onto the crowded dance floor. So almost everyone that was underneath is loosely caught inside a hoop together with someone standing close to them (figure 12). The grid as a whole briefly creates a giant net, a common, crowd connecting chaotic structure (figure 47). However, the clubbers informally collaborate to escape the clutches of this plastic honeycomb mesh, folding up the hula hoops until they end up as a colourful geometric sculpture in the middle of the dancefloor (Mitchell, 2013).

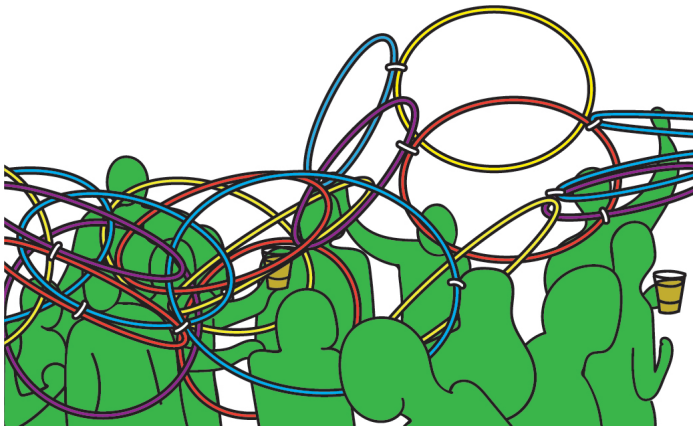

Figure 47. Hoop Down by Robb Mitchell .

WOOF! Deep breath... now you need to chill out for a bit...

2.12 After party

At the after-party, all the seating and cushions follow a similar principle. The couches and armchairs are inflatable, and what is more, an air pipe connects each chair to another . So regardless of whether you choose a two-person or one person seat, you need to synchronise your sitting down with someone else, otherwise, all the air goes to the other seat, and you sink quickly to the floor (figure 48) (Reyes, 2011).

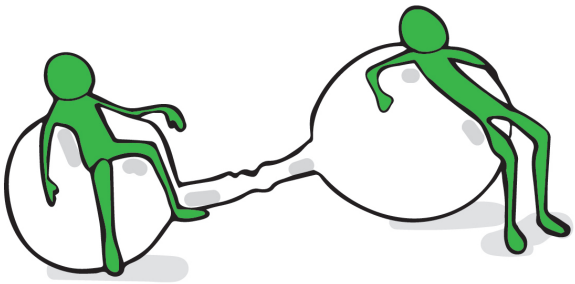

Figure 48. Communicant Chairs by Pedro Reyes.

Something that can put people off starting new encounters is not knowing how to escape the interaction. Getting stuck with someone you don't like or not knowing how to say 'go away'. Because all this socialising can eventually become a little tiring, at the end of a very long day, you are glad of the motorized fan mounted at seated head height, halfway along some of the couches. The fan opens and closes and random intervals. When it is uncurled, it creates a visual barrier between you and your fellow couch sharer - to give you both the option of a pause in your conversation (figure 49) (McCarthy, 2011).

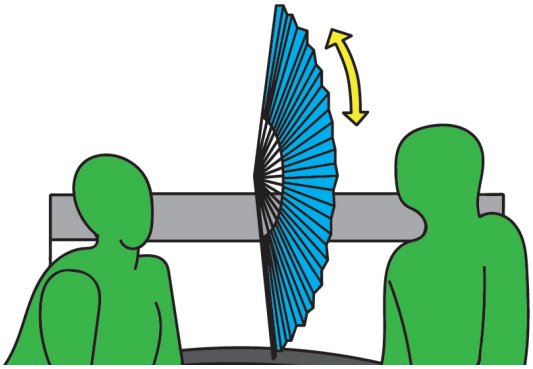

Figure 49. Take A Moment by Lauren McCarthy.

And then home. You are very happy to see your own toilets again, brush your teeth...

3 Discussion

Our narrative contrasts to much design fiction in that the reason that the described objects do not feature in our current daily lives is for reasons other than technological challenges. Thus this narrative potentially turns inside out the 'gap' between the social requirements and technical capabilities that Ackerman (2000) highlighted as a core concern of CSCW. We hope that the narrative generates many responses we could not foresee, but in the following we offer a brief commentary on a couple of aspects that may have puzzled you.

3.1 How was it for you?

The narrator/protagonist describes their experiences with the presented designs in very positive terms. However, the dispositions and responses of the other inhabitants in this envisioned world are deliberately not conveyed. Readers thus are left to fill in the gaps through imagining the responses of other citizens, possibly by picturing how they themselves might react to encountering the narrator in some of the situations described.

The narrator might be a typical citizen in the fictional world, or their enthusiasm for the presented designs might reveal that they have unusual needs and preferences, perhaps even to the point of social deviancy or insanity. In written form, sarcasm can be very hard to detect, so it is up to the readers' interpretation whether the narrator's upbeat attitude is intended to be genuine or as a contribution to some form of satire, parody or farce.

These ambiguities are hoped to open a space for reflection and comparison concerning the desirability of current practices with both solitary and multi-user systems. What would happen if we replaced the strange designs in the text with those from a 'day-in-the-life' of an office worker's reality in 2020? Could an equally enthusiastic description of an office worker's encounters with the collaborative and non-collaborative technologies and practices that surround them be more or less believable than the positivity of our narrative's protagonist?

Face-to-face social interaction that involves intense collaboration or conversation is one way to 'switch off' and forget demanding careers. But if chat and cooperation with co-present others is ubiquitous, how might that influence preferences and practices for professional collaboration?

In our narrative we made an effort to leave certain spaces unexplored. The contents of the working day, for example, are deliberately not described. The intention is that readers are left to imagine what kind of collaborative work practices and technologies might exist and thrive in a world where designs to promote interpersonal relating permeate every other aspect of their waking lives. For instance, these days, due to the always-on internet connectivity of portable devices, and increasing collaboration across time zones, many workers suffer from pressures always of feeling on duty and connected to colleagues. Groupware can transgress many attempts at work-life balance. This design fiction flips the

hard-to-escape networked communications with bosses, clients and colleagues to offer an alternative vision of a world where it is non-professional collaboration with collocated people that is inescapable.

3.2 Bigger than you, and more important?

The time and place in which you encounter this text are likely to have an impact on both your personal and professional response to this fiction. The narrative was created and this paper submitted before the declaration of the COVID-19 pandemic. However at the current time of revising the paper, a serious coronavirus is extremely widespread and many, many countries are subject to some form of lockdown and attempt to enforce 'social distancing'. Thus the desirability of most design examples featured above might now be questioned from the perspective of public health. Most examples, but not all, as several designs incorporate some form of interpersonal barrier that might make them more practical in pandemic situations.

What would need to change from our present reality to make the fictional world more likely? What kind of events do you think could have lead to the world depicted? Or put more simply: WHO IS PAYING FOR ALL THIS STUFF?

This is another aspect we deliberately left open for your imagination. Did you consider the public space design values in the fiction were imposed through regulation? And if so, did you picture a benevolent welfare state attempting to boost social cohesion? A centrist municipality trying to attract tourists? Or a totalitarian leaning government interested in its subjects gaining "herd immunity"?

In pre-pandemic times, many feel-good urban social interventions such as those depicted have been funded as part of corporate branding publicity exercises. But in our fictional world, how might sponsors try to attract attention if social icebreaking stunts becomes mundane? Our narrative stretches from both the public realm into intimate and private places such as bedrooms and bathrooms. Compared to the depicted public and semi-public locations, do you find it easier to imagine the domestic aspects of our vision becoming reality through individuals voluntarily spending their disposable income?

The scenario implies an alternative present with very different design values. Such values do not exist in isolation but ricochet off each other with unpredictable effects. In 2000, Steve Benford et al. highlighted an important distinctions between designing to enable, enforce or encourage collaboration (2000). A close reading of the individual design examples in our scenario could certainly tease out these qualities when inspecting designs one-by-one. However, when taken collectively, things and meanings may change. When there are so few options to not collaborate, the distinctions between e.g. encourage and enforce can become less clear or shift along the spectrum of where we might currently draw a line to separate them.

3.3 Everyday humdrum

We hope that you read the narrative out loud like we suggested? Some silent readers have commented that the narrative in places feels a bit repetitive. This is

intentional. We propose that a certain sense of tedium can be appropriate and beneficial for conveying the normality of the lived experiences of inhabitants in this fictional world. For them, these designs to boost interpersonal collaboration and conversations are entirely ubiquitous and commonplace. If you, the reader starts to experience a lack of surprises in the text, then this might be a sign that you have become accustomed to the fictional world presented. And so you may have incorporated the totality of the vision into your thinking. If at times whilst you were reading, you felt that you knew what might be coming next in the narrative, then you might now be well placed to adapt and extend this vision yourself by considering situations, contexts and technologies that we have not described.

The narrative may lack the richness of plot and characters that are seen in a typical design fiction. However, rather than seeing this blandness as a weakness, we view our narrative as more like a movie script. Screenplays only become alive when actors take ownership of words and action. Thus we argue for the benefits of a 'blank slate' as a means for you the reader to project yourself into this fictional world. And we imagine that you are beautifully rich and complex. So might we ask, as you read this fiction, or had it read to you, 'which' you were you? A socially outgoing version of yourself - happy to be so readily meeting so many new people? Enjoying the novelty of many of the designs? Curious to understand their impact? Or were you cringing, at the endless need to make small talk? Furious at having your personal space invaded or your autonomy impeded? Perhaps you alternated between all of these responses or more? Reflecting upon both the degree and direction of your own reactions to different designs encountered in the narrative is an aspect of the plot that we hoped you enjoyed, but of course also a route to evaluating both the overall desirability and specific details of designing to increase collocated social interactions.

4 Conclusion

We have presented a design fiction, in which we tell a story about interpersonal technology. This is a vehicle to argue for a consideration of context through a collective and connected lens, as a journey through design space rather than a tour of isolated objects. Our fictional world, which is collectively proposed by the designs, may generate insight and provoke debate through exposing connections and conflicts between these existing ideas by placing them in the same space, and revealing implications as constellations.

Our intention with this vision is neutral regarding whether it is utopian or dystopian. We also offer no comment as to whether this vision is achievable, or what might be the obstacles to its adoption. Rather we hope that through engaging with the vision, readers may gather practical design inspiration concerning the theme of the presented examples, have a useful and actionable overview of a design space and be provoked into a critical examination of values and philosophies that underpin design activities. Furthermore, we aim to provide a

methodological platform to stir debate upon how insights and values can never truly be separated when reviewing a design landscape.

This extreme vision is hoped to provoke reflections with CSCW researchers concerning how if widely adopted, and emulated, the systems we design may affect not only near-future work and leisure practices, but also may (in the longer run) influence human experiences and dispositions much more broadly. Winston Churchill's observation when addressing the English Architectural association in 1924 that 'We make our buildings and afterward they make us' was echoed at less macro-scale by Woolgar's contention that 'a chair configures its user' (Woolgar, 1990). Thus we hope by considering this alternative vision of human relations, CSCW researchers might pause to consider both the means and ends of their efforts. Imagine the consequences of your own visions for technologies becoming the new normal for human collaboration. Would you welcome such success?

5 Acknowledgments

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Making Home Work Places

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Abstract. This exploratory paper makes the case for deepening and expanding CSCW research on how knowledge and digital professionals work at home. The steady rise of flexible and 'mobile' working policies and burgeoning of freelance work and solo entrepreneurs, means that working from home is now commonplace. Yet, there are few investigations of how people make working from home 'work'. In response to this gap, this paper focuses on how homes become sites of complex coordination and negotiation for those who use them as workplaces. Following a review of how the relevant literature frames working from home, this paper opens up a set of urgent research questions. It argues that CSCW research needs to attend more closely to those intricate *emplaced* negotiations and coordination efforts that occur at home, not only to collaborate remotely with colleagues and clients, but also to ensure that the more 'intimate' relationships of households and families are protected. In particular, this paper examines how both sets of relationships are shaped by the spatial and environmental organisation of the home as a shared space for most.

Introduction: Flexible Work and Place Making

While 'telework' or 'remote work' have been practices supported by employers for decades (Olson, 1989; Olson and Primps, 1984; Lozano, 1989; Kraut, 1989; Huws et al, 1990; Habib and Cornford 1996; Orlikowski and Barley, 2001; Hardill and Green, 2003), the sharp increase and take-up of flexible work policies in many organisations, as well as of people working independently (freelancers, consultants, etc), means that working from home on a regular basis is growing.[1] It is also likely that the Covid-19 pandemic, which has already shifted working patterns into the home, might bring about a reluctance to return to the office when the closures are lifted.

Digital technologies and infrastructures have long been marketed to companies and entrepreneurs as easy solutions to support work 'anywhere, anytime' (Perry et al, 2001; Sørensen, 2013), including domestic spaces. However, critiques of the promises and actual role of technology in such set-ups show that these forms of work carry their own challenges and require extensive (and often invisible) second-order work in order to happen (Bannon, 1995; Star and Strauss, 1999; Olson and Olson, 2000; Perry, 2007; Erickson and Jarrahi, 2016). Enabling and supporting work away from offices and other institutional spaces is not just about designing digital technologies to replace those aspects of co-located work that are lost or diminished (such as social interaction with colleagues), for example, via 'telepresence' mechanisms (Takayama et al, 2012), or remote activity monitoring within teams (Vuolle, 2010). Rather, it is about understanding how workplaces emerge in and through practices of negotiation and coordination in various environments (Felstead, 2005, Erickson et al., 2014; de Carvalho et al., 2017).

CSCW research on mobility and nomadicity, and related research in organisational studies, sociology of work, mobilities and science and technology studies, have detailed the practices of establishing temporary (and often fleeting) workspaces, of maintaining a range of such workspaces, and therefore of managing a complex constellation of environments, (digital) resources and relationships in their interconnection to locations and work practices (de Carvalho, 2014; Erickson et al 2014; Rossitto et al, 2014). These extend from the 'mobilisation work' of configuring temporary workplaces as part of short and

[1] Although *telework* and *remote work* are labels often used interchangeably (Schall, 2019), slight conceptual differences between the terms may be noted. The former assumes a key role of information and communication technologies to enable work away from an institutional workplace (Nilles, 1994); the latter focuses on the physical distance from the workplace (Daniels et al., 2001). Remote work, as portrayed in the literature, also seems to refer to greater physical distance between the workers and the workplace, which could make it difficult for workers to commute. Remote work can also refer to a temporary configuration of work – for example, when a person is on a business trip. Telework refers to a more stable arrangement, where work occurs mainly away from the workplace, with only occasional in-person presence (Daniels et al., 2001). Telework has been also strongly associated with the idea of working from home, and this is possibly due to the connection between telework and *telecommuting*, which refers more specifically to the practice of drawing on telework and remote work to decrease communting time (Schall, 2019).

long distance physical mobility (Perry, 2007), to the 'meta-work' of maintaining infrastructural and practice stability and flow among the disruptions and fragmentations of unsettled workspaces (Mark, 2015).

From this body of scholarship, it is clear that place is very much a concern for these workers (Brown and O'Hara, 2003; Ciolfi and de Carvalho, 2014; Rossitto et al, 2014). As such, an understanding of place making is essential to comprehending how work is accomplished. For example, practices such as *officing* (Humphry, 2014) entail efforts to actively configure environments, resources and the professional self in context. Liegl (2014) unpacks the 'care of place' that mobile workers practice in making workplaces, including their concern for aesthetics and atmosphere in cultivating productivity and creativity (Pink and Leder Mackley, 2006).

Because place experience has a social dimension, place making is also about maintaining interpersonal relationships with people who are co-located but not colleagues as, for example, in co-working spaces (Spinuzzi, 2012; Swezey and Vertesi, 2019). In such places individual workstations are configured relationally in support of visibility, connectivity as well as in unique and individualised ways to ensure comfort, efficiency and productivity (Mazmanian, Orlikowski and Yates, 2013). While their work practices are mobilised, flexible workers also rely on 'moorings' (Hannam, Sheller and Urry, 2006) and the creation of 'holding environments' (Petriglieri et al 2019) to identify and establish those bonds that provide an anchor for their flexible and fluid practices.

The constant reconfiguration of places (through practices, artefacts and relationships as these intersect with time and identities) underpins contemporary mobile and nomadic knowledge work (Gray, Ciolfi and de Carvalho, 2020).[2] These efforts in making work happen in 'flexible' workplaces include the configuration and use of digital tools and infrastructures.

Space, place and place making have been studied in CSCW and related disciplines in terms of how environments are lived and experienced by human actors (Brewer and Dourish, 2008; Brown and O'Hara, 2003; Ciolfi and de Carvalho, 2014; Liegl, 2014; Rossitto et al 2014). However, this body of work needs to be extended to consider place and place making as relational assemblages of material, social and experiential elements (Malpas, 2012; Pierce, Martin, and Murphy, 2011). We argue for the need to approach mobile and

[2] As with telework and remote work, the terms *mobile* and *nomadic work* have also been recurrently used interchangeably in the literature (Ciolfi and de Carvalho, 2014). Nevertheless, we, like many other authors, think it is important to differentiate between them, as this has some conceptual and theoretical implications (Rossitto, 2009). We use the term mobile work to refer to work involving movement for or during the accomplishment of productive activities. Theoretically, these movements could be both physical or digital – like in telecomuting. Nomadic work, on the other hand, refers to work involving the colonisation of different locations from time to time, depending on the resources that they offer for the accomplishment of productive activities (de Carvalho, 2014; Rossito et al., 2014; Erickson et al., 2014; Gray et al., 2020).

nomadic work as a process of place making – where places emerge as 'bundles' of space-time configurations as well as values, emotions, and relationships, all of which are shaped in relation to other places and movement (Frello, 2008; Massey, 2005). These *place bundles* are socially negotiated and contingent (Kabachnik, 2012): they form 'temporary constellations' (Massey, 2005, p. 141) with purpose and meaning that may be reconfigured when viewed from other perspectives (Kabachnik, 2012, p. 5).

For the purposes of thinking of the home as a particular kind of place, we start with the view that place is a process, that emerges and is continuously made and remade in practice. This framing of place resonates with the CSCW agenda of understanding digitally-mediated, situated practices. It is particularly relevant to the making and remaking of homes as places of work (paid and unpaid), care, leisure, rest and social reproduction. In other words, understanding place and place making as processual (Frello, 2008; Kabachnik, 2012; Massey, 1993; Urry, 2007) rather than static and bounded, allows us to capture home work as a situated, relational, socially and often intimately negotiated practice (Gray, Ciolfi and De Carvalho, 2020). Home in this sense is a place of work that is also interconnected with other workplaces, people, infrastructures and resources.

While the study of mobile and flexible work is not limited to examining how homes are made and re-made as work places, an explicit focus on these practices would add novel and prescient contributions to this broader scholarship. This exploratory paper proposes two contributions to such research agenda: first, by reviewing key findings in the existing literature on home work, it identifies specific gaps; second, it draws on original data collected by the authors over many years of empirical study of mobile work to propose pressing questions about homes as relational, emergent and practiced work places. In the following section, we review key literature on work at home, highlighting some key contributions and gaps.

Homes as Work Places

Homes are places of work (social reproduction work, household work), but also the site of paid labour since pre-industrial times (Bishop, 1999; Christensen 1988). Certain lines of work, such as family farming (Leshed, Håkansson and Kaye, 2014), indeed remain bound to homesteads to this day. Besides paid labour, homes are also sites of other skilled activities: examples are personal finance management, healthcare appointments, supervising children's homework, etc. (Steward, 2000; Verne and Bratteteig 2016). For yet others, their work takes place in other people's homes, for example, the work of personal tutors and health professionals such as caregivers (Grönvall and Lundberg, 2014). Work in the

home has strong gendered connotations, as care work has been long identified as ‘women’s work’ and doing paid work at home is sometimes celebrated as a way of reconciling the (material and emotional) needs for employment and for care (Hochschild, 1997).

In more recent times, the home has become a place for white collar, knowledge-intensive work, includingthe IT, digital and creative sectors. This occurs via different arrangements: some people work entirely ‘out of home’ (Olson, 1989), and therefore professional offices are setup in the home to be primary workplaces for solo entrepreneurs, or freelancers or subcontractors (Lozano, 1989; Salazar, 2001; Thomson 2013). Others work from home in response to specific circumstances or on certain days (i.e. by virtue of their employer’s support of flexible work). Finally, the home is where people who have offices or other designated places of work do ‘supplemental’, ‘overflow’ (usually unpaid) work (Kraut, 1989; Venkatesh and Vitalari, 1992) outside business hours, such as in the evenings or weekends (Olson, 1989; Salazar 2001; Venkatesh, 1996). Kraut terms these typologies of people, respectively, as *self-employed*, *substitutors* and *supplementers* (Kraut, 1989, p. 23).

Work at home ‘under the conditions of independent contractor status (i.e., self-employment) is very different from work at home for a full-time employee, particularly if the employee is on full salary and benefits’ (Olson, 1989, p. 322). Indeed, the different status of the worker and of the type of work done might either signify the freedom to choose the home as a preferred workplace for those privileged enough to be able to do it, or the constraints imposed by lack of opportunity or other obligations. Using one’s home for work is in some cases the only option: this is the case, for example, for solo entrepreneurs starting up a business with limited resources, or for workers with care responsibilities that cannot be delegated. The ‘home office’ takes on different connotations based on the status of the worker and the work: from carefully designed, comfortable and highly connected, to makeshift, uncomfortable and relying on precarious (physical and digital) infrastructure.

Initially, white collar work at home was characterised as *telecommuting* or *telework*, thus constructing the home office as a ‘virtual’ extension of corporate premises, from where people could step into the corporate workplace by digital means. The use of ICTs for this kind of ‘remote office work’, particularly in the case of technologically skilled workers such as IT professionals, has been studied since the 1980s (Kraut, 1989; Olson and Primps, 1984; Venkatesh, 1996). The (optimistic) goal of these ICT systems was to connect the person to the corporate workplace and replicate management and control mechanisms typical of co-located workplaces, i.e. performance monitoring by managers, relationship building between coworkers, etc. These early studies showed that the productivity of telecommuters seemed to be higher due to fewer interruptions and distractions,

however home workers tended to earn less and progress less in their careers (Greengard, 1995). Becker and McClintock (1981) described this as the 'mixed blessing' of work at home: i.e. lower wages and slower careers, but more independence and productivity. A later study by Habib and Cornford (1996) highlighted concerns about working from home expressed in terms of job satisfaction, career progression, and those physical health issues associated with a more sedentary lifestyle. The impact on family and household in terms of a more unbalanced work-life relationship was also reported by these professional workers. Such individual-level studies focused on whether telecommuting and its blurring of the separation of work and home spaces and rhythms were beneficial or not to workers, their family members and their employers. In contrast, organisational-level studies focused on the institutional issues arising from telecommuting, mainly with regard to monitoring workers and maintaining organisational culture outside the corporate workplace (Orlikowski and Barley, 2001).

Recent studies on the long-term impact of home working have shown that it has generated some benefits (i.e. enabling careers for women and those with care responsibilities), and that it is still linked to increased productivity (Halford 2005). However, home workers who are employed by companies also feel the pressure to demonstrate their worth and professional performance, and this can mean a tendency to overwork, particularly for women who might have to perform both paid and unpaid work in the home (Halford, 2005: 21). Indeed, research on people who work exclusively at home has shown that work time becomes 'task-based, rather than clock-based' (Halford 2005: 27). This means that they work long hours and have difficulties deciding when to end the working day (Steward 2000).

One of the downsides of work at home is that it may be an isolating experience for members of a distributed team (Takayama et al 2012; Pierce and St.Amant, 2011). Mechanisms for coordination and communication between remote workers have been studied and evaluated in depth by CSCW researchers (see for example Olson and Olson, 2014 and Nelson et al., 2017). The focus of this work, however, is on how distributed teams achieve collaboration and coordination, rather than on the situatedness of home workers' in relation not only to remote collaborators and environments, but to their immediate surroundings and social relations (Orlikowski, 2007).

Our review of the literature suggests that research on how home work is shaped by the (social, material and emotional) context in which it is done is scarce. Those who have focused on homes as workplaces beyond a concern solely with remote organisations and teams have begun to consider the individual practices of how work is integrated into the spaces, routines and roles of everyday life (see Orlikowski and Barley 2001). Some studies have addressed how

boundaries are set and configured to 'carve' out work in a place that is designated for other aspects of life (Salazar 2001; Thomson 2013). Thomson (2013) identified how *physical*, *temporal* and *psychological* boundaries characterise the practices of making professional offices at home (Thomson 2013). Salazar articulated a 'mandala' of nested boundary categories that emerged from her study of home work, classified under macro-categories of *space*, *electronic*, *psychological*, *roles*, *time* and *working tasks*. The configuring of these boundaries has been identified as a way not only to define locations, times and moods for work at home, but also the relationships with other aspects of life at home.

This work echoes Nippert-Eng's analysis of how people manage the fragmented boundaries between "doing" home and work, not just as locations, but as 'realms of experience' (Nippert-Eng, 1996). The complexity of establishing or managing boundaries is down to the need to constantly reflect on whether they work and how it is done, leading to a constant process of boundary sculpting (Ciolfi and Lockley, 2018; Gray et al., 2017). Boundaries are also seen not only as defining mechanisms (e.g. work vs. personal spaces, busyness vs. rest, etc.), but as coping mechanisms to manage stress. Indeed, some research has found that digital technology design can contribute to the setting and maintenance of 'healthy' boundaries between realms of life to encourage digital wellbeing (Cox et al 2014; Cecchinato, 2014). In other types of entirely home-bound work such as family farming, boundaries between work and life are harder to establish and uphold; however, 'soft' boundaries are constantly sculpted and negotiated around space, time and roles in the home (Leshed, Håkansson and Kaye, 2014). Overall, setting these work-life boundaries is no easy feat, and the failure, or preference not to do so can generate additional stress and difficulties (Ciolfi and Lockley 2018; Gray, Ciolfi, de Carvalho, D'Andrea and Wixted, 2017).

Furthermore, the private and personal aspects of home can be even more closely entwined with professional or income generation activities: an example is network hospitality, whereby parts of the home are made available to paying guests (Lampinen, 2016). Another example is the *Hoffice* network (founded in Sweden in 2014), which facilitates the collective use of private homes as co-working spaces open to external people, according to an agreed code of practice (Rossitto and Lampinen, 2018). While initiatives such as *hoffice* provide lone workers with support and social mechanisms that they might not be able to access on their own, they introduce yet another aspect of fragmentation between realms of life within one's home.

In her study of Australian ICT workers, Melissa Gregg (2011) argued that 'work's intimacy' is what characterises these professions. Intimacy as a dimension of work, and also how digital technologies differently mediate this sense of intimacy, is a main characteristic of home work: both in terms of how it is done (i.e. in intimate places, such as responding to emails in bed) and how it is

communicated to peers and clients (i.e. intimacy of a relationship of constant contact and availability). Interestingly, Gregg (2011) also notes that the women participating in her study had home offices that were located more centrally in their houses, enabling them to monitor other ongoing activities (such as children). This further highlights the need to delve deeper into the ways in which homes are constantly made into place bundles assembling locations, material configurations, social relationships, and shared understandings.

Overall, there is considerable knowledge about the tasks of home work, its organisational and economic implications, the technologies that may be used in support of it, and the roles that individuals embody to accomplish home work and manage its definition and boundaries. However, we know much less about how homes are made and re-made as relational, processual places where routines, physical/digital infrastructures and tools, bodies, identities, values and understanding. We also need to learn more about how these continuously emerge in ever-evolving configurations at the juncture of paid labour, care work, personal life and leisure. CSCW is ideally placed to unpack the spatial, temporal, infrastructural and relational practices that enable collaboration and coordination beyond co-workers when working at home. From the earlier literature-based examples, it is clear that the role of technologies in this domain is multi-faceted: across all realms of a worklife, it is a matter of infrastructure, of cooperation, of productivity, of monitoring (and even surveillance), of identity definition and 'identity work' (Coupland and Spedale, 2020), of reputational management, and of boundary sculpting. Homes are constantly remade places in all these ways, and how this occurs needs unpacking.

Making Homes as Place Bundles: Some Empirical Insights and Open Issues

We now present some data excerpts that give a glimpse of how homes emerge as complex and relational *worklife* place bundles. These are intended to flag issues for further analysis and open up research themes for future empirical work. The excerpts are drawn from qualitative data collected as part of two extensive interview studies of mobile knowledge workers that we conducted in Ireland and the UK over the past number of years, and that involved a total of 74 people (36 women and 38 men) in knowledge-intensive professions. The participants were a mix of IT company employees (mainly software developers and development managers), independent workers in digital industries (web designers, social media managers, design freelancers, etc.), and academics (lecturers and researchers).

These two studies had the goal of unpacking practices of nomadic and flexible work and of work-life boundary sculpting, and therefore they were not limited in

focus on capturing practices of work at home. However, as part of the wider themes of each study, participants gave first-person accounts of how their work takes place at home, therefore providing a rich body of data where homes emerge in their complexity of *worklife* places (Gray et al., 2020), as it is impossible to artificially separate work and life in the accounts of these participants.

The Home as Hybrid Place in the Making

The data portrays not only how boundaries are sculpted, but how homes emerge as hybrid places (de Souza e Silva 2006; Halford, 2005), personal/professional places characterised by complex second-order work of cooperation, coordination and negotiation in a physical and material context invested by diverse values, negotiations and understandings.

To begin with, getting work 'right' is not straightforward at home, in the same way as it is not uncomplicated in other workplaces: it requires the right spatial arrangements and configurations, but also self-knowledge of how to be effective and productive. At home, it can be even more challenging to achieve this in an environment that might only be familiar, or set up to be comfortable, for non-professional tasks, and that has to be re-thought of in a new light - as the quote below by Noel (freelance designer) describes:

> I never worked from home before (…) It's a really hard thing to get used to (…) because the environment is incredibly important. I was in the box room and there is a little small bed and a tiny little desk and a really old laptop with keys and stuff missing on it and (…) it really frustrated me. (…) Every week I'd move things around in the room, whether I'm facing the window or away from the window to try and figure out (…) what way am I getting more stuff done. I've recently moved down into the sitting room which is much better because I used to be at the back of the house, which was always cold because the sun wasn't shining in, so now I'm at the front of the house and it's just a little bit more friendly and [with] more desk space, and the main thing is to get organised and just try and not lose focus during the day (Noel)

As Noel's account indicates, a configuration that suits work in place is not fixed for long and not yet permanent, but always evolving, because the nature of work and its demands change too. This is also the case for Jill: *'I don't always kind of take off to the room [the home office] - that tends to be when I'm doing intensive work where I really need that kind of complete concentration'* (Jill).

Performing different tasks might mean 'local' mobility and movement within the home, rearranging resources and relational configurations to other spaces and people in the home in support of mood or demand. Achieving work at home is not just about setting a boundary between a work-conducive space and the rest of the home, but actively seeking and practicing the right set-up at a particular moment

while being mindful of ever-present hybridity that is perceived and managed in different ways.

When work starts and ends, and how work places are remade in light of this, are not just about setting boundaries: for example, Angela (a software development company owner) has designated one room in her home as only for work. The room is set apart from the rest of the house, so that work does not spill out into family space. Closing the door to that room in the evening signals Angela's decision to end of her working day, but she sometimes returns to her home office after finishing work if she needs to talk to her brother in Australia. However, to avoid the temptation to go back to work, she signs into Skype with a different account set up specifically for non-work conversations. She is in the same space, using the same technology but she actively makes the room the place for a family conversation with her brother. When she opens that door in the evening Angela uses the workaround of a separate account to avoid being drawn into work.

Locations in the home are hybridised to the extent that they are not always dedicated solely to professional purposes, sometimes by virtue of relative position and connectivity. Bob, a freelance consultant working entirely from home, has a permanent home office. However, it is the room nearest main entrance to the house so that it sometimes doubles up as 'holding place' for stuff that needs to be taken in and out, such as mail, packages and bags. While Bob does not mind this very much, he is very aware of the stuff stored in his office, and that this is unlikely to happen in a corporate office. This hybridisation of home work space is also the result of the various ways in which members of the household make these spaces work for themselves, and not just professionally.

Each home also becomes a configuration of space designations and relationships that need to be actively made and understood as worklife shifts through time and routines. Lily (a start-up owner), has an external office, but she also has converted a room in her home into an office to work in on certain days:

> The den…is a fantastic office but I'm kind of pushed out of there now because [the children] do their stuff in there and I tend to actually sit on a high table in the kitchen…is where all my work stuff is now, but yes that office [the den] is there. (Lily)

The home office is remade into a *den* as her children are using it for their own activities. Lily is pushed out of the office that she has designed and which she likes. Yet, it is also her children's den, and when that is the case then her work is displaced to the kitchen table.

Other workers don't have a designated home work room, or space, and much effort goes into creating one and taking it down every day, although it is not completely erased, but often just put aside. For example, Aoife (an academic)

describes how every evening she removes all her work stuff from the kitchen table to make space for dinner with her husband: disconnecting her laptop, stacking papers and books, and moving everything to the floor nearby, and doing it all again when it is time to do some more work.

Worklife Negotiations in Place

These practices of re-making places and of re-imagining them for different activities and moods, of assembling and arranging interactions with place, devices and other people are not always smooth, or unproblematic. Making a temporary workplace (as in the kitchen table examples) also occurs in negotiation with family members, as a particular room, location, or corner, is used or can be used for other purposes. Different points in the home are co-constructed together and relationally, and often not without tension:

> I've got my printer, fax machine, computer, all set up in there. So I would go down there, make myself a cup of coffee, head in and I'd usually start with checking the emails and then I might just check twitter…The kids get up and the rule is 'Mammy is working' so quite often I'll come in [the kitchen] and have a quick breakfast with them…and then…head back in. At least they've seen Mammy…My office is quite often used as a den in the evening because it's a smaller room and it's cosy and the chairs are closer to each other, so quite often [husband] might put a film on, animation or something…and there's a piano inside, [daughter] is learning the piano, so he might be doing the piano with her. (Sharon)

In Sharon's example, family life and work shift in relation to rooms and spaces of the home, but also in relation to their meaning. When Sharon is in the office, she is working and must not be disturbed. Going into the kitchen for breakfast means family time, however family activities also take place in the office (now den) in the evening.

Sharing a home with family members, interruptions and breaks can also be unexpected. In this case, they are not necessarily negative, but need management:

> I'd be having office time while my wife has our daughter and the odd time…she might pop into the office with my daughter. And I sometimes could well do with just taking my head out and screaming before I get square eyes, and just chat with her for five or 10 minutes, that suits me fine too (Dean)

Dean is a start-up owner working solely at home. Having his wife and child around can mean interruptions, but also relief when he is overwhelmed or frustrated. While Dean's priority is getting work done, having his family in the office shifts the emotional register in the place, and can mean a brief moment of support and rest. The management of shifting activities, boundaries and emotions

linked to the home does not only refer to designated work spaces such as offices, but it can be 'carried' into the rest of the home:

> Even if you're working for yourself and you have your own office space, there is a sense of when you physically close the door, you will still have things on your mind but there's a better sense of separation (…). Just walking from one room to another room doesn't really give you enough closure on the day to some extent. (Sharon)

Sharon describes the challenge of achieving mental distance from work when leaving her office. Sharon's quote is also another example of how boundary sculpting is an ever-present practice in home work, in relation to configurations of work demands, family demands, temporal frames, and spatial arrangements. The substantial effort involved in making place bundles where work locations, environments and mobilities, and their interconnections, are identified, managed and appropriated deserves more attention in the study of the home as a workplace.

Managing Tensions and Conflicts at Home

Regarding tensions and possible conflicts, it is clear that the home is far from how it is often idealised as environment of rest and comfort (Bødker, 2016; Greengard, 2006; Hill, Ferris and Martinson, 2003). Sylvia (an academic) works at the breakfast bar in the kitchen in the evenings and her husband joins her with his own laptop:

> We kind of just fell into it together. It could of course cause tensions...But we've got a breakfast bar in the kitchen (…) And we have a laptop on there. So we do have our laptops there constantly. And they can move around the house as we do (...). [Husband] is on the laptop as well cause you know he's checking football, and a bit of social media, newspapers ...More his own interests and sometimes if he's got a particular spreadsheet to sort out...but he is much better. He leaves and office and…He does a lot of hours, and when he leaves he can switch off. (Sylvia)

The tension arises between Sylvia and her husband because he can do most of his work in his company's office, while she ends up working in the kitchen almost every evening. Although they share a space to be together (the breakfast bar) and both use their laptops, Sylvia is not relaxing or pursuing non-work interests like her husband is. They occupy the space in almost identical ways and are close to each other, but the suggestion is that he is 'much better' at making it into a place of leisure.

Another example is that of Betty (a start-up owner), who has an office as part of a business accelerator centre, but does not use it often as she has a poor relationship with the centre's director. Instead, Betty works mainly from her home, which also enables her to take care of her two young daughters:

> I have a home office…which is kind of in the centre of the house…It's not a closed-off room, it's actually an open room on the second floor so I have full access to everything that is happening around the house…I mean I can switch off and switch on very easily from one thing to another. (Betty)

Betty's business is not profitable yet, and her husband is not very supportive of her. For Betty, her home is the right place to work on her business because of a previous conflict with the business centre manager. It also enables to meet her childcare needs. But it is also the place of tension with her husband and where she experiences simultaneous pressure to deliver on the business front and to care for their daughters: *'I do pretty much everything around here'* (Betty). In all of these accounts, the practices and expectations of intimate others in the home are key factors in shaping the diverse and intricate ways in which the home is (re)made to facilitate work.

Conclusion

Our review of relevant studies, as well as our illustrative examples from two empirical studies highlight the importance of addressing the home as a place of work in a relational and processual way. Different agencies across environments, artefacts, resources, technologies, relationships and meanings construct the home not as a static and bounded place, but as a *nexus of place bundles*: i.e. agentic and relational space-time trajectories drawn together by individuals through cognitive and emotional processes (Massey, 2005, p. 119). These trajectories are in a constant process of becoming, making and unmaking. The same rooms and the same technology can emerge differently into place configurations shaped by different relationships, understandings, practices and values in a short span of time. These are often interwoven with other trajectories occurring in other parts of the home.

Our exploratory discussion of existing studies highlighted four themes for further exploration: First, homes as hybridised places in which hybridity is produced, recognised and engaged with in different ways but that nonetheless need to be managed and worked around. Second, the active work of making and re-making home places. Third, the relationality of home as a place bundle is more than individuals tending to work and life in the same environment, it is also the negogiation of co-located (but also interactively shaped) spatialities, temporalities and understandings–both one's own and those of other people. Finally, as well as being a supportive environment, the home can be the site of conflict and tensions that add additional layers to the work of place making in relation to both work and life: this requires both 'relationship management' and 'self management'. Different understandings of and relationships to the same location in the home

often create tensions that can be recurrent and more visible to some members of the household than others.

Home work places emerge out of these processual bundles as ephemeral and impermanent - the result of constellations of agencies and understandings that alternatively shift and settle. Place bundles are also characterised by identity work in the home, as in the examples of Sharon and Betty: spaces where their work ebbs and flows as do their identities, practices and routines as mothers and as entrepreneurs. To the extent that these identities are recognised and evaluated by others as well as themselves, they affect the way spaces in the home are understood.

Overall, the second-order work of making homes work places is substantial and complex: previous research has illuminated how home work relates to work in corporate spaces, and how boundaries of various kinds are set and configured to make work emerge in the home. However, there is a need to further unpack the nuanced practices of relational and processual place making that make home work 'work', and in turn make people feel 'at home in the work' (Petriglieri, 2019, p. 144). As the home becomes a more commonplace site of work for some work sectors, it is also important to identify how this reconfigures household relations and understandings of home as a 'private' space of potential respite from work demands. What aspects of work and/or life thrive when home becomes a more regular site of work? And for which members of the household in which ways? And similarly, which aspects of work and/or life are diminished or adversely affected by home as workplace? What kinds of home-based place making enable the best outcomes for worklife? To address these questions it is important that the home is conceptualised home as a relational and processual place and to examine the ways in which it is enlivened by these many trajectories. Only by such investigations can we begin to grasp the complexities of working from home, and illuminate the nuanced ways in which digital tools and infrastructures can become entangled in emergent, sociomaterial, configurations of making the home a place of work.

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Psychosocial ICT: The Potential, Challenges and Benefits of Self-help Tools for Refugees with Negative Mental Stress

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Abstract. Information and Communication Technology (ICT) has penetrated almost all areas of life today and has the potential to create positive change. This paper addresses the opportunities offered by ICT for improving the resilience and psychosocial well-being of refugees who have experienced mentally stressful events when forced to leave their home country and seek shelter in a different host country. We want to distinguish between perceived stress and clinically-defined trauma, for which therapeutic interventions require direct personal contact with psychological experts. However, we also want to focus on the digital possibilities that currently exist to support establishing this kind of personal connection. Many refugees need to seek psychological help, but social, economic and cultural barriers hold them back. Our qualitative study with refugees, psychologists and volunteers provides insights into how refugees deal with their mental issues and the challenges they face in everyday life. We aim to show that ICT can play a major role in terms of addressing awareness and self-empowerment as an entry point for this vulnerable group. We also discuss the potential challenges and benefits of ICT for refugees seeking to recover their mental stability.

Keywords: eMental Health; Psychosocial ICT; Poetry Therapy; Bibliotherapy; Expressive Writing; PTSD; Refugees; Qualitative methods

Introduction

Information and Communication Technologies (ICT) are becoming increasingly ubiquitous and, in recent years, very sensitive areas such as health and health protection have become an important field of research for ICT-based interventions. A relatively young area in this regard is mental health (Luxton et al. 2011), including depression and suicidal tendencies, with researchers just starting to develop online-tools to connect people who need help with people who can provide it. The internet is now a resource for online-counseling, focusing on psychosocial support (Barak et al. 2008) and psychoeducation (Luxton et al. 2011). The focus here is on people's psychosocial health and the role technology can play in improving it.

The United Nations High Commissioner for Refugees (UNHCR) estimates that there are around 25.9 million refugees worldwide (UNHCR 2020). The conflict in Syria is currently the biggest driving force for migration (6.7 million), but others include the continuing violence e.g. in Afghanistan (2.7 million), South Sudan (2.3 million) and Iraq (2 million) (UNHCR 2020). Monitoring the various routes that migrants use, the EU's external border force, Frontex, detected 1.8 million entries into the EU "*associated with an estimated 1 million individuals*" (Frontex 2016) in 2015. Despite new results in 2019 showing a 92% decline from this peak (Frontex 2019), the so called *"refugee crisis"* remains a global social and political challenge (UNHCR 2016). Germany is a particularly favoured destination (UNHCR 2015b), with more than one million refugees arriving in 2015 (BBC News 2016). This target group face a battery of challenges. Often they travel to other countries at risk of their lives, then struggle with finding relevant information to support everyday existence and ways to make themselves heard (politically and socially). This can lead to a variety of stressful or traumatic experiences. When using the term trauma, we speak of *"psychological wounds"* (Kleefeldt 2018). Basically, reference is made to the description of the situation that caused the trauma, the consequences of this situation or the symptoms of the trauma (Kleefeldt 2018). In our study we focus on all these uses.

The main reason for choosing the vulnerable target group of refugees is that they face many barriers, in view of the current immigration rate in Germany and its upward trend (Alburez-Gutierrez and García 2018). There are generally too few professionals, e.g. psychologists, even fewer who can speak the relevant language or who are at least fluent in English, and who have intercultural knowledge, let alone being experienced with the mental challenges and potentially multiple traumas suffered by refugees (Bajbouj et al. 2018). Schneider et al. (2017) categorize such barriers as structural, while individual barriers are, for example, feelings of shame and self-stigmatization, the lack of knowledge about assistance, or a lack of language among the refugees themselves (Schneider et al. 2017; Mestheneos and Ioannidi 2002). Therapy or even just simple conversations about

their emotions aren't possible if they are preoccupied with how to connect words and what words to use. A social barrier would be e.g. stigmatization through others (Schneider et al. 2017). Also, Western therapeutic approaches cannot easily be transferred to other cultures (von Lersner and Kizilhan 2017). Another problem for refugees is access from their geographic location in their host country (Mestheneos and Ioannidi 2002).

In this exploratory study we conducted qualitative interviews with refugees, psychologists and volunteers to understand how psychosocial health affects everyday life and how refugees deal with it. We will also recap the current state of the art regarding our target group, ICT in mental health contexts and Poetry Therapy with a special focus on Expressive Writing (EW). In relation to this, we will provide an overview of how mental health has been handled by the HCI and CSCW community so far and examine the extent to which ICT and therapeutic methods such as therapeutic writing can help refugees to address negative mental stress and trauma. Specifically, we will be asking: What are the challenges but also the possibilities of 'Psychosocial ICT' for this highly sensitive field and what benefits might go along with them? We use this term to distinguish the interest from therapeutic interventions that deal with serious mental problems. Psychosocial ICT aims to promote self-awareness and self-reflection as well as empowerment and personal growth. To support personal strengths, therapeutic interventions can be transformed into self-help tools, but this should be complementary to psychological treatment, if necessary. This type of support is usually only provided when psychological problems have been identified and a place in therapy is available.

Mental health in the field of HCI and CSCW

Recent years have seen a huge increase in research regarding technology and mental health. We will give here just a small sample of the wide range of studies undertaken to indicate the kinds of topics pursued.

Thieme et al. (2015) addressed mental well-being, noting that it is based on multiple aspects, which are complex and fluid. Well-being factors are based on *"individual needs, context factors, or physical health"* (Thieme et al. 2015). Their concept of well-being has three different focal points: emotional well-being (which is related to the maximization of pleasure), psychological well-being (focusing on increasing self-esteem, personal growth and true authenticity), and social well-being (focusing on embeddedness) (Thieme et al. 2015).

To examine the mental health of adolescents Matthews and Doherty (2011) used mobile-based MMS and their access to and participation in therapy. By creating content that reflected the world view of its users the researchers sought to establish the potential of storytelling using mobile devices as a therapeutic method. Their findings were used as the basis of proposed design implications for developing digital tools for therapeutic interventions in HCI, including: well-structured tasks

between therapy sessions; a wide range of content to work with; an appropriate framework for content use; therapy personalization options; and adaptability to various therapeutic approaches (Matthews and Doherty 2011).

Most important for the design of digital mental health systems are cultural and contextual aspects, as emphasized by Franco et al. (2016) in their community collaborative design study with veterans. Their smartphone-based psychosocial peer-to-peer support system served, among other things, the aspect of early detection of harmful behavior. According to the authors, crisis intervention systems can only be successful if the design considers and promotes the understanding of corresponding user needs (Franco et al. 2016).

Dosono et al. (2016) emphasize the empowerment of resilience of veterans and refugees in the process of (re-)integration. Coming from a war zone, both target groups suffer from identity crises. They found that ICT has supported identity awareness during transitional changes as well as online and offline connection with people from similar contexts, fostering collective processes of meaning, which have helped to increase understanding of new cultural expectations, shape new social practices and receive social support (Dosono et al. 2016).

Bratt et al. (2017) show results in connection with wearable devices and the sensitization and training of mindfulness towards personal states of mind and body to support resilience regarding PTSD patients. In their study, they developed design criteria which among others include: detection of stress and emotions, provision of an indication to the user that stress and negative emotions are present, inconspicuousness to avoid stigmatization and permanent connection to social support systems (Bratt et al. 2017).

Further studies with different age groups have considered other forms of digital support systems based on different social media platforms, e.g. Instagram (Feuston and Piper 2018) or Facebook (Park et al. 2015). Some have focused on different mental issues, e.g. eating disorders (Chancellor et al. 2016), substance abuse and recovery (Schmitt and Yarosh 2018), self-harm (Pater and Mynatt 2017), or depression (Andalibi et al. 2015). Sometimes the focus has been on specific digital devices, e.g. smartwatches (Dibia 2016; Bratt et al. 2017), or on areas like game design (van der Meulen et al. 2018) or virtual reality design (Wrzesien et al. 2011). There is also material relating to mental health awareness (Parker et al. 2013) and management (Murnane et al. 2018).

This list of studies is far from complete and, as public awareness of the scope to use digital tools to support mental health increases, it is set to grow even more in the future. Our own study is focused on how to adapt the insights from such studies for the support of the mental health of refugees.

Refugees and ICT

There has been a growing interest in HCI refugee and migrant research regarding their use of ICT and how they draw upon ICT for support (e.g. Harney 2013). Studies have shown that both smart and feature phones are commonly used among refugees but the knowledge and ability to use ICT varies among its users and is influenced by their level of education, country of origin, whether they lived in an urban or rural setting, and their social status (Baranoff et al. 2015). Individual biographies and the above-mentioned dependency structures underscore the need for refugees to take an active interest in modern ICT as a way of helping themselves in emergencies or to find outside help. The smartphone as a mobile device represents the most flexible way of gathering information. For digital interventions originally based in therapy this would mean a comprehensive auxiliary function on top of existing mental health support.

ICT, especially smartphones, play an important role for refugees, before, during and after their flight (Maitland et al. 2018; Gillespie et al. 2018), but especially afterwards, when they have to cope with new challenges. Few studies have yet explored the role that smartphone applications can play in the handling of trauma by refugees even though studies have investigated how apps and/or websites can help to support psychotherapy in general (Bush et al. 2015; Spijkerman et al. 2016). Here interventions have had a positive impact as studies showed (Bush et al. 2015; Spijkerman et al. 2016), but their conclusion was that research in this area needs further investigation. This is where we want to continue in our explorative study by conducting first interviews with people who experience stress or mental health issues and get more insight into the potential, challenges and benefits of technology-based tools using Poetry Therapy as a self-help method.

Refugees in Traumatic Contexts

In the case of refugees, a trauma is usually brought on by experiences of war and flight. This can be aggravated by the new and stressful challenges that arise upon reaching their destination country (e.g. economic hardships or problems of integration), obstructing the healing process. People who may have had a higher status back home, often find this is diminished or lost, causing isolation, which can be compounded by limited education or language difficulties, increasing the risk of mental illnesses (Kira et al. 2014). The authors mention that the more problems people have with acculturation, the worse their mental symptoms of trauma. It can also be a source of stress when people are separated (Kira et al. 2014). All these things must be taken into account when talking about the concept of resilience, which Southwick et al. (2014) describe as follows:

> *“[…] resilience is a complex construct that may have specific meaning for a particular individual, family, organization, society and culture […] and […] there are likely numerous types of resilience […] that depend on context.”*

Against this background, resilience is a *"variable that changes constantly depending on multiple environmental conditions, resources and loads"* (Kleefeldt 2018) what makes a general fixed definition difficult. Moreover, there is currently no attempt to do so in the context of working with refugees (Kleefeldt 2018). The attempt of a generally sufficient psychological one would be:

> *"Resilience is the ability of people to react flexibly and appropriately to changing life situations and requirements in changing situations and to master stressful, frustrating and difficult situations without psychological consequences, i.e. to withstand such extraordinary pressures without negative consequences (Stangl, 2020).*

If traumas are present, this accordingly means that the traumatised person has not previously had sufficient resilience to cope adequately with stressful life events.
One possibility to restore health can be the salutogenesis model of Aaron Antonovsky (1979, 1986, 1997), which is concerned with a resource and strength-oriented development of health. Its central factor is the sense of coherence, which consists of three components: comprehensibility, meaningfulness and manageability. The feeling of coherence is particularly important in order to achieve a reorganisation of the inner world of experience after traumatic events. The sense of coherence helps to reflect on personal history, whether it is fragmentary, contradictory or ambiguous. It can support the process of growth that follows this story and help to cope with suffering and discard feelings of fear, shame and guilt. According to the authors, refugees in particular show a high degree of resilience here, as they have had the experience of crossing a border that was previously considered to be the end and then survived. The sense of coherence creates consistency against this background (Kleefeldt, 2018). In the context of Poetry and Bibliotherapy such a feeling of coherence can be addressed in a very goal-oriented way, since personal stories can be experienced and explained through reading and writing.

Poetry Therapy, Bibliotherapy & Expressive Writing

Writing, as a medium of self-expression, can be seen to help writers reflect upon themselves and to assist them in rearranging their memories of past experiences. Writing can also be a vehicle to reach different states of mind by opening the consciousness to thought processes (Heimes 2012). Such possibilities address all factors of the salutogenesis model from Antonovsky to create the feeling of coherence (Kleefeldt, 2018). Challenges can be classified and structured, making them more manageable, creating comprehensibility. On the basis of new

perceptions and interpretations, identity can thus be newly created and previous experiences can be considered meaningful, whereby memories prove to be plastic. If experiences can be assigned meaning, they take up less space in everyday life (Kleefeldt, 2018), which reduces distress. The process of writing helps to trigger resilience-enhancing personality factors. Self-perception, control, goal orientation, problem solving competence, the conviction of self-efficacy and personal coping with stressful events become tangible. Social competence has the chance to flourish on basis of this healing process which retroactively supports a positive attitude towards life (Kleefeldt 2018). At this point, however, we must again bear in mind the above-mentioned notion of resilience by Southwick et al. (2014), since personal resilience factors only represent the individual part of successful resilience, which is still surrounded by a collective framework, determined by different systems and system conditions. Some of them may be considered in a socio-technical solution, others are too complex to be solved in one single step. Nevertheless, each partial solution represents an important component of the whole.

A very specific type of writing within a broader approach known as Poetry Therapy is *Expressive Writing (EW)*. The notion of EW was first developed by Leedy (1969) and Lerner (1980) as an overarching term to cover the use of writing and reading as therapeutic interventions. It has been argued to activate cognitive and linguistic processes within the human brain. Thus, Horn and Mehl (2004) argue that:

> *"EW facilitates the formation of a coherent narrative of the experiences, which is then more efficiently stored and can be more easily forgotten. In addition, it assumes changes at the social level that enable the person to respond more actively to their environment and to integrate better into their social network."*

EW was originally proposed a specific form of writing by James W. Pennebaker (1997) who argued that the positive effects of expressing emotions through writing could be used in therapeutic contexts. His studies (and others) have shown that writing has the potential to mitigate physical (O'cleirigh et al. 2008) and mental disorders (Sloan et al. 2009) and thus increases personal well-being. It has been suggested that inhibitions or negative emotions in this context can be harmful (Cameron and Nicholls 1998; Esterling et al. 1999), but EW sessions are conducted in short 15-20-minute bursts over a 3-5 day period. This gives control over the depth and length of expression and its short-term emotional consequences (which are usually negative) gradually become something longer-lasting with certain positive effects. During a session a chosen stressful life experience is addressed and given close consideration (Horn and Mehl 2004). The writing process can then be repeated as often as necessary, focusing on different meaningful experiences.

Bibliotherapy often accompanies Poetry Therapy as it supports the process of writing by making available narratives and perspectives prepared by others with identical or similar background stories as well as a range of individual solutions

and mitigating strategies (Heimes 2012). This builds upon the place of narratives within human history and their role in shaping everyday lives and capturing personal experiences (Peterson 1999). By dealing with other people's narratives, it invites active reflection on non-informational texts. Bibliotherapeutic approaches have produced effective results for things like the mitigation of anxiety and sexual dysfunction (Marrs 1995), anxiety disorders (Rapee et al. 2006), depression (Scogin et al. 1990; Cuijpers 1997; Ackerson et al. 1998; Morgan and Jorm 2008) obsessive-compulsive disorders (Fritzler et al. 1997), addiction (Pardeck 1991), sleeping disorders (Burke et al. 2004), and child abuse (Pardeck 1990; DeMaria 1991).

Both writing and the reading of similar stories to one's own can help people to dive into cognitive processes in which personal experiences can be rethought by reinterpreting their meaning, which has a strong connection to the salutogenesis model of Aaron Antonovsky. Through the digitalization of Poetry Therapy, Socio-Informatics can enable a diverse set of therapeutic interventions, whose effects have already been proven in face-to-face applications (Pardeck 1990; Rapee et al. 2006; Spijkerman et al. 2016). This makes it promising as a first step towards help for vulnerable target groups, but one should not forget that culture is a framework that strongly influences the outcome of psychotherapeutic methods.

Culture-Sensitive Psychotherapy

Using the term *culture* makes it most important do define it in the first place. Following von Lersner and Kizilhan (2017) culture is a system of symbols that is accessible to several people at the same time and is simultaneously dependent on them in its entirety, which retroactively shapes the life of the individual as well as his or her perception of reality. The individual socialization process within a cultural system leads to a habitual application of its values and norms, that people are unaware of in daily life. Culture is therefore a process of *"repeated traditions, ... [and the] creation of spaces of meaning"* (e.g. local background or social milieu), based on *"[common] places, languages or experiences"* (von Lersner & Kizilhan 2017). However, culture has a dynamic structure as those spaces interfere with one another (von Lersner & Kizilhan 2017), before which the sense of coherence takes shape.

To address this in psychotherapy is mandatory but regarding to the definition above, accessing cultural norms and values of others is difficult if you are not specifically trained for this purpose. Intercultural knowledge is therefore the key to culture-sensitive psychotherapy. In this way, professional support can be guaranteed at a high level, which is the most important environmental factor for resilience (Kleefeldt 2018). The development of efficient interventions that will be culturally oriented and therefore accepted by their users serves a high need as Koç und Kafa (2019) emphasize. According to the authors this study is a first step of an

experimental path *"for improving the efficiency and effectiveness of adapted therapies"* (Koç und Kafa 2019).

Research Background

Our research study is based on many years of intercultural experience with the target group. In particular we have concentrated upon refugees from Syria and Iraq.

Results of this participatory research show that, upon arrival in their new host communities, integration is one of the biggest challenges that this target group faces. It is typically defined by the host community and changes over time (Howard et al. 2011), but the BAMF (Federal Office for Migration and Refugees) currently defines it in the following way:

> *"Integration is a long-term process. Its goal is to integrate all people who live permanently and legally in Germany into society. Immigrants should be enabled to participate fully and equally in all areas of society. To this end, they have a duty to learn German and to know, respect and obey the constitution and laws."*

Integration is difficult for many reasons. One of the main causes is the serious negative experiences that have been made at home and on the flight. Most refugees, especially the ones coming from a war zone, leave their home with only the bare necessities. If possible, they sell belongings to cover the costs for travelling to their host country (Die Zeit 2015). To get there, in most cases, refugees have to rely on the services of smugglers to board unsafe rafts to cross from Turkey to Greece (Die Zeit 2015) or to travel from northern Africa to Italy over the sea. Afterwards, they cross Europe using the so called *"Balkan Route"* (Die Zeit 2016a) (cf. Figure 1, Original source UNHCR 2018) to get to their final destination (Die Zeit 2016a).

While on the Balkan Route, they have to negotiate their way through countries with different governments who adopt different strategies towards handling this stream of people. This trip is very dangerous and thousands of people have been reported dead or missing during their attempt to reach safety (International Organization for Migration (IOM) 2016). After a long journey on foot or by rafts, taxis, buses and trains, a proportion of the refugees arrive in their host country, where they have to interact with the police, deal with the bureaucracy of the host government and, in many cases, with an unwelcoming environment for refugees created by political tensions.

A significant problem confronting this group is the multiple traumatic experiences they have had to contend with. Many have witnessed war or poverty in their home country and are seeking to escape from this. Mental instability hinders the integration process and can be severely harmful for the traumatized person if not properly worked through (Schneider et al. 2017). Without mental health support, personal difficulties resulting from stressful or traumatic events can ramify

and become a preoccupation, potentially leading to even more serious mental disorder(s). Therefore, in this study we tried to understand how refugees deal with their experiences, whether they consider themselves as being either infected by negative stress or trauma-impaired and the extent to which they seek help.

Figure 1: Sea Arrivals to Greece and the Onward Movement of Syrian refugees

Methodological Approach

Our recent research projects have been located within the Grounded Design approach (Rohde et al. 2016), which *"can be understood as writing a 'grounded theory' from design case studies by means of a comparative analysis of individual cases in their contextualized complexity"* (Stevens et al. 2018). The authors consider *"such an undertaking [to be] a suitable means of supporting reflective practitioners and gaining design-related insights"* (Stevens et al. 2018). We began

with ethnographic fieldwork, conducting open semi-structured interviews with refugees and experts in order to discover how these issues had come about. We also sought to get a holistic impression of the requirements that Psychosocial ICT will need to address when dealing with this specific group of people and their particular needs. As many people find it difficult to speak about the state of their mental health, trust was a key aspect of the study. Even if not suffering from trauma or mental illness, mental health remains a sensitive issue, so, during the interviews people were not asked their name. The home country, mother tongue, age and gender were the only demographic data requested.

Our interviewer could speak Arabic and already knew the participants in two of the interviews. Two of the others were recruited through these contacts, the other one was acquired by advertising online. The existing connections between most of the participants provided a further layer of trust. The interview questions covered topics about the flight to Germany, their current situation, any stressful or traumatic experiences (before, during and after the flight) and their current coping strategies.

To complete the perspective on the psychosocial health of refugees, we reached out to professionals and conducted three German interviews with psychologists to get their point of view. Further interviews were done with volunteers who work on a daily basis with our target group, where our focus was upon the daily concerns and experiences of the participants.

All of the interviews conducted in Arabic were translated into German by the interviewer and transcribed. The data collected from the interviews and observations was analysed by conducting a thematic analysis (Flick et al. 2004; Schmidt 2004). The analysis was undertaken by each of the authors and resulted in the topic areas *Flight background* and *negative stress events* as well as *Approaches to event processing.* To maximize the reliability of the results, we pursued a threefold triangulation strategy (Flick et al. 2004). First, we made sure that we had covered all of the relevant topics in all of the interviews. Secondly, we compared the interview data with the feedback from the psychologists and volunteers. Thirdly, we contrasted our findings with mass media coverage on refugees and their psychosocial health status.

The Interviewees

Despite its limited size, our interviewee sample covered a good range of refugee backgrounds (Table 1), with diverse levels of age, family, gender, social status and access to technology.

Table 1: Overview of the interviewed refugees

ID	GENDER	AGE	HOME COUNTRY	LANGUAGE	SPECIAL ASPECTS	INTERVIEW VENUE
P 1	Female	17	Syria	Arabic	Unaccompanied during the interview; the only minor	University of Siegen
P 2	Male	28	Syria	Arabic	-	University of Siegen
P 3	Female	40	Iraq	Arabic	-	University of Siegen
P 4	Male	29	Syria	Arabic/German	German wife accompanied him during the interview	University of Siegen
P 5	Female	28	Syria	Arabic	-	University of Siegen

P1 arrived in Germany with her sisters at the age of 14 as an unaccompanied minor (meaning she was without her parents). She used the Balkan route (Turkey, over the Mediterranean Sea to Greece and then through every country up until Germany on foot, by bus, or train (see Figure 1)). During their flight, she and her sisters were forced to work in Turkey for two years to save money for the remaining trip to Germany.

P2 and his friends were forced to leave their village in Syria and moved to Germany over the Balkan route. None of them wanted to join the military to fight the rebels. He now lives in a shared apartment with two Germans and has successfully completed his German language course in order to study at a university.

P3 left Iraq with her two children after her husband died. She got very ill during her escape to Germany and had to have surgery twice after her arrival. For the first three months, she lived in a refugee camp. She was the only participant who couldn’t finish the interview. Her consent to the use of her data was subsequently confirmed.

P4 applied for a Master's degree and came to Germany legally, but then registered as a refugee so as to not have to return after his studies. He didn’t want to return and have to do military service, about which he still has nightmares. The war was of continual concern to him because he had family back in Syria. He is married to a German woman.

P5 had been in Germany for 3 years and was currently trying to get her Bachelor's degree recognized. She had fled over the sea to Europe, despite not being able to swim. She had her son with her, who was only one year old during the flight.

The Psychologists

We interviewed three psychologists about their experience of working with refugees and sought their professional opinion regarding ICT solutions for psychosocial health (Table 2).

Table 2: Overview of the psychologists

ID	GENDER	BACKGROUND	VOLUNTARY WORK	LANGUAGE	SPECIAL ASPECTS	INTERVIEW VENUE
PS 1	Male	Professor of Clinical Psychology	No therapy experience with refugees but supportive work	German	Involvement in a big refugee project with insurance connection in the past	Psychotherapeutic office
PS 2	Female	Bachelor Psychology	Therapy of refugees for 1 year	German	Institution for psychological support of refugees	Psychotherapeutic office
PS 3	Male	Bachelor Psychology	Therapy of refugees for 3 years	German, Arabic	Institution for psychological support of refugees	Psychotherapeutic office

PS1 is a professor of clinical psychology and a psychotherapist. He doesn't treat refugees, but would like to actively participate in refugee assistance. He had acquired some experience with our target group in the past when involved in a large refugee project focused on insurance support.

PS2 has worked as a psychologist at an institute for psychosocial health of refugees since October 2017. She works very closely with social workers who handle the initial care for refugees. She herself works with 10 to 18 clients, although the rhythm of the sessions varies (weekly, two-weekly).

PS3 had previously worked in a reception centre with a large influx of refugees, where small children and teenagers from 10 to 18 years of age would come if their family was encountering problems. He has an Arabic background and speaks the language.

The Volunteers

In addition, three interviews were conducted with volunteers who support refugees during their daily activities and who are therefore aware of their experiences and levels of stress (Table 3).

Table 3: Overview of the volunteers

ID	GENDER	BACKGROUND	VOLUNTARY WORK	SPECIAL ASPECTS	INTERVIEW VENUE
V 1	Female	Social Worker	Since 1.5 years	-	Office of the interviewee
V 2	Female	Research Assistant	Since 3 years	Responsible for international student applicants	University of Siegen
V 3	Male	Paramedic	Since 3 years	-	University of Siegen

V1 is a social worker who has been working in refugee counselling for 1.5 years. Before that, she trained as a teacher and worked with children and young people in the disabled sector for over 8 years. In her work, she is confronted with the everyday problems of the refugees.

V2 teaches German to refugees at a university and is responsible for foreign applicants. The German courses take place on a daily basis and is for both children and adults. She is married to a refugee.

V3 has been working as a paramedic for 8 years and is involved as a volunteer in the general field of disaster control. At the peak of refugee arrivals in 2015, he set up a medical base with others and took care of the new arrivals.

Results

The following chapters present results from the two thematic topics, which were addressed by our participants. Here we focus on the individual stories of the refugees, since they also form the methodological focus within the EW.

Flight background and stressful events

Our participants had various reasons for leaving their home country. There were also strong differences in how their flight was pursued. Only 1 interviewee left legally (by plane) and on his own (P4). The others left in company, on foot, by train, or by bus (P1, P2, P3, P5). The reasons included wanting to survive an armed conflict (P1, P2, P4, P5), freedom and self-determination in terms of role identity (P2, P4) and economic issues (P1). In the case of P3, she was primarily concerned with the needs of her children.

For most of the interviewees, the flight to Germany was a challenging experience. They had to leave their family and dreams behind, *"[...] well, my dream was to become a doctor in Syria."* (P1), for a dangerous journey across different countries and the sea: *"[...] over the sea, of course, as they call it: The journey of*

death." (P2). These experiences built upon experiences of war in their home country, where some of them had witnessed the death of relatives (P1, P3, P5) and often only narrowly escaped death themselves (P1, P5) or had lived in fear of it (P2, P4).

The trauma brought on by these experiences often manifested itself through nightmares. P4, for example, kept actively dreaming about being in Aleppo and being drafted by the military to be sent to war. P3 meanwhile was having nightmares about her situation in Germany as she had lost her husband and was having to cope as a single mother with refugee status. She felt not only broken from fleeing on foot and across the ocean with two children whilst being seriously physically ill, she was also suffering from a sense of not being wanted. In Germany she did not yet feel integrated into the community she was living in, had infrastructural issues, lacked information and was struggling with the language barrier, despite having been in her new home for about nine months. Particularly, she felt unable to socially participate in the everyday life of the German inhabitants around her. Prior to this, they had been put in a refugee camp for three months, which caused her additional mental anguish. As she put it: *"My mental status was very bad and every day I cried in the camp"* (P3). She mentioned the large number of children from various different cultural backgrounds in the camp and the ever-growing conflict between them, the dusty ground they had to deal with on daily basis and her constant struggle to keep their clothes and accommodation clean. Now, she was concerned that her accommodation was full of insects and that barren area around her gave her no opportunity to resume the individual living habits she had acquired in Iraq, such as finding the food she wanted (especially meat that was halal): *"[…] there is not everything that we need and every day I have to cry and nothing is in my hands"* (P3). She also said that she had sought help at the social security office a number of times, without receiving any support:

> *"[…] I went very often and told them about my current situation, that I am suffering from huge stress and that I am sick, that I am losing a lot of blood, […], but nobody helps me and I am always going home again and can't sleep and always cry and my kids scream and nobody is caring for us. […] And the house is old and not nice and there is nothing beautiful around and I am very depressed."*

P2 discussed the intercultural challenges in the refugee camp and the problems of placement afterwards, where he was allocated accommodation where there was almost nobody else his age and the negative emotions this aroused. P2 had left his home country for the same reason as P4: to escape from being drafted into the war. To do this he managed to get to Germany more easily than the other participants, who were obliged to cross the sea, making the so-called 'journey of death'. Despite the massive burdens associated with this and the fact of being separated from his loved ones for an indefinite period of time, he felt he was still well off compared to others who were still living in Idlib or Aleppo. Back home they had no attacks, just

military raids or kidnapping and the constant pressure and anxiety of being conscripted, he explained. He said he laid awake every night worrying about the past and the future, knowing that his parents were still exposed:

> *"At the moment the only problem I have is my parents. My thoughts stay with them 24 hours a day. No matter how happy I am, how much laughing and distraction is going on, there is no way to lose thought of them. Sometimes I am crying."*

P1, P3 and P5 had all lost close family members. P1 lost her father in the war when she was only eleven years old. Her own life back in Syria had been threatened several times by shots and bomb attacks, resulting in an ongoing fear of loud noises. Before she began the "journey of death", she was trapped doing child labour in Turkey for two years trying to raise enough money to move on, which made her physically ill: *"In Turkey I had no dreams. I just went to work like a robot and went back home like that. I had no life goals at all"* (P1). After experiences of poor treatment by others and homelessness, with everything that it entails, she finally arrived in Germany. After her official interview P1 shared some further concerns. She told of her suffering from depression and anxiety, accompanied by loneliness, insomnia and shortness of breath, and driven by questions about the meaning of life itself, questioning the practices of people around her and the hope underlying them: *"Why is it our duty to live? I'm looking for the reason that'll get us to move on. […] Why is somebody asking you to stay, if you'd say that you want to die? For yourself or for himself?"* (P1).

Psychologists and volunteers hear these stories as soon as they come into close contact with the refugees to help them in therapy or with their daily tasks. Many cannot conceive what the refugees have been through before, during and after the flight and feel overwhelmed as stated by V1: *"Some stories I'm overwhelmed with. Or with some stories I also have to say 'stop', no further, because I have to protect myself."* Other volunteers also struggle to imagine the events they are told about, as noted by V3: *"At the end we all just sat in a circle and cried for a quarter of an hour, because somehow this intensity, this experience, this level of destiny, could knock you off immediately (...)."*

Of course, not only the volunteers felt overwhelmed by the things that had happened. V3 spoke about his experiences with refugees in reception camps, where he provided support as a paramedic:

> *„[...] in the moment where this information has taken place in your mind: 'you have made it now you are safe now', people have completely collapsed! Mentally as well as physically because they have always been in such a permanent tension before that they just had to function for themselves, for their own survival, for their families."*

He commented that mothers were especially affected by this.

Psychological experts are better equipped to deal with disturbing accounts. Still, PS2 sometimes took the more harrowing stories home:

> *"[...] you can make sure that you get some rest after work [...]. For example, you can develop a ritual […]. Of course, it doesn't work all the time. [...]. I always try to say to myself [...], I help people and now they feel better. They're safe here, and what we give them [...] makes a little light shine. And that actually comforts me."*

Indeed, pathologies that appear in a lot of cases and add to the burden are trauma and depression or a combination of the two (PS3).

Approaches to event processing

Individual ways of coping with the above include avoiding news about the home country (P4), talking about what happened with people you trust (P4), or, contrariwise, not talking to anyone and retreating until your emotions are less raw, often supported by self-distraction (P2). Another possible way of handling things is maintain some kind of hope (P2, P4).

Only one of the interviewees was receiving therapeutic support at the time of their interview (P3). The interviewees who had so far refused professional help perceived therapy as something for traumatized people with whom they didn't identify. P4 explained that the definition of trauma seemed to be linked to culture and lifestyle when countering his German girlfriend who argued in his interview that he needed psychological support: *"No, I don't think so. But for normal people maybe [it seems that we are traumatized]"* (P4). V3 underlined this impression: *"What a German sociology student would call trauma would probably be accepted by an Afghan farmer just like that."* Yet P4 was suffering from nightmares that weren't enough to convince him to seek help. Instead he continued talking to his girlfriend, just as P2 kept talking to his friends, which was itself rare due to their different mindsets.

Despite this, the participants did say they'd be open to having help if they really needed it. Although she was not very open to sharing her mental state with friends and family, P1 did feel a need to talk, but preferred to cope on her own in the first instance: *"If I am meeting someone, I am forced to wear a mask and pretend I am happy, because I don't like people to see me sad. That they should feel sorry for me. I don't like that. I don't ask anybody for help"* (P1). She believed that nobody would understand her anyway and that certain people might even be happy to see her suffer. She also felt a lot of anger, which could explode at any time, she said. She pointed to the pressure to succeed in the German school system, on which her life goals depended, and to the loss of a sense of home. The responsibility she now bore for her own life and its course caused her a lot of concern, which led her to conclude that life in Syria was better, despite the circumstances. After the interview P1 asked for support in getting in touch with a psychologist who might take into

account her financially-limited situation. She also commented that the interview itself – talking about her story – had made her feel much better and calmer.

The lack of health insurance can have an enormous impact on the willingness to seek the help of psychological experts:

> *"The problem with psychotherapy is always, that it is not allowed to be free of charge. This would be an occupational offence. So far this has been the biggest problem with treatment of refugees […]."* (PS1)

Once they have arrived at the point of treatment, it is essential to deal sensitively with existing traumas and to orient towards them appropriately, e.g. by adapting the therapist's gender in the event of rape as mentioned by PS3. PS2 also said that the language barrier needed to be overcome by involving interpreters. However, an increasing number of psychologists are able to speak Arabic. This development is more than welcome because it is difficult to involve third parties in therapy, not just because of time, but because the translation has to be word-for-word (PS2). She further expressed the view that trauma therapy must come first, then integration, because flashbacks interrupt the concentration that is needed to learn a new language:

> *"[...] first of all they have to be at peace with themselves and work through their history and then they can start to integrate properly. For example, some people find it really difficult to sit down in a language course and concentrate properly in order to learn a new language. Instead, they are still in their country or on the run in their thoughts."*

However, there are exceptions. For some it is helpful to create a social network and reconstruct their daily life first. Social support in the form of volunteering, which can ensure administrative guidance and include fulfilling activities and some inspiring new experiences, offer a good way of going about this (PS2). Voluntary consultations currently try to tackle all administrative hurdles, e.g. filling in documents for the authorities. Nonetheless, personal questions, for instance about being reunited with their families or about daily life in Germany, come to the fore here (V1).

Discussion

The insights from the interviews with the different stakeholders provided a holistic view of the various stressors that refugees are confronted with, which have arisen from difficult as well as traumatic life experiences in their home country, on the flight or after their arrival in Germany and are supported by new problems in dealing with them. They are accompanied by loss of control, insecurity due to unstable living conditions as well as adverse circumstances, personal losses and

lack of successful participation – all factors that weaken resilience (Kleefeldt 2018). Our results show a diverse and conflicting picture of how refugees think about professional therapeutic support. While they are mostly in favour of it, there is almost no action towards pursuing it due to individual, structural and social barriers (Schneider et al. 2017). For psychotherapy to look like an option, a number of variables, e.g. language, cultural understanding, and knowledge of the social structure and laws, have to be dealt with. Then people can actually see the possibility of and reach out for professional help to work on their mental condition. Yet it is their mental condition that often hinders them in managing to do this in the first place. This paradox can run ad absurdum, driving refugees into a cycle that they are unable to escape on their own. Becoming aware of your own mental health, accepting it, gaining motivation for receiving professional help, and finding out where to receive that help and how to do so, are all potential barriers to the integration of refugees within the (health) system in Germany. In view of this, we will now discuss the potential, challenges and benefits of using digital solutions and Poetry Therapy to help refugees cope with such challenges.

Poetry Therapy as a self-help method

As integration on the part of the refugee, as defined in our paper, can only take place if their personal mental status is stable and they are able to deal with the issues mentioned above (Schneider et al. 2017), which has been confirmed by PS2 for some of the patients, this approach is not only complementary to therapy but also a way in which people can recognize their own personal challenges and find the motivation to pursue a path towards better health. By using Poetry Therapy and especially EW, personal ways of thinking can be transformed through the inspection and overwriting of memories, thus increasing well-being and helping people to open themselves to their environment and augment their social capital (Pennebaker 1997; Horn and Mehl 2004; Heimes 2012). This could pave the way for professional support.

The use of such therapeutic methods via technical self-help tools can help refugees to gain insight into the many layers of their own personality revealed by their individual history. Within this framework, the different qualities of therapeutic writing, especially EW, can be activated, the sense of coherence consisting of comprehensibility, meaningfulness and manageability can be generated, and the resilience factors of self-perception and control, goal-orientation, problem solving competence, self-efficacy and successful handling of stress can be positively triggered. In this case suffering due to feelings of fear, shame and guilt decreases (Kleefeldt 2017) while self-confidence and emotional and psychological well-being increase (Thieme et al. 2015). Following Horn and Mehl (2004) the activating effect of writing also leads to an improved integration into social networks, which supports social well-being (Thieme et al. 2015).

Digitization can expand people's access to such proven therapeutic interventions, most of which are currently only used during therapy conducted in situ by psychological experts. Through the digitization of such methods and by offering them in a range of languages, new preventive opportunities arise that could support mental health by providing people with access to these methods by means of a digital self-help tool, whether it is a platform, an app, or a mixture of these things (Mestheneos and Ioannidi 2002). This could give a solid insight into all the information refugees need to understand their situation better, e.g. narrations or therapeutic tasks (Matthews and Doherty 2011). The form and structure of the tool would result in more independence to focus on the processes necessary for personal stability. In order to design such a tool, however, there are several complex challenges that need to be overcome.

Access

Refugees face many barriers in getting access to psychiatric support, compounded by individual barriers (e.g. feelings of shame, self-stigmatization, lack of language or knowledge gaps), structural barriers (e.g. not enough multilingual psychologists, a lack of psychologists in general, lack of intercultural knowledge on the expert side) and social barriers (e.g. stigmatization) (Schneider et al. 2017).

A digital solution can overcome most of these, but people need to be aware of it. It can, designed along the lines outlined above, be free of charge and mobile when linked to an app or online platform (Maitland et al. 2018; Gillespie et al. 2018). Here no financial disadvantages arise and the use is hidden from others, since it is only on a person’s individual device. Digital solutions can also be designed in such a way that language plays no role. It does have the advantage of 24/7 availability and accessibility, when face-to-face care is not available (Bush et al. 2015). However, even the best designed e-mental-health tool can’t help to support resilience and well-being without the cooperation of relevant stakeholders (Kleefeldt (2018). Here (peer) volunteers are especially important because they can take on the role of gatekeepers before experts even come to mind, which also saves the latter much time, serving the fact that the German system is lacking of psychotherapists in general (Bajbouj et al. 2018).

Trust Building

After getting access to the target group, future end users need to understand the idea of the self-help tool and to start using it. However, because of their preconceptions about therapy, they will need to overcome this intrinsic barrier in order to trust the tool and embark upon its application. But not only the end users have to gain this trust first, also the experts who will later interact with the system and the end user have to get to know the tool and trust in its positive results.

For all stakeholders trustworthiness can be created by adopting a Grounded Design approach (Rohde et al. 2016; Stevens et al. 2018), in which psychological

and social experts as well as peer groups work hand in hand during the design process and involve the end users themselves in order to acquire the cultural needs of all of them, e.g. their native language, values and norms (Thieme et al. 2015; Bratt et al. 2017). Getting to know each other within this process, sharing different stories based on personal experience, individual knowledge as well as emotions, either in the same language or by finding another way to communicate and exchange personal but also collective insights will not only help to promote the new technology in terms of its use, usability, user experience and acceptance, but will also help to shape it from the ground in a need- and future-oriented, intercultural and empowering way, which is absolutely necessary for tools that interact with different people from different cultural backgrounds, especially when located in psychosocial contexts (Franco et al. 2016; Bajbouj et al. 2018; von Lersner and Kizilhan 2017). Making intercultural communication part of the tool itself by creating a virtual community network serves as a social resource (Thieme et al. 2015; Dosono et al. 2016) to support identity work regarding personal awareness, change and collective sense making of new cultural norms and practices (Dosono et al. 2016) and thus promotes social well-being (Thieme et al. 2015) and trust. It also meets the resilience factor of social competence, which can develop positively against this background. However, as von Lersner and Kizilhan (2017) emphasized, this requires intercultural competence, the assurance of which can also be part of the socio-technical design by teaching it to all stakeholders, whereby experts in particular should receive training tailored to their role. By doing so, the focus on resilience expands from the individual level to that of the collective, as a first subsystem of the whole is addressed and changed here.

IT-Security

Another important factor for building trust is IT-Security.

Clearly, the tool would need to be fully anonymous and indicate why certain personal data are required and how they are stored and secured. In addition, data should only be collected where absolutely necessary and never beyond. As many of the interviewees had lived in countries with high levels of surveillance, they were aware what this kind of technology was capable of. By involving them in the design process from the beginning (Rohde et al. 2016), their concerns and experiences can be incorporated into a more transparent ICT solution, while being aware of what kind of data is collected and how it is processed. This high degree of transparency is essential for sensitive topics such as mental health.

Pathology Identification

An indispensable aspect of safety is the guarantee of pathology detection (Franco et al. 2016; Bratt et al. 2017) before or during the establishment of a direct connection with an expert, if this has not become available during writing sessions. This point is highly important to assure that people suffering from mental disorders

will not be left alone or without professional support when using the self-help tool as Poetry Therapy opens the door to one's own memories and linked emotions, which usually leads to a degenerative state of mind before emotional improvement (Horn and Mehl 2004).

This could be achieved in advance by integrating an assistant, chat-boat or artificial intelligence to identify symptoms or specific circumstances associated with mental disorders or, in the worst case, even suicidal thoughts. Alternatively, such case identification could also take place during the writing process by means of linguistic analysis, which is less visible, as recommended by Bratt et al. (2017). A positive identification would then have to offer the mediation to an expert in the case of mental challenges and insist on this for further use (Bratt et al. 2017).

Societal Constraints

Something not to forget about is the framework psychotherapy is grounded in. In Germany, as PS1 told us, it is currently hard to charge psychotherapy sessions with refugees. Other reasons why psychotherapy is hardly used by this group are a lack of knowledge about special offers, too short offers which take cultural aspects into account and reservations of experts towards the target group (von Lersner and Kizilhan 2017), which could be another reason for the shortness of offers.

The lack of knowledge about online self-help services can already be taken into account by the collaborative design of the various stakeholders in order to generate acceptance for the digital solution, so that experts can then incorporate the service into their own daily practice and disseminate knowledge about it further in their circles. Higher-level multipliers can also be integrated into project ideas. Reservations of experts can also be addressed and overcome by the socio-technical solution conveying intercultural knowledge and explaining possible cultural misunderstandings in order to train mutual understanding.

Lack of Resilience

Many of the volunteers get overwhelmed as stated by V1 and cannot adequately cope with the stories that have been told by refugees. V3 underlined this by sharing personal experience and the triggered deep sadness of the respective moment linked to this event. But even psychological experts take some stories home with them, as PS2 noted, without knowing how to get rid of them.

Self-care is key here and should be considered in the design process for all experts, but also for peers and end users, as the experiences of others can be harmful, especially if they are the same as one's own and act as triggers. Trainings, including writing itself or e.g. mindfulness, the development of rituals based on that, as PS2 already does, and mental hygiene in form of supervision could be options that could be integrated into psychosocial systems as focussed on in this study to ensure mental stability. This is not only important for experts but for the end users as well who count on them. Another possibility would be to expand the

spectrum of the writing platform itself and at the same time turn experts into permanent end users in order to ensure equal resilience support.

Limitations

Although a diverse set of interviewees were chosen, the number of refugees, volunteers and experts is too low to provide a properly detailed picture. However, the goal of this exploratory paper was to provide first results from an interview study with a vulnerable and hard-to-reach target group, so generalization was not one of its objectives.

A major limiting factor when conducting research in this field is obtaining access to refugees as many are not ready to speak openly about their mental problems, whilst others believe they are unaffected. Even if they are aware of their own mental status, they cannot simply seek professional help. Some, like one of our own participants, quit within the process of speaking out loud, because the emotions and the pressure of remembering past experiences became too stressful. On the other hand, there are refugees who are willing and able to speak about their problems, but who prefer to do this within their own trusted circle of friends or, when participating in research, after the recording devices have been switched off. Future studies need to address this particular issue by using different methodological approaches.

Conclusion

This exploratory paper has sought personal indications of mental difficulty amongst the vulnerable and culturally diverse target group of refugees who have experienced stressful life events or even trauma. We have shown theoretically that there is high potential for Psychosocial ICT to help, also that the challenges and benefits of digitalized therapeutic methods as EW can be highly effective. Studies indicate a positive trend toward the digitalization of these kinds of interventions, if linked to peer and psychological support as a complement to therapeutic face-to-face-interaction. For this, Psychosocial ICT needs to assure the correct identification of mental health issues and to ensure direct networking with experts. Above all, the social and cultural background of refugees make it particularly difficult to convince them to address their negative experiences in therapy. It could be shown theoretically that easy access to an online solution or a solution based on smartphone usage, could minimize the barriers of entry and financing, improve individual progress in terms of self-awareness and self-determination, and open the door to social resources, embeddedness and personal bonding, thus providing for long-term mental stability and their ability to maintain continuity in everyday life. It also helps to overcome language issues and supports the process of integration.

Therefore, we argue, future research needs to focus on transferring well-established concepts such as Poetry Therapy and Bibliotherapy into the digital world.

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Understanding data and cooperation in a public sector arena

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Abstract. This note explores how data work takes place in a public sector arena. We report on findings from a 3-year research project with a Danish organisation, which, amongst other things, aimed to improve current data practices in the organisation. We make use of the notion of 'social arenas' as a lens to understand the complex setting the organisation is situated in. We find that data work in this context takes place among multiple stakeholders and requires cooperation across organisational boundaries. Moreover, changes in data practices in one site changes cooperation among multiple stakeholders in the arena. Additionally, we develop a diagram of this complex setting, which constitutes an analytical tool that supports our understanding of the site (or sites) of intervention where data work is examined. Our study contributes to the field of CSCW by proposing and showing how the notion of sub-arena helps to comprehend the cooperation and interaction within the surprisingly complex public sector and locate the (sub-)arenas and stakeholders affected by a change in how data is provided and used.

Introduction

The growing development and use of digital technologies and data are transforming societies with great implications for how daily operations are (and can be) run in the public sector. This development has generated an increasing number of organisations, who are trying to improve practices and implement tools to transform data into 'insights' or 'innovation' (Bright et al., 2019; OECD, 2019; Ostrom et al., 2015). However, while data is becoming increasingly important in society, at work, and in everyday life, little is known about how the increased focus on data, and thus the increased work with or related to data affect cooperation in the public sector. Therefore, we explore how data practices influence cooperation and impact the organisation of stakeholders in the public sector. Moreover, we question the role data play in this (re-)organisation.

In this paper, we draw on a perspective of data as defined through the ways data are embedded and enacted in everyday practices. As Bossen et al. (2019, p. 465) points out 'data do not sit in ready repository, fully formed, and easily harvestable. Data must be created through various forms of situated work'.
Furthermore, we argue, to research data and data-based services provided by and integrating whole sectors, research as well as design of such services has to develop ways to conceptualise practices and work beyond individual organisations and across societal sectors. We make use of the concept of 'data work'(Bossen et al., 2019; McMillan et al., 2016) as a lens to consider what such conceptualisation of cross-organisational data practices may look like in the public sector.

Our study is situated in a public sector arena that deals with vocational education and continuing education. This arena involves many different stakeholders, including ministries, governmental agencies, trade unions, employer associations, and education secretariats. As our point of departure, we focus on an organisation, Industriens Uddannelser (English: The Education Secretariat for Industry, hereafter the acronym IU is used), which assists the collaboration between these diverse stakeholders to develop, among other things, educational programs for vocational education and continuing education in the industrial sector in Denmark. In this paper, the notion of "stakeholder" is used to indicate that any specific person does not only contribute with his/her expertise, but also represents the interest of e.g. a labour market organisation, a vocational college, or the student body of a specific program.

During our longitudinal study with the goal to develop methods and tools that enable the employees of IU to design data based services, we came to understand that most of IU's activity as well as the respective data needs includes other organisations and stakeholders like vocational colleges, labour market organisations, and other governmental agencies. We recognised that the concepts around data and data work did not provide us with a way to conceptualise these cooperation structures and the interaction between organisations and people.

Therefore, we draw on the concept of 'social arena' (Strauss, 1985) as a way to frame the stakeholders that work and collaborate in this particular part of the public sector in Denmark around vocational education and continuing. We make use of this lens to better understand the types of multiple-stakeholder environments that are common in the public sector in order to further to understand data work and data practices in this context. As any such sector in society, the sector of vocational education and training is further structured to allow for cooperation around more specific concerns. IU facilitates particular meeting structures that enable representatives from different organisations in the arena to work and collaborate in order to address certain shared concerns. We propose to use the concept of 'sub-arena' in order to describe the interaction between stakeholders around specific tasks, e.g. specific educational programs and their implementation at specific vocational colleges, and the interaction of between these sub-arenas and the overall arena, where these sub-arenas are decided on and their mandate is framed.

The note's core contribution is our demonstration of how and that these concepts can help to comprehend the cooperation and interaction within the surprisingly complex public sector and locate the (sub-) arenas and stakeholders affected by a change in how data is provided and used. We propose the set of concepts adopted from sociology as a tool to make sense of and design for cross organisational data work. The remainder of the note is structured as follows: First, we relate our study to previous work in CSCW that has considered the role data play in and for collaboration in different context. Moreover, we elaborate on the concept of social arenas. Then, we present our field site and method before turning to our findings which shed light on the data work in this particular arena on the Danish public sector. Finally, we discuss our proposal to use the concept of sub-arenas and how our diagram may constitute a tool for scoping the site (or sites) of intervention in multi-stakeholder environments.

Related Work

In this section, we elaborate on the notion of data work and present very brief accounts of studies that examine data practices and the role of data CSCW research. Then we explain on the notion of social arena and how we make use of it as our conceptual frame.

Data consists of symbols that are stored to support specific activities, e.g. by representing relevant aspects of a specific domain (Kitchin, 2014). In this paper, what constitutes data reflects the people working in this arena's understanding of data. Thus, we look at data with a broad lens, including a diverse set of data types that encounter both qualitative and quantitative, unstructured and structured forms of data. Moreover, we refer to "data work" as complex and distributed human activities related to data practices (Bossen et al., 2019; Fischer et al., 2017). Specifically, the notion of data work has been conceptualized to address "any human activity related to creating, collecting, managing, curating, analysing,

interpreting, and communicating data" (Bossen et al., 2019, p. 466). This form of work is complex, distributed, and often interdependent of other stakeholders (Bossen et al., 2019; Fischer et al., 2017). The literature on data work and digital data practices cover various contexts. Examples includes studies examining data practices in the context of civic engagement, which emphasise that although data are often 'broken' (Pink et al., 2018), they are essential to the work of activists because it supports actions around social issues (Alvarado Garcia et al., 2017). Thus, data and data work strongly influences how non-profit organisations can work and coordinate future initiatives (Erete et al., 2016). In the context of distributed collective practice and scientific data collections, scholars addresses the opportunities and challenges that data sharing and collaboration hold for the design of data directories and more broadly scientific communities (Birnholtz & Bietz, 2003; Paine et al., 2015). Moreover, examples in the literature include investigations into the growing current work practices related to data science (Muller et al., 2019; Passi & Jackson, 2018; Tanweer, 2018). These studies examine amongst other things what constitutes current data science practices and they develop in different organisational contexts.

These different perspectives on data work emphasise practices related to work and cooperation around data as recognised activity and show data as an acknowledged entity that to various degrees shape how work (can) take place. Our study contributes to this discourse by demonstrating how data work takes place in a multiple-stakeholder environment in the public sector.

The notion of distributed organizations is well-known in CSCW. The concept is often used to shed light on the various social and technical aspects of work and coordination that is needed in order to support work across distance (e.g. Becker, 2001; Hinds & Kiesler, 2002; Ribes et al., 2013). Previous research has examined data sharing and collaboration in dispersed contexts (Paine et al., 2015). In our case, data work also takes place across organisations. We therefore considered if we could conceptualise our case as a distributed organisation. However, we were not able to identify one organisation or governance body, but a set of independent and cooperating heterogeneous stakeholders.

In our attempts to make sense of and describe this highly connected field site, we made use of the notion of 'social arena' (Strauss, 1985). The concept of social arena has been defined as 'a place in which different communities of actors meet to discuss shared or overlapping projects or concerns' (Balka et al., 2008, p. 517), and thus constitutes a field that is contained by dominant processual and structural conditions (Strauss, 1985). The place is here meant in a metaphorical sense as a forum for discussion and negotiation. Gärtner and Wagner (1996) apply the notion of social arena as a lens to consider different forms of participation in industrial research and design projects. They propose a framework, which describes three arenas for participatory design in this context. The arenas are characterized as follows: 'the political and policy-making context (Arena A); the institutional/organizational context for action (Arena B); and the context of design – support of work practice, public spaces for community involvement, and so on (Arena C)' (Wagner, 2018). The authors argue that the social arenas, where systems

and workplace design take place, have to be thought of as local interpretations and understandings of processes that cut across the arenas and are adapted and embedded within them (Gärtner & Wagner, 1996). They propose to use the concepts to make sense of the the highly situational context of a project. In this note, we will not apply their framework per se; however, we will draw on their idea that the notion of an arena emphasises the political and organisational context of social action in a large network of distinct organisations.

Method

This note builds on data from a 3-year action research project, which focused on how organisational members of IU could improve their data practices as a means to deliberately promote the organisation's design and innovation of data-based services. Hayes states "action research offers a systematic collaborative approach to conducting research in HCI that satisfies both the need for scientific rigour and promotion of sustainable change" (2011, p. 2). We draw on this perspective and understand Action Research as a methodology that implies that the research aims to induce change and improvement of certain aspects of the targeted research domain (Hayes, 2011; Reason & Bradbury, 2013; Robson, 2002). In this case, the primary research domain constitutes IU. To engage with the research domain, the first author was working in the organisation approximately three days a week from September 2016 to July 2019. During this period, the author used different methods to understand the field site, in particular, the stakeholders involved, and the data practices used by different stakeholders to collaborate, negotiate, and make decisions. Overall the fieldwork consisted of more than 250 units of observation, including (1) design, facilitation, and documentation of 22 workshops, (2) participation and observation of 51 meetings, (3) 12 in-depth interviews, (4) approximately 70 documents (emails, reports, presentations), (5) images, and (6) ongoing field notes to document informal conversations, observations and reflections throughout the project period. The result of the action research is discussed in other articles. This note addresses a challenge, we as researchers and designers were confronted with: How to understand and relate to the complex network of stakeholders that the organization collaborated with in order to solve its core tasks. We observed that this organization fell outside the category of a 'normal' organization that mainly use data (at least in part) for internal tasks. As argued above, the concept of distributed organizations did not fit either. On the contrary, IU is an organization that is put into being – in a specific location – to support public governance of a specific domain, and this organizational constellation influences how data are used. For this reason, we chose to make use of our body of material to analyze the complex collaborations between different stakeholders and how data are used in these collaborations within particular area of the public sector domain. We developed our analysis in two main ways, which happened in parallel and influenced each other.

One way we developed our analysis was by identifying specific examples that could help us to develop our thinking about what constitutes collaboration in

this arena, and whether/how data are used. We categorized the examples, and on this basis four themes emerged: (1) Data work underpins much of the cooperation in this public sector arena, (2) data interdependence shapes data work, (3) data are used to support negotiation and decision-making, and (4) enables new forms of data work to emerge which further prompts new forms of cooperation to emerge in this context. We drew on the whole dataset to develop our categorization and especially looked out for examples that would not fit. We elaborate on the themes in the Findings section.

The other way we developed our analysis was by trying to depict the arena. The fieldwork generated rich empirical material that led to an in-depth understanding of the complex network of actors that constitutes the arena. The complexity of this arena is depicted in the description below, and, especially in the diagram (Figure 1). Initially, the diagram emerged from discussions about how to characterise IU as an organisation. As the diagram developed through 10 iterations, it became an analytical tool for relating the data work at IU with the cooperation of different stakeholders in the arena. As a way to prevent researcher bias in this flexible design, the first author checked the understanding the diagram represents by discussing with organisational members at IU (Robson, 2002). This occurred in two rounds; the first round included the CEO and a manager, and the second round involved the three employees in the IT-department (a senior IT developer, a senior IT consultant, and a junior IT-consultant). In both instances, the organisational members related instantly to the model, which they thought reflected a good understanding of "their world". The CEO and manager asked if the trade associations could be named so they could print the diagram and display it at IU. The members of the IT-department questioned the "level" of the diagram, and also suggested adding more details, for instance, "the individual student who contacts IU outside of their vocational college or industry employer. However, due to the focus of the paper we decided to maintain the diagram at an organisational level. As such, figure 1 constitutes a significant finding in that it has provided an overview of the arena and its (data) interconnectedness.

Field site

Based on the perspective of IU, this research deals the public sector arena that works to maintain and develop vocational educations and continuing educations in Denmark. In order to make sense of this arena, we briefly introduce the Danish labour market model, which constitute a central governing frame for the stakeholders in this arena. This is followed by an elaboration of IU, as a way to describe this complex space in more depth.

Danish labour market model constitutes a dominant condition for how organisations in Denmark operate and collaborate, and thereby becomes an important aspect for understanding the wider context of our field site. The model is a term for the overall organisation of the Danish labour market, which constitutes a division of labour between the state and the social partners (being employers'

organisations and trade unions) (Danish Business Authority, 2019). In our case, it is, in particular, the model's inherent requirement for Tripartite Cooperation that governs the ways in which vocational educations and adult vocational educations are negotiated, regulated, and developed in Denmark. Tripartite Cooperation refers to the embedded obligation for the social partners to be accountable for agreements being made, e.g in relation to negotiations regarding topics such as 'work environment' or 'education'. The public sector arena which we focus on this paper can be considered an outcome of the Danish Labour Market Model because the social partners of the labour market are required to develop the educations in accordance with the Tripartite Cooperation.

In order to bundle interests and expertise, the governance of vocational education and training is organised according to four main fields: 1) Food, agriculture, and experiences, 2) Office, trade, and business, 3) care, health, and pedagogy, and 4) technology, construction, and transportation. This study specifically focuses on the organisation of the 4th field, which includes Industry-related educations. The central stakeholders in this arena include the government, in particular the Ministry of Education, the governmental agency for Learning and IT, employer associations, trade unions, industry companies, vocational colleges (and students), and education secretariats, such as IU. The many different stakeholders represent varying and different interests in the arena. They all cooperate on an ongoing basis to solve their shared or overlapping projects and concerns related to vocational educations and continuing education courses. Much of this cooperation takes place in committees like Sector Skills Councils, Local Education Committees, and Development Committees. In the following, we elaborate on IU, which constitutes a particular organisation that exists to support and facilitate much of the cross-organisational collaboration in this arena.

IU is an education secretariat based in Copenhagen, Denmark. IU was founded as a self-governing institution in 2000 by three major employer and employee associations. As such, these core stakeholders gave IU a mandate to facilitate and support the corporation that is necessary in order for them to meet the requirements of the Danish labour market model. The aim of the organisation is to improve the utilization of resources in order to enhance efficiency and improve the quality of processes related to the maintenance and development of vocational education programs and continuing education courses.

IU has six overall tasks that emphasise the work the organisation performs in this public sector arena. These overall tasks include: 1) Education development, 2) Operations of educations, like e.g. approval of companies to train apprentices, 3) Events to promote vocational industrial educations, 4) Communication with the same purpose, 5) Policy-support, and 6) Administration. IU provides and facilitates particular meetings structures that enable representatives from different organisations in the arena to work and collaborate in order to address certain shared concerns. We term these cross-organisational fora as sub-arenas to make this specific collaborative character of the arena visible.

Findings

This section presents the main findings from our exploration of data work in a public sector arena and the role data play in this context. First, we make the complex setting in which IU is situated visible by presenting a diagram that depicts the public sector arena. On this basis, we show how data work underpins much of the cooperation in this large network of stakeholders. Furthermore, we show how data interdependence shapes data work and how data support cooperation amongst the many different stakeholders in this setting.

Data work underpins cooperation among stakeholders in the complex world of vocational educations

To maintain and develop vocational education and continuing education requires involvement of multiple stakeholders for IU to solve its core tasks. We have attempted to visualise the complexity of the arena in Figure 1, which illustrates how IU interacts with the many different stakeholders in order to maintain and develop the organisation's service provisioning. Every circle is an actor in the arena. Every line indicates collaboration and participation. The triangles represent sub-arenas, formally established as well as temporary committees of cross-organisational collaboration. Considering the model in this way emphasises the complexity of the arena in which IU exists and navigates.

For example, the way in which IU maintains and develops the education programs is through highly organised committee work. IU handles and facilitates 12 Sector Skills Councils (see triangles in figure 1), which constitute authorities that are responsible for making sure that the vocational education programs and continuing education courses are developed according to the needs of the labour market. A sector skills council consists of representatives from employer associations and unions, and an education consultant from IU who coordinates and support the council and its members. Altogether, IU handles 39 vocational educations and more than 1000 continuing education courses. Our examination of data work in this public sector arena is primarily based on the perspective of IU. Thus, in the process of understanding what constitutes data work in this particular arena, the diagram enabled us to consider which stakeholders might be involved and/or affected by the data work we examined.

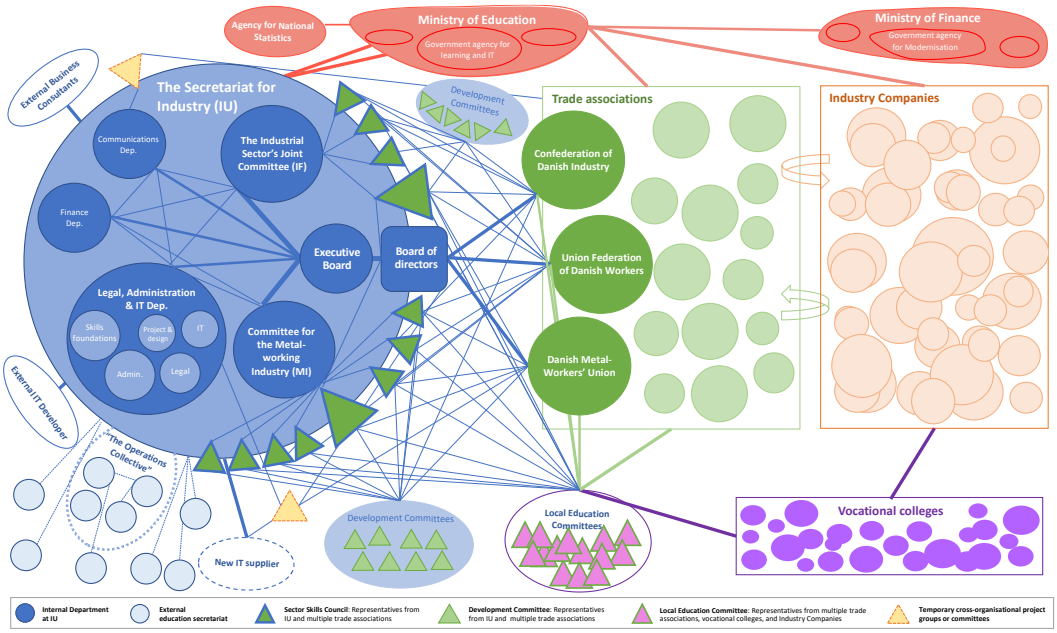

Figure 1. Diagram of the public sector arena for vocational education and training in Denmark.[1]

To illustrate what constitutes data work this complex setting, we elaborate on an example were data practices in and across multiple organisations support cooperation in the arena. The example revolves around Local Educations Committees (LECs, visualised as pink triangles in figure 1) that exist to strengthen the relations between the local industry and vocational colleges to ensure agreement between the labour market's needs and the vocational educations. LECs work locally to implement the legal frameworks provided by the Sector Skills Councils and the Ministry of Education (Danish Ministry of Education, 2019). LECs are made up of 4-8 committee members that represent both employer associations and unions, and additionally, two representatives from the local vocational college. The representatives from the employer associations and unions are often local people who have been appointed by the association or union they are affiliated with. There are 165 LECs alone in the industrial sector in Denmark (IU, 2019). As shown in previous work (Seidelin et al., 2018), it requires careful organisation and cross-organisational data work to audit the members of the LECs and to make sure that each LEC is equally staffed with representatives from employer associations and unions, as required by law. IU acts as a "neutral" part between the stakeholders, and has been trusted with the task to collect, store, and maintain all relevant data about the LECs in the so-called LEC database. In order for IU to be able to maintain the data, it is necessary to coordinate with other stakeholders in the arena. When a LEC member retires, or a new member is appointed, an administrative worker at IU initiates an array of data practices that involves multiple stakeholders, leading

[1] The size of the figures in the diagram does not indicate the actual size of the organisations. Due to the situatedness of the research project, the diagram highlights the perspective of IU. This means that the figures might have been depicted differently in the diagram if another stakeholder in the arena had been the focal point of the project.

to the formal assignment of a new member and update of related data in the LEC database (Seidelin et al., 2018). Consequently, the LEC data and the related maintenance work constitute a system that assists ongoing cooperation in the arena. This example demonstrates how cross-organisational data work supports the collaboration around the shared task to maintain the LECs.

Data work shapes negotiation and decision-making in the arena

Data practices related to certain tasks play a key role in how negotiations (can) develop and how decisions are made in this public sector arena. To substantiate this observation, we highlight an example that show how data work inform negotiations and support decision-making.

The example revolves around data work which was undertaken to investigate the state of automatization in the Danish Industry. Industry 4.0 is a concept that has been used to describe the automatization of the industrial sector (Schwab, 2018). Industry 4.0 is expected to have a major influence in terms of which skills will be needed and in order to support an increased level of atomisation in Industry (Tænketanken Mandag Morgen & Teknisk Landsforbund, 2018). This development has also attracted attention amongst stakeholders in the arena. The trade associations (depicted as green circles in figure 1), in particular, were very concerned about how Industry 4.0 will affect for instance the need to upskill workers in industry. IU was therefore commissioned by the board, and thus multiple trade associations, to develop an analysis of the current level of digital competencies in various industry companies.

An education consultant at IU explained how the data work they undertook both shaped and supported the following negotiation process among the stakeholders:

> "We were talking a lot about Industry 4.0, and therefore it was decided that we should do a "digital check-up", which consisted of us [education consultants] interviewing a number of industry companies about their understanding of Industry 4.0. The purpose was to develop an analysis and a report that described the current state in various Danish companies. Based on the interviews, we concluded that "Industry 4.0" is primarily a concept that is used in big cities and in academia. For me, it was a realization of how we play a central role in the conceptualization of this concept… Most companies did not have an organizational narrative about "we are 4.0", but we needed "company profiles" to provide the "digital check-up". So, by questioning them [industry companies], we are also shaping the need to be 4.0… When we question this system [the arena], we disturb the system so that it begins to reflect on why, for instance, our machine operators are not learning about Big Data. This changes things". (Education Consultant. Workshop video recording. May 2019)

The citation illustrates how organisational members of IU created data and insights through their data work. The outcome of these practices was eventually included in negotiation and decision-making processes related to how the many involved stakeholders should address the requirements of Industry 4.0. The data created and interpreted by the education consultants at IU influenced multiple stakeholders in the network through their data practices. Specifically, this array of data practices resulted in, amongst other things, new continuous education courses for plastic processing technicians about, e.g. data-driven production and maintenance (3D-

printing). Consequently, industry companies are now upskilling their employees in technologies and techniques that prepare them for Industry 4.0.

During our research, we observed similar situations, for instance, when IU consultants were discussing the development of educations and new courses with external stakeholders in sub-arenas; when management was developing a new strategy; or when vocational students would make a complaint about their apprenticeship. Thus, the example emphasised here demonstrates that when certain data practices are undertaken in the arena, it is likely to influence what future steps are (and can be) taken in negotiation and decision-making processes.

Changes to data practices changes cooperation in the arena and sub-arenas

Data and cooperation are tightly intertwined; changes to data practices changes cooperation in the area and sub-arenas. To illustrate this finding, we elaborate on an example where a specific dataset was included to support routine cooperation, initially, in one sub-arena. The example deals with Elective Specialization Courses (ESCs), which constitute a mandatory part of all vocational education programs in Denmark. ESCs are developed by the sub-arenas, who are responsible for making sure that the vocational education programs are developed according to the needs of the labour market. The ESC arrangement is therefore designed to be dynamic to make sure the education programmes meet current needs and future industry demands. The demand for a new ESC can emerge from different stakeholders in the arena. However, the vocational education act states that there can only be a certain number of ESCs per vocational education program. This means in order for a council to develop new courses, they need to close down others. It used to be very difficult for the sub-arenas to decide whether to maintain, develop, or close down an ESC. Education consultants at IU used to share a spreadsheet with relevant vocational colleges and ask which ECSs they offered. The vocational colleges often replied that they offered all courses, and this prevented any action. To improve this work practice, an education consultant at IU reached out to an acquaintance at the governmental agency for IT and learning. This person developed an SQL query that provided a dataset that contained the number of gradings for each course. This data was used as an indicator for whether and to which degree an ESC is actually taken. The underlying assumption was that '*if you get a grade, then you have most likely attended the course*' (Education Consultant at IU. June 2019). The availability of this dataset has allowed the sub-arenas to get new insights about the ESCs in order to update the education programs continuously. Today, this dataset is used regularly both to close down courses in order to develop new ones, and likewise, to identify popular ESCs that might become a mandatory course due to the documented increased demand. Thus, the example demonstrates how the changed data work changed the cooperation amongst involved stakeholders in the area and sub-arenas.

Discussion

Based on our empirical findings, we discuss three key points that contribute to a better understanding of the role data play and how data work takes place in a public sector arena. First, we discuss how the organisation of this particular arena involves sub-arenas and how it requires IU to use data both on a routine basis and in emergent ways. This is followed by how data constitutes a form of participation in the arena. Finally, we discuss stable and emergent data needs in the arena and point to future work.

Data interdependence and Sub-arenas

The stakeholders in this public sector arena work together – though in different ways – to maintain and develop vocational education that addresses the needs of the labour market in the industrial sector in Denmark. Figure 1 emphasises the complexity the actors of the arena navigate in. The diagram reveals how many different sites of collaboration exists and are needed in order to maintain and develop the tasks determining the arena. In this way, we shed light on how data work takes place and the role data play in the creation and maintenance of the interdependence among stakeholders in this particular public sector arena. The diagram also reveals the importance of IU's role to facilitate and support different meeting structures in order to ensure the cross-organisational collaboration that enables representatives from different organisations in the arena to cooperate around shared concerns.

We have proposed the concept of sub-arenas to describe the regular interaction between stakeholders around specific tasks. Furthermore, our empirical findings show that there are two types of sub-arenas in this context. We categorise these as 'fixed sub-arenas' and 'temporary sub-arenas' (Figure 1, green and yellow triangles). The Sector Skills Councils and LECs constitute fixed sub-arenas in that these entities are well-established and formally organised. This form of sub-arena primarily involves routine-based data needs that support continuous committee work. However, sometimes this form of sub-arena addresses emergent data needs, for example, when IU was commissioned to develop the analysis of the current level of digital competencies companies. With 'temporary sub-arenas' we refer to forms of organisation, where different stakeholders collaborate within a provisional time frame to define and/or solve a specific problem. The temporal aspect of this form of sub-arena creates situations were discussion about what data should be included for a specific project are explored and defined "on the go".

Our study reveals that most of the data usages were concerned with making specific aspects of the domain of industrial vocational education and training accessible to the stakeholders of the arena. Thus, rather than informing and supporting one organisation, data was in most cases collected, used and acted upon across different organisations.

A tool for scoping the site of intervention in multi-stakeholder environments

This section discusses how the diagram (Figure 1) that emerged through our explorations of data work in the public sector might constitute a way to support researchers and designers when scoping the site (or sites) of interventions in multi-stakeholder environments. In this study, the diagram has constituted an analytical tool that has allowed us to model (sub-)arenas and stakeholders and in this way grasp the complexity of a particular public sector domain. Stakeholder mapping and analysis are part of many project management and (service) design methods. The concept of social arenas enables one to more easily recognize the shared interests and objectives that constitute social arenas when identifying and involving stakeholders, instead of relying on simple checklists.

When first studying the data practices around one specific set of data in this context, we 'followed the data' to identify relevant domain experts as a way to make sense of the data work related to the LEC database (Seidelin et al., 2018). Initially, we perceived this databased and its related services as a relatively simple. However, this intervention unfolded into a complex interorganisational cooperation, which also influenced stakeholders who were not directly involved in the data work round LECs. Over time, we learned that this high level of interdependence and complexity was the norm, rather than the exception, when it comes to data practices at IU. In this context, any data-based service design will involve a heterogeneous network of actors who are either directly involved in the data practices or effected by the change. We would argue that a tool, such as Figure 1, from the very beginning of the research process could have helped us to
identify both stakeholders and individuals directly involved in the data practices as well as stakeholders who are affected by the project and thus would have to be involved. For example, in our research, vocational colleges did not figure as directly involved in the data practices in the beginning. Including them in the redesign would have allowed stakeholders to address collaboration through the LEC data in a more comprehensive manner early on. In sum, the figure that emerged from our explorations of data work in the public sector and the concepts of arenas and sub-arenas point to a useful way to shed light on the fact that there are many different ways to scope the site of intervention. This could help designers and researchers to not only acknowledge the complexity, but also to better understand and furthermore to be able to be more precise about our scoping of the site of intervention.

Conclusion

The aim of this note was to develop a better understanding of the role data play and how data work takes place in a public sector arena. By examining some of the overall tasks of a central stakeholder in such an arena, our findings highlight how data work in this context takes place among multiple stakeholders and require

cooperation across organisational boundaries. We propose to use the notion of sub-arena to describe the interaction between stakeholders around specific tasks, as a way to comprehend the cooperation and interaction in a multi-stakeholder environment such as the public sector. Moreover, we provide a complex figure of the public sector arena, which we argue constitutes an analytical tool for understanding the site of intervention. Thus, we offer these concepts as a way to make sense of and design for cross-organisational data work. *

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AI Ethics and Customer Care: Some Considerations from the Case of "Intelligent Sales"

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Abstract. This note considers the topic of AI ethics as it relates to applied, industrial AI projects. In particular, it examines "intelligent sales," a strategic management concept that envisions the enhancement of workflows within a sales organization with the use of Big Data and artificial intelligence (AI). This note examines common depictions of intelligent sales campaigns in management literature, identifying key topics in these discourses: *data fusion*, *responsive customer care*, *automation*, and *streamlined delivery*. We focus on ways in which intelligent sales is envisioned to enrich the customer-sales relationship through the use of Big Data and AI, surfacing ethical considerations around: training data and the use of AI outputs in everyday work practices. This paper contributes to discourses on the fairness, accountability, and transparency (FAccT*) of algorithmic systems by raising a number of emergent concerns in enterprise AI applications and in particular some considerations from the emergent management concept intelligent sales.

Introduction

Contemporary organizations are increasingly scrutinized on their ability to perform "data drivenness," that is, demonstrate the innovative development and use of Big Data and artificial intelligence (AI) technologies and capabilities to enhance, standardize, and optimize their business operations. Commonly signaled today in popular business and management trade press under monikers such as "intelligent enterprise" (Schoemaker and Tetlock 2017) or "cognitive enterprise" (IBM Institute for Business Value 2018), these trends are not new. Indeed, they follow a long-tailed trajectory of scientific management (Bear 2009; Braverman 1998; Taylor 2003) and statistical governance (Desrosières 2002).

The aspirations of the cognitive enterprise are propelled by two entwined phenomena: the emergence and maturing of the Big Data era; and the renaissance of AI and machine learning (ML) development that has followed in its wake. The impact of Big Data and AI are seen as offering great potential to transform contemporary society, similar to the PC and computerization social movements of prior decades (Kling and Iacono 1988). It is undeniable that these two keywords ("Big Data," and "AI") are driving forward contemporary business and strategic management discourses, obvious to even the casual reader of trade publications like *Harvard Business Review*, *MIT Technology Review*, *Forbes*, *CIO*, and *The Economist*, to name a few.

Big Data and AI have changed many aspects of everyday, consumer life, but these trends also pose opportunities for transformation in a wide range of industrial domains and processes. As Chui et al. (2018) discuss in a *Harvard Business Review* article, supply chain management, as well as sales and marketing are the two domain areas heralded as having the most immediate promise for enterprise AI. While specific imagined application areas are diverse, popular management discourses often focus on two overarching visions of how data will transform businesses. One, is the ability of a firm to leverage previously "untapped" data sources within their organization, often unstructured data like text documents ("data re-use" transformation). Another is the incorporation of novel data sources into organizational information practices, such as bringing social media or Internet of Things (IoT) data to bear on internal firm processes ("novel data" transformation). AI capabilities build on these Big Data stores, with novel algorithms and techniques introduced on an almost-daily basis that can provide predictive outputs and enable machine action to execute computational tasks with remarkable accuracy.

In this note, we focus on Big Data and AI transformations in the sales domain, and in particular efforts commonly called "intelligent sales." Sales is a complex and multi-faceted business process, requiring the coordinated efforts of many departments within a firm (e.g., sales staff, but also: marketing, accounting,

account management, procurement, delivery/fulfillment, to name a few). Considerable effort is required to see a "lead" (a potential customer, also called a "prospect") all the way through to "cash" (revenue flowing from the customer to the sales organization). This overarching super-process is often referred to as "lead-to-cash," a simple phrase that encompasses a complex web of interdependent processes and sub-processes that weaves together many sociotechnical actors. As Sinha (2018) describes in a *Future of Customer Engagement and Experience* report: "Lead to cash is arguably the most important customer-centric process in an organization, starting with the customer's intention to buy, and ending with revenue recognition." Many leading IT service providers, such as SAP, Salesforce, IBM, or Microsoft, offer software products and services to support the complex information processes of sales organizations. "Intelligent sales" is an emergent management concept that sees sales processes as ones ripe for Big Data/AI transformations.

Although particular implementations may differ, there are several key themes salient across intelligent sales products and services, as discussed in grey literature from the business management field. Grey literature is "the diverse and heterogeneous body of material available outside, and not subject to, traditional academic peer-review processes" (Adams et al. 2017) (p. 433). While care must be taken to contextualize its non-peer-reviewed status, grey literature can productively enhance scholarly knowledge by providing "relevant contemporary material in dynamic and applied topic areas where scholarship lags" (Adams et al. 2017) (p. 433). In this note, we outline four key themes identified in popular business and management trade press discourses on the topic of intelligent sales:

- *data fusion* – pooled and integrated data across departments within the sales organization, providing a "global" view of customer accounts and profiles;
- *responsive customer care* – enhanced sales relationships, where salespeople have broader, data-driven understandings of customer needs;
- *automation* – the reduction of repetitive tasks throughout the sales process via robotic process automation (RPA); and
- *streamlined delivery* – standardized, data-driven processes of offering selection, pricing, contracting, and fulfillment.

In each of these, Big Data and AI play particular roles in changing segments of the lead-to-cash process into various data-driven workflows. These hoped-for changes aim to transform organizational life sociomaterially and at varying scales, with implications at the technological, work practice, as well as strategic level. Readers will note threads which tie intelligent sales to longstanding issues within the CSCW community: data integration and re-use, workplace automation and standardization, and changing service relationships – these have all been topics of concerns since workplace computerization in the 1970s and 1980s. We make note of these ties and also draw attention to the novel considerations raised in the Big Data/AI context and in particular how the case of intelligent sales presents us with emergent questions on the design and study of data-driven

workplace technologies. Most notable of these questions are ones of ethics raised by Big Data/AI. We identify a number of ethical issues that the intelligent sales case implicates, organizing them into two themes: training data and the use of AI outputs in everyday work practices. This note brings discourses on the fairness, accountability, and transparency (FAccT*) of algorithmic systems in conversation with those in the CSCW community on practice-oriented computing, raising a number of open and pressing questions in need of further interrogation and scrutiny.

The rest of this note is laid out as follows. In Section 2, we provide an in-depth description of the "intelligent sales" concept, its key features, and case studies. In Section 3, we discuss two ethical themes surfaced through the intelligent sales case study. Then in Section 4, we conclude the paper.

Intelligent Sales

Sales is a complex business process that involves many different departments within an organization – for example, marketing, sales/account management, finance, procurement, delivery/fulfillment, and customer service, to name a few. These departments must coordinate efforts and information – towards shared goals of contracts being signed, revenue being realized, and services delivered. Sales organizations are driven by both a commercial logic (closing deals) and also a service ethic (serving customers) (Brokling 2014; McClaren 2000; Oakes 1992) and intelligent sales is seen as a way of meeting both demands together. Many leading IT service providers (e.g., SAP, SalesForce, IBM) offer software products and services to support sales organizations. Intelligent sales is a strategic concept and approach that envisions a "nextgen" sales experience transformed through the infusion of Big Data and AI capabilities to enhance, streamline, and make more efficient the various work processes of a sales organization (Sinha 2018).

We organize these into four key topics that feature prominently in management literature on the concept of intelligent sales. *Data fusion* is a technical antecedent for the intelligent sales concept – data must be pooled and integrated across sales departments before "downstream" processes may be data-infused. But data fusion reflects a desire to transform organizational life both infrastructurally (i.e., data practices) as well as epistemically (i.e., knowledge practices) by imagining new practices of knowledge generation and the surveillance of distributed, diverse organizational actions such pooled data might make possible. *Responsive customer care* and *automation* are both constitutive elements of the intelligent sales concept that focus on the work-practice level, imagining how the everyday work practices of salespeople might change, whether augmented with data (responsive customer care) or off-loaded onto machine agents (automation). *Streamlined delivery* also constitutes the intelligent sales concept – but instead imagines how it might change operations at an

organizational level, by standardizing and rationalizing various sales processes like pricing or fulfillment. We elaborate on each of these four topics below.

Data Fusion

Like all AI endeavors, data are the lifeblood of the intelligent sales concept. Given the complexity of sales organizations, with various departments involved along the lead-to-cash process, a key premise in intelligent sales is a unified and integrated data lake at the heart of the sales organization. This data lake provides a "single source of truth" about a customer – meaning that different departments can gain visibility into information about what is or has happened with the customer. As a first step (even before AI insights) this data integration is seen to enhance coordination and collaboration across departments. For example, Salesforce's documentation for *Einstein*, their intelligent sales solution, states the benefits of this type of data integration thusly: "All data are connected so all departments can work together seamlessly sharing data to help each other succeed" ("Artificial Intelligence Technology and Resources" n.d.).

This type of cross-functional coordination and collaboration is envisioned as enabling a wholistic or "global" views of lead-to-cash sub-processes, providing executive management with data-driven measurement on their return-on-investment (ROI) and efficacy. For example, according to Salesforce documentation, marketing efforts (such as emails or adverts sent to customers) can be "traced" through the sales pipeline, measuring if and how different tactics influence conversion (turning a prospect or lead into a paying customer): "Companies want to know if they sent emails to prospects and they're not coming to their web site, if those marketing efforts are having any impact," one executive shared in a business press article, "Now, if I can see the prospects are having meetings and exchanging emails with salespeople, I can see the impact of my marketing dollars." ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019) (p. 6).

Responsive Customer Care

A core value proposition for intelligent sales is its potential to enrich the customer relationship. One envisioned way for the predictive power of AI to transform sales work practices is creating more *pro-active* (rather than re-active) relationships with customers, as Sinha (2018) writes in a *Future of Customer Engagement and Experience* report. For example, in an article for the magazine *CIO*, Thomas (2019) describes AI that can analyze historical data to predict which customers might churn and why, alerting salespeople to accounts in need of additional care. Even before leads or prospects become customers, intelligent sales is imagined to provide insights, for example, in developing customer profiles, matching sales reps to prospects with similarities to their previous successful accounts (Thomas 2019). "To pursue an opportunity, salespeople

spend extensive time searching for customer information that is typically spread throughout a disparate system, and then go with their "gut feel" or personal network to pursue it," challenges seen as remedied by an AI solution with integrated data and predictive insights (Sinha 2018). Salespeople have to "make decisions on a daily, or even hourly, basis as to where to focus their time when it comes to closing deals to hit their monthly or quarterly quota," as Antonio (2018) writes in *Harvard Business Review*. In an intelligent sales ecosystem, the decision on where to focus can be made data-driven through the use of AI: "With AI, the algorithm can compile historical information about a client, along with social media postings and the salesperson's customer interaction history (e.g., emails sent, voicemails left, text messages sent, etc.) and rank the opportunities or leads in the pipeline according to their chances of closing successfully" (Antonio 2018).

Like many enterprise applications of AI, the intelligent sales concept emphasizes *augmenting* workers rather than replacing them, as Pettey (2018). writes in a *Gartner* report. An intelligent sales solution is seen as offering salespeople a broader and more robust picture of their customers – a data-driven portrait – supporting sales staff in their efforts to tweak tactical approaches (and the offerings they package) to customers' unique situations. Sales is not solely pecuniary work – sales organizations are driven by both a commercial logic (closing deals and realizing revenue), but also a service ethic (working with customers towards shared goals) (Brokling 2014; McClaren 2000; Oakes 1992). The enhancement of sales processes through the infusion of Big Data and AI are aimed as serving both of these logics – intelligent sales is seen as enriching customer experience in the sales process, as well as those in the sales organization. In a recent survey by *Harvard Business Review*, 82% of respondents at large companies believed AI "has the potential to make human work in sales and marketing more meaningful and valuable" ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019) (p.1).

In this vein, AI is seen as a much-needed innovation for the daily practices of salespeople, as they struggle to remain a customer's "trusted advisor" amid increasingly complex and multi-faceted market dynamics (Sinha 2018). For example, a Deloitte case study describes the use of AI in the sales organization of a food & beverage company ("Business Analytics and AI Case Studies" n.d.). The project used various Big Data sources and AI to transform a national-level sales strategy into a "hyper-localized" one, enabling sales teams to tailor their approaches for regional segments/markets and provide more customized offerings to customers that leveraged a "locally-focused, fact-based strategy" ("Business Analytics and AI Case Studies" n.d.).

Automation

Another key theme in the intelligent sales depictions is automation, often through the use of robotic process automation (RPA). A common application of RPA, as

described in *Harvard Business Review*, is in automatically generating the documentation that is required of salespeople after client contact and then entering it into customer relationship management (CRM) systems. Many CRM systems fail to flourish, with many salespeople seeing them as a "necessary evil," rather than a useful or insightful tool (Edinger 2018; "Why Do CRM Projects Fail" n.d.). A recent *Harvard Business Review* survey reported on two case studies which used RPA to address the problem of client contact documentation – one at Lyft Business, a unit of the ridesharing company focused on the enterprise market, and another at Gainsight, a software and services company ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019). The sales team at Lyft Business grew rapidly from 20 to 200 people across locations, which made it difficult to understand differences in productivity across accounts and reps ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019). By automatically collecting data on the sales teams' activities, the case study reported that the organization was able to run subsequent analyses and detect patterns driving productivity numbers. Sales reps were concerned with the heightened surveillance of their activities, worries reported to have "faded quickly when [the reps] realized…the data could help them make more sales" ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019) (p.3). Automating data collection, then, is seen as beneficial not only in that it frees salespeople up from tedious and repetitive tasks (e.g., creating CRM entries after every phone call or email from a client) but also in that it produces more data which can be analyzed to provide further insights into the sales process. This was a similar finding in the Gainsight case study, where automating client contact documentation via RPA was reported to have helped reveal trends in top closing accounts: "Gainsight learned, for example, that 94% of its top deals correlated with salespeople scheduling a meeting within the last two weeks before closing" ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019) (p. 3). Other example applications of automation in sales documentation practices include the automatic transcription and summarization of sales calls and providing real-time "to do" items for salespeople to follow up on, as discussed in a recent *Gartner* report (Panette 2019).

Automation is also seen as transforming client contact itself, for example using chatbot and other AI agents to follow up with prospects and leads, as discussed in recent *Harvard Business Review* and *MIT Technology Review* articles ("AI-powered software robots are getting into the sales business" 2018; Kannan and Bernoff 2019; Kardon 2019; Shaner 2018). Some have noted the ethical issues with automating business activities like this in publications such as *TechTarget*, *Strategic Finance*, and *Business Horizons* (Botelho 2017; Castelluccio 2019; Przegalinska et al. 2019). A recognition of these ethical concerns has led some companies to establish guidelines for the ethical use of chatbots. For example, IBM has issued a "code of ethics for chatbots" which establishes the rights of

customers to know they are interacting with a machine and not a human (Reddy 2017). Other issues include intellectual property (IP) and the ownership of information shared with a chatbot, as well as safeguarding privacy of personal data shared with a chatbot (Reddy 2017).

Streamlined Delivery

Streamlined delivery is another thread in intelligent sales rhetoric, which envisions the transformation of various dimensions of offering selection, pricing, contracting, and fulfillment. Through the use of AI, for example, strategic recommendations could be made on upsell opportunities and prices could be optimized for individual customer accounts (Antonio 2018). Furthermore, AI forecasting can help sales managers more effectively leverage and coach sales teams across open accounts ("Accelerating Sales and Marketing Efforts Through Artificial Intelligence" 2019; Antonio 2018). Text-generating AI can also be used to create contract drafts automatically (Lohr 2017; Rich 2018), while other forms of natural language processing (NLP) can help manage changes and discrepancies over the contract lifecycle (Gabbard 2019).

The online retailer Amazon has famously disrupted the eCommerce industry by using AI in every aspect of their business model, including order fulfillment and shipping (Karlinsky 2019; Terdiman 2018). But more traditional retailers also leverage AI to gain real-time predictions on inventory and shipping costs. For example, in a *IBM Blog* article, Geoffroy (2019) writes about an REI engagement with Watson that aimed to implement an AI-driven order management system to provide real-time store inventory data, as well as distribution center inventory data, to customers. Instead of losing sales due to out-of-stock inventory, the article states the AI system helped the company "see an increase of $100 million in sales the first year, in addition to a 27% lift in 'buy online, pickup in store' orders" (Geoffroy 2019). In business-to-business (B2B) settings, delivery and fulfillment are also tied closely with supply chain and logistics. As this note mentioned earlier, these two domains (sales/marketing, and supply chain/logistics) are seen as the most promising enterprise application areas for AI (Chui et al. 2018).

AI Ethics in Intelligent Sales

All workers encounter ethical dilemmas in their everyday work practice. The ethical dilemmas faced by salespeople can be unique, though, due to their role as "boundary-role performers," meaning their work practices maneuver between the sales organization and that organization's customers (Weeks and Nantel 1992). Navigating between various stakeholders (e.g., prospects, customers, competitors, managers, executives, order management, and delivery support etc) often creates a dynamic and high-adrenaline daily practice, which can lead to increased

workplace stress and tension, causing a heightened affective experience and perception of ethical dilemmas (Weeks and Nantel 1992). This ambivalent dynamism, along with the twinned logics of commerce and service that drive sales work, can create a fragmented experience for salespeople and the feeling of being pulled in many directions (Brokling 2014; McClaren 2000; Oakes 1992). Introducing emergent technologies (like Big Data and AI) into sales work, then, heightens an already intense – and ethically-laden – workplace experience.

The past few years have seen a rapid growth of communities of scholars investigating the fairness, accountability, and transparency (FAccT*) of AI systems. For example, a number of workshops have been held at leading AI conferences such as AAAI, NeurIPS, and ICML. The growth of these communities is motivated by a recognition that AI systems can and do have great societal power, which requires careful consideration on their sociotechnical considerations and repercussions. Concerns on the ethical, humane, and intuitive use of emergent technologies is of course not new to those in the social computing field. Indeed, the contemporary AI renaissance – and the ethical issues raised in its wake – provides a pressing opportunity for social computing researchers to work together with technical AI community to design just and human AI futures (Loi et al. 2019; Wolf et al. 2018).

The ethical questions around Big Data and AI are sociotechnical (boyd and Crawford 2012; Shin and Choi 2015). This means that what we have come to know as "Big Data" or "AI" is comprised of and steered by both technological and social actors, and importantly the entangled interplay amongst them (boyd and Crawford 2012). The datasets used to train AI models, the algorithms developed to organize them, the compute power and cloud computing that makes such data transformations possible, the interfaces that display model outputs – they cannot be understand or analyzed without also looking to the developers who clean data and write code, the subject-matter experts who label data and shape training sets, the project managers and executives who oversee applied AI projects and re-design business processes, the workers who touch AI outputs, and so on (Wolf 2020). The design of the overarching AI ecosystem – and in particular, the ways in which business processes are re-designed – are also ethical questions, of worthy scrutiny alongside those which are more technologically-focused (Martin 2019; Wolf and Blomberg 2019). How will an AI system be integrated into organizational practice and what roles and responsibilities will it re-configure? How will these changes re-design the nature and experience of work?

Next, we highlight two themes with ethical valence: invisible actors (training data) and explainability/literacy (use of AI outputs in everyday work practices). While we organize these into two themes to provide analytical traction, we recognize the concerns they surface are dynamic and fluid, overlapping in situated practice.

Invisible Actors – Training Data

Recent work in the FAccT* community has called attention to the important role that training data plays in the development of AI systems (Gebru et al. 2020; Holland et al. 2018; Mitchell et al. 2019). While theoretical research and algorithm development in the AI community typically uses standardized "off the shelf" datasets (such as MNIST[1] the dataset of hand-written digits, or LISA[2] photographs of road signs), in applied AI projects, real-world training sets derived from the domain setting are used (Wolf 2019a). There is considerable data engineering work (commonly called data pre-processing) that AI/ML developers and data scientists must undertake to ready real-world training sets, which are often messy, noisy, and incomplete (Wolf 2019b, 2019a).

As we have outlined above, there are many potential applications of AI to various dimensions of the overarching lead-to-cash sales process – from predictive pricing and offering recommendations, to automated recordkeeping, client interactions, and content creation. Across these various use cases, an important question to ask is: what data are these AI models trained on? Understanding a model's training set is important in not only assessing whether it encompasses a representative sample of the domain and actions of interest; it is also important in appropriately bounding subsequent outputs and any insights they might offer. AI models are statistical representations of their training set – thus the training set becomes the "universe" of information the model considers and accordingly acts upon.

Who and what is represented in the training sets that underly AI sales applications? Ethical concerns over training data are absent from current management discourses on intelligent sales. While others have pointed to ethical issues with Big Data use in marketing (particularly digital advertising (Kitchin 2014; Nunan and Di Domenico 2013; Pasquale 2015; Zwitter 2014)), the intelligent sales concept sees marketing blending with sales through cross-department data fusion, raising new questions around ethics and transparency that require careful scrutiny.

In B2B settings, whose behaviors and actions are captured and used to train AI models? Take a hypothetical scenario in the retail industry, where an IT services firm (the sales organization in this scenario) is selling a cognitive service to a clothing retailer that monitors social media activity (e.g., clothing worn in photos by people in particular market segments of interest, like women ages 20-27) and predicts regional fashion trends for that segment (insights useful to the retailer's warehousing and fulfillment). Such a scenario raises issues of consent and privacy around the initial data collection, of course; but it also raises concerns over

[1] http://yann.lecun.com/exdb/mnist/

[2] http://cvrr.ucsd.edu/LISA/lisa-traffic-sign-dataset.html

transparency in whose behaviors and actions are depicted in the training set (i.e., representativeness) and also whose subsequent behaviors and actions the trained model is used to predict (i.e., training/target alignment). Do the ethical stakes change if the industry is in the food/beverage sector? Pharmaceuticals? What about tobacco products?

Furthermore, who has visibility into these pieces of the AI pipeline and to whom are discussions of their ethical considerations owed? Many real-world applications of AI leverage pre-trained models, often accessed through "model marketplaces" made possible via application programming interfaces (APIs) ("AI Market Leaders Join Forces to Release ModzyTM, an AI Platform and Model Marketplace, Introducing Choice, Scale, and Security" 2019; "Democratizing Data Science in Your Organization" 2018; Pscheid 2018). This creates distance between model creation and model use, rendering important questions on what is made visible at different points in the AI pipeline and what becomes obscured. To what extent does a data science team picking up and bootstrapping off a pre-trained model know the origins and composition of the model's training set? To what extend can (and should) they be able to describe the model's underpinning to their subsequent users? As noted above, in creating their "chatbot code of ethics," IBM listed the right of customers to know they are interacting with a virtual agent (instead of a human being). How might such a right to visibility play out in scenarios where pre-trained models are used? Careful consideration is needed to more fully think-through the ethical questions raised in applied AI projects, such as intelligent sales.

Explainability/Literacy – Use of AI outputs in Everyday Work Practices

The ability for humans to make sense of and reason about algorithmic, AI actions – the "explainability" of AI – is an important topic of research that has flourished in recent years (Adadi and Berrada 2018; Guidotti et al. 2018). Explainability is a particular concern in AI systems which use black-box modelling techniques, like Deep Learning, that model data in extremely high dimensionality. This complexity makes it difficult to explain model actions in ways that humans can comprehend. This has led to a fast-growing area of technical research known as XAI (eXplainable AI). Despite significant technical progress in XAI, a gap exists between explainability of AI from an academic or research point of view and the types of explainability requirements that arise in real-world AI deployments and settings of end-use (Wolf 2019c). A number of concerns arise in business settings, where AI capabilities may be infused in one sub-process – deeply embedded within, and perhaps invisible to downstream actors in an overall workflow (as discussed above).

For example, consider the scenario where AI is embedded into a business decision-making point, a typical use case for enterprise AI. Interacting with the

AI output requires a certain level of technical literacy – the business user must be able to understand and assess the AI model's output in the context of the business decision at hand. Does this mean all workers must now have a basic understanding of AI in order to appropriately use cognitive services in their everyday work practices? A further consideration is the collaborative nature of many work practices. Is only one worker involved in the decision-making process? If others are involved, do they also interact with the AI output or must they rely on the "user" (the person who actually touches and interacts with the output)? What new forms of translation work are required on the part of the user to adequately convey the technical details of the AI system in others involved in the decision-making process?

Further questions around explainability and literacy also arise in relation to the sales-customer relationship. For example, does a saleperson need to be able to explain to the customer why the system has made a particular recommendation – whether it be the prediction of churn or a customized offering layout? Are sales staff to disclose the use of an AI system to a customer when presenting a bid? Does a customer have a "right to know," as we saw articulated in the chatbot code of ethics? What about in self-service situations, where the customers might be browsing a catalogue of offerings and experience directly AI-driven customization? Such questions remain ripe for ethical interrogation. Such considerations pose open questions around labor transformations in almost every imagined enterprise application of AI.

Another concern around the intelligibility of AI systems is the "freshness" or currency/relevancy of data streams. Related to the issue of training data (whose data are used in training sets and what activities are being modelled) are questions of when is training data collected and modelled. As AI systems are deployed into settings of end use, their deployment can influence the object of interest – similar to the adage "the simple fact of observation changes behavior," introducing an AI model into a situation also changes it. Questions of freshness – of the "old" data used to train the model, as well as the ongoing alignment between the model's predictive targets and the phenomena of interest, require careful attunement.

Further, downstream in an applied AI pipeline, where are input data being pulled from (i.e., the new pieces of data that will be run through the AI model to make some sort of prediction) and are such input streams current? In the sale context, questions of currency and relevancy can be particularly tricky given the cyclical nature of sales – in B2B settings, these cycles are driven often by procurement and budgetary concerns, and in consumer settings, they are often driven by things like seasons and holidays, as well as inflation and labor market conditions. How do these concerns factor into the ways in which input data are collected and predictions are subsequently made? How should they frame the potential insights such predictions might offer?

What makes the explainability and literacy of enterprise AI systems an ethical concern? As practice-oriented CSCW scholars, we are concerned with everyday practices – and the ways in which those practices are aligned, integrated, burdened, displaced, or replaced by technological systems. In our endeavors to understand and influence the entangled nature of practices and technologies, we are beckoned to interrogate the societal impacts of the systems we build and deploy. Workplace technologies can have a "dark side" that we must not ignore (Nauwerck and Cowen Forssell 2018). As Walsham (2012) provocatively asks: are we making a better world with ICTs? Applying this question to the topic of enterprise AI, we might ask ourselves: are we making a better workplace? Narratives around enterprise AI often emphasize time savings and the relief that machine action and automation might provide to workers from burdensome or boring tasks. But workplace stress and burnout are global problems in the contemporary experience of work (Carod-Artal and Vázquez-Cabrera 2013). "Do more with less" is often experienced as an oppressive imperative of organizational life, not simply a motivational aspiration. Does adding complex, statistically-driven AI systems into work processes (and the sensemaking practices it demands of workers) increase the risk of workplace stress or burnout? Is the re-skilling required to effectively work with AI systems adequately scaffolded and supported, through the organizational provisioning of appropriate training materials, as well as the time to actually study and learn them? The explainability and literacy of enterprise AI systems raises important questions on the nature and experience of everyday work, as well as its implications for workplace empowerment and well-being.

Conclusion

In this note, we have outlined an emergent management concept known as "intelligent sales," which sets out a vision of transforming sales processes through the use of Big Data and AI capabilities. We have surfaced a number of ethical issues that case of intelligent sales raises, particularly: invisible actors (training data) and explainability/literacy (use of AI outputs in everyday work practices).

These issues – and indeed, the broader ethical landscape of intelligent sales – requires further investigation and analysis. This note is intended as a starting place, provoking further attention within the CSCW community on the fairness, accountability, and transparency (FAT*) of algorithmic systems by raising a number emergent in AI applications in enterprise settings.

In addition to further research by social computing scholars and researchers, we also note the need for collaboration around these issues that is both social and technical. Given that intelligent sales is a strategic management vision for the future of organizations, the management community needs to be engaged in shaping conversations around the ethical (and unethical) uses of Big Data and AI

capabilities. Foundational research on ethical behavior in sales work more broadly has found efficacy in the posting clear ethical guidelines for sellers – that is, when an organization makes clear the ethical bounds for sellers, sellers found ethical dilemmas more manageable and less distressing, leading to increased ethical behavior (Weeks and Nantel 1992). While these insights draw on sales work generally (not specific to Big Data or AI) they are instructive in how we can shape the future of intelligent sales today – through clear guidance on the ethical use of such systems and the data-driven insights they might provide. In presenting the case of intelligent sales, and several ethical issues it raises, this note hopes to start a conversation within our community on how to work towards such a goal.

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