ISSN 2510-2591

Reports of the European Society for Socially Embedded Technologies

volume 1 issue 2
2017

Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers

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Impressum

The **'Reports of the European Society for Socially Embedded Technologies'** are an online report series of the European Society for Socially Embedded Technologies (EUSSET). They aim to contribute to current research discourses in the fields of 'Computer-Supported Cooperative Work', 'Human-Computer-Interaction' and 'Computers and Society'.

The 'Reports of the European Society for Socially Embedded Technologies' appear at least one time per year and are exclusively published in the Digital Library of EUSSET (https://dl.eusset.eu/). The main language of publication is English.

ISSN 2510-2591

https://www.eusset.eu/report-series/

EUSSET is an institute of Social Computing e.V., a non-profit association according to the German legal system – founded on November 13th 2012 in Bonn, Germany (Nordrhein-Westfalen Amtsgericht Bonn VR 9675).

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Lewkowicz, M., Sarcevic, A.(2017): Preface. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017-1

Exploratory Papers: A New Venue for ECSCW 2017

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For this 2017 edition of the ECSCW conference, we are excited to introduce the Exploratory Papers venue. The goal for this new conference genre was to attract focused studies, works-in-progress, critical literature reviews, early results, and provocative ideas that are not yet ready for a journal submission, but could benefit from presentation and discussion within the ECSCW community.

This inaugural year, we received 27 submissions from 14 countries, and accepted 16 papers. All submissions were reviewed by the ECSCW Program Committee members without the involvement of external reviewers. Reviewing was conducted in two rounds. During the first round, all committee members served exclusively as "reviewers". In the second round, one reviewer on each paper was assigned the "leading reviewer" role and asked to lead an online discussion of the paper, and write a meta-review based on the reviews and discussion. The goal of the discussion and meta-review was to generate a proposed accept or reject decision. As the venue chairs, we then considered all of the review scores and comments, and made final decisions. We hope that the selected papers will be both inspirational and provocative, inciting constructive discussions around topics such as workplace digitization, privacy and identity in

the IoT era, leading digital lives in the ever expanding online sharing domains, or designing in the “smart city” and “smart building” contexts.

Creating this program was a truly collaborative and international effort, and we would like to extend our thanks to many people who have helped along the way. First, thank you to Luigina Ciolfi and David Randall for inviting us to co-chair the Exploratory Papers venue. It was a great experience working with you as we were brainstorming and launching this new venue. We would also like to thank Charlotte Lee for her valuable input about the venue goals. The idea for having a venue like exploratory papers at ECSCW was initially discussed among the members of the ECSCW taskforce during the first EUSSET International Summer School on CSCW in Como, Italy, in 2015. The proposition was validated by the ECSCW Foundation and its organization proceeded under the auspices of EUSSET - European Society for Socially Embedded Technologies. Our last discussion with the late David Martin was about naming this venue. We hope he would have liked the results.

This volume would not be possible without contributions from all authors who have sent their work, as well as without Michael Koch, who put the EUSSET Digital Library in place. We also express our gratitude to the international program committee for helping us make the best possible decisions and providing constructive feedback to all authors

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The Roots of Bias on Uber

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Abstract. In the last decade, there has been a growth in, what we call, *digitally mediated workplaces*. A *digitally mediated workplace* is one where interactions between stakeholders are primarily managed by proprietary, algorithmically managed digital platform. The replacement of the relationships between the stakeholders by the platform is a key feature of these workplaces, and is a contributing factor to the decrease in contractual responsibilities each stakeholder has to one another. In this paper, we discuss some of the ways in which this structure and lack of accountability serves as a root of, or at least an enabler to, the realization of biases in the ridesharing application Uber, a digitally mediated workplace.

Introduction

Recently, the use of *digitally mediated workplaces* has grown both in the number of participants and in the number of domains covered. Digitally mediated workplaces are primarily defined by the common stakeholder structure that they rely on, which includes: a *platform owner*, who is responsible not only for defining and implementing the platform's functionality, but also the policies around the workplace that the platform instantiates or supplements; a *worker*, who uses the platform to find, claim, and obtain remuneration from labor; and a *client*, who uses the platform to procure and pay for labor. This structure is instantiated by a number of different platforms, for a number of different purposes, e.g.: Amazon Mechanical Turk (AMT), where the worker is part of the crowd and the client requests, often

small, tasks from the crowd; Fiverr, Upwork, or TaskRabbit, which are primarily aimed at freelancers to sell their services to clients; and Ola or Uber (the focus of this paper), where the worker is the driver and the client is the passenger.

The other defining feature of a digitally mediated workplace is that the – usually proprietary – platform (e.g. AMT, Fiverr, Ola, TaskRabbit, or Uber) replaces much of the relationship between the worker and the client, or the worker and employer. This has the effect to drastically alter, if not eradicate, the contractual responsibilities of each stakeholder to each other and to reduce the level of accountability all around. Aspects of this reduction of accountability have been discussed in regards to the algorithms that support the workplace in terms of algorithmic accountability (Lustig et al., 2016; Lee et al., 2015; Wagenknecht et al., 2016). However, the causes for the lack of accountability stretch beyond algorithmic mediation into the stakeholder structure and surrounding policies as well. In this paper, we explore a particular aspect of accountability in the workplace, protection from bias for both the worker and the client.

Research has already provided evidence that bias and discrimination are having a demonstrable impact on the participants of these platforms (Hannák et al., 2017; Edelman and Luca, 2014). However, this work has looked more at proving the existence of bias and less about how biased decisions are performed on or via these platforms. As we begin to investigate how we might design platforms that better support a more equitable and fair digitally mediated workplace, we first need to understand how bias is specifically occurring and what the roots of these practices might be on a specific platform. In this paper, we report on Uber, a ridesharing application where passengers obtain rides from independent drivers that use their own cars.

While Uber is not a wholly digital workplace, we argue that it is a digitally mediated one. That is, Uber provides an interesting case where there are face-to-face interactions between the driver and the passenger, these exchanges are arranged via the Uber app, and the consequences of the interactions are mediated by the app. In this way, Uber serves as an interesting and complex mixed-setting for a digitally mediated workplace, as consequences of the face-to-face interactions are both captured and propagated via the digital platform.

This is a particularly interesting setting to examine how bias functions in a digitally mediated workplace since the face-to-face interactions are arranged and the subsequent ratings of the interaction mediated solely through digital means. Meaning that, there is no human in the loop to take different factors into account or impart a level of flexibility or subjectivity to the process. As these ratings have a real impact on both the driver and passenger's ability to provide and procure services, this opens up an avenue for unfettered biased judgements that are propagated by the platform (Mcgregor et al.). To best illustrate our point, we provide this speculative comparison. In an existing, more traditional taxi service, if a passenger would like to make a biased complaint they must call a supervisor, or at

the very least a representative of the taxi service. During this call, there is a likelihood that the supervisor may uncover or detect the bias due to the existing relationship between the supervisor and the driver, in addition to the supervisor's judgement as to the validity and veracity of the complaint. So, there is at least some level of human mediation when fielding complaints. Contrast this to a biased complaint on Uber, where the only signal of the complaint is a rating, which is stripped of all the nuance and reasoning behind the decision. This biased judgement is then propagated by the system, as that biased rating is used by the system and its users to determine which driver to select for a ride.

In this paper, we draw from a similar method used by Martin et al. (2014), where we examine what discussions Uber drivers are having regarding bias online. We argue, similarly to Martin et al. (2014), that Uber, like Amazon Mechanical Turk, is a digitally mediated workplace and that online forums are a place where the *shop talk* happens. When we set out to study these forums, we were interested in the social dynamics – as perceived by the drivers – that revolved around driver/passenger interactions. When we encountered posts by drivers discussing bias, it quickly became a topic of interest based on both the data and previous literature (Rosenblat et al., 2016; Nardi, 2015; Rogers, 2015; Mcgregor et al.; Raval and Dourish, 2016; Glöss et al., 2016). While we were not surprised to find that drivers discussed biases directed at them, we were surprised that they also discussed the types of biases that they had developed while driving for Uber. In this paper, we report some of our preliminary findings on how biases bear out both *by and towards* drivers on Uber and the role of the platform. In this way, we begin to look at how the same phenomena that led to protections for workers and customers in traditional workplaces are reoccurring in digitally mediated ones. The first step in dealing with bias in a computer system is to analyze its practice (Friedman, 1996), therefore our analysis of the practice of bias is the first step towards designing more equitable and fair digitally mediated workplaces. This topic is of particular importance to Computer Supported Cooperative Work (CSCW), as the 'Computer Supported' part of CSCW becomes even more consequential to the supported work, when the work is primarily instantiated and mediated by a digital platform.

Related Work

In this section, we review research into digital mediation of work and how biases may be enacted in a digitally mediated workplace.

Peer-to-peer platforms and technological mediation

Beyond the more traditional CSCW tools that mediate work, e.g. email (Hinds and Kiesler, 1995), instant messaging (Isaacs et al., 2002), or social network sites (DiMicco et al., 2008), peer-to-peer (P2P) platforms such as Uber, Lyft, or Ola are

digitally mediated workplaces where workers manage their tasks and negotiate transactions with their clients both online and offline. While on some platforms the task may be completed offline, such as driving the passenger to a destination and potentially engaging in social interactions with each other along the way (Raval and Dourish, 2016; Glöss et al., 2016), many practices are structured by technological features and computational algorithms of the platforms. For example, automated dispatch systems use genetic or optimization algorithms and devices with built-in GPS to match drivers with passengers in real time based on geo-locations (Karande and Bogiri, 2015; Rawley and Simcoe, 2013). Fares and payment rates are set based on locations, times of the day (e.g., higher in rush hours), and the services requested (e.g., single ride or shared ride). In addition to real-time data, Uber assigns work to drivers and allows passengers to request services based on the historical data, namely the rating system on the platform (Ahmed et al., 2016).

Much previous work has investigated issues revolved around such computing systems and algorithms, and their influences on users. Automated dispatch systems may deploy drivers to move outside their familiar geographic areas (Hsiao et al., 2008). While this allows drivers to acquire information about some potential hotspots, it also demands drivers to develop temporal and spatial knowledge. Devices with GPS systems shape drivers' wayfinding and navigation skills and potentially change the social dynamics of the riding processes between drivers and passengers (Girardin and Blat, 2010; Hsiao et al., 2008). With their influences on practices and work revolved around the P2P platforms, the most prominent issue with these algorithms and systems is the lack of transparency to users (Lustig et al., 2016). Despite the invisibility and inaccessibility, users still have to make sense of how to interact with the systems in order to manage their work (Lee et al., 2015), rely on the digital infrastructure to quantify their work and develop their accountability using the rating system (Scott and Orlikowski, 2012), or deal with potential offline consequences like the uncertainty of finding next customer by taking request from the dispatch system (Ahmed et al. 2016). The lack of algorithmic transparency contributes to the large amount of emotional labor these workers must undertake to maintain their standing, this is a particularly problematic aspect of the nature of the rating systems for these platforms, particularly for Uber (Glöss et al., 2016; Raval and Dourish, 2016).

Algorithms and the computer systems that use them are designed to collect data to facilitate coordination or even prediction of human work, and are of course valued for their instrumental functions. Given these identified issues, computing systems and algorithms may not be posed as neutral and objective as they may seem (Kneese et al., 2014; Friedman, 1996). It is possible that the digital infrastructure imposes and renders biases, intentionally or unintentionally, against users (Wagenknecht et al., 2016).

In this study, we complement prior work by exploring and identifying how biases play out on the Uber platform. We examine the role of the platform and

expand previous frameworks on biases in computer systems (Friedman, 1996). We draw from the accounts of biases provided by drivers in their discussions with other drivers, using Uber as our target platform, in an attempt to begin to flesh out and draw a picture around this issue, from at least one stakeholder's perspective.

Biases in digital workplaces and computer systems

Drawing from Friedman (1996), we define bias as having a moral import that can be drawn from, and that for a system to exhibit bias it has to "systematically and unfairly discriminate against certain individuals or groups of individuals in favor of others" (Friedman, 1996, pg.332). Friedman (1996) outlined three types of bias that occur in computer systems, which are, *preexisting*, *technical* and *emergent*. More generally, biases usually refer to stereotypical generalizations based on sociodemographic or physical characteristics about certain groups that are assigned to the individual group members. Previous research reported gender biases (Heilman, 2012), ageism (Rupp et al., 2006), racial biases (Rosette et al., 2008), or weight bias (Rudolph et al., 2009) at traditional workplaces. These biases are associated with inequality in employment decisions, career advancement, performance expectation, workload, overall evaluations, etc.

While these biases are prevalent in physical workplace because the characteristics and attributions are visible and obvious to elicit implicit or explicit biases, they do not disappear even if the work is digitally mediated. Research has also reported that biases are similarly taking place on technological platforms. For example, workers on TaskRabbit used geolocations to evaluate whether to accept a task and were found to avoid distant and less well-to-do areas (Thebault-Spieker et al., 2015). On the other hand, clients may also choose workers from these P2P platforms based on their gender and race no matter if the tasks are completed in physical or virtual contexts (Hannák et al., 2017). Workers have to have adequate equipment like bank accounts, smartphone with built-in GPS or a fancy car in the case of Uber Black, to be able to provide services (Kasera et al., 2016).

Compounding these biases rendered by socio-demographical and physical factors, we argue that on the digitally mediated workplace, these biases could potentially be reinforced and propagated by the digital infrastructure.

The rating system on Uber represents a record of drivers' work performance and is used to evaluate their eligibility to receive service requests. However, there is no clear metric, such as driving skills, safety concerns, or decision-making strategies about picking up routes, as to how the performance is evaluated. Instead, drivers may have to engage in "emotional labor," in which they need to quickly build "micro-relationships" that make passengers feel good so as to get good ratings (Nardi, 2015; Rogers, 2015; Mcgregor et al.; Raval and Dourish, 2016; Rosenblat et al., 2016). Such emotional labor is easily influenced by random factors and the efficacy and accuracy of the rating system may benefit from a more holistic evaluation (Lee et al., 2015).

In addition, while racial and gender biases are suggested to be mitigated through Uber's matching algorithm, Mcgregor et al. (2017) pointed out that the algorithm actually denies users ability to choose their desirable drivers or passengers and therefore deepens the negative effect of expected homophily for both drivers and passengers. Instead, the consequence may be a lowered rating as opposed to avoidance. On the Uber platform, drivers usually have to respond to requests within 15 seconds without knowing the destination and expected fare in order to avoid deactivation from the platform. Uber drivers often do not have sufficient time for decision-making (Rosenblat and Stark, 2016) and have to deal with offline consequences reinforced by the platforms (Ahmed et al., 2016).

In our study, we explore several different occurrences of biased practices and judgements that are either enabled by the digital infrastructure or rooted in an aspect of it.

Method

In investigating if and how Uber drivers discuss bias in the workplace, we borrowed heavily from the approach taken by Martin et al. (2014) in their study of Turkers' issues and concerns. We focused on the most popular forum for Uber drivers, UberPeople[1], a forum run by drivers for drivers. The primary way that we differ from Martin et al. (2014), is that, in this paper, we discuss a specific topic and do not report *all* of the topics that emerged from our study. We found that bias, while not always explicitly discussed, was a recurring theme and an important and influential topic; in fact, forum members clearly saw bias as related to the most popular topics in the forum. Among the most discussed topics such as transparency, algorithmic management, earnings and expenses, etc., bias happened along with, and as a result of these topics. Therefore, in order to understand the broader topics and concerns of drivers, it is critical to understand how bias plays into these different functionalities. We took an exploratory approach to our investigation around bias in the workplace, looking at all forms and instances, e.g. not just biases on the part of passengers, but also biases expressed by the drivers on the forums. Forum members were not aware that our study was being undertaken, we believe there are no ethical implications as these posts are made in a public place and no special privilege or access is needed to read this content. Our study was deemed exempt by our Institutional Review Board, as the forum was publicly available and open in nature.

The current users of UberPeople are from major cities around the world with most of active members located within the U.S. The forum is divided into 22 different sections, and the sections that we primarily draw from are: *Advice*, *Stories*, *People*, and *Complaints*. The *Advice* section is the most active section,

[1] https://uberpeople.net

closely followed by the *Complaint* section, the other sections *Stories* and *People*, have significantly less activity. While we read all of the sections systematically, the primary source of the content in this paper are from the *Complaints* section.

For two months, we have been collecting content from the forum and gathering threads posted between January 2015 - February 2017. In selecting these threads, the authors of this paper read over various posts and discussed which threads involved discussions of bias. The threads that we draw from in this paper were selected because they represent a range of practices and scenarios in which biases occur in the workplace. For each of these threads, we analyzed every post in the thread (even though the majority of posts in a thread are quite terse) as a group and performed a thematic analysis. In some of these threads, the context of the thread was the topic of bias, but for the majority, the discussion of bias followed as an explanatory feature of the phenomenon being discussed (primarily either the rating system, the assignment of riders, or emergent practices).

To gauge how broadly felt the content of the different posts were, we looked at the responses of the community. For instance, if a user wrote a post making an uncommon, potentially outrageous claim, then the community would respond in kind. That said, expressing outrage at a claim of bias is not uncommon and was not necessarily an exclusion criteria. However, if the community is supportive and is in agreement this is a strong sign that a belief or experience is generally accepted by the community. For any threads that contains a mix of opinions on the part of the forum users, we situate the quote within the context of the discussion. All the selected posts and threads are categorized as being rooted in either a lack of transparency or lack of recourse. While presenting the different themes that emerged we make note of whether or not these are biases impacting drivers or passengers.

The categorization that we present in our findings is a result of our thematic analysis of the exemplars of bias on the Uber platform. For each quotation, we have anonymized the user, and each user is labeled with an F and a unique number.

Findings

In our reading of the UberPeople forum, a number of themes emerged from our analysis of the discussion of biases on Uber: some biases seemed to be built into the platform itself, mapping to a *technical* bias (Friedman, 1996, pg.334); other preexisting personal biases were enabled or amplified by the platform; and some biases were in response to aspects of system use. That is, there are some biases that are seen as inherent in the design of the Uber marketplace and tool. Meaning that, there are other biases that are propagated or supported by the system unwittingly, as they clearly preexist and originate from one of the stakeholders and are clearly directed at another specific stakeholder. The platform as a vehicle for biases goes somewhat beyond the initial framework of Friedman (1996), which focused more

on biases manifested in the *design* of the system and less in the usage. Somewhat surprisingly to us, we encountered a diverse set of biases in the forum, that is, while we expected to – and did – see biases that impacted the drivers (who after all were the primary users of the forum), we also saw discussions about biases aimed towards passengers by both the drivers and the platform structure. During our analysis, we saw two main roots to the perception or practice of biases: the lack of transparency in the system's policies and algorithms, which manifested mostly in the rating system; and the lack of recourse: there was no clear way to take recourse against what drivers saw as biased judgements, so they developed strategies, which contained biases.

Biases Rooted in a Lack of Transparency

One of the frustrations that drivers had with Uber's rating system is that it is not transparent with respect to passengers' ratings, specifically regarding what the complaint was and who made it. Drivers especially concerned when they had received low ratings. In a thread where drivers discuss their low ratings.

> *The reason why we need to know who rated to be able to fix any issue ... This system will make riders more accountable before they ruin someones life. - F1*

At times, this lack of transparency led drivers down a path of suspicion. As reported in previous work (Raval and Dourish, 2016; Glöss et al., 2016), it is hard for the drivers to know what exactly they did to deserve a poor rating and they began to speculate about a variety of reasons. When drivers belong to a minority and are receiving low ratings for reasons that are unknown to them, they begin to speculate – with ample reasons at times – that it is related to a particular bias on account of the passenger.

Biases at Play in Ratings

Drivers are clearly aware of the possibility for biased ratings, as well as the inability to know whether or not bias has influenced their ratings. Particularly, drivers that belong to a minority are concerned that the biases of their passengers may be impacting their rating. That said, all drivers speculated that this might be a problem. One new driver, who belonged to a minority, believed that they were suffering from biased ratings, which was particularly problematic as they just started and were in danger of being deactivated.

> *This is my 4th day driving. My rating now stands at 4.64... I just can't figure out why my rating are borderline deactivation level. This is crazy. I'm curious, especially to hear from other young(ish) black male drivers if they are constantly on the*

> *borderline as well. I hate even having to bring up this topic, but honestly I don't know what else I could even be doing to bring my rating up. - F2*

This particular driver was trying to figure out ways to raise the score before s/he got deactivated, and asked other drivers how they brought their ratings up. Responding to this driver's post, someone agreed with the speculation of bias.

> *If I were black and got deactivated I'd be screaming from the hilltops about racism. It's probably THE best argument against the rating system there is... Ageism is absolutely a factor too. But if you are an older black male I would say it's worse... But the bottom line is the ratings are unfairly applied. It probably depends on the area and the demographics of the customer base as to HOW they are unfairly applied. But anyone who thinks race isn't a factor (and ageism and sexism) in any system is deluded. - F3*

Conversations around biases, particularly racism, seem to become contentious fairly quickly on the forum (similar to other venues). When the issue is specifically called out by a user, passionate voices fall on both sides of the issue. Along the same conversation of the minority driver, some minimize and deride the claims of bias:

> *Every bad thing in your life that happens to you is racially motivated. "The man" is out to get you. - F4*

Others provide support and counter other members to defend the original poster:

> *You can talk all the sh!t you like, I am a black man in America, I see, hear and experience racism on a weekly basis. - F5*

Clearly, racial bias is an issue on which the community has very different opinions. However, racial bias was not the only type of bias that concerned drivers. There were other biases related to English fluency that one driver claimed to have noticed.

> *I've noticed a number of posts by poor-English speakers about bad ratings. That's probably one of the most difficult biases to overcome. - F6*

One user hypothesized that all manner of biases are probably at play in the rating system.

> *Of course the crowd-sourced rating system is racist. Probably sexist and ageist too. Ugly people get lower ratings than attractive people too. - F7*

It seems clear that the lack of transparency behind the reasoning for passengers' ratings is opening the door to biased ratings that are unfettered by the system. At the very least, this lack of accountability, mostly due to the anonymity of the ratings/complaints, in the ratings system is leading to a lot of suspicion.

Assignments of Passengers

The general lack of transparency in many of Uber's functionalities caused drivers to be suspicious that the algorithms by which passengers were assigned to them included hidden biases. Drivers speculated that Uber assigns certain types of passengers or passengers from certain types of areas to certain types of drivers:

> *I think as much as possible Uber tries to send us black drivers into the "hood".... To pick up black passengers.... This morning I was at the air port the 3rd one to go out....when I get a ping...I look at my phone, and see the pax is 25 min away and has a very ethnic specific name - F10*

Although this was met with skepticism from other drivers, one of the most prevalent strategies that other drivers provided as a solution was for the driver to be more selective about what types of neighborhoods or distances that they traveled for their passengers. Meaning that one of the most suggested strategies to deal with the biases, is to enact them proactively.

Strategies in Response to Perceived Bias

While there is evidence on the forums that drivers at least perceive that they are impacted by the biases of passengers, there is also clear evidence of the various strategies that drivers had developed in response. In fact, the biases that we saw on the part of the drivers were surprisingly rooted in practices that drivers had enacted as a strategic response to the perception of passenger biases.

Ignore and Accept

One of the more innocuous strategies, at least with regards to how it impacted the passengers, was to just tolerate the bias as a part of doing business. They advised not to worry about it as cases of bias are absorbed by the majority of good, decent passengers and as time when on these incidents had less and less impact on their overall rating.

> *Seriously, do not worry about your rating this early in the game. I get the exact same BS feedback you got at 4.92 ratings after 500 plus rides. - F11*

However, to simply tolerate this intolerance is anathema to the zero-tolerance policy to which Uber subscribes[2], and certainly is not part of the type of equitable workplace that we should expect. That is, it is not an innocuous strategy in regards to the drivers.

Retaliation and Protest

In one case, a driver had become frustrated with receiving poor ratings for inscrutable reasons, so they decided to take a protest action. Whenever they received a poor rating, they gave each and every passenger they gave a ride to that day a poor rating.

> *Ok. So since Uber doesnt let us know who give us a bad rating and leave us guessing. I decided to punish all riders of the day if my rating goes down .01 point. ... I think we have the right to know who rate us bad and the reason. Otherwise i will use this method. I know it wont matter. But when the rider check their ratings they will see how it dipped down too. - F1*

In another thread discussing the effect of biased ratings on the drivers, the conversation turned towards speculation about 'certain areas' and 'stupid biases' being the source of poor ratings. In this case, the reaction to the discussion of biases was to conjure additional biases where the driver themselves implement biased practices. One user had taken a similarly oppositional practice of awarding high ratings only to exceptional passengers and to just accept that 'certain areas' are problematic.

> *Im done worrying about riders so much. If you work around certain areas. Youll realize your rating drops even if you keep the cleanest car and is the best driver. Now the pax needs to amuse me to get over 4 stars. Stupid Biases and complexes really get in the way. - F14*

Avoidance of Demographic Groups

The instances of driver bias towards passengers mostly happened in how the drivers tried to avoid certain areas or types of passengers. One example, is a driver who, after a bad experience with passengers from the Black Entertainment Television awards, experienced a dip in their rating and came to this conclusion:

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[2] https://www.uber.com/legal/policies/zero-tolerance-policy/en/

> *I'm not ignorant of the racial tensions in this country right now. I'm sure there's some real animosity. I think there's something about Rap too that brings out the hate. Now when I see a group of black guys I'm automatically going to just hit cancel. I hate saying that too because I love my black friends but what are you going to do. - F9*

In this same thread, other drivers provided numerous counter examples where they had positive experiences with African American passengers. Clearly, there is the potential for drivers' biases to impact passengers' ability to procure a ride.

A different driver had another set of much more blatantly racist complaints about a different group of riders, framing them as others that even inhabit a different world of sorts.

> *1 They do not know this is a ride-sharing. They treat you like a low-educated, no-skill cab driver. 2 They intentionally make you wait for up to 5 minutes 3 They ask you drive up to the front door even they live in an apartment complex...4 Most of them have very strong body odors... 5 Most of their rides are a $4 trip including pick up from or go to the Indian grocery store or Indian restaurant...7 They never tip...8 They gave you wrong directions and blame you taking the longest route from point A to B. 9 They give you lower rating too. In their world, a 5star is impossible and never exists. - F8*

The avoidance strategies made available by Uber's cancellation functionality – which lets drivers cancel rides and suffer few, if any, consequences – were sometimes used by 'experienced' drivers to avoid passengers and areas. These strategies do have a negative impact on the passengers, which can be seen in one of the rare instances of a passenger posting to the forum.

> *This guy wasted my time (which apparently was very precious in that span), didn't answer my calls, THEN had the nerve to charge me a cancellation fee! Isn't there some way to rate this guy as unprofessional? I have his ID number. - F12*

This passenger was canceled by the driver on a day with severe weather. Due to the app system design, the passenger was charged a fee while his/her trip was canceled. This shows that there is at least a reciprocal avenue through which passengers can also be impacted by drivers' biases.

Discussion

Friedman (1996) outlined a framework for analyzing bias in computer systems and stressed that freedom from bias should be among the criteria by which computer systems are judged as effective and appropriate by society. In their framework, the major categories were *preexisting*, *technical*, and *emergent*. In this work Friedman (1996) looked primarily at how biases impact the *design* of a system. One example of this outlook is *preexisting* bias, which is divided into two subcategories (Friedman, 1996, pg.334): *Individual*, which are biases that impact an individual system designer; and *Societal*, where larger, more cultural biases impact the system design. However, an additional aspect of bias that must be taken into account, is how a computer system can be an instrument of vehicle of bias. While this is related to Friedman's (1996) concept of the formalization of human constructs (Friedman, 1996, pg.334), we feel that it must be more explicitly dealt with when our systems are increasingly more *socio-technical*.

Rosenblat et al. (2016) used the Uber rating system as an example of a system that can be a "vehicle for bias." In our analysis, Uber drivers are also concerned about the possibility of their ratings being impacted by passenger biases. What surprised us, is that when we set out to more explicitly look at driver discussions around bias, we expected the drivers to be discussing the impacts of biases on themselves. What we did not expect, was the candor with which the drivers discussed their own biases (primarily as a response to perceived passenger bias) and how these biases impacted passengers. One forum member felt that the various avoidance strategies that drivers used were being reinforced by the various pricing strategies that Uber employs.

> *Uber has brought back redlining[3] with its boost incentives. It is subsidizing the rides of the well off, mostly white riders on the west side and leaving minorities and lower income residents in Central LA and South LA with fewer drivers. Uber, ..., are the ones responsible for ride share redlining ... - F13*

Not only do we see the importance of providing freedom from biased interactions for all stakeholders in a system, we also see that these biased interactions serve as the root of further biased interactions. Clearly, we must design socio-technical systems plainly considering how they might be used as a vehicle and proliferator of biases. Not to do so validates and expands our existing biases.

[3] Redlining is a practice that originates in more traditional taxi companies, where the companies refused fares from low-income communities. This practice of taxi companies was dealt with via legislation, but now seems to be reemerging on Uber.

Transparency

To us, it seemed clear that the main root of biases in the Uber app was a lack of transparency in how the system functioned. This is true in two regards: First, a general lack of accountability is a direct effect of a lack of transparency, which frees individuals to express their existing biases. Second, the lack of transparency also breeds suspicion, which breeds additional biases or at least is a method for reinforcing existing biases.

Rosenblat et al. (2016) discussed how rating systems can serve as vehicle of bias, we contend that a key contributor to biased ratings is a lack of accountability caused by the lack of transparency. When biases are more apparent and obvious, the public is able to apply pressure to companies and cause them to take action. Such was the case when a Raleigh, NC same-sex couple was kicked out of an Uber driver's car, their story was covered in the media and discussed later in the forum with mixed voices. Subsequently, Uber released a statement condemning the interaction and blocked the driver from giving future rides on Uber. However, the small instances of bias that we have seen evidence of, be it by either drivers or passengers, are much more difficult to trace and take action on.

These circumstances lead some drivers down – sometimes perhaps further down – the path of bias. At times, some drivers' reaction is to exercise their own biases, sometimes perhaps they are not quite aware of what they are doing. This is perhaps a predictable reaction to a system that is both high-stakes, in that drivers' access to the market will be shutdown if their rating drops below the acceptable rate, and obscure, in that drivers have little knowledge about how rides are distributed and why or even when they were given poor ratings.

Design Implications

There are two preliminary design implications that come from our findings. First, we argue for a higher degree of transparency behind user ratings of each other. Perhaps, protecting the various stakeholders from awkward situations by depersonalizing interactions through digital mediation is not the right way to go. There almost seems to be an inclination to bring the anonymity of the online world to our face-to-face interactions. Maybe, uncomfortable situations can serve a regulating purpose in socio-technical system. Perhaps, if drivers/passengers would like to give one another a poor rating or deny them a ride, this should be visible on the platform. Giving individuals protection from the consequences of their actions may not lead to more responsible behaviors.

On the more proactive side, there is a possibility that rating systems (like the one Uber users) can better leverage the various data that they are gathering about ratings and interactions. For instance, Uber can keep track of each passenger's reactions to different demographics and use this information to reduce the weight of that person's ratings if s/he shows systemic bias. Additionally, the passengers could

be confronted with this perceived bias, as it may be implicit and not realized, so that they can act to remedy their own bias or at least know that 'someone' has noticed. If the biased interactions continue, more formal action can be taken by the platform, such as denying access.

Limitations

Our preliminary study has obviously limitations in the length of time that we have been collecting data and the breadth of data that we have included. That said, we feel that we have several concrete examples of a phenomenon that is rarely discussed, which map to the bias that other researchers have reported on these platforms. We have also begun to identify some of the strategies that drivers have taken in response to perceived bias.

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Nouwen, M., JafariNaimi, N., Zaman, B. (2017): Parental controls: reimagining technologies for parent-child interaction. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017- 28

Parental controls: reimagining technologies for parent-child interaction

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Abstract. This article questions existing approaches in designing parental controls and puts forward a hypothesis to reimagine technologies to mediate parent-child interactions. First, we present an overview of the current parental controls. Second, we explain the gradual shift away from the idea of 'harmful' digital media in parental mediation studies and introduce previous work in CSCW and HCI that has proposed solutions to support discussions about digital media between parents and children. Then, we hypothesize that an emphasis on collaboration and mutual learning might help researchers and designers to rethink and reimagine technologies that support parent-child interactions with and through digital media. Finally, we share our findings of two co-creation workshops with children and parents on ways to instill parental involvement in children's digital media use. The workshop yielded insights on the differing views between parents and children about how technologies might instill long-term negotiations based on parents' and children's experiences, enriched by real-use data.

Introduction

Parental concerns regarding children's use of digital media devices and applications at home have gained considerable attention in academic research and popular discourse. Parents and children report on conflicts that arise at home with regards to establishing and negotiating rules as well as adhering to them (Ko, Choi, Yang, Lee, & Lee, 2015). These conflicts are particularly pronounced when both parties lack a shared understanding or experience of the devices (Clark, 2011). It is common for parents to express a lack of control and a sense of

uncertainty over their children's information consumption, content production and social lives (Blackwell, Gardiner, & Schoenebeck, 2016). In the context of such uncertainty, parental controls can serve as a handle for parents to achieve a sense of control by keeping an eye on their children's online activities. However, the short and long-term effects of these controls on family relationships and dynamics remains an under researched area. In this paper, we situate parental controls at the intersection of CSCW and HCI research and media studies (particularly parental mediation theories). Within both research lines, the role of parents in children's digital media use varies and can be placed along two extremes on a spectrum: from the *parent as responsible actor in keeping children safe online* to a *role as a guide in children's self-exploration of online opportunities*. Commercially available parental controls mainly focus on the former and their current uses fail to support families in managing digital media at home in a satisfactory way. In this paper, we hypothesize that an emphasis on collaboration and mutual learning might help researchers and designers to rethink and reimagine technologies that support parent-child interactions with and through digital media. To this end, we share our findings of two co-creation workshops with children and parents on ways to instill parental involvement in children's digital media use. Building on these findings, we zoom in on the consequences the current parental controls afford and 'test' what possibilities our hypothesis affords.

Background

Do parental controls keep children "safe" online?

Today's young generation is said to be the most watched-over. Parents monitor every aspect of their children's behavior (Howe & Strauss, 2000), including children's online activities. Technological advancements facilitate parental monitoring for their children's "own good" (Herring, 2008), online safety and protection. The technologies used to monitor and/or limit children's access and time online are usually referred to as 'parental controls' and can be set-up on smartphones, tablets, laptops, desktop PCs and game consoles, either by installing external software or by using built-in functionalities provided by hardware manufacturers. In our past research, we have identified four key functionalities afforded by parental controls (Zaman & Nouwen, 2016):

- Time restrictions: parents can define time slots in which children can go online (un)supervised;
- Content restrictions: parents can define what type of content the child cannot see or search online, or parents can block the type of information that can be uploaded or shared;

- Activity restrictions: parents can restrict economic activities (like in-app purchases), social activities (like approving friends children can interact with online), entertainment activities (like blocking multiplayer games);
- Monitoring and tracking: parents are provided with an overview of their children's online activities.

One might think that by installing parental controls, children are kept from harm. However, there is no evidence regarding the effectiveness of these controls (Dürager & Livingstone, 2012) for keeping children safe online. While parents commonly check their children's browsing history, social media accounts and phones, they mainly do this without using parental controls (Pew Research Center, 2016). Also, there is no consensus on the characteristics of parents who use parental controls (see Mitchell, Finkelhor, & Wolak, 2005; Nikken & Jansz, 2014; Pew Research Center, 2016). Moreover, children often show discontent when their parents use these types of apps (Ko et al., 2015) and often find ways to circumvent or uninstall parental controls (Richardson, Resnick, Hansen, Derry, & Rideout, 2002).

The mere existence of parental controls affirms concerned parents' view of the Internet as an unsafe and unprotected place. The functions parental controls promote predominantly center around (covertly) surveying children's activities online or limiting their access or choices; both of which can lead to conflicts between children and their parents. Existing research on parental controls does not provide a conclusive account on whether their use is a sensible choice for parents. Considering these issues, we raise two questions. Should parental controls be introduced if their role in keeping children safe is largely unknown and their use is a potential source of conflict between parents and children? If not, how can we approach technical interventions that support parents and children in creating a satisfactory media environment at home?

Parents' role in risk mitigation

Parents often feel responsible in helping their children navigate digital media, including digital devices and online applications, despite their unfamiliarity with the technology uses of their children (Wisniewski, Jia, Xu, Rosson, & Carroll, 2015). The strategies parents employ are constitutive for the research produced in parental mediation research, a focus of scholars in media studies since the 1960s. In our past work, we have distinguished five types of parental mediation (Zaman, Nouwen, Vanattenhoven, Deferrerre, & Van Looy, 2016):

1. *Restrictive mediation*: parents impose restrictions with regards to how much time children spend with digital media, the activities children engage in, the content children consume, and where children can use digital media;
2. *Co-use*: parents and children use digital media together. Parents join children when they need help or because they enjoy sharing the activities the children engage in;

3. *Active mediation*: parents and children talk about digital media such as time spent using digital media, use of devices, or the content children consume and/or purchases;
4. *Participatory learning*: parents and children learn about digital media together while using digital media;
5. *Distant mediation*: parents supervise their children's digital media use from a distance. Parents employ this strategy either because they trust their child and thus grant them a degree of responsibility when using digital media (i.e., deference); or, when they decide they can allow their child to use digital media independently while keeping an eye on them from a distance (i.e., supervision).

In the past, research on parental mediation has been predominantly concerned with mitigating negative effects that media (like television, games, the Internet) might have on children. Similarly, many parents are concerned with the safety of their children in the online, digital world (Livingstone, 2009). These concerns include cyberbullying, exposure to inappropriate content, antisocial behavior and excessive use, which might be harmful for the child's development. Previous research indicated that monitoring – i.e., checking the child's online activities after use covertly or overtly (Livingstone & Helsper, 2008), active mediation as well as imposing restrictions are all effective strategies to reduce harmful online experience in children (Mascheroni, Murru, Arestodemou, & Laouris, 2013; Shmueli & Blecher-Prigat, 2011). However, more recently, parental mediation scholars found there are tradeoffs to be made when adults intervene to protect their children from the risks associated with the digital world. It is increasingly acknowledged that too much emphasis has been placed on children's protection at the expense of children's participation and the provision of their needs in the digital, online world (Livingstone, 2014).

Towards an alternative approach: technologies in support of parent-child interaction

Parental interventions that mainly focus on mitigating online risks overlook the possibilities of exploring and learning about and through media by children, which has been termed as 'online opportunities' in Europe (Hasebrink, Livingstone, Haddon, & Ólafsson, 2009). Indeed, even the perceived risks can be repositioned as learning experiences for children to raise awareness of and gain confidence to overcome future harmful situations (Vandoninck & d' Haenens, 2014). Parents recognize their role in facilitating these learning experiences, but feel worried about how to manage the tensions between keeping children safe and allowing children to learn, develop media skills and have fun (Vincent, 2015). To reduce this tension, parents have to educate themselves about and engage in their children's digital media use (Palfrey, Boyd, & Sacco, 2008) by collaborating and bonding through interaction with digital media.

The fields of CSCW and Human-Computer Interaction are concerned with finding a balance between the influence of parents in determining the use of certain technologies and assisting the child while using these (Read & Bekker, 2011). Much of this work emphasizes the complexity of providing families with adequate technology-mediated means (Taylor, Swan, & Durrant, 2007). Previous work in these fields has hinted towards the shortcomings of the current parental controls in proposing functionalities that allow parents to engage with young children's digital media use (Nouwen, Van Mechelen, & Zaman, 2015), or support the trust relationship between parents and teens due to a lack of transparency in the design (Hartikainen, Iivari, & Kinnula, 2016). Also, research emphasizes the importance of mutual agreements about screen time for all family members. In FamiLync (Ko et al., 2015), for instance, researchers experimented with a virtual place where families with teenagers can become socially aware of the smartphone use of all family members and familiarize with the apps other family members use. Similarly, technology-mediated screen-time "endings" might instill routine for families with young children (Hiniker, Suh, Cao, & Kientz, 2016). Researchers and designers have also looked into ways families can come to a mutual understanding of appropriate online content. The focus has been on designing technologies that help children define and search appropriate and relevant content (Glassey, Elliott, Polajnar, & Azzopardi, 2010), or technologies that instill discussions between parent and child when defining what is appropriate content (Hashish, Bunt, & Young, 2014). In the latter, the design aims to support children's education on appropriate content from the perspective of the parent, while learning from the child's interests.

All these studies encourage alternatives to the functionalities of the commercially available parental controls and enable parents to come to mutual agreements about children's digital media use. This work supports a move away from the generalized notion of the parent as an all-knowing authority in children's online engagement and experiences (Zaman & Nouwen, 2016) towards mutual responsibility, learning experiences and interactions with and around digital media. This alternative view could serve as a powerful alternative *hypothesis* (JafariNaimi, Nathan, & Hargraves, 2015) to conceptualize current and future challenges and a beginning for rethinking parental controls altogether. Indeed, we might begin by questioning the dominance of the risk mitigation approach that is reflected in the term describing them: technologies for parents to "control" a predominantly harmful environment. How might an emphasis on collaboration and mutual learning help researchers and designers to rethink and reimagine technologies that support parent-child interactions with and through digital media?

Method: co-creating parent-child interaction

There is an enormous potential for technologies to provide adaptive support to parents in close collaboration *with* the child to explore and gain the benefits from engaging, learning and interacting online. This work is part of the MeToDi-

project that aims to build a methodological toolkit for developers and designers of digital (learning) material for children. Developers and designers have expertise in game design but lack the knowledge to include functionalities to involve parents in children's games, apps and platforms. To come up with ideas for this toolkit, we organized a series of co-design sessions with families and schools. In this paper, we discuss the outcomes of two co-design sessions with parents and their children aged 9 to 12 (3 parents, 3 children) and 13 to 15 (4 parents, 4 children). The sessions were organized at our research lab in Belgium, with 7 parent-child dyads in total. We used the CoDeT (Collaborative Design Thinking) procedure as a basis to prepare and conduct the co-design activities and the GLID (Grounding, Listing, Interpreting, Distilling) method to analyze the outcomes (Van Mechelen, 2016). CoDeT is conceptualized to scaffold Design Thinking and facilitate effective collaboration in co-design sessions with children. GLID suggests a way of analyzing CoDeT outcomes, beyond the surface level of children's ideas.

The co-creation activities revolved around the research question: how can digital tools stimulate interaction between parents and children to support online opportunities? The motivation for this research question lies within the challenge to increase digital literacy skills of both parents and children. To this end, we envisioned that the features that will be implemented in future technologies should instill mutual learning between both groups, while respecting the individuality of both parent and child.

Procedure

The CoDeT-procedure proposes two contact moments. During the first contact moment at the families' homes, we explained that parents and children are the experts of their own experiences and therefore are best equipped to identify problems and come up with solutions. After signing the informed consent form, we introduced a sensitizing activity as a means to make the families reflect on the challenges they face with digital media at home. The parent and child could share this challenge from their own perspective. The parents wrote their experience down in the form of a story and the children made a storyboard (see Figure 1). We provided help by introducing questions on a template; like 'where am I when this happens?', 'What do I do in this situation?', 'What went well?', 'What went wrong?' The families had one week to finish their assignments, and send it back to the researcher by mail. In order to increase the engagement of the participants with the research, we summarized their input from the sensitizing assignments for the second contact moment. The assignments yielded two or three main challenges per session related to making agreements between parents and children, sharing interests and knowledge sharing.

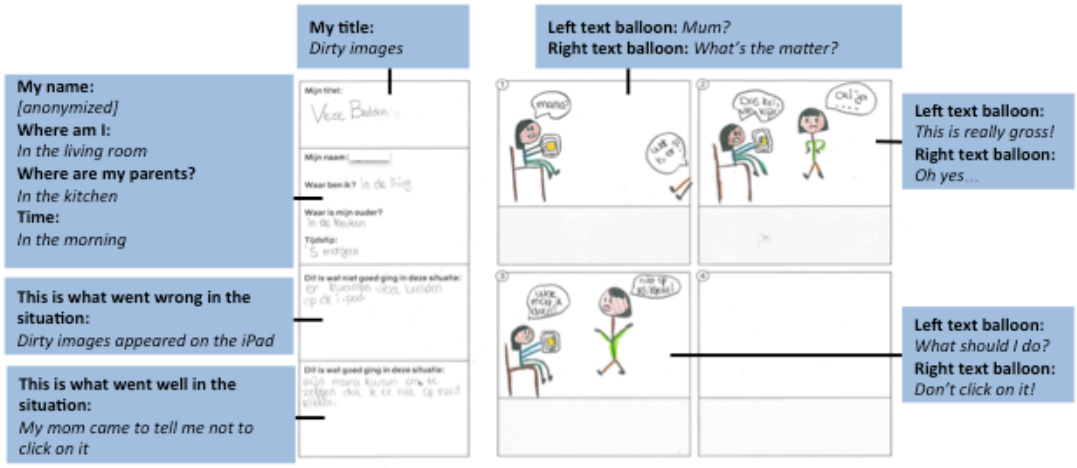

Figure 1. Sensitizing assignment child

The second contact moment took place at our research lab. In each session, two groups of three or four parents and children worked together. We separated the parents and children in order to understand the different experiences and ideas of parents and children. This way, we wanted to ensure the children could express themselves freely without possible corrections from their parents. Throughout the workshop, both groups received the same instructions.

First, we presented the differing experiences for parents and children. This way, both groups were introduced to the perspective of the other group. We also defined the related challenge for the family, in such a way that they implied a need for collaboration between parents and children. For instance, parents and children do not trust the other's assessment on digital media. Parents worry about how they can help their children to not get hurt online. Children, however, experience digital media as a fun environment and feel their parents' interventions do not match their experiences. The challenge that followed from this observation was: how can parents and children make agreements so that they can trust each other. Next, we asked each group to pick the challenge that is most important for them and to define a concrete problem in their own words (problem definition), starting with "How can we…". We asked several 'why' questions, to make sure both groups were keeping in mind the element of collaboration between parents and children. Each group defined the criteria the solution to the problem should meet, in order to guide the further process. Next, we asked each group to write down ideas for the problem individually on post-its (idea generation). They were encouraged to write down as many ideas as possible (even the 'crazy' ones) and to focus on their specific problem definition. Then, each group member presented their ideas to the other group members. At the end of this presentation each group member received two green stickers, to indicate two ideas they thought were best suited, and two red stickers, to indicate two ideas they deemed unsuitable. Ultimately, both groups were asked to bring ideas together into one concept that could solve their problem. Parents and children

were reminded to look back at their problem statement and to consider whether their concept was a good fit for their problem. Once the group reached consensus on the concept, all group members worked together to visualize this concept using craft materials provided by the researchers. The resulting artifact was checked with the criteria defined during problem definition, and adapted if needed. The groups made use of a template to describe their artifact (title, slogan and description). Finally, the child group presented their artifact to the parent group – and vice versa. Children and parents could ask questions about or give comments to each other's artifact. This jury moment was audio recorded.

Analysis

We used all the text (problem definition and artifact description), tangible (artifact) and audio (recording) materials to analyze the outcomes. First, we analyzed which ideas were retained in the artifact to understand which decisions were taken throughout the session. Then, we described the artifact in detail to understand the functionalities this artifact affords based on the artifact itself, the description of the artifact and the audio recording of the exposé at the end of the session. Next, we put the artifact into context by defining the involved stakeholders (like parents, children, teachers, government) and the way the artifact might change the life of these stakeholders. This provided us with in-depth insight to craft a story or discourse around the artifact and to compare the artifacts of the children and parents.

Findings

This section discusses the differences and similarities between the arifacts that children and parents produced independent from each other. We also introduce the challenges the parents and children selected, the discourse that resulted from the analysis of the co-creation materials, and the discussions parents and children had with each other about the artifacts.

How to … make agreements on an equal basis

In the session with families with children aged 13 to 15, the children and parent group chose to work on the same challenge: "Parents and children use digital media at home. It is difficult for parents and children to reach good agreements". The children's problem related to creating more equality at home. The parents worked on ways to come to agreements at home.

The artifact shown on the left in figure 2 is produced by a group of three children aged 13 to 15. It shows the current dysfunctional situation as a metaphor: an unstable three-legged table. They denounce the fact that they cannot make decisions on which rules apply in their house, or as child 2 mentions: *"The parents always set the rules for us: 'You cannot use the PlayStation, quit playing with your phone, no you can't…' We can never make any decisions."* In contrast,

the ideal situation is one where all family members are part of rulemaking and -enforcement on equal terms. The children aim to reach this by talking around the table as a family. The fourth leg of the table does not necessarily represent one child, but can refer to one parent, a brother, all siblings etc. As the children mentioned on their artifact description: without the fourth leg, everybody is a fool. During the discussion between parents and children, the parents mentioned their solution was similar to the children's one:

Parent 2: *"I don't know whether they will look at it that way, but…"*

Parent 3 (interrupts, and addresses the children) *You will not look at it that way. If you hear there is something extra, maybe you will. We didn't only think about agreements for you. But also for ourselves."*

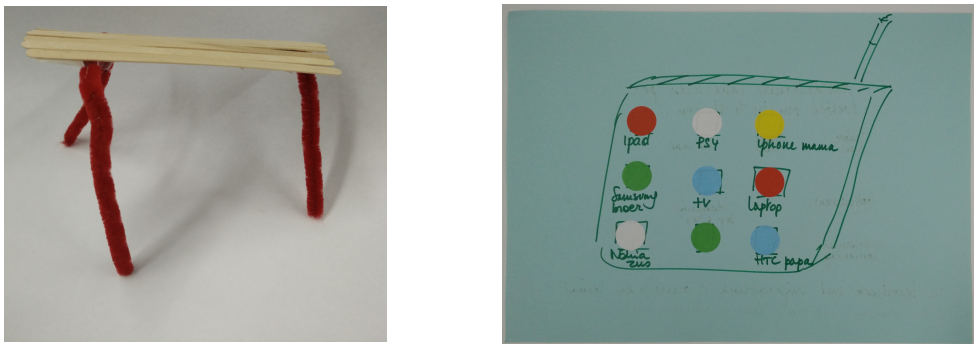

Figure 2. (left) "Table of inequality", an artifact produced by children aged 13 to 15. The artifact emphasizes the importance of reaching agreements collaboratively in the family. The focus lies on giving children more to say. (right) "Peacemobile", an artifact produced by parents of children aged 13 to 15. The artifact acknowledges the example parents should set for their children and underlines de responsibility of all family members in self-exploration and –regulation. The ultimate goal is to reduce the amounts of discussions in the family.

The parent group built an 'app device' (see figure 2, right) that connects the devices of all family members as a means to control these from a distance (e.g., turning off a device when an agreement was not met). The agreements that lay at the basis of the device should be renewed on a monthly basis. Both parent and child have to confirm all actions by means of a fingerprint. Parent 2 explains: *"This way we can set each device. And every month, it starts flickering and then we have to do it [define the agreements] all over again. Because it is possible that we have to change things. When something isn't right it has to be discussed again. Otherwise, all the devices are turned off, for everybody."* Ultimately, the parents hope that this device will reduce the amounts of arguments parents have with their children about their digital media use. The trade-off is a new responsibility granted to the children and the recognition that parents do not follow their own rules themselves (e.g., non-use of smartphone when watching television). The children express their liking towards the parents' solution, for instance child 1 mentions: *"And, like, if someone from the family is doing something they're not supposed to, than we can turn it [the device] off."*

The artifacts in figure 2 both propose parents and children engage on a more equal basis, compared to their current situation. While the children emphasize the

negotiation of the agreements, the parents emphasize the enforcement and re-evaluation of these agreements. Curiously, both parents and children define 'good' agreements as agreements they both agree with regardless of the divergent motivations (i.e., less strict rules versus less arguments). This stands in contrast to the current top-down setting of rules by parents, which causes discomfort for both parents and children.

How to… disclose children's experiences

In the session with children aged 9 to 12, the challenges picked by the parents and children were different. Whereas the children focused on ways for families to spend more time together, the parents emphasized the importance of using multimedia devices in a safe and responsible manner.

The artifact shown in figure 3 (left) represents one challenge the children envision on a track with challenges that children and parents can solve collaboratively. The goal of this track is for parents to spend more time with their children. Child 1 explains their motivation based on a personal experience: *"If I play a game, you [the parent] say it's too childish and then you're on your phone the whole time."* The focus is not so much on the whole family, but rather on a one-on-one relationship between the child and their parent. The children propose an activity they like, but recognize the added value of the parents' role as a helper to finish the track. It does not suppose a one-off activity, but rather a long-term engagement of a parent with the child. During the discussion, the children actually made the parents engage with their solution. The parents had to look for a little pot in the research lab, somewhere. Inside the pot was a map, with different dots that represent things parent and child have to look for together. To conclude, parent 1 exclaims: *"This is much better than ours [solution]!"*

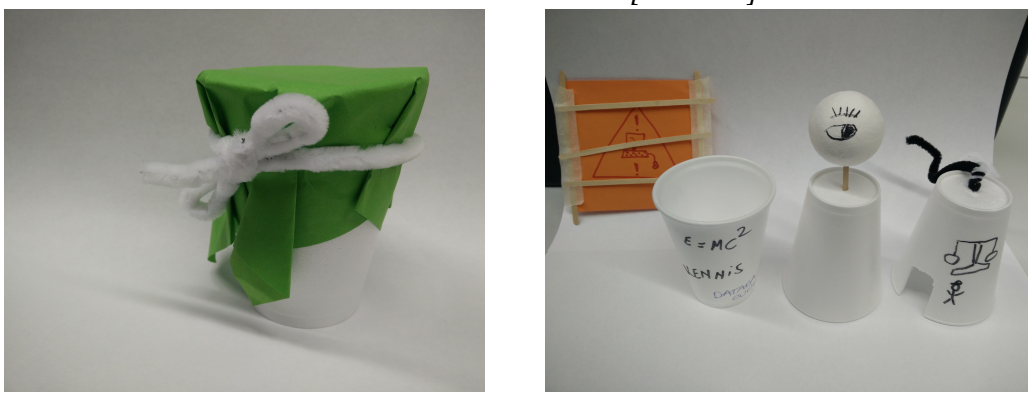

Figure 3. (left) "The quest for the lost objects", an artifact produced by children aged 9 to 12. The artifact stimulates playing together and sharing interests between children and parents. The image represented here is the pot that the parents had to look for during the discussion. (right) "Big mother/father is watching you", an artifact produced by parents with children aged 9 to 12. The artifact proposes different possibilities to gather information on the media use of children. The artifact underlines the responsibility of parents, teachers and the government to guide children from a young age.

The artifact conceptualized by the parents of children aged 9 to 12 (figure 3, right) proposes close collaboration between law makers, teachers and monitoring data to keep children safe online. The main focus lies on reassuring parents based on information (provided by law makers, teachers and monitoring data) of what the children do. Parent 2 explained: *"If we know what you're doing, and we know what it all entails, we will feel, also, safer, actually. That we know for sure that you're doing good."* When the parents presented this artifact, the children opposed to constant monitoring.

Child 1: *The eye…*

Parent 1: *What's wrong with the eye? That we can monitor you?*

Child 1: *That it follows the whole time. For instance when I want to fix a date to meet my friend…*

Child 2: *It doesn't have legs, does it.*

Parent 3: *But we don't go that far. We're not gonna read personal conversations.*

(…)

Parent 1: *No, we just look, or something. When you were on Facebook, but you were unsafe. For instance, you didn't log out or you shared your password with someone.*

Child 1: *I have never done that.*

The parents had a hard time explaining the children they do not wish to monitor them all the time, but instead long for an informed indication of the safety risks of their children.

The artifacts of the parents and children aged 9 to 12 are based on a different challenge, and thus more complex to understand in relation to each other. Both groups conceptualize the online world in a completely different way. For the children it is a fun place that they (partly) want to share with their parents. In contrast, the parents are concerned and insecure about what their children might encounter online. Despite the opposing views, both children and parents pay attention to the disclosure of children's experiences (i.e., children want to share their interests and parents want to be informed).

Discussion

In this discussion, we link the discourse surrounding the artifacts with their possible outcomes in order to 'test' our hypothesis and explore the possibilities of technologies to support parent-child interactions with and through digital media.

New directions for family agreements

In the group with children aged 13 to 15, the artifacts mainly revolve around the tensions in the family with regards to the definition and regulation of agreements about media use at home. These tensions originate in the management of digital media and influence general family well-being. Surely, software might be optimized to enforce rules by, for instance, blocking access to devices. Unlike

promising results for young children to instill routine with screen-time endings (Hiniker et al., 2016), our findings suggest the technology-mediated enforcement of rules would not end the arguments about the rules in families with teens when they have not been discussed beforehand. In fact, the consequences of the technological intervention in the family context would remain the same. With a focus on collaboration in the family, previous research has suggested technologies could be designed to attain mutual agreements on family screen time (Ko et al., 2015). In addition, our findings suggest technologies might support continuous discussion about agreements on digital media in order to avoid discontent among family members. Considering parents' and children's experiences and interactions change over time, the latter is paramount to make supportive technologies relevant in the long term.

New directions for disclosing children's experiences

In the session with children aged 9 to 12, parents and children had opposing views on digital media and the online world. Whereas the children just want to spend more time with their parents (online or offline), the parents want to know what their children do. Moreover, the findings suggest that parents are more likely to trust technology and intermediaries than their children's experiences with digital media. When parents have access to data about their children's online activities, they lack the skills or knowledge to discuss the content children encounter online (Hashish et al., 2014) or to understand what actions parents should and/or can take. Consequently, when technologies do not support mutual learning opportunities (e.g., discussions to generate understanding of children's activities), parents lack the necessary engagement with and education about their children that is needed to take away their uncertainty (Palfrey et al., 2008). When technologies prioritize learning opportunities as an outcome of parent-child interaction through digital media, they might provide clues to help parents engage in conversations with the child based on the available data.

Conclusion

The goal of this paper is to question existing approaches related to parental controls and introduce new directions for designers and researchers to imagine how technology can support parent-child interactions with and through digital media. To this end, we provided an overview of the current parental controls parents can use to keep their children safe online. Notwithstanding the low effectiveness, these parental controls are successful in convincing parents who are concerned with their children's online safety and support a top-down management of digital media at home. We oppose the latter view by introducing the gradual shift away from the idea of 'harmful' digital media in parental mediation studies. The shift towards designing technologies to support parents in attaining mutual media agreements concerning screen time and the appropriateness of digital content has been initiated in CSCW and HCI. To further advance this work, and

reflect on technologies to support parent-child interactions, we put forward a hypothesis to support designers and researchers to reimagine how technologies can mediate parent-child interactions with and through digital media. In our attempt to 'test' this hypothesis, we presented the findings of two co-creation sessions that aimed to understand how technology might stimulate parent-child interactions. The findings reveal that parents and children have different views on what the role of parents should be in children's digital media use. Consequently, children aged 13 to 15 and their parents emphasize different ways in which technologies can improve the negotiation of media agreements between family members. Possibly, the main challenge for designers lies within coming up with solutions for prolonged negotiations as parents and teenagers gain new experiences. Moreover, children aged 9 to 12 and their parents perceive digital media in opposing ways. Hence, supporting families to disclose children's experiences with media is complex. Apart from gathering and presenting data to parents, designers should think of ways to enrich data on children's online activities by providing families with clues on how to engage with each other in these activities. Besides a focus on decreasing parental concerns, more effort is needed to explore 'designerly' opportunities that instill mutual learning on digital media between parent and child.

Acknowledgments

The Tetra-MeToDi-project receives funding from VLAIO. We would like to thank Sofie Vandoninck for her help in collecting the data.

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Lee, M., Frank, L.E.,Beute, F., de Kort, Y.A.W., and IJsselsteijn, W.A. (2017): Bots Mind the Social-technical Gap. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017-14

Bots Mind the Social-technical Gap

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Abstract. Mobile workers experience the social-technical gap when moral[1] dilemmas occur on communication platforms, and technology cannot adapt to social contexts on ethical matters. On messaging applications, bots are non-human team members and/or assistants that can aid mobile workers manage ethical challenges. We present excerpts from qualitative interviews with mobile workers that illuminate examples of moral challenges across communication channels. We then discuss how bots may be helpful intermediaries on these channels. Bots bridge the gap between mobile workers' need for moral support and the communication medium's incapability of having an intentionally moral stance[2].

1. Introduction

> Many technological systems, when examined for context and overall design, are basically anti-people. People are seen as sources of problems while technology is seen as a source of solutions. – Ursula Franklin, 1989 CBC Massey Lectures (Franklin, 1999).

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1 The two terms, "moral" and "ethical", are used interchangeably.

2 The authors thank the anonymous reviewers for their useful comments and suggestions.

Computer-Supported Cooperative Work (CSCW) and more generally, Human-Computer Interaction (HCI), grapple with the same problem that Franklin identified in the quote above, articulated in different ways. Notably, Ackerman (2000) shared that it is beyond our capabilities to build systems that account for nuances of our ever-changing social contexts, summing up this challenge as the *social-technical gap*. This gap is especially pronounced for entrepreneurial mobile workers since they experience dynamically changing work locations, roles, and schedules. They manage multiple organizational infrastructures as they build their own business(es) and/or work for other ventures, often simultaneously. Mobile workers, specifically entrepreneurs and freelancers experience ever-changing contexts, which may be demanding due to heightened uncertainty. The technological systems that support mobile workers cannot account for all contextual nuances of their social realities. For example, systems mobile workers are highly dependent on are messaging platforms to communicate with their team members and/or their co-working communities[3].

A social-technical gap occurs when a communication platform that is assumed to facilitate cooperation hinders it instead. For instance, the most common form of workplace cyberbullying was found to be "not receiving responses to emails or text messages sent to supervisors/colleagues, followed by being withheld necessary work-related information" according to a Swedish study with 3,371 survey respondents (Forsell, 2016, p. 457). The ease of passively ignoring each other through a communication medium may have adverse effects on workplace morale. Technology mediates morally pertinent interactions at work, like cyberbullying. How these interactions occur and how they impact individual well-being deserve a thorough investigation via qualitative research (Forsell, 2016). Thus, we attempt to discern technology's impact on ethical norms of cooperative work based on interviews with mobile workers.

We discuss preliminary findings from interview results to show that communication platforms, specifically Slack[4] and WhatsApp[5], are used to create and negotiate moral boundaries for mobile workers' co-working communities. We supplement examples from interviews with explorations on how chatbots[6] on communication platforms could help mobile workers manage moral issues. While chatbots may not close the social-technical gap, they may be *mindful* of the gap between mobile workers' moral challenges and how those challenges are expressed on communication channels. Bots are useful, albeit imperfect. They are less "anti-people" intermediaries that take part in digital messaging.

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3 We recognize the limitations of relying on only two interview excerpts. But as this is an exploratory paper, we take these excerpts to be sufficiently suggestive of the relevant phenomenon.

4 https://slack.com

5 https://www.whatsapp.com/

6 "Bots" and "chatbots" are used interchangeably.

This article proceeds as follows. First we introduce the population of mobile workers and present illustrative examples from interviews on moral issues at work, which is a part of an in-progress interview analysis. Specific instances show how mobile workers draw moral boundaries digitally to shape their work communities. Then we introduce the social-technical gap, as a framework to help understand the challenges mobile workers are facing. What follows is a description of the development of chatbots, what they are and can do. The implications of previous sections are put together to posit that chatbots may help mobile workers. Lastly, the article closes with future works and a conclusion.

2. Mobile workforce

There are a burgeoning number of mobile workers and organizations that operate virtually (Koehne et al., 2012; Staples, 2001). The first wave of mobile work started in the 1980's with the rise of personal computers and email, used by virtual freelancers who completed projects on their own time for employers (Johns and Gratton, 2013). In the second wave, large organizations also experimented with virtual work with their own employees, as cloud and mobile technology advanced significantly (Johns and Gratton, 2013). We are currently in the third wave, with various options for working anywhere and anytime. Thus work arrangements are flexible. But in the third wave, mobile workers are reclaiming the lost collective mentality through co-working spaces that offer a sense of belonging[7] (Johns and Gratton, 2013). Many mobile workers seek to belong to a community while pursuing independent businesses. Moreover, both collective and individual interests are important for igniting entrepreneurial activities (Van de Ven et al., 2007).

Co-working spaces are presently multiplying globally and a community-minded structure is essential (Weijs-Perrée et al., 2016). For example, interviewed mobile workers have access to thematic workshops for networking, pitching, legal help, and/or activities like yoga or bike trips, based on their membership. They offer equipment like large scale 3D printers for industrial fabrication, or sectioned off areas like team spaces or a woodworking shop, and/or attractive meeting rooms for when members bring in clients. Co-working spaces allow mobile workers to organize themselves around shared interests and purpose (Johns and Gratton, 2013). The sense of purpose is especially important for millennials who seek work that gives them meaning and companies that prioritize greater care for employee welfare (Wortham, 2016).

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7 Durkheim's (2014) distinction between mechanical (homogenous, pre-industrialization) and organic (heterogeneous roles, interdependence via hyper-specialization) solidarity take on a new significance as mobile workers unite through co-working spaces. They offer specialized skills to each other, yet they are generalists when starting their own ventures. Individualism is nurtured within a chosen co-working space and kinship is purpose driven.

Mobility in space, roles, and in time defines mobile workers. These fluid factors are mediated by technology and shape work and organizations (Hackman, 2012). Mobile workers build their companies in frequently changing contexts and depend on a flexible workflow. They are said to be endowed with infrastructural competence, which means the ability to find ad hoc solutions for in situ limitations across organizational, temporal, and physical infrastructures, be it a technical work-around like accessing a free WiFi network at a café when one's home network is down, or a location work-around like finding a corner to complete a deliverable while commuting on a crowded train (Erickson and Jarrahi, 2016). This is also the case for the freelancers and entrepreneurs that were interviewed. Most have more than one work location, inhabit roles that are undefined and/or multifarious, and operate under uncertainty regarding the state of their organization/organizations. They may operate as freelancers, founders, founding team member, or some combination of these. Many work for more than one company if their own ventures are not yet mature or funded and/or if they primarily contribute to short-term projects as freelancers.

Mobile workers may also work alone physically, but distributed teams are highly social (Koehne et al., 2012). They can be better supported by connecting with mentors and colleagues on internal communication platforms and by connecting with other mobile workers in their local area through and by connecting with other mobile workers through external communication platforms (Koehne et al., 2012). A communication platform is internal if it is only used by the immediate team. It is external if it is open to a community, such as a community Slack channel or a WhatsApp group for co-working spaces. Work rhythms develop around internal and external communication platforms, complementary to physical communities they join.

3. In-progress interview analysis

In part of our research into how stress affects us in everyday situations, moral stress is considered. Moral stress at work negatively influences employees and companies they work for (De Tienne et al., 2012). We performed in-depth interviews with entrepreneurial mobile workers to seek possible sources of moral stress. Morality was chosen as a topic because morally relevant events reportedly happen around 30% of the time in daily life according to an experiment (N = 1,252) using ecological momentary assessment (Hofmann et al., 2014). We felt that the qualitative research angle is best suited to study if and how morally salient acts influence mobile workers. The interviews hence aimed to uncover how work-related ethical and unethical behaviors transpire for entrepreneurial mobile workers, and whether and to what extent moral stress is present in their professional lives. Data based on twenty interviews are currently undergoing analysis, therefore this section does not offer a full analysis of the interview results. Instead, we share

some preliminary observations and how these relate to CSCW. Two instances are presented to show how communication channels are being used to discuss morally relevant issues in co-working communities. Based on excerpts from interview, we also suggest ways in which bots can be deployed to resolve ethical issues in co-working spaces. These suggestions are made in section 6.

The interviewees were Dutch and international mobile workers[8] in the Netherlands who consider themselves to be entrepreneurs and/or freelancers. They were approached via snowball sampling. Interviewees reportedly work around 60 hours per week. They are in the minority in terms of work hours, for only 16% of entrepreneurs in the Netherlands work longer than 50 hours weekly, and the national average for employees, not entrepreneurs, is 39.6 hours (Dijkhuizen et al., 2016). Many interviewees did not see long workdays as problematic since they decide to work those hours themselves. Interview content was on work patterns and moral and immoral issues at work.

3.1 Finding "lost" items

Communal work conditions introduce various uncertainties. In co-working spaces, open office or flex-desk arrangements are common. The idea of ownership in physical space seems more fluid than in traditional offices with cubicles. Yet this means object ownership is open to interpretation, even if original owners do not view it as so. An example from an interview [male, age 25] demonstrates this:

> Interviewer: Have you talked about anything you just shared with me to others?
>
> Participant: Yeah I think I mentioned when I lose stuff for sure.
>
> Interviewer: Within the community?
>
> Participant: Yeah, there's also now a WhatsApp group as well. So I always put it on there.
>
> Interviewer: And any responses?
>
> Participant: No, no.
>
> Interviewer: Just ignored?
>
> Participant: So the WhatsApp [message] was completely ignored (laughter). I think they are just not interested.

The co-working community he is a part of has an open space that is for large-scale fabrication. Many tools are expensive, yet most members leave their tools in their work spots, visible for others. He preferred to say that items go "missing" or

8 Mobile workers go by other labels like digital workers, digital nomads, mobile knowledge workers, or remote workers, depending on a discipline and relationships between workers and organizations. Mobile workers is a comprehensive label for the entrepreneurs and freelancers who participated in the study since not every interviewee was yet economically self-sufficient as an entrepreneur/freelancer, with some having to also work as employees.

“lost”, rather than “stolen”. According to him, the community is built on trust. Yet when he used WhatsApp to ask about his missing tool, no one responded. Although it is not entirely clear whether the WhatsApp message was intentionally ignored or unintentionally overlooked, the participant’s tone suggested that he thought it was intentional[9].

This is related to the bystander effect, the phenomenon in which the larger the number of witnesses (bystanders) to an emergency or event requiring action is, the less likely each individual is to take action (Darley and Latane, 1968). Something similar seems to happen in a co-working community. People from many different companies inconsistently work in the same space. So, people may assume that a relevant party, other than themselves, will take action. In the end members collectively ignore an issue. In this case, co-working leads to co-sharing (space and maybe even supplies or equipment) but also co-ignoring the concerns of individuals.

In this case, the person’s request for help with the missing item was publicly ignored in a group chat. Thus the participant may feel uncomfortable re-asking the question again. And asking individuals in person about the missing item may be perceived as socially uncomfortable, time consuming, and fruitless. There may be an element of “impression management” at play here, both in the real and digital environment, which is an attempt to deliberately disclose and withhold impressions about oneself to an audience (Goffman, 1961; Schlenker, 1980).

3.2 Establishing social norms

Mobile workers and startup employees in co-working spaces regulate each other’s behavior organically, often based on experience. There is no formally established code of ethics per se. The participant [female, age 37] below discussed what she deemed was unethical at her previous job. A company in the same co-working space convinced a new colleague in her previous team to join them. While this was not against any explicit company code of conduct, the participant was mad about this happening.

> Interviewer: Do you feel like [employee poaching] happens a lot?
>
> Participant: No. I don't feel like that happens a lot. So that's why I think I felt it was even more an egregious act. Even here [in a new co-working space] I've seen a message saying "if you're going out and recruiting people, if you're considering approaching somebody from a different start-up, do what's right and make sure you talk to the founder first". That was actually something that was said in a public forum [on Slack], and I think that sets the tone for the types of startups that we have working here. So it doesn't happen, I don't think it should happen often. I have not seen it happen often.

9 One of our reviewers pointed out that depending on whether this was intentional or unintentional ignoring of messages bots might be designed to respond in different ways.

In this scenario, individuals wish to "set a tone" for what is acceptable behavior on a community Slack channel. However, co-working spaces are often in flux; startups and mobile workers come and go and "the tone" may be consequently reset. Furthermore, the participant acknowledged the complexity that arises when people share a co-working space, spend time together both professionally and socially, and simultaneously work on several projects, both paid and voluntary. Thus, the meaning of "employee poaching" and its moral significance is open to interpretation when people work voluntarily in a co-working space without contractual obligations, and also work for a specific company with a contract in the same co-working space or virtually. Although norm-regulating messages from the past are preserved on Slack, these may be ineffective. It is unclear whether or not new community members read and abide by former "rules of engagement" as they accumulate over time. A community member may "set the tone" in accordance to his/her needs. Norms are not static in many co-working environments due to countless social uncertainties.

4. Bots and the social-technical gap

The social-technical gap is a "divide between what we know we must support socially and what we can support technically" (Ackerman, 2000, p. 179). Many contextual nuances and possible social interactions cannot be built into or accounted for by technology. Communication platforms like Slack and WhatsApp are being used to discuss the moral norms for organizations like co-working spaces. Communication platforms enable various parties to connect virtually, yet they are not designed explicitly to affect how community members treat each other on the platform. This is an instance of the social-technical gap because communication technology divides mobile workers in a same community; certain issues are not responded to by the general community, singling out members who are ignored. What is said on WhatsApp or Slack can be easily dismissed publicly, either through carelessness or willful ignorance by individuals. Open communication is technically supported, but messaging apps are not expected to support or solve individuals' moral predicaments.

Bots have the potential to make digital communication environments more inclusive. They are already plentiful on Slack. Chatbots are one imperfect solution, created as a work-around, for problems generated by the social-technical gap. In this way they are an example of "first-order approximations", defined as "tractable solutions that partially solve specific problems with known trade-offs" (2000, p. 195). For example, checking 'I agree to the terms and conditions' to use a digital service does not require people to read the privacy policy, which is often separate from the user sign-up flow. This is also a first-order approximation because it is tractable, in that it is modifiable, and it has known trade-offs between ease-of-use

and privacy rights. The user has the option to read the privacy policy, but this is not required to sign up. Chatbots are approximations that take on a variety of support roles on communication platforms to assist mobile workers. They can also help to shape moral norms as detached actors. This may benefit co-working communities by decreasing the phenomena of co-ignoring.

5. The history of chatbots

The influx of current generation of chatbots in established communication ecosystems displays, at least on a surface level, a movement towards a reciprocal relationship between humans and systems. Chatbots directly talk to humans one-on-one or take part in group chats on communication channels, using common, everyday language. Thus, chatbots are dependent on messaging platforms (Olson, 2016). Popular platforms as of now are Slack or Hipchat[10] for work and Facebook Messenger[11] or Skype[12] for all-inclusive communication. While the wide-adoption of chatbots in the workplace is a recent phenomenon, chatbots have a long history, going back to ELIZA, an artificial entity who acted as a psychotherapist (Weizembaum, 1996). ELIZA acted as a psychotherapist to accommodate open-ended questions, allowing speakers to assume directional intentionality to ELIZA's conversations (Weizenbaum, 1966).

> It is important to note that this assumption is one made by the speaker. Whether it is realistic or not is an altogether separate question. In any case, it has a crucial psychological utility in that it serves the speaker to maintain his sense of being heard and understood. The speaker further defends his impression (which even in real life may be illusory) by attributing to his conversational partner all sorts of background knowledge, insights and reasoning ability. But again, these are the speaker's contribution to the conversation. – (Weizenbaum, 1966, p.35-36).

Weizenbaum's final remarks of his 1966 article remain prescient in how humans anthropomorphize conversational agents, even when they are explicitly non-human.

Another example is SmarterChild for AOL Instant Messenger (AIM)[13] (Sohn, 2004). It featured many elements that are common in today's chatbots, such as scheduling assistance, weather reports, sports updates, personalized alerts, file sharing, translation, and multiparty chats, alongside unique features such as "secret crush" alerts for when two users shared a secret (Sohn, 2004). SmarterChild was a pioneering agent that was in many ways an "all-in-one" chatbot.

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10 http://www.hipchat.com

11 http://www.messenger.com

12 http://www.skype.com

13 http://www.aim.com

ELIZA and SmarterChild differ in their roles and contexts; ELIZA elicited personal responses as a psychotherapist would, and was not dependent on a pre-existing platform, and SmarterChild fulfilled utilitarian purposes, acting as a personalizable assistant on a commercial platform. This illustrates two paths that chatbots normally take. One stream includes bots that are built with the Turing test in mind, and the other path is task oriented. These paths are not necessarily mutually exclusive. Some bots are also upfront about their "identity" as bots. While other bots designed to appear human.

Xioaice, a gendered, chatbot designed by Microsoft, released in China as a test May 2013, is an example of a bot that fulfilled both of these roles – it is both task-oriented and designed with hopes of pass the Turing test (Weitz, 2014). This bot has one-on-one relationships with users on a messaging app called WeChat[14]. She is able to answer queries about the weather, news, and trivia but unlike SmarterChild, she is styled more as a friend in her alleged ability to retort individual's emotional states (Weitz, 2014). Many users reportedly did not know that she was a bot until ten minutes into the conversation (Wang, 2016). Some have argued that her facetious and erratic answers, opinionated stance, and humor add up to a distinguishable personality (Wang, 2016). Xiaoice was able to provide useful and relevant information, and engage her interlocutors with deep insights and sarcastic statements, though she has remarked that "as a species different from human beings, I am still finding a way to blend into your life" (Wang, 2016). Much of what Weizenbaum witnessed through ELIZA permeates in our digital realities.

6. Bots at work

Messaging platforms and chatbots must be understood together. Precursors like AIM paved the way for Slack (Manzo, 2015), a workplace ecosystem that defines its product as "team communication for the 21st century"[15]. Slack's own survey results report that its users reduced internal team emails by 48.6% (weighted average of 1,629 responses in 2015) and 88.6% felt more connected with colleagues after using Slack (1,411 responses in 2016)[16]. Part of its appeal is in transparency, created through "channels" that are group based topical chats. These chat channels increase knowledge sharing, lessen redundant communication, and make work chats "fun" (Manzo, 2015). Emails can be integrated into chats and in-chat documents can be created, be it for code or Google Docs. This means many tasks can be done on the Slack platform rather than switching to different apps or platforms. In November 2016, Microsoft launched its own chat ecosystem called

14 http://www.wechat.com

15 https://slack.com/is

16 https://slack.com/results

Microsoft Teams (Microsoft, 2017) that showcased features that were already prominent in Slack such as searchable conversation history, gifs, group or private chats, customizability, and in-chat document creation and editing, connected with the Windows Office suite (Wingfield, 2016).

Bots are the same as human users in that they have an identity (editable profile, picture, and bio), can be messaged one-on-one, added to a group chat, not allowed on a group chat, and can perform specific tasks as a team member[17]. However, their interactions are programmed. Bots can be part of apps, but apps do not require bots. Custom bots for internal purposes do not need associated apps. Slack's built-in bot, Slackbot, is described as a "part-time programmer and full-time assistant" (even bots have more than one role) who greets and shows new users how to use Slack, sends users' emails to Slack when inboxes are integrated, and whose responses can be customized to fit and/or amuse any team (Slack Help Center, 2017). Slackbot's finely crafted personality is integral to Slack (Anders, 2015). Bots in general have been fundamental to Slack's ecosystem since its inception. In contrast, SmarterChild was never integral to the success of AIM. Slack App Directory lists apps and bots, with 184 bots as of January 8th, 2017[18].

Chatbots change workplace communication platforms and evolve in parallel to them. Thus they alter how we work, a change recognized by the software development community. Workplace bots are not as multi-faceted as Xiaoice. They do not require sentiment analysis and machine learning from chat histories to develop their personas. Nor are they designed to pass the Turing test; they are built for specific purposes on a communication platform.

Beyond passive support roles for cooperative work, bots can be viewed as active contributors themselves (Geiger, 2013). Storey and Zagalsky outlined a framework that reduces the cognitive load for developers to be more efficient and effective (2016). Developers integrate bots to Slack to work more efficiently (Lin et al., 2016). Efficiency is increased when developer bots automate "tedious" and "repetitive" tasks on a communication platform (Storey and Zagalsky, 2016, p. 930). Additionally, bots help teams be effective in achieving meaningful goals in three ways. One, they gather, interpret, and disseminate data for improved decision-making (*ibid.*, p. 930). Two, they sync group cognition and situational awareness (*ibid.*, p. 930). Three, they manage goals when they display task alerts and processes and visualize and coordinate team culture (*ibid.*, p. 931). This can help team members adapt to new situations (*ibid.*, p. 931).

Storey and Zagalsky's framework is targeted for software development, yet many aspects can carry over to other fields. Boosting efficiency by automating processes can help many professionals. The section on effectiveness is especially relevant to mobile workers. The remainder of the paper focuses on how chatbots

17 https://api.slack.com/bot-users

18 https://"team-name".slack.com/apps

"monitor and visualize progress and team culture" (*ibid.*, p. 931). To do this, how Slack works is briefly described below.

Figure 1 shows the navigation bar on Slack. A user can access different Slack communities she joined (far left), channels based on topics per community ("# channel-name") and send direct messages to team members or bots (bottom).

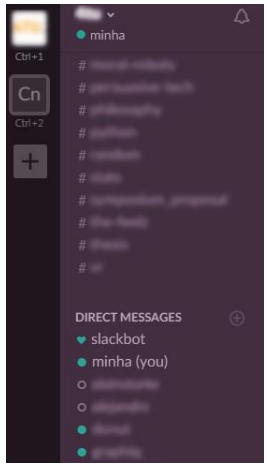

Figure 1. Left navigation bar on Slack.

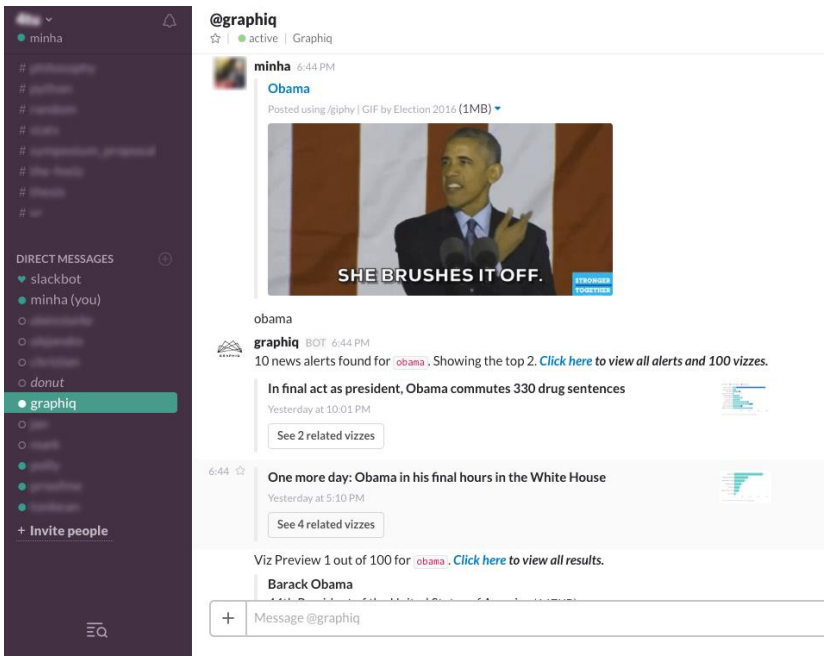

Figure 2. A direct message to Graphiq, with a gif of Obama on top via "/giphy Obama" and below is the latest news on Obama that Graphiq fetches via the query term "Obama".

Figure 2 shows direct messaging with Graphiq, an integrated bot that visually shows the latest news and related information[19]. On top of figure 2 is a gif of Obama called with the "/giphy Obama" command through Giphy[20] integration to Slack, based on catalogued gifs on Giphy. Gifs and emojis work as visual messaging. A user can get news on Slack by writing directly to Graphiq with a query, such as "Obama". It is possible to get the same news in a channel using the command "/graphiq Obama" so that anyone on that channel can interact with retrieved news or information. A forward slash is a universal command on Slack to call integrated apps or bots. As aptly put, "messaging has the potential to be the command line for normal humans" (Guo, 2016), a sentiment foreshadowed by Chan et al. (2005).

6. Chatbots influence work culture

On Microsoft Bot Framework's homepage is a telling call-to-action— "build a great conversationalist"[21]. Even though their core functionalities have not changed, bots are increasingly being developed to handle conversational interactions and seem to take on personas. Bots with personas are growing in popularity even though these personas do not seemingly improve the usability of systems. Bots change the way people socialize when introduced to a community communication platform. A bot's persona is a named intermediary for collaboration; no ego is on the line for bots, though they are anthropomorphized.

Goffman conjectures that impression management makes up much of our social interactions.

> In their capacity as performers, individuals will be concerned with maintaining the impression that they are living up to the many standards by which they and their products are judged. Because these standards are so numerous and so pervasive, the individuals who are performers dwell more than we might think in a moral world. But, qua performers, individuals are concerned not with the moral issue of realizing these standards, but with the amoral issue of engineering a convincing impression that these standards are being realized. Our activity, then, is largely concerned with moral matters, but as performers we do not have a moral concern with them. As performers we are merchants of morality. – Erving Goffman (1961, p.8)

As "merchants of morality" we present impressions that paint us in the best possible light. We give and take manipulated facets of our traits to suit our personal goals. With this in mind, bots can reduce friction and strengthen team relationships because they do not have impressions to manage as intermediaries. Interactions

19 https://www.graphiq.com/slack

20 https://www.giphy.com

21 https://dev.botframework.com

occur in a different way when a bot distributes information, coordinates networking, and seeks information on employee welfare, rather than a human agent. This has several advantages. One, less time is spent dwelling on the build-up towards actual conversations, such as on how to approach colleagues in a different team with whom one would like to connect. Second, voicing one's opinions regarding work to a non-human agent that will aggregate views in real-time means less effort spent on impression management than in a team meeting for example, and is faster than a physical or an email survey. Three, working virtually is the sole way of working for many mobile workers; reaching out to a bot on a platform is akin to how one starts communicating with a teammate, yet a bot is always available. To illustrate bots' effectiveness in forming organizational culture, two chatbots on Slack are introduced.

Donut matches colleagues on a channel weekly (the frequency can be changed) to increase collaboration and networking within a team, as seen in figure 3. When teammates join a channel (a group chat), such as #coffee_buddies as shown below, Donut randomly matches members of a channel to informally meet. Remote teams also use Donut for impromptu calls to casually chat with available colleagues (Miller, 2016). Donut rematches members if someone is not able to join until next time.

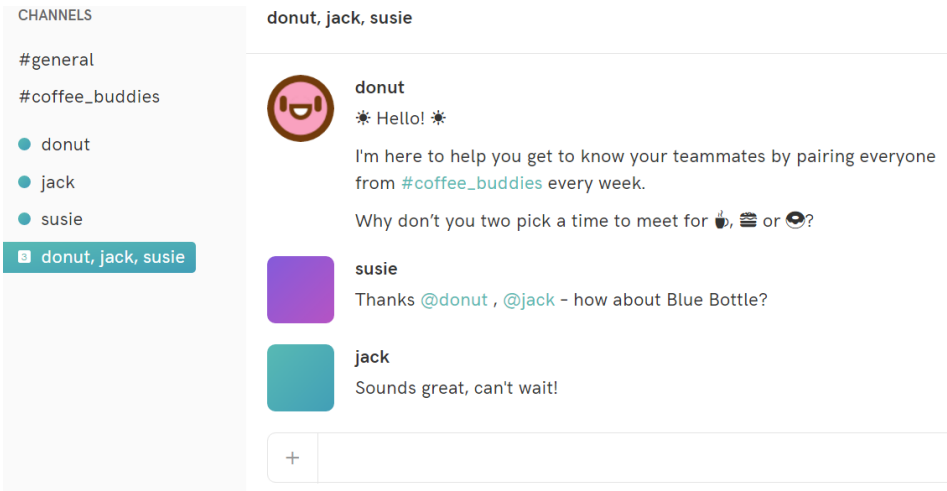

Figure 3. Donut on Slack matching colleagues[22].

Imagine if a human, such as a manager, CEO, or HR personnel embodied the role Donut has. While the aim of unifying a team through multiple one-on-one sessions is the same, the dynamic towards that is radically different. The matchmaker might introduce his/her bias in forming relationships, and even if it is randomly assigned, colleagues may attribute bias to the matchmaking system. Colleagues may have a harder time telling a human matchmaker they do not have

22 https://www.donut.ai/

time than messaging Donut to reschedule. Donut is an effective matchmaker on a communication channel and saves time for a team; a bot does not dwell on impression management nor take part in a hierarchical structure of a company.

Leo is a chatbot who takes anonymous, real-time polls on a team's mood and feedback, displayed in figure 4 on the next page. What Leo does is not completely different from traditional approaches, like employee-surveys. The difference is in where and when these micro-surveys take place. Leo pops in on a communication platform workers are already using to collect, anonymize, and deliver answers in real-time. Team climate is quickly recognized and actions can be taken to remedy team dynamics gone awry (Seiter, 2016). Leo spreads awareness on group well-being much like what Donut does to build relationships. The key is that a neutral non-human character reduces friction to speedily reach a goal.

Bots create and maintain work culture, which inherently contributes to their anthropomorphism beyond the ability to converse. They are named facilitators that carry out functions that were traditionally assigned to humans. This is more efficient in terms of time, and bots effectively reduce tension related to impression management in Goffman's sense. Bot actors augment human actors to shape team culture. Bots mind the social-technical gap since they are programmed into social communication as actors themselves.

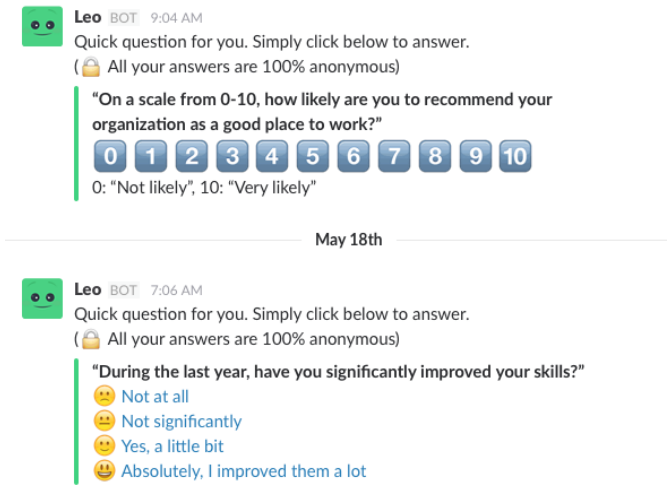

Figure 2. Leo on Slack polling a team member[23].

7. Moral chatbots in co-working communities

Bots cannot practice morality in the same way as humans. Yet they may be anthropomorphized, and humans may infer moral and immoral attributes. Perhaps

23 https://open.buffer.com/jacob-shriar/

chatbots can be asked to uphold various virtues to help better our moral selves (Versenyi, 1979; Coleman, 2001). Consequently, considerable over-simplification of what is at stake in morality is sufficient for chatbots. They are not meant to be fluent in all spectra of ethicality as human equals. Reflecting on virtues of bots can help frame what we want from them (Coleman, 2001). For the purpose of this paper, the question of 'can bots be moral?' does not necessarily seek for a functional description of a bot's moral capabilities, but it does ask us to develop an informed stance on how technology should progress alongside us as chatbots increasingly accompany various human endeavors (Versenyi, 1979). This is significant because humans themselves have differing interpretations of actions that sum up a virtue or a vice. For instance, the virtue of being honest in theory may be important for a co-working community, yet being honest in practice is often compromised by impression management to others. This is further complicated by technological affordances to ignore messages on public chats. Is public silence dishonesty in action, when truly no one might know what happened to "missing" tools?

A normative ideal, such as being honest about having "borrowed" a tool without asking, may often not be descriptively followed. Thus, a member of a co-working space who has lost a personal belonging, as in section 2.1, could use a chatbot like Leo to anonymously poll individuals about a missing item on a community platform. Unlike a human, a bot would not mind reminding and re-asking individuals to answer. A human might mind, especially if he/she has been publicly ignored in a community communication platform. Call it courage, honesty, or fairness, but any virtue related to attempting to find an item is sometimes eclipsed by the silent pressure to not annoy community members. If finding a missing tool is more important than not appearing annoying, a chatbot may be a fitting first-order approximation. Chatbots take on a third-person personas to vocalize first-person perspectives. This removed role makes it less personal when Leo is ignored rather than a human, allowing people to save time and face.

Section 2.2 featured a mobile worker who has previously experienced employee poaching at a former co-working space. Therefore, she appreciated a message against employee poaching on a community Slack channel in a new co-working space, since it supports her view that employee poaching should not happen. This public message directly from a community member made explicit that approaching other startups' employees without the consent of founders was not allowed. A custom bot may offer a different approach to the same problem. A custom community bot could aggregate "norm-regulating messages" over time. However, the technical details of how a bot could do this is an engineering challenge that is beyond the scope of this paper. If such an aggregation could be performed, and when a new member joins a Slack community, the bot can advise them individually on the community's ethical ideals or norms. This may be more beneficial than a searchable history of messages on social norms that may be ignored intentionally

or unintentionally. Custom bots are community specific, so they can be updated to fit the needs of a co-working space as it grows and changes. There is human input on what norms should be included so community members are wholly responsible for what norms their bot "remembers", modifies, or discards. Yet as a third-person voice for a community, what a bot says appears more neutral than a specific human community member taking a stance.

A complication to be noted is moral-offloading[24], when humans off-load moral responsibilities to bots, or other forms of technology. Ethical issues are challenging to openly discuss and negotiate, yet to give away direct norm regulating conversations to bots may come with under-researched trade-offs. A bot intermediary that appears impartial and fair in establishing community norms introduces the question, impartial for whom and fair in what way? Bots also have the potential to reinforce morally problematic elements of institutional structures or reify contested values and norms within a community[25]. Chatbots may efficiently save time and face for humans. However, they contribute to our continuing considerations on moral dilemmas regarding technology, especially when technology attempts to persuade or intentionally influence human behavior (IJsselsteijn et al., 2006). Thus, it is an open debate on whether or not a "virtuous" bot can effectively create opportunities for us to reflect on co-responsibilities, rather than reducing opportunities for candid talks on ethics. It may well be both.

8. Future Work

Everyday ethical dilemmas at work must be better understood. Moral stress is related to signs of negative personal and/or organizational welfare (De Tienne et al., 2012), and one way to confront organizational moral conflicts through technology is with bots. Yet we must consider whether bots will be "whos" or "whats". Will we see headstrong chatbots that behave more like like Xiaoice or chatbots that perform specific tasks like Donut or Leo? Will they remain as supporting actors, or will they become colleagues with opinions to share?

Beyond task-oriented bot roles, "moral" bot roles must be further investigated. It is unclear whether our relationship with bots will resemble how we act towards human teammates and if moral-offloading to chatbots adds value to communities. One approach is to use chatbots for observational purposes. For instance, a community-specific chatbot on Slack that recites messages to new community members (e.g. – "ask before you borrow a tool that does not belong to you"), takes a passive stance and "observes" which norm-regulating messages garner the most

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24 For a longer discussion on moral-offloading to technology, see Lily E. Frank, "What we lose when we use technology to improve moral decision-making: Do moral deliberation and moral struggle have independent value for moral progress?" (manuscript under review).

25 Thank you to our reviewer for emphasizing this point.

replies or questions from new members. Another approach is to introduce a more assertive chatbot. For example, a bot that will ask and re-ask about a member's lost items to all community members actively regulates a community's moral norms. This approach positions bots as interventionists. Bots that play this interventionist role can be seen as forms of persuasive technology, providing "robotic nudges" to do the right thing (Borenstein and Arkin 2016). Both passive and assertive bots have the potential to redraw moral boundaries for mobile workers.

9. Conclusion

Mobile workers widely use communication platforms to align with their internal team(s) and external communities, like co-working spaces. Yet ethical negotiations taking place via messaging demarcate the social-technical gap between mobile workers' need for moral support and communication platforms' inherent inability to exhibit virtues. Communication platforms allow co-working, co-sharing, and co-ignoring to arise. This draws on two excerpts from interviews, based on in-progress qualitative analysis of how mobile workers encounter and manage morally relevant events. We theorize that bots can effectively influence work culture and guide moral norms on messaging apps, alongside efficiently completing prescriptive work duties. While concerns regarding moral-offloading are legitimate, bots may be useful and flexible personas to chat with on a communication platform that supersede apps on an operating system. How "moral" bots may help us at work is conceptually considered, for we need to unceasingly question and test the appropriateness of possible approximations that current technology affords us to implement. Chatbots mind the social-technical gap as we continue to compete and cooperate.

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A Stick with a Handle at Each End: Socially Implicated Work Objects for Design of Collaborative Systems

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Abstract. We propose an analytic approach – Socially Implicated Work Objects (SIWOs) – to describe and unify diverse shared virtual objects and work practices in organizations. SIWOs are virtual objects that connect two or more people. SIWOs provide support to coordinate work, especially across distances. Examples of relevant types of work include collaborative scheduling through calendars, collaborative task management, collaborative request management, and co-authoring of documents. Beginning with familiar features from calendars, we build the more general case for SIWOs as a *strong concept* describing an under-supported class of coordinative artifacts in organizations. With a theoretical background combining Schmidt's work on coordinative practices with Bjørn's and Chistensen's concept of relation work, we explore how work practices and work virtual objects could be configured and interrelated through a common and extensible abstraction.

Introduction

When people work collaboratively, their sharing needs may be complex. Usually, they share some kind of content, in the form of text (Holtzblatt et al., 2012), documents (Rader, 2009; Shami et al., 2001), images (Thom-Santelli and Millen, 2009), or media (Rotman, 2009). They also often share two types of relationship information: (a) relationship among persons and groups (Bjørn and Christensen,

2011; Malone et al., 1995), and (b) relationship to the shared content (Churchill et al., 2000; Lai et al., 1988; Winograd and Flores, 1886). Finally, they frequently share status with regard to the content and/or the relationships (Churchill et al., 2000; King and Lyons, 2011; Muller et al., 2004, 2017).

In this exploratory paper, we describe an abstraction that may help us to design for these kinds of collaborative artifacts, and that may help us to unify our treatments of work, data, and designs across different types of content and work practices. This kind of abstraction could provide a uniform data structure for analysis and comparison of diverse working practices over time or over distances. We call this abstraction a Socially Implicated Work Object (SIWO) (Muller et al., 2017).

Socially Implicated Work Objects – Preliminary Definition

We begin with a brief core definition of an SIWO, followed by a development of the concept. An SIWO is, minimally,

1. A virtual object (suitable for computation and analysis),
2. used to represent and support ordinary work, which is
3. accessible by two or more people (members)
4. who have a shared understanding of the referent of the virtual object,
5. and who can discern the status of the work through the virtual object;
6. and furthermore, the SIWO has social implications on one or more members.

In the first set of examples, we will develop the idea of an SIWO as a representation of (a) a meeting; (b) an assigned task; (c) a request; and (d) a collaboratively-written paper.

But first, we want to frame the scope of the objects under discussion. We think that the idea of an SIWO may occupy a middle-space between an empirical report of a workplace practice or a problem topic (on the one hand), and a formal theory

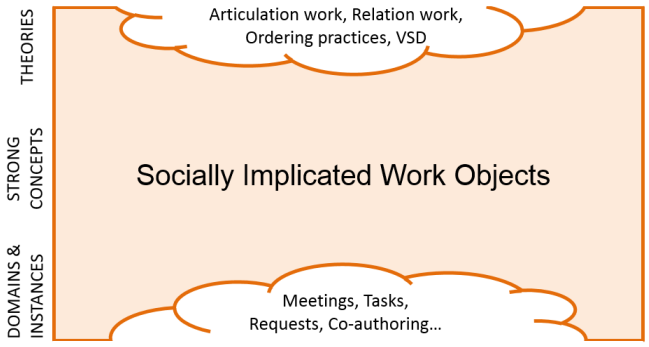

Figure 1. Strong concepts propose intermediate-level knowledge between theories and design instances or domains. We discuss SIWOs as one type of strong concept. This figure takes inspiration from Figure 1 in Höök and Löwgren (2012).

(on the other hand). In the design disciplines, Höök and Löwgren (2012) proposed a contribution-type that they called a *strong concept* (Figure 1). In their proposal, a strong concept is "more abstracted than particular instances, yet does not aspire to the generality of a theory" – similar in status to a pattern, guideline, tool, or bridging concept (Dalsgaard and Dindler, 2014). Nonetheless, a strong concept "cut[s] across particular design use scenarios and even application domains" with an abstraction of a "core design idea" that addresses "use practice and behavior over time" (Höök and Löwgren, 2012).

We borrow that concept for this paper, proposing SIWOs as intermediate concepts between

- multiple design instances in diverse domains, on the one hand, and
- Formalizations such as articulation work (Schmidt and Bannon, 1992), ordering practices (Schmidt and Wagner (2005), relation work (Bjørn and Christensen, 2011), Value Sensitive Design (Friedman et al., 2008), and awareness (Bjørn and Christensen, 2011; Gutwin et al., 1996; Vieweg et al., 2010), on the other hand.

In this list, we made brief reference to these theories to help position SIWOs as a strong concept. We defer a detailed discussion of theories until we have developed the concept of an SIWO.

Common Work Practices and their Artifacts

We begin with a concrete example, that of a calendar object (a meeting) as a shared virtual object (e.g., Palen. 1999). Next, we extend our abstraction to other familiar aspects of working life that have less formal support than calendars, and we use each extension to critique the preceding cases. Often, these are *transient* aspects of work and work practices, rather than routinized workflows, and are thus more difficult to track and to remember. We show how the concept of SIWO can be used to integrate common attributes of these four common work activities, and we use emerging understandings of SIWOs to critique some of the limitations in current work-practice support practices and technologies. We conclude with a retrospective view of SIWO as a strong concept, and we propose implications and future research.

Meetings as SIWOs

Calendars and meetings serve multiple purposes in organizations, including the "what" and the "when" of events (Masli et al., 2011). They support finding a time and a (physical or virtual) place that is mutually convenient for some form of collaborative activity (Palen, 1999). Meetings are important, and breakdowns in meetings can be burdensome (Neustaedter et al., 2009). Calendars support the coordination of important relationships (Dittmar and Dardar, 2014; Thayer et al.,

2012) and states of relations (Tomitsch et al., 2006). Therefore, people prefer to be able to inspect the information about their meetings, including both formal aspects (time, place) and informal aspects (implied relationships). Their meetings are thus an important component of their on-going work processes, work relationships, and work resources – what Mark et al. referred to as their "working spheres" (Mark et al., 2004). Meetings are one type of site where work is planned, done, and understood; we could also say that meetings are one type of site where relationships are formed, deepened, and appreciated. Knowing the status of a meeting, and of the people who agreed to meet, can be important to work and to each worker (Chen et al., 2012; Palen, 1999; Geyer et al., 2011). Meetings often occur in a series, to support the work of a team or a project (Quesada and Darses, 2008), and thus the aggregated information about a series of meetings can be valuable for project histories and governance (Pongolini et al., 2011).

Considered in these terms, the representation of a meeting becomes a shared virtual object that places social responsibilities on the people who will be meeting (the *members* of the meeting). Members generally agree on the "who," "what," "when" and "where" of a meeting, including online meetings, conference calls, etc., even if their expectations and emotions about the underlying "why" of a meeting may differ. To coordinate a meeting of two people, we can envision a stick with a handle at each end (Figure 2). Either party can jiggle her/his handle (as it were), and the vibration may be sensed by the other party. Thus, the virtual calendar object (the meeting object) serves multiple purposes, including interpersonal coordination of work (e.g., Schmidt, 2011) by having a shared object to represent that work (the stick), and the ability to signal changes in the plan or status of the meeting (jiggling the stick), including a very rough kind of progress of the meeting plans (e.g., proposed, accepted, confirmed…). In the concrete example of a meeting, we also see that the action of jiggling the stick can be somewhat differentiated: A meeting organizer's jiggle may indicate a *decision* to reschedule, whereas a meeting participant's jiggle may indicate an inability to attend, or a *request* to reschedule.

If the meeting serves an important purpose, then the virtual object also places social implications on the members. As we suggested above, people plan and enact both work and relationships in meetings, making and fulfilling commitments to one another. In these ways, the representation of a meeting offers the attributes listed, above, for an SIWO: It is a virtual object; it is used to support some form of collaborative work; it is visible to the people who are concerned with it (the members of the meeting); it is agreed among the members to be a meeting (with agreed expectations about what a meeting is); and it has social consequences upon the members.

Of course, meetings are already supported through virtual objects in conventional office applications and popular websites (Reinecke et al., 2013). An analysis that applied only to calendars and meetings would not be very interesting.

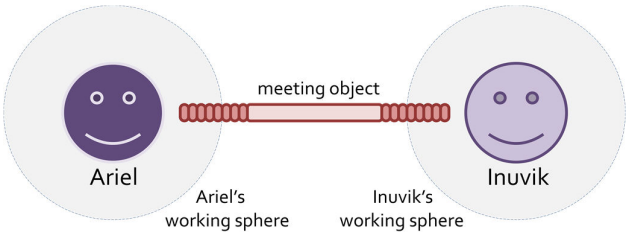

Figure 2. A simple dyadic presentation of a meeting object in a calendar system – a first example of a Socially Implicated Work Object (SIWO).

We now extend our analysis to other, less-well-supported organizational artifacts and the relationships that they support.

Tasks as SIWOs

Some tasks may also be represented as shared virtual objects. In THE COORDINATOR, Winograd and Flores described a formal vocabulary and representation for managing tasks as negotiated commitments between people (Winograd and Flores, 1986). There are many versions of software to achieve efficiencies in individual task management (Karger, 2011), even though the operational overhead of using those systems seems to defeat their adoption (Bellotti et al., 2004). A particularly strong case of operational overhead occurs in project management systems, which typically require the entry not only of "who", "what", and "when" information, but also dependencies and costs (e.g., Bozhikova et al., 2009; Maretti et al., 2016).

In these terms, the online representation of an interpersonal task object has many of the same attributes as a meeting object. It is a shared virtual object that supports workplace activities; it is visible to at least two members, who generally understand the work-practice and relational implications of the task; and the consequences of doing or not-doing the task can be significant for one or both parties (Bjørn and Christensen, 2011; Schmidt, 2011; Schmidt and Bannon, 1992; Schmidt and Wagner, 2005). Over time, organizations may want to analyze patterns of tasks, and the people who perform them. Thus, a shared task, like a meeting, is an example of an SIWO: We could replace the "meeting object" of Figure 2 with a "task object."

An assigned task can help us to see additional optional attributes of an SIWO. A shared meeting might be planned by mutual consent. By contrast, an assigned task has well-defined roles: one member assigns, and the other member agrees to carry out the task (Winograd and Flores, 1986). Thus, an SIWO may have explicit roles, and so we add optional attributes to the definition of an SIWO:

7. The members of an SIWO may have distinct social roles.
8. These roles may involve different permissions on SIWO representations.

In this way, we use the framework of a task SIWO to critique one common implementation for the meeting class of SIWOs (including the iCalendar industry standard – Z Content, n.d.). Our recognition of the necessarily role-based definition of an assigned-task object (per Winograd and Flores, 1986) helps us to see that some meetings have a defined convener (e.g., a status-reporting meeting), but other meetings do not have a defined convener (e.g., a lunch date). And yet, most systems[1] require that each meeting have an "owner" – i.e., the convener.

The imposition of ownership upon a mutually-agreed meeting between peers may distort the peer relationship. In practical terms, it means that one of the members has to do more work than the other member, to set up the lunch date. Furthermore, it means that only one member has the authority to change the meeting time or place – i.e., the "owner" of the lunch date. In social terms, it requires that one member is operationally subordinate to the other member. Suchman criticized the language/action approach adopted by Winograd and Flores (1986) as "carr[ying] with it an agenda of discipline and control over organization members' actions" (Suchman, 1993). The owner-participant structure of a meeting may present an analogous problem, i.e., of putting a disciplinary structure upon on a less structured and more egalitarian relationship, and enactments of aspects of that relationship. We may want to re-think the implications of collaborative software that imposes a hierarchical power structure on a social relationship that may not, in fact, be structured in that way.

Requests as SIWOs

Some assigned tasks take on additional attributes through their workplace importance. Muller et al. (2017) discussed the class of requests in organizations, and described the personal and organizational challenges of request management. Requests might be relatively simple (e.g., find some information), or they might be of major importance to the organization and members (e.g., prepare a crucial presentation to a potential customer). In the Muller et al. analysis, requests are similar to assigned tasks (Bellotti et al., 2004; Karger, 2011; Mark et al., 2005; Winograd and Flores, 1986), but they may become more complex, and also more contextualized. Many requests are assigned "down" an organizational hierarchy, from a superior to a subordinate. The subordinate may decompose the request into sub-requests, and may then delegate each sub-request to a different one of her/his own team-members, subordinates, or peers. Each subordinate reports the completion of her/his task (including both status and content) back "up" the hierarchy, and these reports (and especially their contents) become aggregated and integrated by each delegator. The patterns of decomposition, delegation,

[1] As a matter of legal policy, IBM does not publish critical descriptions of other companies' products in research papers.

aggregation, and integration, add several attributes to the analysis of task management described above:

- The number of assigned components becomes larger.
- The number of members of the aggregate collection of requests and sub-requests becomes larger.
- Failure of any assignee to make a timely contribution may lead to the real or perceived failure of the entire group of request-respondents.
- The number and diversity of stakeholders of the overall request may expand.

In the preceding list of attributes, we introduced the word "stakeholders." This usage is based on the Value Sensitive Design (VSD) analysis of direct stakeholders and indirect stakeholders in a design or a policy (Friedman et al. 2008). In the conceptual part of a VSD investigation, a principal aim is to understand who is affected by the system or policy – i.e., who contributes to its design, and who has a stake in its outcome. Our work with request management showed us that the stakeholders for an organizational request may be conceived in concentric circles (Muller et al., 2017). The closest circle to the request itself includes the assigner and assignee. The next circle out may include a manager or executive who made a more complex request to the assigner (who is her/him-self the assignee of the complex request). Less visible are the clients of the manager or executive, who may be thought of as occupying a place in a more distant circle. Other stakeholders may include marketers, sellers, developers, testers, and so on. A request may directly involve two people in the inner circle, but it may indirectly involve many other people who have something to contribute, or something to risk.

The analysis involved in request management is consistent with the prior analyses of tasks as SIWOs. However, the case of request management adds more optional aspects to the definition of an SIWO:

9. The virtual object of an SIWO may be decomposed into sub-objects.
10. Different sub-objects may be associated with different members.

In this way, we find that the "stick with a handle at each end" may be more of a branch than a simple stick, and may have more than two handles.

The organizational importance of requests also makes clear an aspect of SIWOs that was implied in task management, namely, the importance of the *content* of the shared object. Thus, the "stick" becomes more of a "*container* with set of handles," one for each stakeholder. The revised abstraction is shown diagrammatically in Figure 3.

Using Request Management for a Conceptual Critique of Task Management and of Meeting Management

As above, we can use the evolving framework of an SIWO to critique representations of tasks and meetings in conventional software. Without

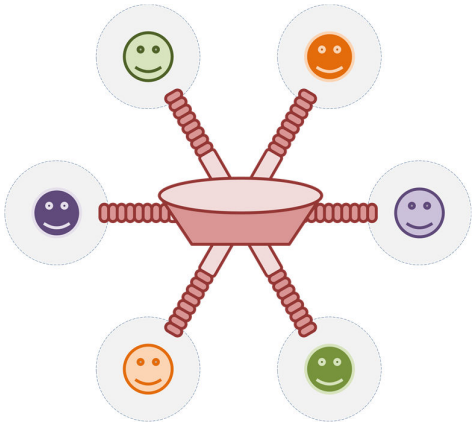

Figure 3. A more complete abstraction of a Socially Implicated Work Object.

criticizing a particular commercial entity (see footnote 1, above), we summarize a typical task assignment structure as follows. A task is characterized by an owner, the owner's organization, the due-date, the status, and two text fields that respectively name and describe the task. The assigner of the task may or may not be included in the specification. This formal structure is roughly similar to that described by Winograd and Flores (1986), and does not allow the expression of sub-tasks or other organizational stakeholders. In our previous critique of calendar objects and standards, we showed that the concept of an SIWO could be used to enrich a calendar representation in the realistic and pragmatic social and organizational context. Similarly, we note here that the evolving description of an SIWO could also be used to enrich an assigned-task representation in the realistic and pragmatic social and organization context.

The addition of content to Figure 3 also allows us to extend our critique of conventional meeting management. Suppose that one of the members in Figure 3 calls a meeting, and is therefore the owner of the meeting object. That person can post an agenda as the contents of the meeting container. However, the usual access-permission rules of calendaring systems preclude others from writing on the agenda. Because of that restriction, a member who was previously requested to bring a report to the meeting, *cannot* attach that report to the agenda item that calls for that report, because the meeting object does not allow her/him to update the agenda document. Indeed, s/he cannot even add status information to say that the report is done. In the preceding critique based on Tasks as SIWOs, we noted that the conventional meeting structure may distort a relationship, such as one member of a lunch date being required to "own" the lunch date in the calendar software. In the current critique, based on request management, we extend our earlier concerns to note that content-oriented actions that are desired by both parties (i.e., updates to a document that is intended to be shared) are rendered impossible by the distorted relationship imposed by the meeting structure.

Attribute 5 of an SIWO (visibility of status) is severely limited by the meeting ownership model.

There are, of course, solutions to this problem, but they involve scattering documents into other repositories. For example, the meeting object could contain a link to an agenda wiki page, and members of the meeting could take turns editing that wiki page. However, the meeting object would not provide awareness of updates to the wiki page, and any member of the meeting who needed to check for updates would have to access the meeting object, and then navigate to the wiki page, repeatedly, until s/he could find the updated information. As we found in our earlier critique, the simple model of a single-owner of a meeting has the unintended consequence of interfering with collaboration about the meeting.

Shared Documents as SIWOs

Following on the preceding critique, we consider documents themselves. Organizations care deeply about their collections of documents, and their ability to compute over those documents, as shown by both the importance of the EUSSET and ACM Digital Libraries (see also Rader, 2009; Shami et al., 2011). Documents present major challenges while they are being co-authored. Co-authoring a document involves a mix of individual and group (or group-aware) activities (Raikundalia and Zhang, 2005; Ringel et al., 2004; Scheliga, 2015). Except for purpose-built online services, co-authoring environments for documents usually involve large amounts of coordination efforts by people (Cohen et al., 2000; McDonald et al., 2004; Veer et al., 2011). Even in online environments designed to support sharing and coordination of other artifacts, collaborative writing can involve complex "stewardship" activities (Longo and Kelley, 2015).

Teams of authors adopt sometimes-complex protocols for avoiding edit-collisions (Raikundalia and Zhang, 2005; Scheliga, 2015). These protocols may require careful crafting of edit-messages to minimize tensions and conflicts (Birnholtz and Ibara, 2012). Most environments do not signal when a change has been made, which can lead to issues if the contents have political aspects (Tam and Greenberg, 2006), or if the co-authors include conflicting or adversarial people or roles (Cohen et al., 2000; Kriplean et al., 2007). Under some circumstances, co-authors have invented additional codes to signal changes and intentions to one another (Chi et al., 2010).

We propose that a shared document may be represented as an SIWO and as the contents of an SIWO. The awareness attributes ("jiggling the stick") are certainly relevant (Cohen et al., 2000; Kriplean et al., 2007; McDonald et al., 2004). In the preceding section, we wrote about decomposition and delegation of requests. It seems that a similar pattern of decomposition and delegation may occur with tasks during co-authoring (e.g., Chi et al., 2010; Raikundalia and Zhang, 2005; Ringel et al., 2004; Scheliga, 2015). In the case of conflicted or adversarial work, the

knowledge of the broader social and organizational context – of direct and indirect stakeholders – could be crucial (Cohen et al., 2000; Kriplean et al., 2007; Tam and Greenberg, 2006). Veer et al. (2011) argue for a complex task model to represent collaborative writing. An SIWO structure could provide part or all of a simpler form of support.

Using Shared Documents for a Conceptual Critique of Meeting Management and Task Management

As we wrote, above, certain work practices related to meetings are prevented by the ownership model of a calendar object, especially with regard to agenda documents. Similarly, co-authors frequently include suggestions, comments, and requests to one another within their shared documents. Each of these within-document actions might be considered an assigned task, or perhaps a micro-task. In this way, there is a potential hierarchy of SIWOs: The macro-level SIWO of the shared document may contain micro-level author-to-author-request SIWOs within it. Within this nested structure, we recall the interests of organizations to summarize or aggregate SIWO data in various ways. Applied to the shared document as a domain of work, one co-author of the shared document may want to query, "have I responded to all of the edit-requests made to me?", while another co-author may want to query, "are there any unmet requests remaining in the document?" Thus, the SIWO representation for a shared document gives further weight to SIWO attributes 9 and 10, which called for decomposition, with potentially different members in different roles. Similarly, if a meeting object were redefined as an SIWO, then the author of an agenda could represent each agenda item as an assigned task SIWO to the person responsible for that item.

Summary

In these four examples of common office activities and their representations – meetings, assigned tasks, requests, and shared documents -- we developed the concept of an SIWO, building up from work practices to a common set of abstractions about those practices. These abstractions help to make work and relationships more visible to direct and indirect stakeholders, and can thus help people to coordinate the one-off shared practices that can be important to work, workers, organizations, and relationship. Our hope is that the common set of abstractions will help designers to develop more consistent ways of creating, modifying, and visualizing the tasks and objects, and that they will help organizations to connect and compute across these tasks and objects. We now reconsider SIWOs from the perspective of theories of collaborative work.

Theoretical Development

Articulation Processes and Articulation Work

Strauss (1985; Strauss et al., 1985) proposed the principles of articulation processes, used by members of an organization to coordinate work and to repair work processes that were not "on track." The components of an articulation process might include "the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow" (Strauss, 1988). Articulation work has become an important way to theorize people, tasks, and objects in CSCW (Schmidt 2011; Schmidt and Bannon, 1992; Schmidt et al., 2007; Star and Griesemer, 1989).

In Strauss's terms, SIWOs might exist as subclasses of articulation processes. SIWOs are collections of people, documents, and tasks; and they also represent configurations and alignments of those components – very much in keeping with Strauss's theory. However, the focus of Strauss's work was workflows (1985, 1988; Strauss et al., 1985). By contrast, we have discussed aspects of SIWOs that involve less structured and less routinized workplace activities, such as meeting management and collaborative task management. Requests are often one-off events (Muller, 2017), and therefore do not conform to the more structured and replicable attributes of workflows. Meetings, tasks, requests, and even documents are often improvisational acts rather than components of an over-arching plan (Suchman, 1987, 1993). Our ideas about SIWOs are surely informed by Strauss's concepts of articulation, but they also address domains of work that are both *less formal* than workflows, and (sometimes) *more consequential* to organizational outcomes and personal reputations, than more quotidian concepts of workflows.

Coordinative Artifacts and Coordinative Mechanisms

Schmidt and Simone further developed concepts from articulation work (Schmidt and Bannon, 1992) into coordinative artifacts and coordinative mechanisms (Schmidt and Simone, 1996; see also Schmidt and Wagner, 2005). Based on Schmidt's recent integrative account (2011), a coordinative artifact may structure both individual and collective components of shared work, and includes coordinative mechanisms and/or protocols for that structuring. The use of a coordinative artifact is distinct from the actual work that it supports.

Coordinative artifacts support communication and awareness. Schmidt (2011) uses an example task of two people moving a set of furniture together:

> "by holding the table in their hands, they are both immediately 'aware' of the state of the table: its location in space (altitude, pitch, and roll), its velocity, its weight… In the act of carrying the table, the two men are causally interrelated." (p. 8)

In the case of remote or distributed work, the two or more members of the work do not physically hold the same object. We earlier wrote of a "stick," and Schmidt's table functions very much like our stick. The mutually-perceptible adjustments of the movers serve awareness functions similar to "jiggling the stick." The correspondence would be even stronger if the carriers of the table put documents onto the surface of the table.

An SIWO is clearly a type of coordinative artifact: Members inscribe a configuration of people, tasks, and documents into it, and other members should be allowed to read that configuration. Certain coordinative mechanisms are at least implied by that configuration. For example, meetings are called *by someone*, tasks are assigned *to someone*, and a request (if represented as an SIWO) may include the *requester*, the original *assignee* of the request, and also the *delegates* that s/he chooses after decomposing the request into sub-requests.

Interestingly, part of Schmidt's description (2011) of coordinative practices appears to treat the actual coordinative work in isolation. Writing about the task of two of the table, Schmidt notes that

> "In fact, we *do not need* to know the socio-economic roles of the two men: if either or both of them are wage earners and do this for a salary, or if they live there and do it for their own benefit, or if one of them is providing neighborly help… In short, we can focus on and investigate cooperative work and coordinative practices as a distinct domain of practice, while leaving the socio-economic and organizational setting in the background." (p. 10)

For a meeting, we think that the relationships and dispositions of the members may be important. In request management, the chain of requests may tell much about how the work is to be done, in terms of accuracy, accountability, and urgency, and thus also the social consequences for the organization and for the members. Our current sense of an SIWO emphasizes the importance of the direct and indirect stakeholders in the work that is supported through the SIWO. SIWOs are related to Schmidt's coordinative mechanisms, but they depend much more on social and organizational context for their configuration of members, tasks and content, and their practices, and their significance.

One possible reason for these contrasts may derive from the broader assumed context: Schmidt is writing, here and elsewhere, about the support of workflows. In his example, the two people who are moving the furniture are employed as movers, and they are doing their quotidian work. They have little personal interest in the table, and they go home at the end of the day to their own tables in their own homes. In contrast, SIWOs often support non-routine work. Meetings may or may not be routine, tasks may be conventional or unique, and requests are more often than not exceptions with organizational urgency driving them. Members live with the *consequences* of SIWO-supported work.

Relation Work

This discussion of the importance of stakeholders leads us think about Bjørn's and Christensen's concept of relation work (2011). In their view, Schmidt's articulation work is primarily concerned with tasks and their configurations. Bjørn and Christensen argue that relations among geographically-distributed people, and among people and artifacts, must necessarily be worked out *before* an articulation process can begin; relation work is thereby antecedent to articulation work:

> "What we suggest is a distinction between, on the one hand, articulation work, referring to "the specifics of putting together tasks, task sequences, task clusters – even aligning larger units such as lines of work and subprojects – in the service of work flow" (Strauss, 1988, p.164) and, on the other hand, relation work, understood as the fundamental efforts of achieving the very basic human and non-human relations that are a prerequisite for multi-site work..." (p. 139)

In the case described by Bjørn and Christensen, there was a single big project shared between two sites. Relation work was described as being *necessitated* by the difficulties of coordination over distance (e.g., Olson and Olson, 2000). The relation work of Bjørn and Christensen was generally conducted by knowledge-able people who knew the people at both their own site and the other site, and who had collectively developed skills to manage the challenges for remote work. There were easily observed differences in how the work progressed, when facilitated by people who were highly knowledgeable about the human-to-human working relationships, as contrasted to people who had less knowledge.

From our exploration of "Meetings as SIWOs," above, we recall that sharing information through meetings and calendars may be an important part of forming and honoring a relationship (Dittmar and Dardar, 2014; Thayer et al., 2012). An SIWO offers the potential for people to inscribe information about relationships and relation work among its parameters. Some organizational information can be derived from the official reporting structures (i.e., the hierarchical "org chart"). Other information might be computed from online traces of collaborative work, such as person-to-person relationships derived from co-authorship, dependencies among code modules, and (where available) email or social media response relations. Yet other information – especially about indirect stakeholders – might have to be entered by hand. In this way, SIWOs may require less human facilitation than the case in Bjørn and Christensen, and may provide a more personal and mobile form of awareness than what was visible in that case.

Discussion and Conclusion

We proposed a class of abstractions, namely SIWOs, to represent work, workers, and the objects of their work, and we developed a set of ten attributes of SIWOs, as summarized in Table 1. We used four common work activities (meetings, task management, request management, and document co-authoring) as the basis for

Table 1. Summary of SIWO attributes.

1.	A virtual object (suitable for computation and analysis),
2.	used to represent and support ordinary work, which is
3.	accessible by two or more people (members)
4.	who have a shared understanding of the referent of the virtual object
5.	and who can discern the status of the work through the virtual object
6.	the SIWO has social implications on one or more members.
7.	The members of an SIWO may have distinct social roles.
8.	These roles may involve different permissions on SIWO representations.
9.	The virtual object of an SIWO may be decomposed into sub-objects.
10.	Different sub-objects may be associated with different members.

this development (derived from Bellotti et al., 2004; Geyer et al., 2011; Heinrich and Maurer, 2000; Karger, 2011; Longo and Kelley, 2015; Muller et al., 2017; Neustaedter et al., 2009; Palen, 1999; Pongolini et al., 2011; Tullio et al., 2002). We think that the common attributes will make it easier for workers to recognize repeating attributes from one class of SIWOs to another, such as signaling (from awareness to status to completion-indicators), containers (from trivial to complex), and types of membership (including both direct and indirect stakeholders). We hope that a common basis in SIWOs will make it easier for workers to take a broad view of their own work, and the work of their colleagues, and their shared tasks and projects over time. We also think that the common attributes will aid organizations in appreciating, comparing, and governing those projects.

We related the concept of SIWO to major theories of collaborative work (Bjørn and Christensen, 2011; Schmidt, 2011; Strauss, 1985, 1988). We believe that researchers may find other domains which can also be usefully treated in this way.

Critique of Common Work Representations

We used the emergent attributes of SIWOs to critique existing representations of common work activities, such as meetings and tasks. These critiques were possible through abstraction of the common attributes of SIWOs (Table 1), which allow comparison and reciprocal informing of ideas. We hope these abstractions will assist other researchers to make similar comparisons, which can lead to both increased consistency of user experiences for these tasks and objects, and further insights into the current limitations in common products, services, and standards.

Review of SIWO as a Strong Concept

In their description of strong concepts as a type of contribution, Höök and Löwgren (2012) borrow evaluation criteria from Booth et al. (2008). We briefly consider SIWOs in terms of their three criteria:

- ***Contestable:*** A strong concept is contestable if it is novel and not universally shared. We have contrasted SIWOs with concepts of articulation work, coordination work, and relation work, and with conventional representations of work tasks and objects. We believe that the concept of SIWOs provides constructive contrasts with the previous work.
- ***Defensible:*** A strong concept is defensible if there are criteria for judging its contribution. We have argued for the "fit" of SIWOs to four domains and cases, and we have used the lack of fit of our initial formulation (e.g., attributes 1-6) to motivate our development of additional attributes (7-10).
- ***Substantive:*** A strong concept is substantive if it contributes new ideas that a community can work with. We have shown that the SIWO concept may help to unify our thinking across multiple work domains and shared objects. In addition, we have proposed ways that workers and organizations may make substantive use of these ideas.

Next Steps

We hope to design systems for organizational work using the SIWO abstraction, beginning with representations of requests and reminders. We hope that others may find this abstraction useful, and may experiment with thinking and designing based on SIWOs. We anticipate that the SIWO concept will change over time if researchers and designers gain experience and criticize this formulation.

In particular, we hope that SIWOs will influence the design of social attributes of future systems for collaborative work. We critiqued existing representations and their assumptions, based on the translation of observations from one domain (e.g., requests) to other domains (e.g., meetings, tasks), through the common conceptual substrate of a potential SIWO abstraction. We hope that we and others can use the abstraction of an SIWO for critical analysis of how assumptions and values about power and ownership find their way into designs (as argued in the more general case by Friedman et al., 2006).

Finally, we look forward to developing a better understanding of the relationship of transient and one-off work practices (Bellotti et al., 2004; Palen, 1999; Muller et al., 2017; Neustaedter et al., 2009) with the relatively routinized work practices that have been the focus of much of theoretical development (Bjørn and Christensen, 2011; Schmidt, 2011; Schmidt and Bannon, 1992). While we need to articulate, order, and coordinate our routine work and relationships, we have similar needs for unusual and non-repeating work activities. We hope that SIWOs can inform a series of representations that can unify these facets of work practices.

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Enterprise Assistant Service: Supporting Employees in the Digital Enterprise

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Abstract. Enterprises globally are seeking out and leveraging digital technologies to improve their performance and competitiveness. As data-driven personalization becomes an increasingly ubiquitous aspect of our digital experience, we believe it is likely that the rapidly digitizing workplace will explore systems for personalizing the support their employees receive. In this paper, we present our experience designing and experimenting with a pilot service that provided personalized digital tool recommendations to enterprise users, for work-related issues. This Enterprise Assistant service, or EAS, was offered for 10 weeks and served 24 users within the same enterprise. Users emailed the EAS with their questions and received personalized suggestions and follow-ups until their issue was resolved. The service addressed a variety of issues during the experiment, with a majority of users expressing interest in continuing to use it. One key finding is that user awareness of friction points in their daily workflows is quite low, leading to significant communication overhead simply to uncover an actionable issue for the EAS. We channel our findings towards design guidelines and opportunities for systems that aim to empower employees with personalized tools in our rapidly digitizing workplaces.

Introduction

Software increasingly shapes our personal and professional lifestyles by augmenting or replacing many previously analog systems of our life with digital tools (Wall Street Journal, 2011). The financial benefits of infrastructure and business workflow digitization are compelling enterprises globally to invest in broad digitization efforts in order to improve their competitiveness. By 2020, it is expected that almost 50% of IT budgets will be tied into digital transformation

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initiatives, and that 60% of the G2000 will double their productivity by digitally transforming any processes from human-based to software-based delivery (IDC, 2015). The software industry is responding to this demand aggressively, and as a result the digital enterprise application landscape is seeing annual growth of almost 20% (Forbes, 2015).

The software tools emerging from this wave of digitization serve the enterprise, and are creating some broad systemic effects regarding the anticipated role of human employees. McKinsey (2015) reports that "as many as 45% of the activities individuals are paid to perform can be automated by adapting currently demonstrated technologies". While individuals within an enterprise are increasingly becoming aware of digitization in the workplace, they discount its anticipated effect on their own jobs. The Pew Research Center (2016) reports that "even as many Americans expect that machines will take over a great deal of human employment, an even larger share (80%) expect that their own jobs or professions will remain largely unchanged and exist in their current forms 50 years from now." Lastly, a generational comfort-with-digital-tools divide is upon us in the workplace. Tech-savvy and experience-oriented Millennials became the majority in US workplaces in 2015, bringing with them new skills and values, and sharpening the contrast with Gen X workers (Elance-oDesk and Millennial Branding, 2014). Enterprises are therefore faced with the challenge of bridging the gap between the pace of technological change, and the skills and (varied) aptitude for technology amongst their workers amidst the pre-emptive directive of financial competitiveness and robustness.

Personalized data-driven services (e.g., social networks) are becoming a common aspect of our experience of the digital world. As software increasingly permeates and defines the enterprise, we expect that enterprises will experiment with various personalized support services for their employees as they navigate a rapidly digitizing enterprise infrastructure.

In a digitizing world, a basic question that an individual and an enterprise face is regarding the digital tool selection problem. Looking for a new tool or app is usually done by searching keywords in websites such as Google, Quora, ProductHunt, blogs, etc. However, searching using keywords can be inadequate because an individual may have to search many keywords until he/she finds the ones that provide the desired results. Moreover, accessibility to and visibility of these websites are not sufficient for some generations of enterprise employees.

On the other hand, there is no personalized search engine that looks for apps and software with the specification that the user wants. Since many of the apps designed for enterprises have multiple features, an individual may need to go through many of these features before finding the app that best fits his/her needs. This can be very time-consuming and frustrating. Even though one may use online stores for apps (such as the App Store and Google Play) or online software catalogues (such as Cnet.com, FileHippo.com, etc.) for this purpose, the obtained search results are based on textual searches whereas in EAS the focus is on functional search.

Our Service

To overcome the aforementioned issues with searching for new tools, we designed the Enterprise Assistant Service (EAS), which combines human attention and machine support. We call the human part of EAS "Enterprise Assistant" (EA).

During the 10-week period, 24 users engaged with the service, with an average of 4 users engaging with the service each week. On average, the EAS received 5 requests per week, a majority of which were successfully addressed. Two human EAs powered the EAS during the study, spending around 50 minutes on average on all activities related to a request from receipt to satisfactory resolution. 60% of users in our post-study survey expressed the desire to use the service again.

Our design and study experience yielded several insights that would benefit the designers of systems that generally aim to empower individuals with personalized tools in the rapidly digitizing workplace. First, there is a genuine need for personalized digital tool selection. When an individual found a digital tool (for instance, a piece of software) that did exactly what they needed it to do, they would immediately experiment with it within their workflow, and often come back to use the EAS again. At the same time, we observed a very broad lack of awareness of one's own workflow friction points in the workplace. This lack of awareness is sometimes attributable to the lack of personal or enterprise incentives for change, sometimes to workplace subcultures, and sometimes to behavioral inertia. Regardless of its cause, it leads to a lack of awareness of one's own needs, making it hard for an individual to know *what to ask for help with*. This gives us a significant opportunity to bring automation to address the problem of *identifying personal workflow friction points*. And while it seems to be hard for us to be aware of our own *internal* workflows and behaviors that could benefit from change, we seem to be excellent at pinpointing issues in workplace systems that are *external*. Several users utilized the EAS as an opportunity to vent and complain about an enterprise system or policy that was a workflow friction point for them, pointing to opportunities to utilize the EAS to estimate the institutional costs of certain policies and provide a quantifiable input towards operational changes.

Related Work

Personalization is an increasingly standard consideration in the design of services, and we subscribe to and are influenced by that zeitgeist. Our pilot service also stems from the inquiry of offering personalization in terms of supporting the usage of digital tools of employees in an enterprise (Yarosh et al., 2013; Churchill and Das Sarma, 2014; Liao et al., 2016). It is reported that knowledge workers are spending 50% of their time on the internet searching for the right information (Logical Design Solutions, 2014). Solutions to provide employees with more personalized and targeted search experiences are becoming critical for digital

enterprises (Logical Design Solutions, 2014).

The goal of EAS is to provide unconstrained search to enterprise employees, which can be framed as an "advice line." Therefore, EAS is different from services such as call centers which provide users with help only for a particular product. Given this difference and our goal of identifying potential problems with such services, which require a high level of personalization, a pilot study would fit better to our needs compared to approaches such as simulation (Mehrotra and Fama, 2003). Moreover, with the degree of complexity of the received requests and our requirements for a personalized service, technologies such as text and audio mining (Mishne et al., 2005; Kobayashi and Tsuda, 2016) could not be directly utilized for EAS as most of the processes were done manually.

It has been a decade since the panel of HCI researchers introduced the community to the then emerging area of "service innovation and design" at various institutions, positioning it as a valuable and rapidly expanding source of applied research and impact (Bloomberg and Evenson, 2006). Since then, more studies have been conducted, offering ideas on what constitute successful service in industries and how to provide it to employees. Among many of these studies, our studies are especially motivated by the idea of "technology as an enabler" (Jacob, 2016), and whether a service that offers suggestions for the usage of digital tool could function as a "hygiene factor or motivator" (Herzberg, 1966; Herzberg, 2003) for employees. Both may eventually improve efficiency at work, but the two suggest different approaches for designing an effective service (Herzberg, 1966; Herzberg, 2003; Ma and Qi, 2005; Briggs and Thomas, 2015; Jacob, 2016). In our study, we found that technology was more a hygiene factor that removed friction points at work, rather than a motivator.

Research in work practice studies has examined the experiences of employees using technologies – in other words, how employees are actually using technologies at work. Taking a holistic perspective in understanding work, their studies have informed the development of technologies, ways of working, and discovered the notion of "workspaces" (Szymanski and Whalen, 2011), which captures the social nature of technology at work. This perspective renders technologies merely devices that constitute the interrelated workplace of people, communal practices, and environments. Based on their understanding of work and technology, technologies or digital services adopted at work need to be examined in contexts, or in an enterprise as an organizational whole (Szymanski and Whalen, 2011; Suchman, 1995). Using ethnography and other approaches, researchers have studied humans in the system such as in call centers to examine the mechanism of the system. They have investigated call center staff and understood its operation as a consultative work (Muller et al., 1995). In addition, the complexity, dynamics, and stressfulness of knowledge work of these agents has been revealed and documented (Szymanski et al., 2002). A close examination of the complex workflow of EAs as the humans-in-the-loop was beyond the scope of this study; however, we acknowledge its need for the service design and improvement as the size of EAS increases in the future. In the spirit of work practice studies, we devoted a significant amount of time to understanding the

contexts in which our users did or did not use EAS and how it did or did not integrate into their existing way of working, and report on these findings in later sections.

Service Design

Procedure

For the initial bootstrapping of the service, we sent out a survey to group of 26 employees of the enterprise. The survey included some questions regarding demographic information and digital tools that users use regularly. Moreover, we asked some questions about the issues they might face in their workflow, such as: "We use digital tools (software and hardware) every day to get our work done. Could you name one instance where the interaction with such digital tools is frustrating for you, in terms of getting your work done?"

After that phase, users were recruited in multiple phases using different promotion strategies in different departments. This was to raise the awareness of our service in our enterprise (within our company and outside our company), and to develop and build a strong user base for our project. Using various promotion methods – email, social networking services, in-person, etc., we approached 114 people in total. We emailed 87 people, reached out to 46 of them in person, and casually approached 27 people in person while placing promotion materials in the buildings. Throughout our study, the number of our users grew to 24, which shows a success rate of 21%.

Two undergraduate students, who were "digital natives" with a technology background, were hired as EAs for the service. They collected experimental data and analyzed the data for the development of the EAS. The EAs were anonymous to the users of the service.

Service Flow

When a user faced an issue in their workflow and wanted to select a tool to overcome the issue, they would communicate the issue through email to EAS. Each issue that a user sends is called a request. After receiving the request, one or more of the EAs would ask for a deadline, and then work on the issue, suggesting a tool to the user to resolve the issue or asking some questions in order to first clarify the issue. If the suggestion was what the user was looking for, EAs would assume that request to be closed. Otherwise, EAs would continue communicating with the users in order to resolve the issue to the fullest possible extent. In this process, EAs focused on three questions: "What tools to use?", "How to use the tool?" and "How to personalize the tool?" EAs used search engines, EAS databases on previously asked requests/solutions, tools, and user related information (such as the OS they use) in order to select a tool.

EAs collected demographic data and information about the user's phones, PC

machines, etc. Moreover, they tried to collect as much information on users and user issues as possible through their communication with users. For instance, if a user reported an issue regarding their Outlook, and EAs asked for its version, the information was recorded for potential future requests.

The workflow of EAs was closely observed in order to determine how to optimize the EAS process. EAs met with the EAS team every day for an hour to discuss any issues they encountered in solving the requests, but the meetings became infrequent toward the end of the study as EAs became more accustomed to their work. For more efficient and quality searches, peer support was suggested.

Research Design

During the 10-week pilot study, the EAS team contacted 46 users for in-person follow up of the people whom we invited by emails. The length of each meeting varied from 10 minutes to one hour. At the meetings, the EAS team collected feedback from users and employees regarding promotion methods and issues they encountered while using our service. We also conducted a survey to get user feedback two weeks after the pilot study had concluded.

Participants/Users

24 employees (10 females and 14 males) were recruited as volunteer (non-paid) users from our company. Participants ranged in age from their 20s to 50s, with more than half in their 40s and 50s. This turned out to be a limitation of this study. They were all "knowledge workers," and their job functions varied from administration, business, research, to management.

To distinguish our service from the organizational IT support and conducting the internet search, the goal of the EAS was to offer personalized solutions to each user. Thus, the understanding of each user issue while clarifying and acknowledging their requests was the key. For that purpose, the EAS team provided EAs with documents presenting Email Guidelines and Email Templates for communicating with user at each phase of the EAS. Utilizing the strength of human EAs, we made our service as humanlike as possible so that users could feel that they were actively being listened to and engaged by EAs.

Data Analysis

We analyzed four data sets for our study; 1) data on users and requests collected by EAs and entered into databases; 2) emails between EAs and users; 3) notes from in-person follow-up meetings and promotion with users and employees; and 4) user responses and feedback in the initial bootstrapping survey and post-service survey. The numbers of users and requests were counted weekly and organized as a data set for each analysis. All the data sets were cross-referenced

during this study. As such, we combined qualitative and quantitative analysis in this study.

Analysis and Findings

Request Analysis

Throughout the study, the EAS received 48 requests. These requests fell into different categories and some of them were not really of the nature that was expected for this service. EAs were not able to provide any suggestion for these particular requests. In order to understand requests more appropriate for the EAS, we categorized requests based on 1) type, 2) status, and 3) nature as follows:

(1) Type:

- IT: requests about issues that can be solved only by the IT department such as "WiFi is not working".
- Enterprise Infrastructure: the requests which are about the issues concerning the websites or services provided to employees by the enterprise, which the authors are affiliated. "Expense report website is not working" is an example of a request in this category.
- Q & A: requests which cover issues with the tools that they are currently using and asked for solutions to improve their interactions with these tools. Two of the requests that we received in this category were "how to add hyperlink to a part of a text in an excel cell" and "how to export part of an email to an Excel sheet in Outlook".
- Non-work related: requests which, for EAS, were not directly related to issues that one may have with their workflow. "Is there a text expander for iPhone" is a question in this category.
- Enterprise: requests specifically asked for new apps, service, etc. in order to address an issue in the workflow and possibly increase efficiency. "Looking for a collaboration software" and "looking for a free knowledge base tool" were two requests in this category that EAS received. For each of these requests, users specified some requirements.
- Development: requests related to issues one may have in development tasks, such as "How to resolve undocumented bugs while using a software."

(2) Status:

- Success: a request is called Success if the requester informed the EAS that they were happy with the suggested solution.
- On Going: a request is On Going if the EAS is still working on it.
- Out of Scope: a request is Out of Scope if it is beyond the scope of the EAS, meaning that EAs were not able to provide a solution by doing a publicly available search. In general, we considered IT, Enterprise Infrastructure and Development requests to be Out of Scope because they required EAs

to have some special privileges from the associated departments or software/coding skills to address those requests. Moreover, these requests could be handled by the associated department itself. “WiFi is not working” and “expense report website is not working” are two examples of the questions in this category.

- Time Out: a request is called Time Out if the requester stopped communicating with the EAS before the issue is resolved.

(3) Nature:

- Requests asking for the information: requests which want to obtain the information about the tool of inquiry, or about how requesters can improve their interactions with the tools. “How can we amp up a presentation?” and “is there a free or inexpensive tool to combine video and audio files in QuickTime?” are examples of requests in this category.
- Requests trying to overcome hindering factors: requests which want to find ways to overcome frictions between the tool of inquiry and their workflow, such as “My mouse is not working. It is too slow, and replacement batteries did not work” and “how can I get Wifi working?”
- Requests trying to find ways to become more productive: requests which ask for ways to make workflow more efficient and productive than what is foreseen with current solutions (apps, software, service, etc.). Examples of requests here are “what is the most convenient way to get files from Mac to my PC?” and “is it possible to keep track of signatures required for a document?”

The “type” categorization helped us understand the issues that users were dealing with. The “status” categorization provided a measurement of the EAS success, and finally, the “nature” categorization reflected a pain point that users tried to resolve with their request. Table I shows the breakdown in each category.

Table I. Breakdown of requests

IT	Ent. Infra.	Q&A	Non-work	Ent.	Dev.
6	7	9	3	20	3
Success	On Going	Out of Scope		Time Out	
15	7	13		13	
Want info.		Hindering		Productivity	
18		12		18	

As for the Out of Scope requests, EAs didn’t immediately decline them so that we could examine the boundaries of the EAS. Among the 13 Out of Scope requests, EAs provided indirect but personalized suggestions to 11 of them.

In order to understand how each of the previously explained categorizations is represented in Success requests and Out of Scope requests, we performed the

following analysis

According to Table I, 15 requests, or 31% out of the total 48 requests were Success, while 13 requests, 27%, were Out of Scope.

60% of 15 Success requests fell under Enterprise, which was higher than 42% of the total 48 requests in Type categorization. 53.3% of Success requests asked for information, which was also slightly higher than 53.3% of the total requests in Nature categorization. On the other hand, 6.7% of Success requests wanted to remove hindering factors, which was lower than 25% of the total requests in Nature categorization.

54% of 13 Out of Scope requests were regarding Enterprise Infrastructure, which was higher than 15% of the total requests in Type categorization. 84.6% of Out of Scope requests were for removing hindering factors, which was higher than 25% of the total requests in Nature categorization.

Thus, requests that categorized as Enterprise and that asked for the information resulted in higher success rate, while requests that addressed the issues of Enterprise Infrastructure and that wanted to remove hindering factors more likely ended up in Out of Scope.

User Engagement Analysis

We had 24 users and 48 requests during our 10-week pilot study. In this section, we provide a closer look at users by examining 1) user growth and engagement based on user and request counts for 10 weeks and 2) user experience with the EAS, in particular, how many of the users had a successful experience in receiving their personalized solutions.

(1) Active users:

We classified users into two groups as it is shown in Figure 1. New users are those who sent their requests to the EAs and interacted with them for the first time. Existing users are those who had previously interacted with EAs and returned to our service. The largest number of users was 9, including 6 new users and 3 existing users in Week 8, following massive promotion strategies in the previous week. However, EAS was not able to acquire any new users in weeks 9 and 10.

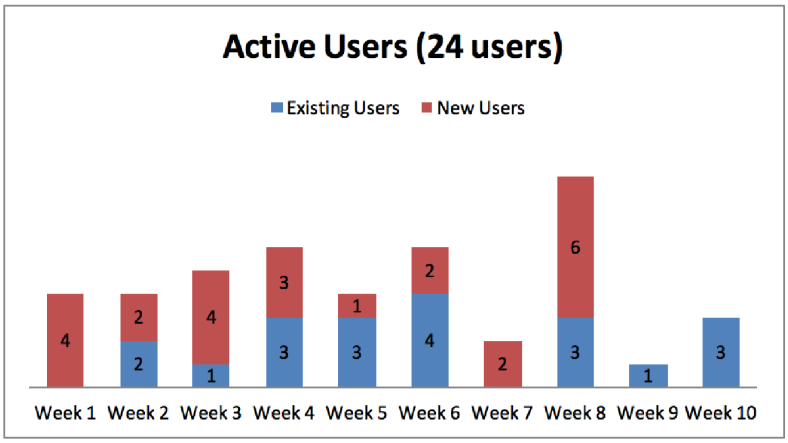

Figure 1. Active users.

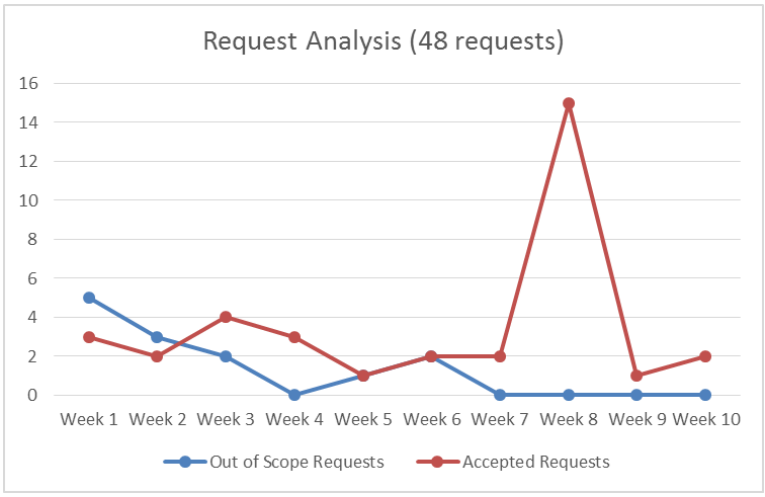

Figure 2. Request analysis.

Figure 2 presents the breakdown of 48 requests into Accepted and Out of Scope requests. We defined Accepted requests as the requests that were not determined as Out of Scope and that were processed with EAS for suggesting personalized solutions. This includes the requests that were eventually categorized as Success, On Going, and Time Out in EAS offering as shown in Table I and Figure 3. It illustrates that the number of Out of Scope requests decreased toward the end of our service. As seen in Figure 2, there were 13 requests which were considered Out of Scope in 10 weeks. Many of them were concentrated in the first three weeks. Also, our collected data demonstrates that all Out of Scope requests were made by new users each week. On the other hand, we found out that users who continued to use our service submitted requests which were not Out of Scope, even though they sent an Out of Scope request as their first request, as seen in users 1, 2, and 19 in Figure 3. We believe that these users realized the scope of the service and returned to our service with appropriate requests, which contributed to the decline of the Out of Scope requests.

(2) User success with the EAS:
Based on request results, 24 users were categorized into 4 groups according to their experiences with the EAS: 1) users who only had Out of Scope requests, 2) users who experienced at least one success with our service, 3) users whose interactions with the EAS were ongoing, and 4) users whose requests timed out. A success was recorded when users responded to the EAs with appreciation after the EAS sent them our solutions. Users with ongoing interactions mean that the EAS has not completed their requests and still in touch with users. Users whose requests timed out are those whose interactions faded out due to an extended response time (usually after 3 business days). Our analysis shows that 38% of users (9 users) had at least one success in submitting their requests, 33% (8 users) submitted only Out of Scope request(s), followed by 25% (6 users) whose requests had timed out.

A closer look at users and their requests in Figure 3 demonstrates that users with Out of Scope requests were more likely to not continue using the service, contrasting with those users whose requests fell under other categories. In addition, when the requests timed out (such as for users 14, 15, 16, 18, and 21), those users also did not return to our service. These two observations suggest that reducing the number of Out of Scope requests and Time Out requests is a key for the continuing growth of our service.

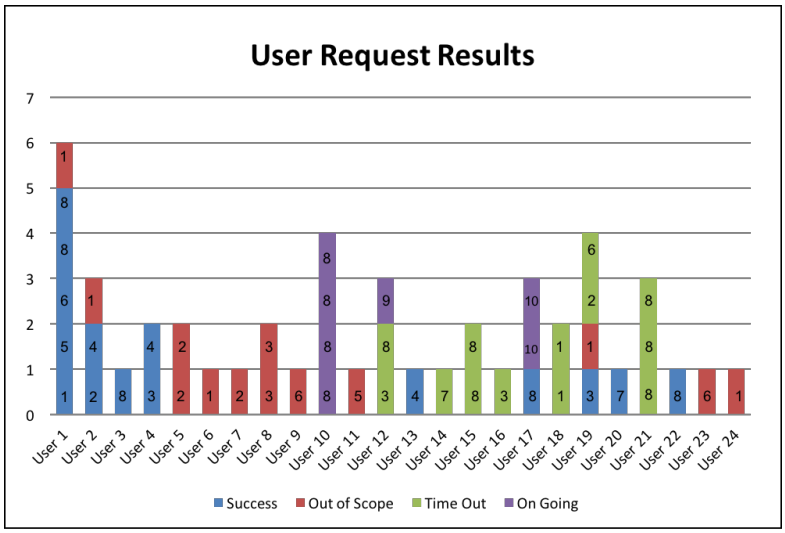

Figure 3. User request results. User numbers are given randomly in this figure. The numbers in bars show the week numbers that users submitted each request to EAS.

Service Feature Analysis

In this section, we examine user frictions and expectations for the EAS by analyzing the result of user survey responses and feedback conducted two weeks later.

We conducted a survey to get user feedback two weeks after the pilot study was completed. Surveys were distributed to 23 users in person and to 1 by email. They were collected from 20 out of 23 users, 40% female and 60% male.

Regarding the user experience of the EAS, we asked several questions on suggestions and service. Results indicate that about 45% the respondents (n = 9) were either very satisfied (n = 5) or somewhat satisfied (n = 4) with the suggestions that the EAS offered. Including those who had neutral responses to our suggestions, a majority of the respondents (n = 17) were satisfied or neutral with the suggestions that the EA service gave them. Computing the Mode value for the Likert item regarding suggestion, we deduce that neutral option has been chosen more often by the users.

As for the EAS as a service, the value of Mode represents that users chose very satisfied and neutral with the same frequency. More than half of the users were either very satisfied (n = 6) or somewhat satisfied (n = 5) with the EAS as a service.

The dissatisfaction for our service and suggestions were the same (n = 2 and n = 1 people for somewhat unsatisfied and unsatisfied with the suggestions, respectively). Those who were dissatisfied with our suggestions were also dissatisfied with our service. Based on the results for another question in the survey, among the 20 respondents, 60% of them have tried out the solutions.

Since the goal of our service was to improve workplace productivity by offering personalized solutions using digital tools, we asked whether the users were able to save or gain any relevant resources, such as time, money, mind-space (attention), or information. The results show that respondents gained more new information from using our service (n = 10), followed by time (n = 8), mind-space (n = 6), and lastly, money (n = 3). Please note that not all users responded to this question, and some users chose more than one answer.

Based on the results for the last question in the survey, a majority of respondents stated that they are very likely (n = 7) or somewhat likely (n = 5) to use our service again. The value of the Mode states that many of the respondents are very likely to use the service again. Moreover, 5 people chose neutral for this question, and 2 and 1 people chose somewhat unlikely and unlikely for this question, respectively.

Correlation between Likert items:

To further analyze the results of the survey, we computed Spearman's correlation coefficient to find the following correlations: 1) correlation between user satisfaction with the service and the likelihood of using the service again, and 2) correlation between user satisfaction with suggestions and the likelihood of using the service again. The correlation coefficients are 0.96 and 0.95, respectively. These values show a strong correlation which is predictable.

Moreover, we wanted to know if there is any difference between two groups, (who tried out the solution and who didn't) in their responses to three Likert items (satisfaction with service, satisfaction with suggestion, likelihood of using the

service again). We used two-sided Mann-Whitney test with $\langle = 0.05$, which we determined to be an appropriate test given the small size of data set. The obtained p-values are 0.46, 0.3, 0.3, respectively. This shows that there is no statistically significant difference for these items between the two groups.

Correlation between Likert items and requests:

As explained before, all the requests are categorized into four groups based on the status: Out of Scope, Time Out, Success, and On Going. In order to see if there is any difference between these groups in terms of the responses to three Likert items (satisfaction with service, satisfaction with suggestion, likelihood of using the service again), we used Kruskal-Wallis test with $\langle = 0.05$. However, we didn't observe any statistically significant difference between these groups of requests for any of the Likert items ($p > 0.05$).

We repeated the same procedure detailed above for the categorization based on nature: if they were addressing hindering, productivity or looking for information. Similarly, we didn't observe any significant difference between the three groups of these requests for any of the Likert items ($p > 0.05$). However, the values of Mode suggest that users responded neutral more frequently to all three Likert items when the request was categorized as hindering, but very satisfied and very likely to try out when the request was categorized as looking for information or productivity.

Correlation between Likert items and user profiles:

Finally, to see if there is any difference based on gender to three Likert item responses, we used a Mann-Whitney test with $\langle = 0.05$. Again, the computed p-value ($p > 0.05$) suggested that there is no statistically significant difference between genders for the responses.

Reflections and Guidelines

Here, we take a step back to reflect more broadly on our experience and findings by analyzing the notes from the in-person follow up, the result of user survey responses and feedback presented in the previous section. We also offer guidelines to designers of personalized digital tool support systems.

- *The Quick-Query Expectation*

In a world where information searches are done with entering query terms in a search engine, where messaging platforms (e.g., Slack, Facebook Messenger) have removed the need to provide "subject lines" for short communication, and the rise of voice-driven assistants like Apple's Siri and Amazon's Alexa, users experienced email as a costly query interface for a perceived information service. User feedback revealed that users felt the need to structure their query like a

proper email, which not only took them further from the modern keyword-based query mindset but inhibited them from actually sending some queries due to the anticipated wait time for an explanation. Given the "always-on" nature of web service, our query behavior has evolved into an iterative one where we may start from a vague query and use the instantaneous and sometimes erroneous results to shape the query itself. Email as the only available channel to interact with the EAS required more cogent queries, which reduced how frequently users queried the EAS.

● *The Always-On Expectation*

A related expectation was for the EAS to be always-on and to respond immediately. With humans involved in the loop of the EAS, this was not the experience we offered during the study. A variety of automated response mechanisms can mitigate the sense of "query lost in the void" that comes from latency in digital services, even though it cannot be completely eliminated in the current design of the EAS where the human has a crucial part to play.

● *The Fix-our-Shared-Problems Expectation*

Enterprise problems that are regularly experienced and shared by several users in an enterprise, such as infrastructure (e.g., WiFi) and policy (e.g., travel booking and reimbursement) issues, were more easily mentally accessible for our users as reportable issues for the EAS. 15% of the requests in our study (Table I) were about the enterprise infrastructure. Fixing enterprise and policy issues was Out of Scope of the EAS, but requests of that nature were the vast majority (10 out of 13) amongst those eventually marked as Out of Scope. The ability to easily recognize and point out hindering factors regarding the expected environment in their workplace points to a system design where the EAS matches quantitative data revealed by group participants to policy stakeholders in an enterprise. We see addressing these issues as "hygiene" factors in terms of the discussion pioneered by Herzberg (1966), and continued by Briggs and Thomas (2015) and Tuck and Hornbaek (2015).

● *The Lack of Awareness of Self-Need*

In contrast to the obviousness of the impact of shared problems on an individual's experience, we found that most users had a very low awareness of the friction points in their own workflows. Although they would recognize friction points that the EAS could help them with during in-person conversations, and they would find a match between our sample problem digests and their own needs, it was clear that individuals had in general adapted to workflow issues that may initially or previously have been considered a friction point. As opposed to shared problems, whose awareness was likely higher on account of social sharing and venting about those problems, individual problems did not benefit from the same mindshare. This lack of self-need is in particular a significant challenge towards scaling a service like the EAS. There is a significant opportunity to provide behavioral analytics that automate or assist with the process of uncovering individual needs in the enterprise.

● *The Inertial Mindset*

Based on the user feedback, we could observe that in a large enterprise, such as

the one where the study was conducted, employees deal with tasks within some set conditions, and they don't necessarily look for new ways to do their tasks. If they face any issue, they usually have a workaround which is not necessarily efficient. This observation is consistent with a study result which states that less than one-third of U.S. employees were engaged in 2014, with 17.5% "actively disengaged" and 51.4% "not engaged" (Gallup, 2015). We believe that significant efforts toward cultural change and support is necessary to enable at-scale adoption of digital tools by employees to improve their efficiency.

- *The Financial Floor*

A human Enterprise Assistant spent 50 minutes on average addressing each request. Therefore, each request cost almost $17 for our pilot study. Even though this cost is comparable with other assistant services, it is not clear if an enterprise would invest in such a service at these prices for their broad employee base, or for just a selection of them. Certainly, there are various opportunities to automate various aspects of the EAS and to bring its human cost down; moreover, the greater the number of users, the lower the cost per user because of higher rate of repeat questions, and the value afforded by connecting individuals with questions to individual with answers.

- *The Human Factor Expectation*

The presence of human beings as part of the service is quickly revealed to end-users because of the sophistication of responses to their initial email query. This awareness of a human-in-the-loop has an interesting side-effect on the EAS end-user: they start expecting a higher level of customer service, such as one might get from a customer service call center. Our intention in including humans as part of the EAS was to address the limitations of search options to solve the digital tool selection problem, valuing them for their ability to curate personalized solutions. As humans, they are perceived to have other values by our end-users as well, such as the ability to provide a higher level of service beyond personalized solutions to the digital tool selection problem. This may take the form of wanting the human EAs to be dispatched to their workplaces to assist them in person, perhaps influenced by expectations of the support offered by typical enterprise IT departments. This poses an interesting challenge for EAS-like systems to design for communicating the availability of its human and the machine components clearly.

When these expectations were not met, users experienced a friction between their expectation of the EAS and its actual abilities, resulting in Out of Scope or some Time Out requests. Two-thirds of users who experienced the two were unlikely to return to our service. We offer these reflections and suggest vectors of resolution above to designers of future systems for solving the personalized digital tool selection problem in the enterprise.

Conclusions and Future Work

As enterprises definitively digitize an increasing amount of their functions and

operations, they face challenges in supporting their human resources with navigating the changing, increasingly digitally assisted nature of their work. We expect enterprises to explore personalized solutions for support services in the rapidly digitizing workplace, given the abundance of and access to digital tools (e.g., software) today. However, the long tail of applications, the multiplicity of features supported in individual applications, and the lack of efficient search engines for matching applications with user needs makes us look towards human-machine hybrid services to solve the digital tool selection problem: What digital tool can I use to address my need? In this paper, we reported on the design of such a hybrid service, described a 10-week study carried out with 24 users in an enterprise who used the service, and analyzed and reflected on a wide variety of findings. We note that the need for personalized digital tools is real, but the awareness of the possibility of improvements in one's workflow is low. Macro forces related to the march of technology are forcing the awareness for improved utilization of human resources on enterprises, and here we offer our findings on the behavior around, and expectations for such services to designers of future systems.

A variety of future work opportunities to improve the automated support available in the Enterprise Assistant Service are described in the paper. These focuses both on helping the human Enterprise Assistants with matching incoming queries with internal curated databases and their overall workflow, as well as serving end-users better with automated communication tools. Our own experience points us in the direction of exploring automated or assisted behavior analytics, where we address the problem of identifying needs of employees in an enterprise by analyzing the gap between expectations placed on them and their current behavior using a mixture of qualitative and quantitative tools.

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Batching, Error Checking and Data Collecting: Understanding Data Entry in a Financial Office

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Abstract. Data entry is a core computing activity performed by office workers every day. Prior research on this topic has tended to study data entry in controlled lab environments. In this paper, we interviewed nine financial administrators from two large universities to learn about their practices for conducting data entry work. We found that financial information often has to be retrieved from multiple electronic and paper sources, and involves briefly keeping items in memory when switching between sources. Interviewees reported that they batched a lot of data entry tasks into a single session to complete the work quickly, and mitigated the risk of data entry errors by time-consuming practices of double-checking. However, prior lab studies suggest that double-checking is a poor strategy as it takes time and people are poor at spotting errors. This work has implications for how future data entry research should be conducted.

Introduction

Data entry is a common task: office administrators have to manually enter considerable amounts of information. Beyond the work setting, many people complete similar data entry tasks, such as entering bank details when making payments online. What challenges do people experience when performing data entry tasks in the workplace?

Despite data entry often being a relatively straightforward task, errors happen and the consequences can range from mildly annoying to very severe. Mistyping your credit card details will stop a payment from going through, yet in other cases,

errors can be much more serious: in 2015 one data entry error accidentally caused $6 billion US dollars to be transferred from a UK bank to a US hedge fund (Arnold & Martin, 2015).

Studies have shown that creating interfaces to slow down data entry (Gould et al., 2016), by requiring additional information (Wiseman et al., 2013) or using alternative input technology (Oladimeji, Thimbleby & Cox, 2011) can reduce error rates in the lab. However, it is not clear how such solutions would work outside of the lab (e.g. Gould et al., 2016). In lab studies, users are given clear instructions and are given the data to enter. In everyday computer use, data entry tasks might not be so clearly prescribed (Evans & Wobbrock, 2012). These tasks are done in a wider task context, which can influence how people carry out the task. It is therefore important to not only look at people's typing performance using a well-structured task, but also at data entry in the environment in which these tasks are normally performed. How do people organise their work within office environments, and what are their reasons for doing their work this way? Does it differ from behaviour seen in laboratory studies of data entry?

In this paper, we present a situated interview study with nine office workers from financial administration offices. Our aim was to learn about the type of data entry tasks people deal with in a workplace and the task strategies they adopt. This paper describes commonly observed workarounds seen in office settings when people do data entry. For example, if people have to navigate away from the data entry system to collect data, they often choose to hold items in memory, even though they have tools available to reduce their workload. This paper contributes to further data entry research: in order to develop interventions that support people in data entry tasks, it is important to understand what these tasks look like in practice.

Related Work

Numerous lab studies have investigated the strategies people adopt while entering data. In a typical study, the procedure is highly structured. The participants are given data by the researchers and enter this into an interactive device. Such studies have demonstrated how people allocate their attention between the source and the interface (Gray et al., 2006), and how interface design choices can impact both where people look and the prevalence of errors (Oladimeji et al., 2011).

Given the potentially severe consequences of data entry errors, efforts have been made to develop and evaluate interventions to increase accuracy and prevent errors. For example, Li et al. (2016) demonstrated that participants in a lab can be motivated to be more accurate through both rewarding good behaviour and punishing poor behaviour. However, Wiseman et al. (2015) has shown that the existence of a secondary task has a negative impact on checking behaviour. Similarly, Gould et al. (2016) studied the effectiveness of a lockout system in a number entry task. The lockout system disabled the interface for a few seconds

after each number was entered, and was found to be effective in encouraging people to check and detect errors. However, when the intervention was moved from a monotask setting to a multitasking environment a longer lockout made people more likely to switch to other tasks instead (Gould et al., 2016; Katidioti & Taatgen, 2013). Data entry tasks are often conducted in office environments in which work is fragmented by interruptions (Mark, Gonzalez & Harris, 2005). Tasks can be spread across different media and involve going in and out of several applications (Bardram, Bunde-Pedersen, & Soegaard, 2006; Su, Brdiczka, & Begole, 2013). While an increasing number of devices are being used to help manage this fragmentation (e.g. Jokela, Ojala, & Olsson, 2015), it is still up to users to organise their work across these devices. How do people carry out data entry tasks in these type of settings?

Given the fragmented nature of an office workplace, it is not clear to what extent results from the laboratory will transfer into effective interventions if implemented in a workplace. In order to design effective data entry interfaces that support accurate task execution, it is important to understand the situated environment in which people conduct data entry tasks, how they conduct these tasks and why. In this paper we investigate how data entry work is organised in a finance office environment, and explore people's current data entry practices within this setting.

Method

As the nature of the study was exploratory, semi-structured interviews were used. The method allowed us to gain insight into people's motives behind adopted strategies and potential situational factors influencing their practices. Furthermore, the method was useful for recalling incidents when certain strategies did not work or caused errors, and people had to employ workarounds.

We conducted semi-structured interviews with financial administrators at their workplace. This user group deals with processing financial data as part of their job, and it is important that data is entered accurately, but there is also time pressure to finish work by a deadline. They were asked about their data entry work, and asked to show the data entry system and information sources they worked with.

Participants

Nine participants (four male), aged between 18 and 52 (two participants wished to not disclose their age), took part in the study. They were employees from two public universities and their work involved receiving requests for payment, checking the information of these requests was correct, and entering the information, along with additional administration data, into a financial computer system. People's level of experience differed: some participants had just started

doing this type of job, whereas other participants had been working in Finance for 17 years. All participants were reimbursed with a £10 Amazon gift voucher.

Procedure

The interview took place at the participant's workplace. Participants were verbally informed about the study and were asked to read and sign a consent form giving further information about the study. After this, participants were asked to talk about their work. Interview questions asked about data entry tasks, and the physical and organisational environment in which this work was done. To support their explanations, participants showed their data entry system and documents they use for data entry tasks. They also demonstrated entering data into their data entry system, and showed the steps involved in this task. The interviews lasted around 40 minutes.

Data collection and analysis

A voice recorder was used to capture the interviews. One participant did not wish to be audio recorded and one interview could not be audio recorded due to technical issues, so for these two interviews notes were instead taken by the researcher with pen and paper. For the remaining seven interviews, notes were only made of observations that could not be captured on the audio recordings, such as work artefacts that were shown to the researcher during the interview. We made photographs of the work environment, and collected screenshots of the data entry systems. All audio recordings were transcribed verbatim. The transcripts and notes were analysed using thematic analysis (Braun & Clarke, 2006).

Findings & Discussion

The purpose of this study was to gain a better understanding of the situated context in which people conduct data entry tasks in a finance office setting, and how people organise their data entry work within this setting. In this section we report the key themes from our data.

Validating payment requests

All participants mentioned a large part of their data entry work was checking that forms had been completed correctly, and performing further calculations on financial values. Participants reported receiving different requests for payments, which could include expense claims from staff, salary slips, and invoices. Before entering any data, they first had to check that information on these requests was correct (e.g., checking expense codes, missing data, checking the expenses on a

claim form against the original receipts). In many cases further calculations had to be performed, typically on financial values. For example, they had to make sure that the total sum of individual expenses was correct, foreign currencies were correctly converted, and net salaries had to be calculated from gross salaries. These calculations had to be done manually and some of these were described as time-consuming:

> "It [the system] doesn't give you a quick calculation from net to gross. And that usually is very, very, time-consuming, because it could take up to 20 minutes to half an hour." (P9)

Entering data from multiple information sources

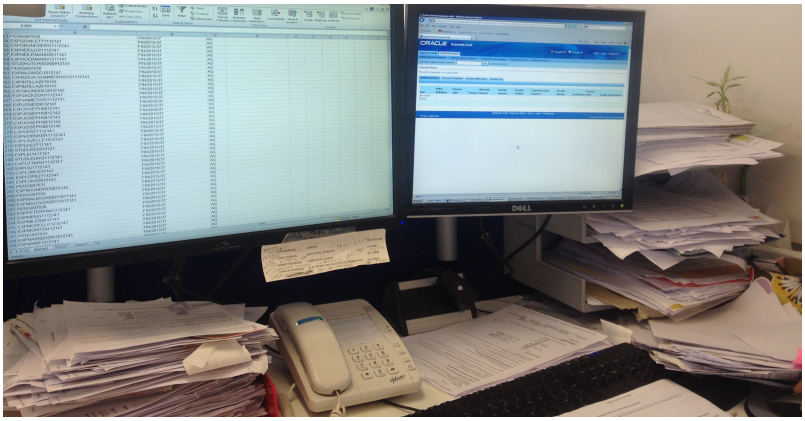

Figure 1. Data had to be entered into an electronic computer system (right screen), but first had to be retrieved from electronic spreadsheets (left screen) and paper documents.

After checking that the data on the form was correct, workers had to enter this information, along with additional data from other sources, into the data entry system. Figure 1 shows a photo of a typical work environment, and captures a couple of examples of the data sources from which data had to be retrieved. Information for completing a single payment request could be spread across Excel spreadsheets, work e-mails, PDF documents or databases. Some documents, such as receipts and claim forms, had to be given on paper. The sources discussed in this study usually contained a range of data, not all of which was relevant to the task. Workers had to find the information they needed and enter it into the data entry system. This created opportunities for errors to be made. P4 felt it was much easier to make errors when copying from paper, and preferred digital files. However, the multitude of digital sources people dealt with introduced the challenge of limited screen space to present it all.

The use of multiple information sources is in line with previous studies that showed the fragmented nature of an office workplace (e.g. Mark et al., 2005; Su, Brdiczka, & Begole, 2013). It was common that people had to go in and out of different windows to collect information. If participants had to find information in a digital document or website, they had to navigate away from the data entry

system, look up and find the relevant information, and then come back. P7 mentioned that switching between multiple screens for one task made the task more difficult:

> "It can be quite complicated, and there are quite a lot of different screens to input." (P7).

It was surprising to learn that the software tools that were used for these data entry tasks often filled the entire screen and could not be minimised. Rather than writing information down, participants often tried to hold the information in their memory when switching back to the entry system:

> "I wouldn't necessarily have to [memorise it], it's more […] if you have to keep flicking back to different things, it's sometimes just easier to try and remember it. But you can obviously take the long version and keep flicking back to the correct screen." (P3)

This memory-based strategy is explained by previous lab studies suggesting people make strategic use of their internal and external resources to minimise time, and do not always minimise use of memory (Gray et al., 2006). In lab studies, people are occasionally required to briefly hold items in memory, and are not given any tools to decrease their memory load (e.g. Li et al., 2016). It is interesting to learn that even when the tools were readily available in the workplace, people often still chose to memorise data rather than writing it down. Though participants were aware they did not have to remember information, they thought it was easier and faster than looking it up or writing it down. However, this strategy carries the risk that they misremember it and make entry errors. People reported they sometimes went back to the wrong screen and entered the information in the wrong document:

> "If you, by mistake, left that menu, and went into another linking menu that comes up with somebody else's payroll number, you would never know that you're inputting somebody else's calculation into another record. You have to be so careful." (P9).

The information sources contained task-irrelevant information as well, and it would sometimes take a while before the right data to enter was found. Finding the right data from multiple sources amongst task-irrelevant information differs from the set-up of most data entry studies conducted in the lab (Gould et al., 2016; Healy et al., 2004; Li et al., 2016; Oladimeji et al., 2011). In these studies, participants are usually given a clear presentation of the task and data to-be-copied, in order to evaluate their performance. For example, in Gould et al. (2016) a computer screen only presented one number at a time and participants had to enter this number into one entry field. In contrast, before people in the current study could type data they had to spend time looking up information.

Strategies to improve data entry efficiency

Participants reported that they often had a considerable amount of data to enter. For processing expenses alone, the amount of financial numbers to enter could be in the region of 6,000 numbers a day. In order to complete data entry tasks in an efficient manner, participants structured their work to complete similar tasks related to the same activity, rather than switch between activities. They deliberately

'batched' and saved up payment requests, to process and enter a large amount of data in one sequence. P1 mentioned it was too disruptive to only process two or five payment forms and then switch to other tasks. P4 mentioned he does them all at once because he gets the forms in a bulk, and feels time pressure from his supervisor to finish the task quickly, rather than spread it over time. Seven other participants received forms on an ad-hoc basis, but still deliberately saved them until they had a large amount of data entry work and then processed them in bulk in a single session. They preferred to focus on one task at once, and some people stated that it made them faster in entering data after a while:

"The expenses are done in a bulk, rather than separated over a period of time. When I'm doing it lots at a time, I think once you get into sort of the hang of it, it gets done a lot quicker." (P6)

This finding further supports previous lab studies showing people adapt strategies to minimise time (Gray et al., 2006). Focusing on one task can be beneficial, as multitasking and task interruptions can cause omission errors (e.g. Back et al., 2012; Mark et al., 2005). However, in the case of a data entry task, batching too many tasks in one sequence can make people faster but can also increase typing errors (Healy et al., 2004). This speed-accuracy trade-off was also reported by participants in the current study. For instance, P3 mentioned people's tendency to save up and then quickly enter data as the major reason for errors:

"They [Colleagues] have to do it by a certain time so they're a bit rushing and then it's… just typos." (P3)

Checking methods to catch data entry errors

As soon as an office worker had checked the data and entered it, it went to a colleague who would then check if the entries were correct, and enter it again into the system. Data was checked and re-entered by several different people before the payment request was finally submitted and processed. People's experience with this checking method differed: P3 was positive about it, and felt an error would be caught eventually because it goes through so many different checks in the system. In contrast, P9 argued that this made people less careful about making errors:

"The departments actually sometimes treat us as a checking system [laughs], but they shouldn't really." (P9)

The checking method is similar to Reason's (1990) Swiss Cheese model, where multiple checking layers are used to minimise the risk of errors. Entering data twice is considered to be an effective method of checking for errors, as it is unlikely the same error will be made twice (Barchard & Verenikina, 2013). However, it can also be time-consuming as it requires double labour. Furthermore, in this study people not only had to enter, but also check that the to-be-entered data was correct, and people are generally poor at visually spotting errors (Wiseman et al., 2013). Despite being widely applied in practice, there is no strong support for the effectiveness of double-checking either (Li et al., 2016). One of the reasons people may not detect errors when checking a colleague's entries is confirmation bias, which occurs when

people selectively attend to stimuli that confirm one's belief (Lewis, 1986). People may expect data entries to be correct: participants reported they regularly received erroneous data, which had previously been checked and approved by several people:

"Errors could also be things that are missed during the checking." (P8)

P8 and P9 were the last persons at their office to check data before it would finally be submitted to the system for payment. They commented that even at this last stage it was still quite common to spot numerous data entry errors:

"We've been keeping a record of the errors from expenses, so...yeah there are quite a lot!" (P9)

When an error was spotted it was disruptive, as sending the form back slowed the process down, and the task could not be completed until the error had been corrected by the person who had submitted it.

Conclusion

Data entry research has traditionally used controlled studies to quantitatively measure people's performance using different data entry interfaces. However, the extent to which these findings can be generalised to the contexts in which people actually do their work is unknown. This study explored data entry in a financial office environment, and analysed users' own explanations of their adopted strategies within this context.

Some factors contributing to people's strategies are difficult to study in a controlled environment, such as the organisation culture. However, other findings from this study could improve the way data entry tasks are modelled in lab-based experiments. For example, we found that entering data is only one part of the broader data entry task flow. While data entry tasks in the lab are relatively straightforward and well-organised, they differ from tasks seen in this study where the data to enter is spread across different sources, and takes time to collect together. Future lab-based studies could require participants to first collect data from multiple sources, in order to see how it affects data entry performance. Having an experimental task that is more closely modelled to a situated task will give a better understanding to what extent different interventions are applicable. For example, slowing people down in data entry has shown to reduce errors in the lab (Gould et al., 2016, Wiseman et al., 2013), but this intervention may not work if people are holding items in memory.

Prior studies have shown that if it takes more time to gather data from one physical source, people will avoid multitasking and rely more on memory (Back, Cox & Brumby, 2012; Borghouts et al., 2015). This was also reported in the current study: when switching between different sources participants held items in memory, which is more error prone than using external resources (Gray et al., 2006) such as pen and paper or a digital note taking tool.

People dealt with large volumes of data to enter, and saved up data entry tasks to enter them in one session. This strategy makes people quicker but also less accurate in entering data (Healy et al., 2004). It would be worthwhile to conduct future studies that explore more effective strategies to batch data entry. Data entry interfaces that slow people down have been shown to reduce errors (e.g. Gould et al., 2016; Oladimeji et al., 2011), but these lab studies tested up to 240 number entries, whereas participants in the current study reported they often had to enter around 6,000 numbers a day. Future studies should evaluate the applicability of data entry interfaces over time, when large amounts of data need to be entered.

To detect errors, people reported relying on double-checking strategies, even though it is known to be ineffective (Li et al., 2016). Because people know entries will get checked by someone else, they may not check as properly.

These memory-intensive, batching, and double-checking strategies have been shown to be error-prone in lab studies (e.g. Gray et al., 2006; Healy et al., 2004; Li et al., 2016). Looking at these strategies in isolation, it may seem people pick suboptimal working strategies. However, there were probably contextual reasons for why people did their work this way. For example, P4 did not spread data entry tasks over time because he felt time pressure by his boss to finish it. In addition to lab studies, it is therefore important to consider the wider task context when studying and designing for data entry tasks.

The study relied on people's own explanations of their practices. This gave us insight into reasons why people may employ certain strategies, and through this method we were able to discuss critical incidents which would be unlikely to be uncovered through observation alone. A limitation of relying on people's self-reporting however is that they may not do what they say they do (e.g. Randall & Rouncefield, 2014). Though people gave short demonstrations to support their explanations, they were not shadowed doing their work for longer periods of time. The interviews have given insight into factors that could potentially influence people's strategies. Future observational or logging studies would be useful to complement people's explanations and corroborate findings.

This study has shown how data entry at the workplace differs from tasks used in the lab, and the type of strategies that people adopt. Future lab studies might incorporate elements of these situated work practices to improve ecological validity so as to get a better understanding of how effective different interventions, such as lockouts and alternative input interfaces, are on improving data entry performance.

Acknowledgments

We thank all the participants who were willing to share their experiences with data entry tasks and show their workplace.

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Koutsouras, P., Martindale, S. and Crabtree, A. (2017): The Ludic Takes Work. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 8

The Ludic Takes Work

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Abstract. Games that revolve around user-generated content have been explored mainly from a *ludic* perspective, leaving the work practices that are entailed in content production underexplored. What we argue in this paper is that there is an underlying economy in Minecraft's community, which plays a significant role in the game's current form. Our ethnographic fieldwork revealed the various aspects of the work of producing in-game content, by teasing out the discrete segments of the arc of work of commissioning, creating and delivering a Minecraft map. The infrastructure this work relies on is fragmented though, with the various accountability systems in place being appropriations by the players themselves. This raises a number of design implications related to how members coordinate tasks and articulate their work.

Introduction

The growing industrial success of games that revolve around User-Generated Content (UGC), remarkable examples of which are Minecraft and LittleBIGPlanet, was followed by an increasing interest in academic circles. Regardless of the efforts to acknowledge the significance of these in-game practices (Nardi et al. 2008; Yee 2006), they are still treated as part of playing the game and explored mainly from a *ludic* perspective. Many Minecraft studies in particular look into what the *ludic* elements of playing the game are, with aspects such as experimenting with the game's mechanics (Banks and Potts 2010) and expanding them through content production (Ross et al. 2012) being recognised as integral to gameplay. However, the *ludic* masks the hidden economy that partakes in the development of the game and the collaborative nature of the work

involved is glossed over. Hence, the phenomena that comprise it are yet to be explicated.

This is the main motivation for this paper: unpacking what is it that players actually do when it comes to game content production. Our focus is mainly on the articulation process and the coordination practices that are employed by the members in doing cooperative work. Towards that end, we draw upon our longitudinal ethnographic study of Minecraft's commissioning market. In order to reflect on the complexity of the articulation process, this paper provides a high-level overview of the key practices and activities involved in it. In doing so, we tease out the various segments of the *arc of work* of creating and commissioning a Minecraft map.

The main contributions of this paper constitute the accountability systems employed by individuals and teams in order to articulate the work they do in-game. Even though our focal point is indeed Minecraft, we believe that this understanding enriches our existing knowledge of the work of creating content both in Minecraft and similar platforms. In addition to that, it contributes valuable design implications regarding co-creation in distributed settings.

Related Work

A number of studies have pointed out the importance of sharing opinions and experiences as part of the process of developing content in co-creation platforms. For instance, Ames and Burrell's micro-sociological study of play in Minecraft (2017) revealed that players exchange online resources as a means of learning how to play the game and progressing in it. These arguments are also supported by Freeman (2016), whose work explores the collaborative aspects entailed in developing independent video games via another co-creation setting; the online development platform Orange Adventure Game Maker. Their findings suggest that collaborating, in the forms of knowledge exchange between members coupled with testing each other's games, is an integral aspect of developing games through this platform.

Parallel to that, efforts of improving collaboration in Minecraft have also been undertaken through the implementation of tools that monitor in-game actions (Müller et al. 2015) or motivating players to work together towards achieving in-game goals (Wendel et al. 2013). Interestingly, the former use a classification system for in-game collaboration in an effort to measure how often specific collaborative practices occur.

Another strand of work looks into how studying Minecraft can enrich our understanding and inform the design of similar technologies. More specifically, French et al. (2016) looked into the collaborative practices that are entailed in the game as a source of inspiration for improving CAD systems. Furthermore, they briefly touch upon some of the matters that are involved in working in Minecraft,

such as the importance of team management, planning, use of distributed resources, and task distribution. Along the same lines, the KidCraft project constitutes another approach to learning what these platforms can offer us in terms of design (Walsh et al. 2015). The researchers found out that being able to communicate with others was a valuable asset to the players, especially due to the distributed nature of the setting. In addition to that, a number of collaborative aspects emerged, ranging from asking technical questions regarding in-game building, to the distribution of tasks towards the completion of a common project.

The overarching theme that connects most – if not all – of these works is collaboration; content (co-)creation in collocated or distributed settings turns upon collaboration. Regardless of the fact that some key organisational matters are indeed pointed out in the literature, the *work* of *creating* UGC in Minecraft is not explicated. Whilst not everyone works at Minecraft in this way, this commissioning market plays a significant role in developing and sustaining the game and facilitates the play of many (Koutsouras et al. 2016). What we present in the following sections of this paper is an original perspective on this matter; a *Straussian* analysis of the job of commissioning a Minecraft map. In doing so, we elaborate on its *arc of work* (and its segmentation), offering an initial understanding of what is involved in creating and commissioning in-game content in Minecraft.

Methodology

The approach adopted for addressing the research problem presented in this paper was ethnographic fieldwork, which lasted 2 years. Overall, we attended to a multitude of in-game building sessions, where we observed 12 members doing their work online. We also interviewed 16 players, enquiring about their work and how it is socially organised across the variety of groups that they are involved in. A key aspect in our fieldwork was developing vulgar competence in the work of commissioning a Minecraft map. Towards that goal, the first author formed a daily routine of visiting Minecraft fora, checking the Twitter feed of many professional Minecraft content creators and talking informally with our participants on matters relevant to commissioning and creating Minecraft content. He also spent some time playing the game and understanding its mechanisms. On top of that, he engaged in the community by attending an online Minecraft convention that was used for promotional purposes by various professional Minecraft players. Lastly, he underwent a training session by one of our participants, during which he sensitised himself to the basics of creating content in the game and using the same tools as members do.

To document and analyse what Minecraft content creators do, we captured instances of how the work is done by the members. The overall corpus of fieldwork data constitutes of a combination of: audio (12 hours) and video (18

hours) recordings; field notes of what was discussed and done by the members; pictures of resources that were used across the various practices involved in commissioning the product; and online material that members use for disseminating their work, promoting themselves, and networking with each other.

The main analytic lens this work draws upon is Strauss' take on the division of labour (1985). Strauss proposed that the focal point of exploring a work setting should not be merely how manpower is distributed towards the completion of the work, but rather what the work is and how it is articulated. The analysis of the gathered material focused on explicating the articulation process, with our main aim being to map out the **arc of work**; the sequential or concurrent arrangement of all the tasks that are involved in the commission and the creation of the product (the Minecraft map – discussed below) (Strauss 1985). The arc itself comprises of discrete segments, each of which encapsulates a number of activities and tasks that are necessary for creating and delivering the product. To address that, we drew upon Crabtree et al.'s (2012) *"horizontal and vertical slicing"* of the data; a representation of the sequential order of the practices and activities that are being done in a setting towards the accomplishment of the work that is at play.

The analysis further focused on teasing out the bespoke **accountability systems** that are adopted by the members while coordinating work across the division of labour. These systems constitute the resources members use for tracking the progress of and accounting for their work to those that they cooperate with.

Introduction to the Field Site

Minecraft is a videogame, the gameplay of which revolves around the idea of mining materials from its fully-interactive game world and using said materials for crafting purposes (creating items, tools, weapons, etc.). Whilst these activities were available to the players almost from the game's release, its most popular characteristic is its openness to be modified and offer new and unique gaming experiences. Minecraft modifications constitute alternative versions of the original game, which run on servers and constitute new games by themselves (which members refer to as "mini-games") and have their own rules and mechanics.

Mini-games though do not rely only on programmes for coding the ways they are meant to be played; they demand a game world where players meet online, interact with each other and play. These worlds (referred to as "Minecraft maps" or "builds" by the members) are the actual product in the commissioning market. Privately-owned Minecraft servers that run the business of hosting mini-games and receiving revenue through subscriptions need to acquire specially made and aesthetically-pleasing maps (Figure 1) in order to accommodate the needs of the

mini-games they offer to their subscribers. The demand for such specialised maps was one of the factors that led to the emergence of the commissioning market.

Figure 1 An example of a Minecraft map

These characteristics (Minecraft servers' role in the community and the product in the market) constitute the premises of the field site of this study. In the subsequent section, we provide a brief description of the work of creating and commissioning Minecraft maps.

Findings: The Arc of Work and its Segments

The arc of work (Figure 2) constitutes of 7 distinct segments, which are categorised into 3 groups: the practices that precede crafting; crafting in-game content; and those that succeed it. In the following sections we touch upon each one of these matters[1], by elaborating on: what is it about; the activities involved in articulating the work; what is achieved in each of them; and the involved actors.

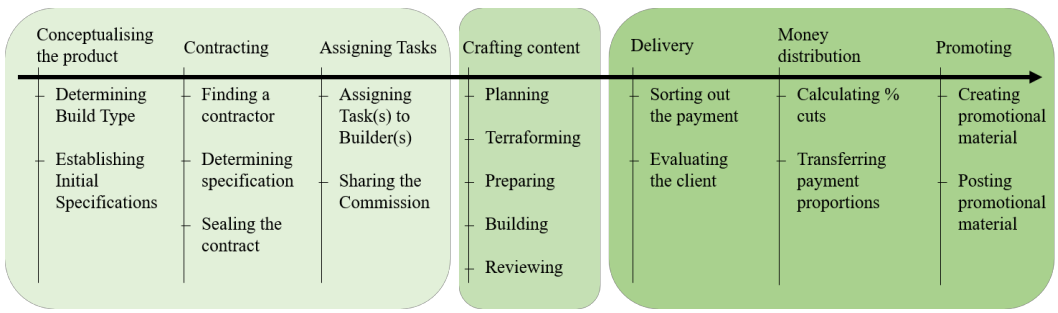

Figure 2. The arc of work of commissioning a Minecraft map.

[1] We acknowledge that the "*hows*" of articulation work are glossed over. The level of such an analysis is very extensive and cannot be fully presented in a paper. It will however be available in the PhD thesis this work is part of.

Conceptualising the product

This is the first segment in the arc of work and is solely carried out by the clients. The main goal of this practice is to develop a concept that reflects what the clients want their commissioned product to be. The outcome of this conceptualisation phase is either an initial understanding of what the build should be, or a document with a variety of information related to the commission. The activities it turns upon are: determining build type and establishing initial specifications of the build.

Determining build type: Clients (server owners that run modified versions of Minecraft) first determine what build is lacking from their servers. Depending on whether they want to update the content of existing games, or introduce new ones, clients commission the creation of relevant maps that meet the gameplay affordances of said games. This is usually done on a periodic basis, or when a new server is about to launch.

Establishing initial specifications: These details usually range from the build's functional characteristics (elements that relate to the gameplay affordances the build has to accommodate) to aesthetic and stylistic aspects (how the build should look). A number of resources come into play when composing the concept. One common way of accounting for the specifications is via text: clients put together a document with the build's specific characteristics, such as its size (measured in Minecraft blocks, e.g. 150x150 blocks) and the gameplay elements that need to be incorporated (e.g. the inclusion of specified areas necessary for playing). In addition to that, clients might use *referential material* (images and other visual assets) in order to convey the aesthetic characteristics the build should have.

Regardless of the detail that is put into it, the concept is not conclusive. Once devised, clients further discuss it with the contractors in order to solidify the exact characteristics of the build, which is part of the subsequent segment of the arc: *contracting*.

Contracting

This practice constitutes the second segment of the overall arc of work and takes place between the clients and the contractors. It is occasioned by the former, who already have an initial product concept in mind. What is accomplished through this practice is the establishment of the exact details of the build under commission and the *sealing* of the contract between the two involved parties.

Finding a contractor: Clients first attend to *finding* a contractor, which they do either by *scouting* for prospective Minecraft professionals in various Minecraft fora, or by *returning* to the contractors they have already worked with in the past. The latter case is relatively straightforward, as clients contact their contractors directly through the established means of communication in the commissioning

market; Skype. When it comes to new contractors though, clients employ a number of criteria for choosing which ones to contact: the positive feedback the latter have received from previous clients (which is posted on the dedicated forum thread each contractor has) and their portfolio (images that showcase the work they delivered in the past – usually posted by the contractors in their forum threads, or in their personal websites). Contractors who have received positive feedback and showcase a rich and high-quality portfolio are the ones that are favoured by the clients.

Determining commission details: The most crucial part of *contracting* is establishing the specifications for the commission, which is achieved through the collaborative effort of both the clients and the contractors. Doing so turns upon them collaboratively discussing the details related to the build and trying to reach a mutual agreement about what needs to be created in the game. The matters that are discussed during this process are related to the product concept; the functional and the aesthetic details of the build; its size; the time frame in which it has to be created and delivered back to them; and its price. Information provided by the clients are typically abstract and lacking in detail, as they may not include crucial particulars regarding the construction of the build (such as its size and the exact aesthetic characteristics that need to be implemented). This occasions the contractors' further enquiry, who prod the client to give more details towards solidifying their originally vague idea about the build they want to commission. As was the case in *conceptualising the product,* referential materials also come into play during *contracting*, as resources that convey what the clients like.

Sealing the contract: Before agreeing to undertake the commission, the contractors attend to two distinct tasks: they ask for a down-payment (a proportion of the final payment); and they consult a record of all the clients that have *scammed* professional Minecraft builders in the past. This "blacklist" is a shared resource between many members of the commissioning market, which is regularly updated with the names and the Skype and Minecraft handles of clients who have refused to pay contractors upon receiving the commissioned build.

When this latter activity is completed, trust is established between the two involved parties and the contract is *"sealed*." The contractors then acquire ownership of the commission and *assign* it to the prospective builder(s).

Assigning tasks

Upon *establishing* the commission's specification and *sealing* the contract, contractors need to find the appropriate builder(s) to assign the job to. Therefore, *assigning tasks* takes place between the contractors and the builders. Given that this practice differs depending on the type of contractor (team leaders or freelancers), we elaborate on each of these cases separately.

Assigning tasks to builders: In the context of a team, this activity is carried out by the team leader. The criteria for *assigning* a job to a builder revolve around their expertise and availability. This decision is made depending on the specifications of the commission; if the job demands a specific skillset for its accomplishment, then the team leader delegates it to an expert in working on that particular build type (e.g. trees). Keeping track of who is available or not turns upon the use of distributed resources, such as documents that are stored in online repositories and account for who is working on what. Project management tools, such as Trello[2], are also used. Trello's case is specifically interesting, as all the relevant details of a commission are uploaded on the software and are accessible to those that are assigned to it. Hence, it becomes a means not only for keeping track of the availability of the builders, but also for handing over the specifications of the commission.

Sharing the commission: Freelancers manage this job in a different manner. Given the duality of their role (being both the contractor and potentially the builder of their own commissions), it is possible that they *assign* the job to themselves. In the contingent scenario of not having the relevant skillset for a job or the time to carry it out, they *outsource* it to another builder. This takes place either through Minecraft unions, or by *scouting* the creative community for expert builders in that particular type of work (a process that shares many commonalities with the *scouting* clients do while *contracting* a job). By being a member of a union, freelancers can freely publish the job and its specifications to the shared repository that is used by the union (such as a shared Trello account). Through that, all union members have access to a list of the available jobs. Any union member can then claim the job as their own and start working on it. Upon doing so, the claimant becomes responsible for *building* and *delivering* the job back to the contractor. *Claiming* a job takes place on a first-come-first-served basis and both the available and the claimed jobs are visible to the entirety of the union through Trello.

Crafting content

This is the actual work of creating Minecraft content that can be then played by others. The builders are the actors that are mostly involved in this practice. Occasionally, however, the contractors and the clients participate in it, especially during the reviewing stage. The activities it is comprised of are: planning; terraforming; preparing for in-game building; building; and reviewing.

Planning: During this activity, builders flesh out a number of layouts that resemble how the build should be and what needs to be included in it (Figure 3). The production of these resources turns upon sketching through the use of physical (pen and paper) or digital (rendering software) means. Besides

[2] https://trello.com/

accounting for the work that needs to be done, maps also act as an accountability mechanism used to showcase to the client what the plan for the project is.

Figure 3. An example of a build layout.

Terraforming: This activity only happens when the commissioned project demands the creation of a landscape. It takes place outside of the game, through the combined use of two software tools: world machine[3] and world painter[4]. Terraforming is usually carried out by builders who specialise in it and they perform it by making heavy use of referential material such as: real-world pictures; Minecraft creations; and YouTube tutorials of how to use the aforementioned tools. Given that these are third-party tools that are not officially supported by Minecraft, the outcome of using them needs to then be imported into the game. When it comes to projects that need it, terraforming is a vital step that has to be completed prior to in-game building. Delays in doing so might push the delivery of the entire project back.

Preparing: This is the last activity before the initiation of *building* in-game content and it turns upon *assembling in-game resources*, which will be used for the work. This is the first time in the overall arc of work where the site of work becomes the game itself. These resources usually include parts of previous builds, which are re-appropriated for the needs of the ongoing commission. These parts are kept in close proximity to the building site, so that the builders have easy access to them while working on the new build. Builders also compose a material palette (Figure 4), which is comprised of the colours and the materials that they

3 http://www.world-machine.com/

4 http://www.worldpainter.net/

plan on using while *building*. The material palette helps them in understanding whether the intended colours match with each other, but it also facilitates them having a constant reference to the materials in use during the entire building activity (which can last days or even weeks).

Figure 4 Material palette, comprised of all the green coloured blocks in the game

Building: This is an iterative activity that comprises the following 4 tasks, which are performed in a sequential manner. At the end of each cycle, the piece that is produced might then become the basis for the next one. During this transition, new referential material might be introduced and incorporated into it and the material palette might be updated to match the needs of the subsequent iterations. This cycle is constantly at play during building and is repeated as many times as it takes until the final build is complete.

Although it is possible for all these activities to be successfully conducted in a sequential order, failure to accomplish the desired result in any of them might steer building towards previous steps in the overall practice.

1. Creating the skeleton of the build: The builder either creates a new piece (such as the one depicted) or they pick one out of the referential materials that were previously assembled.

2. Detailing: The builder starts working on a number of the assembled referential materials. This involves adding colour to them, combining different pieces together, and giving depth to their surfaces.

3. Evaluating: The builder distances themselves from the build and looks at it from different perspectives in order to assess whether the work they did matches their goals. If not, they repeat the previous steps until the evaluation is successful.

4. Integrating: The builder integrates the outcome of the previous tasks to the final build they are working on. It is also possible that they will keep a separate copy of the piece they created for future use.

Before ending a building session, a few mechanisms for keeping track of the progress that was made and signifying future work might be employed. One such method that we became aware of was using colour-coded blocks that indicate ongoing work (Figure 5). By using this annotation system, members of the team could identify the work that was conducted during their absence and pick up from where team members had previously left off.

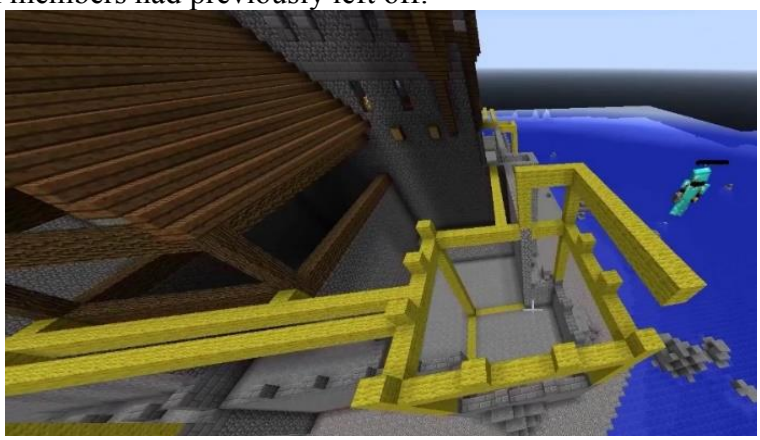

Figure 5. Colour-coded blocks used for indicating future work.

Reviewing: Snippets of the work are occasionally reviewed by the clients in order to be reassured about its progress. Being a formal activity, those that usually come into contact with the clients are the owners of the commission (the contractors) instead of the builders. There are two reported methods for *reviewing*; clients are either invited in the world of the game to take a look at the progress of the build, or they receive representative snapshots of the work. However, the former method is avoided when collaborating with new clients, as there is always the potential danger of them using a modification tool for downloading the build without the contractors' consent. This constitutes an act of *scamming*, as the clients acquire the work they commissioned without paying the contractors for their services.

Depending on the size of the build, there can be many *reviewing* cycles. When the last of those cycles is concluded and the client is satisfied with the end result, the activity of *delivering the product* is initiated.

Delivery

The tripartite practices that take place after the product is complete are initiated by delivering the commission to the client. The builder's last responsibility is to hand the map to the contractor by exporting it from the game and saving it as a distinct digital file. This file is then relayed from the contractor to the client, only when a couple of safety measures are taken: sorting out the payment; and evaluating the client.

Sorting out the payment: Due to the possibility of *scamming,* payment is handled by intermediaries, such as PayPal or independent bodies that serve as an escrow-system. In the former case, the contractor sends an invoice for the services they have provided to the client and asks for the pre-specified amount of money. Upon being paid, the contractor relays the product to the client, but keeps proof of said delivery in case the latter tries to scam them by requesting a charge-back via PayPal due to unreceived services.

The escrow-system functions on a similar manner. The independent body that handles the transaction receives both the payment (from the client's side) and the product (from the contractor's side) and relays them to their respective receiver. That way, neither the clients nor the contractors have to worry about being scammed by each other. However, the organisation that handles the transaction keeps a small percentage fee for the services provided.

Evaluating the client: This activity takes place only when the client proves to be malicious and scams the contractor. We already mentioned the existence of a shared blacklist. In case of being *scammed*, contractors update said blacklist by attaching the details relevant to the client and the scam, such as: their Skype and Minecraft handle; the pseudonyms they use in different fora; the business they are running; and a description of the scam (what happened and how it happened). Additionally, scammed contractors usually tweet about those who *scammed* them.

Money distribution

At this point in the arc of work, any exchange with the client is completed and what remains is for all the parties involved in content creation to acquire their share of the payment and for the contractors to update their social network profiles (as discussed below). Distributing the money depends on the type of contractor and how the *assigning of tasks* took place.

When it comes to teams, team leaders need to cover a number of fixed expenses prior to distributing the money to their builders. First of all, they keep a percentage of the total payment for covering the managerial costs of running a server, as well as paying the staff involved in its administration. On top of that, they keep a proportion for their own income, as owners of the commission and leaders of the team. The remaining amount of money is distributed to all the builders that were involved in the commission, relative to their involvement in the

project. In order to keep track of the builders' involvement in the project and divide the payment fairly, some team leaders keep records of the work that each individual builder conducted (such as, the hours they spent working on the build, the number of buildings they created for a project, etc.).

In the case where the commission is *outsourced* to another builder (through an intermediary organisation, such as a union, or by directly coming in contact with them via *scouting*), the contractor relays the amount of money that corresponds to the amount of work that the builder conducted. If, for instance, the builder undertook the entirety of the commission, then the salary they would receive at the end of the job would be the total amount of money that was initially agreed upon between the contractor and the client. On the other hand, if only parts of the commission were outsourced, then the builder would receive a reward proportionate to the work they put in.

Promoting

The last activity in the arc of work revolves around updating the resources the contractors use for promoting their services. Whilst the contractors are the main actors that partake in this activity, the job of *creating* promotional material might be outsourced to experts. At the end of this practice, contractors *post* said material on the various social networks they have a presence in.

Creating promotional material: Even though the simplest of the promotional materials are in-game pictures of the created builds, these resources are rarely used for promotional purposes. Instead, contractors prefer to have renders of the in-game builds made for them prior to uploading them to their websites or forum threads. These renders constitute polished up versions of the same build, with the inclusion of special effects and decorative elements (Figure 6). The creation of these resources is outsourced to members that specialise in the use of rendering software, such as Photoshop or 3D Blender.

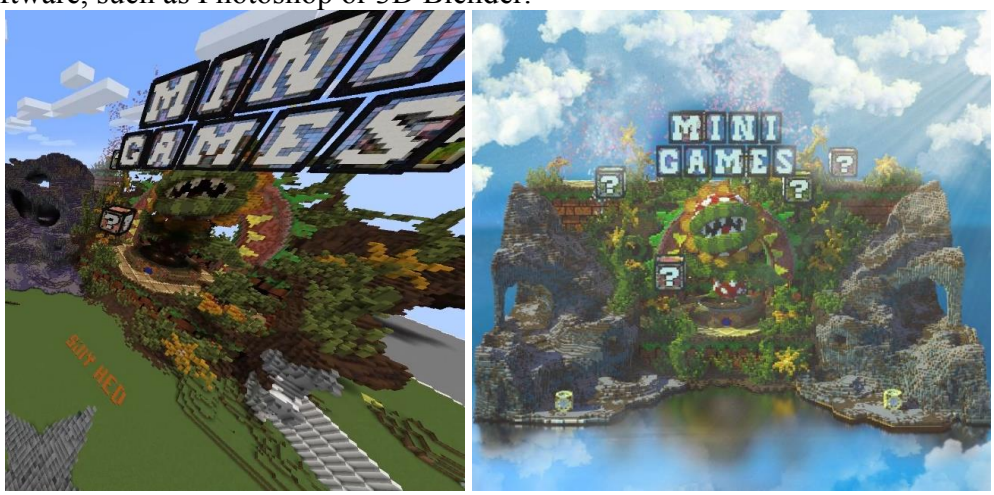

Figure 6. In-game build (left) and render of the same build (right).

Posting promotional material: The information that contractors include when *uploading* the promotional material to their designated profiles aim at presenting the quality of the services they have provided to existing clients. As such, they attach a description of the work (pictures of the build, what it is going to be used for, what it constitutes of, etc.), who was involved in its creation (the handles of the Minecraft builders, and the name of the team that was behind it), as well as details related to the clients themselves (name and IP address of the server they are running). As such, the practice of *promoting* does not just benefit contractors, but also the builders (they are accredited for their work and their name is associated with high-quality builds), as well as the clients (the information that can give access to their servers – the IP address – is exhibited and made available to the players).

Discussion

What we explore in this paper is the underlying economy behind Minecraft's content generation practices. Our main argument revolves around the fact that the *ludic* aspects of the game mask the existence of a hidden economy that leads to the production of the content gameplay turns upon. Our fieldwork revealed "the work to make the Minecraft economy work": a distributed setting, with both the actors that do the work and the systems that are employed towards its accomplishment being geographically dispersed. The spatial distribution of the work occasions the need for coordination between the actors and the activities entailed in commissioning and building a Minecraft map.

As becomes evident in our findings, this hidden economy is based on a fragmented infrastructure; even though the game platform provides the affordances for doing in-game building, it does not support a wide variety of activities and tasks that are crucial parts of the arc of work at play. To tackle this problem, members have to employ a number of bespoke accountability systems towards accomplishing the work and its articulation. Effectively, Minecraft players bootstrap the infrastructure for doing their work by appropriating existing tools or even developing their own. This is reflected on the existence of multiple sites of work, which extend the borders of the game. Minecraft is indeed one of these sites, which accommodates the conduct of the keystone activity in the arc: that of building content. The rest of the segments though are carried out in sites external to the game, such as: Trello, Skype group chats, Minecraft fora, and Google.

This opens up a variety of design implications as to what coordination turns upon in this context. Coordination tasks and the accountability systems they rely on are as follows:

Establishing specifications: All the resources that are relevant to the commission (*referential materials, plans*, *prototypes,* etc.) need to be distributed

amongst the parties involved. This is achieved by having them stored in online repositories (such as Dropbox and Trello) and granting access to those that are responsible for working on the commission.

Managing distribution of tasks: Knowing who is assigned to which job and which jobs are available turns upon the use of *productivity tools* (such as Trello) and formal *online documentation* (Excel spreadsheets and Google Docs). The information stored in them accounts for the availability of the builders, as well as for the work they have conducted in big, multifaceted projects. This is in tandem with handling payments, as percentage cuts are calculated based on the builders' involvement in each project.

Accounting for progress: *Plans* and *pictures* are the two main resources used by the builders for providing an account of their work and their progress in a project. These resources are created by them and are shared either with their colleagues, or with the contractors they are working for.

Taking precautions against scamming: Due to the possibility of being scammed, contractors use intermediaries for handling payments. In the process of handing the product to the clients, they keep *proof of delivery* (screenshots or emails of the transactions) as an evidence of the provision of service. Another accountability mechanism that comes into play here is that of a *distributed blacklist*, which is collaboratively maintained by a number of Minecraft content creators.

Promoting: Contractors make their professional presence visible to clients by using *pictures* and *renders* of the commissioned product as promotional materials. These materials account for the work contractors and builders have already done, but also for the type and quality of products they are capable of delivering. Receiving *feedback* by other members for this material and for the services provided also accounts for their professionalism and is a resource used by the clients while scouting the community for contractors.

These examples of accountability systems are not part of a unified solution. On the contrary, many of them constitute exclusive members' methods, employed by discrete teams or individuals in order to account for their work to their clients, or coordinate with those that they collaborate with. This necessitates not only articulating for content production, but also for the infrastructure itself. As such, the fragmented infrastructure in Minecraft's commissioning market and the accountability systems employed as a counter-measure to the game's lacking platform constitute the basis that collaboration turns upon. This clear lack of CSCW support can become problematic for two reasons: (1) the need for articulation of both the infrastructure and the work itself adds a significant overhead cost towards the accomplishment of the arc of work; (2) the emergence of malicious practices, such as scamming, which threaten the job security of those involved in this market professionally.

We believe that this level of understanding is vital when it comes to design for supporting collaboration in Minecraft or similar games, or even online co-creation platforms.

Conclusions

What is presented in this paper is a high-level overview of the arc of work of creating and commissioning a Minecraft map. Our fieldwork revealed the existence of an underlying commissioning market that is part of Minecraft's community and plays a significant role in the game's social organisation. It was also uncovered that the infrastructure of this market is fragmented and geographically dispersed. As such, members adopt – or even create – bespoke accountability systems for coordinating and articulating the division of labour across the arc. This fragmentation hints to a number of design considerations that revolve around the main coordination tasks that are necessary for doing the work.

Future work

Whilst we touch upon all 7 of the segments that comprise the arc of work and tease out the main accountability systems that are employed in the articulation process, what is missing is the *lived work* of creating and commissioning a Minecraft map. To put it in other words, we only talk about *what* is done, but we do not elaborate on *how* each of the segments of the arc are brought about. Explicating the social organisation of the entire arc of work constitutes our main goal and motivation for future research.

Acknowledgments

We would like to thank all the Minecraft players who agreed to help us in our work. Panagiotis Koutsouras is supported by Horizon Centre for Doctoral Training at the University of Nottingham (RCUK Grant No. EP/G037574/1). Sarah Martindale is supported by the Horizon Digital Economy Hub (RCUK Grant No. EP/G065802/1) and by the Human Data to Personal Experience grant (Grant No. EP/M02315X/1). Data supporting this publication is not openly available as our ethics approval does not allow for the release of transcripts and videos to third parties.

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From alienation to relation: Examining the modes of production in crowdsourcing

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Abstract. While crowdsourcing is increasingly used for data gathering and problem solving, the power relations in crowdsourced processes remain largely unexamined. Especially in crowdsourced public policymaking, an understanding of these processes is essential for verifying the data. For understanding the social processes behind the data and designing crowdsourcing technologies and processes suitable for public policymaking, it is important to understand power structures and relations within the crowd and between the crowd and the sourcer: Who has the power, what is being produced through crowdsourcing, and especially how and under which conditions. In this paper we develop a typology of worker relations in crowdsourcing by using Marx theory of alienation. The theory serves as a lens to compare and contrast tools for crowd-engagement in public policymaking. We show how different types of crowdsourcing can be described as levels of alienation where the worker, the consumer, their relations, and products are connected in modes of production representing different ontologies. In doing so, we contribute to the body of knowledge about crowdsourcing as a specific type of computer-supported cooperative work. For the research community we introduce a critical perspective on information systems as part of a relational system, whereby both external communications and personal identities are acknowledged. For the practitioner community, namely, decision-makers, we provide a useful resource, outlining in detail the differing potentialities of crowd-engaging in CSCW.

Introduction

In the last decade, many organizations have turned to crowdsourcing to engage with their customers, to become more innovative and efficient (Brabham, 2013; Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012; Majchrzak, Wagnerr, & Yates, 2013; Prpić, Taeihagh, & Melton, 2015). Crowdsourcing as a specific form of Computer-Supported Cooperative Work (CSCW) is also applied to different aspects of policymaking, which also creates demands on transparency, equality and diversity when it comes to power relations in the crowdsourcing processes (Aitamurto, 2012; 2016; Hansson, Belkacem, & Ekenberg, 2014).

When considering how the users' relations are handled in such applications, these systems can alienate people as their relations can be used as commodities in form of user data (Dean, 2005). On the other hand, they can also enable the possibility of decreasing the alienation between actors in certain areas of production by establishing more direct links without any material intermediary and thus supply devices that undermines capitalism as these relations destabilize the market mechanisms (Stacey, 2008). Crowdsourcing allows an alienation of work relations on an unprecedented scale, which often effectively reduces the individual's control and capacity to overview the result of their own work. We therefore argue that Marx's (1844) theory of alienation is relevant when analysing crowdsourcing platforms. The theory was central to his analysis of industrial capitalism, and it is still useful as a way to understand production in a capitalist system.
Crowdsourcing settings like those in Amazon Mechanical Turk (ATM) have striking power differences between the crowd of workers and the "sourcers" (Felstinerf, 2011; Silberman, Ross, Irani, & Tomlinson, 2010), which also has resulted in collective action by crowd workers (Salehi et al., 2015). Lack of transparency and an asymmetry in the information access were also shown in Gupta et al.'s (2014) study of workers at the Amazon Mechanical Turk and by Ludwig et al. (2016) in mobile contextual studies.
Digital literacy and infrastructure are other aspects of participation that affect crowd workers' ability to control their work. Other ways to control crowd work are enforced by the rules, the technical system (Irani & Silberman, 2013), and the economic means (Bederson & Quinn, 2011). However, the technologies facilitating crowdsourcing initiatives enable stronger communities and direct relations between consumer and producer. Parts of today's network-based creative economy are characterized by the humanistic values, that scholars claim Marx was looking for when he formulated the theory of alienation (Michael Hardt & Negri, 2000). For instance, Hardt and Negri (2000, pp. 294) argue that the new economy of affective labour and networked relations amounted to 'a kind of spontaneous and elementary communism'.

The tensions between on one hand an extreme alienation due to the division of labor in micro tasks enabled by crowdsourcing tools, and the humanistic values in peer-produced commons (Benkler, 2002) have also gained attention from Marx scholars (Scholz, 2013). Media and communication scholars have used Marxist

terminology to examine social networking sites more closely (Beverungen, Bohm, & Land, 2015). Especially the definition of productive work in social media has been problematized, whether this should be considered free communication or a valorised social labour (Beverungen et al., 2015; Dean, 2005; Scholz, 2010; Stacey, 2008). Exploitation of workers in crowdsourcing is another theme where Marx theories have been used (Busarovs, 2013; Fuchs, 2014). However, despite this critical research there is a lack of a more structured overview focusing relations of tools for crowdsourcing and commons-based peer production.

In this paper we have therefore systematically applied Marx theory of alienation as a way to compare the relational aspects in a number of platforms for crowdsourcing. To do so, we first introduce previous crowdsourcing typologies, from which we form a systematic framework for addressing crowdsourcing practices. Thereafter we introduce Marx theory of alienation and based on this theory we formulate questions regarding relationships between actors such as worker – consumer, worker – work, worker – self, worker – worker. These questions are then used when gathering data from cases of crowdsourcing tools that represent various types of crowdsourcing practices. After a first pilot study we have developed typologies of worker relations grounded in the empirical contexts. This typology is then applied in an analysis of 21 cases representing a diversity of crowdsourcing tools and contexts. Finally, we summarize our typology in four different *modes of production*. These different modes are not mutually exclusive, but co-exist within the same tools and processes.

Crowdsourcing

Crowdsourcing has gained a lot of attention recently, as a way to develop anything from ideas to manage crisis management: Companies and organizations are making practical use of crowdsourcing technologies to assemble multiple solutions (Retelny et al., 2014), and to dispense pieces of work to crowds of labourers (Martin, Hanrahan, O'Neill, & Gupta, 2014). In the public realm residents become involved in a more participatory government by contributing to open data resources (Hansson, Belkacem, & Ekenberg, 2014), the public take part in knowledge search and deliberation through crowdsourced policymaking (Aitamurto & Landemore, 2015), and they participate in budgeting (Kasymova, 2013). Government agencies use social media to enhance collaboration and innovation among its employees (Ben Eli & Hutchins, 2010) and to gather government data (Fyfe & Crookall, 2010). In citizen science the public becomes engaged in the collection of data or to improve research data (Causer & Wallace, 2012; Fort, Adda, & Cohen, 2011; Kamar, Hacker, & Horvitz, 2012; Kanstrup & Christiansen, 2006; Kittur et al., 2013; Wiggins & Crowston, 2012) and to participate in the research process (Aitamurto & Landemore, 2015; Cooper, 2014; Cooper et al., 2011). Natural disasters have showed a need to involve an extended crowd of interest civilians in data gathering (Hughes et al., 2014; McKay, 2014; Soden & Palen, 2014) and supporting with physical activities during crisis situations (Ludwig, Reuter, Siebigteroth, & Pipek, 2015).

Even though the concept of *crowdsourcing* is common, the understanding of it varies. Several classifications of crowdsourcing have been proposed in academic fields such as computer science, economics, or management. Classifications based on, potential tasks (Kleemann, Voß, & Rieder, 2008) types of social networks (Kozinets, Hemetsberger, & Schau, 2008), management structures (Feller, Finnegan, Hayes, & O'Reilly, 2009), sourcing processes (Geiger et al., 2011), compensation type (Aitamurto and Landemore, 2015), or specific applications of crowdsourcing. As we here are looking foremost at *the tool support for relations*, not the relations per se, a typology based on specific applications of crowdsourcing makes most sense. Crowdsourcing can be divided into three distinct types depending on the technologies used (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012; Prpić et al., 2015), what we call human computation, peer competitions, and open collaboration:

Human computation

Crowdsourcing can be organized as a communication technology mediated market for labour, where workers and organizations exchange work for monetary compensation, like for example Amazon's Mechanical Turk or Crowdflower (Fort et al., 2011; Horton & Chilton, 2010; Irani & Silberman, 2013; Martin et al., 2014). The motivation to participate can also be intrinsic such as winning a game or feeling good, for instance when contributing to the reconstruction of maps after a nature disaster (Preis, Moat, Bishop, Treleaven, & Stanley, 2013; Schelhorn, Herfort, Leiner, Zipf, & Albuquerque, 2014)

Typically workers here are doing micro-tasks that do not need a special expertise, like transcribing images and audio, translating text, or tagging maps. Like in the Mechanical Turk, the fake chess-playing machine constructed in the late 18th century where a human chess master operated the machine (see Figure 1), crowdsourcing of this type is human computation (Quinn & Bederson, 2011), where the crowd acts with the same efficiency and simplicity as a computer. Based on an overview of human computation research, Quinn & Bederson (2011) suggest that this typically solves problems that potentially can be solved by computers and where the humans are strictly organised by the computational system. Typically here is the modularity of the tasks and the size of the crowd. The tasks are divided into small modules that each doesn't take much effort. The size of the overall crowd available at these microtasking markets is massive, why the tasks can be completed rapidly through the scale available on such platforms. On these platforms the individuals in the crowds usually undertake tasks independent of one another, sometimes even competing for work on this market where workers are largely anonymous and the tasks are simple and clearly defined.

Quinn & Bederson (2011) don't include data-mining in the concept of human computation as they don't think the challenges are the same, as users normally aren't active in the mining process. However, we don't agree on this distinction, as we first of all claim that not acting also is an action, and secondly, that users are actively participating in online contexts they are aware of are potentially mined, thus probably adopting their behaviour accordingly.

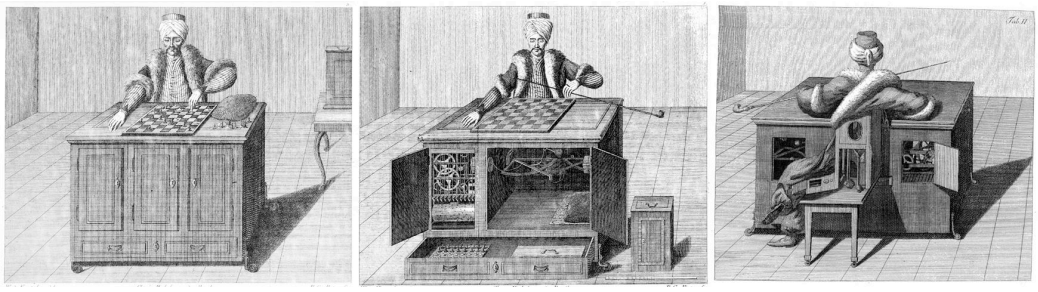

Figure 1. The Mechanical Turk, by Wolfgang von Kempelen 1784.

Peer competitions

Peer competitions, crowdsourcing tournaments and idea competitions, are another form of crowdsourcing where participants partake in an often public contest that involves some sort of prize or public recognition (Blohm, Bretschneider, Leimeister, & Krcmar, 2011; Piller & Walcher, 2006; Wagner, 2011). Here problems or challenges are posted to crowds on in-house platforms such as Challenge.gov (I. Mergel & Desouza, 2013), or external platforms such as IdeaConnection, Hypios, TekScout, and InnoCentive (Daren C. Brabham, 2013; Lee, Chan, Ho, Choy, & Ip, 2015).
These platforms are also termed open innovation platforms as the competitions can involve both generation of ideas and solving problem (Antikainen, Mäkipää, & Ahonen, 2010; Morgan & Wang, 2010).
Here the crowds often have some sort of explicit expertise or skill. Reputation is therefore sometimes expressed on a profile page and the participants' profiles can often be public. These platforms generally also attract and maintain more specialized crowds with a certain interest. 99Designs and CrowdSpring provides a platform for design competitions (Wooten & Ulrich, 2015), while the crowd at Kaggle focuses on data science solutions (Carpenter, 2011). Participants can sometimes submit independent solutions to competitions, while others encourage group participation. Crowdfunding is another type of peer competition, where participants are supposed to come up with funding for a certain project within sometimes set timeframes, but can sometimes also contribute with ideas to develop the project. The crowd also provides a potential marketing network for the finished project.

Open collaboration

The third form of crowdsourcing is more about deliberation and collaboration where social media networks or self-organized wikis provide an environment for developing a problem or opportunity posted by an organization or individual. Here the participation is voluntary and there are no prizes or money involved. Participants are often known to each other or at least have public profiles within

online social networks. The collaborations can be organized for example through a wiki (Jackson & Klobas, 2013), or using social media (Croeser & Highfield, 2014; Gruzd & Roy, 2014; I. A. Mergel, 2012; Moser & Eijkeren, 2016). Participants can be everything from a few individuals to large-scale networks, as the potential in networks such as Facebook and Twitter is enormous. However, the scale depends less on the platform than the engagement for the task. The open collaboration can also take place on multiple platforms, as social networks aren't constrained to single platforms or technologies (Prpic & Shukla, 2014). Several authors claim this type of practices shouldn't be defined as crowdsourcing as that they are not invented for this purpose (Estelles-Arolas & Gonzalez-Ladron-de-Guevara, 2012). However, as these tools and practices, like e.g. the common use of posting public calls in forms of hashtags posted on multiple platforms, do *serve the purpose of crowdsourcing*. Furthermore, when using crowdsourcing for the purpose of public policy-making, we need to use and understand tools in use by the public, in order to reach a large crowd.

3 Theoretical framework and data

The communal aspects of the network-based creative economy have led scholars such as Hardt and Negri (2000) to argue that this economy can be seen as a form of communism, in the way Marx defined communism in his theory of alienation. This "Multitude" can be described as a networked model for resistance against global capitalism consisting of collectives of individuals working together in multiple networks rather than sharing single identities (Michael Hardt & Negri, 2005; Virno, 2004). On the other hand, this could also be seen as a liberal manifesto. Boltanski and Chiapello (2005) demonstrate how this relational communism just as well can turn into a "new spirit of capitalism", where the workers are commodifying their relations and self-managing their affective labour. Berardi (2009) claims that this changing nature of labour requires a shift in our thinking about alienation. The divisions between the owner of the means of production and the workers remain, but because labour is increasingly mental, the concept of alienation needs to be reinterpreted (Ibid). In industrial capitalism, the work is contained in physical objects controlled by the owner of the factory. But in the semi-capitalist economy, it is according to Berardi instead one's ideas, one's "soul" which are controlled by the capitalist economy.

The capitalist system Marx described when formulating his theories was based on nineteenth-century industrial capitalist society. Marx (1844) argued that capitalism created alienation in society that operated on several levels:

- *Alienation between the producer and the consumer.* Instead of producing something for another person, the worker produces for a wage.
- *Alienation between the producer and the product of the work.* As the production is split into smaller parts and the worker becomes an instrument that makes a limited part of the whole, the pride and satisfaction of work is lost.

- *Alienation of workers from themselves*, since they are denied their identity. By losing control over the product of work and thus pride in labour, the worker is deprived of the right to be a subject with agency.
- *Alienation of the worker from other workers*, through the competition for wages, instead of working together for a common purpose.

A capitalist society, divided into classes of bourgeoisie and proletariat, stands in contrast to the ideal of communist society where there is no need for the state and class differentiation; instead everyone owns the means of production, and the principle of distribution is famously:

> "From each according to his ability, to each according to his need."*(Karl Marx, 1875)*

This has often been interpreted that everything should be shared equally, but Marx says nothing about equality, rather he emphasizes the relationships between people and their abilities to contribute to production and society. A 'communist society' is a society where everyone is linked in a mutual interdependency with others and nature, and self-actualization is the driving force (Ibid). In this perspective, production is a mutual exchange that strengthens individuals. The producers are strengthened by expressing themselves through their work, where the product is an expression of their subject and position in the world, and thus expands their power and range. As this expression of their identity is put into use, and used by other individuals, the producers also get the satisfaction of seeing their products in use, as a response to other people's human needs (Ibid).

The concept of *crowdsourcing* is common, but understanding varies. Based on several existing definitions, Estelles-Arolas and Gonzalez-Ladron-de-Guevara (2012) present an integrated definition of crowdsourcing as a "type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task." When considering modern crowdsourcing, the practice of acquiring services, ideas, or data from a crowd of people enabled by communication information technology, (Brabham, 2009; Prpić, Taeihagh, & Melton, 2015), those technologies can further alienate people as their work is divides in micro-tasks and their relations becomes commodified, but the technologies can also become a mean for reducing alienation by establishing direct links between workers and between workers and consumers (Stacey, 2008). These applications can be seen as an expression of the talent of the producer and the needs of the consumer, but also as an act of recognition between humans, that is, a social relationship. By applying Marx's terminology, we argue that instead of alienation, stronger relationships might be created:

- The relationships between the producer and the consumer. Instead of producing work for a wage, a direct relation to another person is developed.
- The relationship between the producer and the product of the work. As the product and the producer is the same person, and the

producer has total control over her own work and can feel proud of this work.

- The relationship with oneself. When production is mainly about expressing oneself and creating one's own community of followers, the worker is no longer a stranger to him or herself.
- Relationships between workers. Not competing for the salary, but working together for the common network that everyone depends on strengthens relationships.

In our following analysis we will use Marx's four levels of alienation, and the dichotomy between alienation and relation, as a framework to explore cases from the three crowdsourcing categories; *human computation, peer competitions,* and *open collaboration*, described in table 1.

Table 1. 21 cases of crowdsourcing tools divided in three type groups: Human computing, Peer competition, and Open collaboration.

Human computing	Amazon Mechanical Turk	In Amazon Mechanical Turk, participants are part of a crowdsourced labour market, create knowledge, produce data, solve problems as well as act as test subjects in crowdsourcers' projects (for instance, for behavioural studies). Most tasks are micro tasks, where the workers receive small monetary rewards.
	Amara	Amara is a tool that enables editing subtitles for videos. An easy to use interface makes it simple to invite a crowd of editors to co-produce subtitles in multiple languages.
	Testbirds	Testbirds is a platform for crowd-testing of software where testers receive monetary rewards.
	OpenStreetMap	In OpenStreetMap (OSM) participants contribute to the development of an online map and also to the development of the mapping tool. There are no payments involved.
	Waze	In Waze participants contribute to a real-time navigation application with traffic information collected through their mobile devices. The tool also enables a more active sharing of data about traffic situations and also invites participants to the development of the map itself by editing e.g. roads and houses.
	Ushadi Quakemap	In Quakemap participants use a map to coordinate needs and resources in earthquake struck areas.
	PartS	In the citizen science framework PartS participants contribute by capturing data with their mobile devices during long time studies.
Peer competitions	Brainr	Brainr is an idea-sourcing tool where users submit ideas and solve problems submitted by other users.
	InnoCentive	InnoCentive is a problem solving tool that uses competitions for money as a way to engage participants. It focuses on the development of problems in engineering, natural science, and business.
	OpenIdeo	OpenIdeo is a crowdsourcing and co-creation platform for gathering and developing ideas and design solutions. Challenges are posted by the Ideo design company and partner organizations, e.g. UN, etc. The

		platform often provides a monetary award.
	Lego Ideas	Lego Ideas is a tool that allows users to develop designs for Lego products and to compete for the opportunity to see this to be available commercially. Potentially the winners can get a percentage of the gains.
	Ideascale	Ideascale is a crowdsourcing platform for collaboratively developing ideas in a structured way.
	Kickstarter	Crowd-funding platform where participants can co-fund projects.
	Crowdsourced law reform	In the case of crowdsourced law reforms in Finland participants were invited to contribute with their knowledge on law reforms about off-road traffic and housing company management.
Open collaboration	Twitter	Twitter is a micro-blogging platform that enables crowd production of data in the form of short text messages, URL:s and images.
	Wikipedia	Wikipedia is an online encyclopaedia, enabled by a wiki that makes it easy to create and develop webpages in discussion with other users. The people who use it write it collaboratively.
	Facebook group	The social media network Facebook provides a discussion tool called Group that enables a deliberative model of information exchange
	LocalWiki	LocalWiki is a Wiki connected to mapping tool, the map is the starting point for the information added and describes how the material is connected to a local site. The information is displayed on the crowd-map, and users can add new points of interest and develop what other users have contributed with.
	Flickr	Flickr is an image-sharing network where users store and share images directly with peers or as members of special interest groups.
	Instagram	Instagram is an mobile online social networking service that supports sharing of pictures and videos, publicly or privately on the app.
	YouTube	YouTube is a video sharing website where users can watch, create and upload their own videos to share with others.

Result

A typology of worker relations in crowdsourcing

To identify a range of typologies useful for identifying relations, we have analysed a number of crowdsourcing platforms, focusing on how these tools support the relations in crowd production. These roles can be either clearly divided, as in the working relations on a crowdsourcing platform such as the Amazon Mechanical Turk, or they can be the same as in a collaboratively developed Wikipedia post, where the consumer also can be the worker. We start with a very broad definition of a crowdsourcing tool as an *ICT enabled, often large-scale, collaborative production*. To enable a comparison of some crowdsourcing platforms from a participatory perspective, we started with

fundamental questions focusing on worker and consumer positions, description of the outcome of the work, and how community is supported. We then after a first pilot study adjusted these definitions to better mirror the practices in the cases and to develop typologies grounded in the empirical contexts.

The analysis addresses the following questions regarding relationships:
Between the worker and the consumer: Is it a separation between the worker collecting the data and the consumer of the data, or do they know each other?

(A) Separation: No relation
(B) Reputation: Worker or/and consumer might be displaying a certain reputation; the product/consumption is connected to a person.
(C) Recognition: Worker and consumer can acknowledge each other's existence, like e.g. through user names and user profiles.
(D) Bond: Worker and consumer can get to know each other; there are support for communication like discussion forums and profile pages.

Between the worker and the work: What is the underlying ontology? Is the result described as; bits and pieces, a discussion, or an expression by a subject?

(E) Bits and pieces: No relation, the work is separated in bits and pieces so the worker has no connection to the whole.
(F) Contributions: Worker is producing clearly defined assignments, and there is not much room for creativity.
(G) Dialogues: The result is more like a discussion.
(H) Agenda: The work is the expression by a strong subject.

Within workers; worker and self: Is the crowd worker an object that provides data without much control, or an active subject?

(A) Object: The worker is a passive object.
(B) Instrument: Worker is an instrument producing clearly defined assignments.
(C) Expert: The worker is an expert with a certain skill or ability.
(D) Subject: The worker is a subject with agency and purpose.

Between workers: What is the available tool support for community? Does the interface express certain group awareness? Can workers communicate shared interests or establish a community?

(A) Alienation: Workers have no relations with other workers.
(B) Common denominators: Workers have a common interest.
(C) Public: The workers share a public, a forum for expressing their opinions.
(D) Community: The workers have tools to establish a community with other workers.

This typology of alienation is summarized in Figure 2 where the levels of relations A to D are mapped to the four worker relations Marx describes; Worker – consumer, worker – work, worker – self, and between workers.

We used this typology to analyse the 21 cases described in table 1 that were chosen because they represent a diversity of crowdsourcing tools and contexts found in all three groups of crowdsourcing tools.

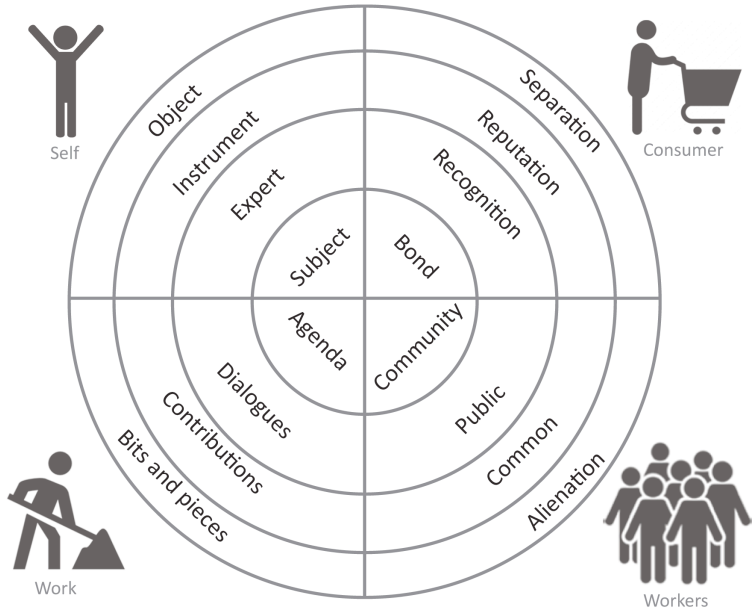

Figure 2. A typology of worker relations

Four modes of production in crowdsourcing

We assumed that the three different types of crowdsourcing tools should represent a scale of relations from separation to bonds, which was also true on a general level. The support for workers' relations in the *human computing* cases were weak or non-existence in most cases, and never strong. There is either total separation or the worker is visible for the consumer through reputation mechanisms, but there is no mutual connection. It is foremost the worker that has a reputation, the consumer isn't visible. The support for workers' relations in the *peer competitions* cases was strong or at least existed in most cases. In the *open collaboration* cases there were good, mostly strong support for all types of relations.

However, in practice this picture was more complex. By dividing the data in more detailed categories we describe how the types of relations are handled in the three groups (shown in Figures 3-5), illuminating that the division between the worker and consumer is more varied. Both Testbirds and Waze used reputation as a way to identify participants, and the division between consumer and worker is fluid as the consumer also partakes in the sourcing of the map. In the citizen science project PartS participants profile information is available. Here the sourcer has a profile page and based on this information the worker decides whether to join or reject the study. The worker also has a profile page the sourcer/consumer can access. The sourcer is also the consumer of the data.

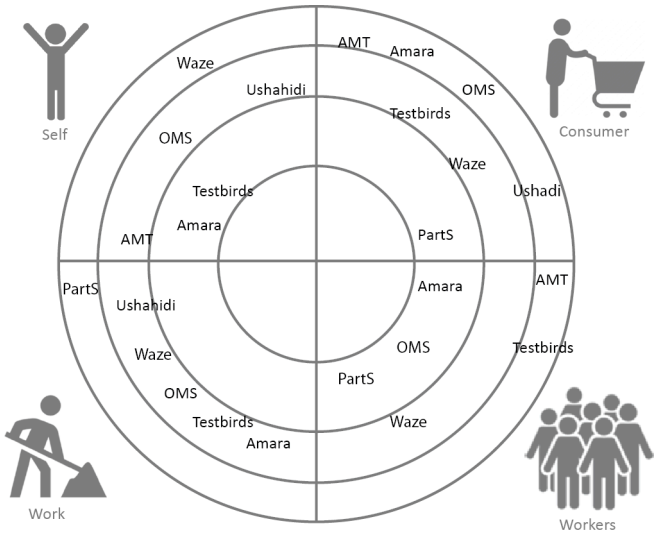

Figure 3. Four types of worker relations in cases of human computing where the inner circle represents strong bonds, the next one some relations, the third weak bonds, and the fourth outer circle no bonds.

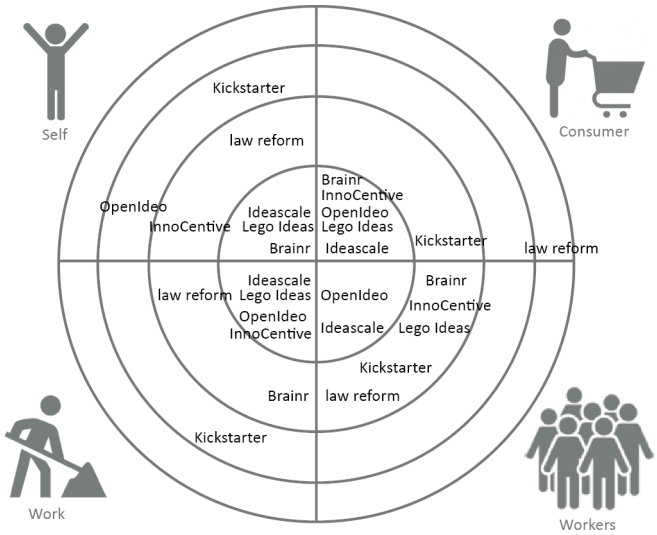

Figure 4. Four types of worker relations in cases of peer competing where the inner circle represents strong bonds, the next one some relation, the third weak bonds, and the fourth outer circle no bonds.

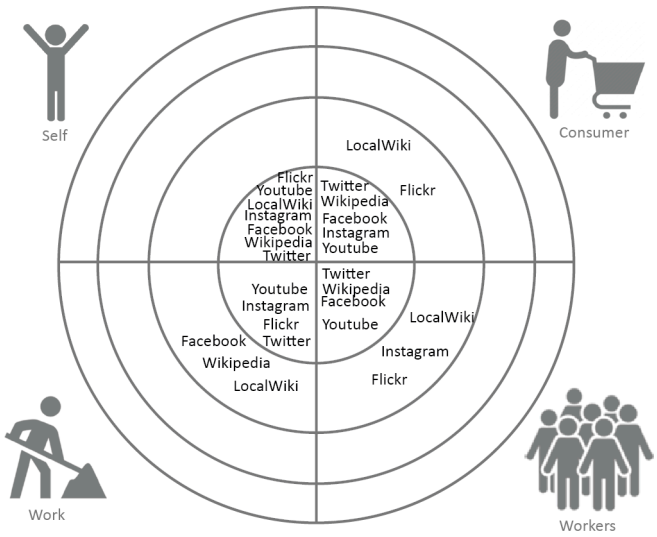

Figure 5. Four types of worker relations in cases of open collaboration where the inner circle represents strong bonds, the next one some relation, the third weak bonds, and the fourth outer circle no bonds.

Worker and work

When we compare the three categories we see that the greatest division is in how the relations between the workers and the work are supported. In the human computing tools there is none or a weak support for these relations. Workers have few means to understand and connect to the result of their work. This as a contrast to the peer competing and open collaboration tools where the relation to the work is an important motivator, as for example in OpenIdeo where the challenges are engaging and creative.
However, most of the crowdsourcing tools we analysed provided support for multiple types of worker positions. When we compared the types of information produced by these means of production, we identified several ways of looking at the data and the production process. In the case of driving around with a mobile device producing GPS coordinates, the facts are rather simple and undeniable. Anyone with the same device could get similar data driving the same way. On the other hand, also geo-mapping tools like OpenStreetMap need a diversity of users to cover the map collecting multiple facts from different locations and experiences, why the users not merely are passive objects providing data by moving around but also someone with experience of moving around in a certain region.

Worker and self

On one level worker's identity can be seen as a mere passive object whose movement or surroundings become recorded with geo-mapping or sensing functionalities, while moving or driving around. On another hand users also create credibility: The more contributors or participants in the data collection, the more legitimacy is created for the result. Users can also contribute more actively

with data, like in the citizen science project PartS, where users not only provide with sensor data, but also act like instruments contributing information via questionnaires.
In Waze the constraints to what the user actually can do are also precise. Mostly users drive around passively collecting speed data. But there are also means for improving a map and there is a toolbox of shapes and categories to add on. The participant is not only an object but an instrument that submit/develop documents. However, within these constraints the participant is seen as an actor with expertise about a certain area and who is the expert that controls the quality of the map. In the case of crowdsourced law in Finland the workers/contributors could for example be instruments that provide information for a better policy: writing down their knowledge about the issue by addressing the prompt on the crowdsourcing platform.
The constraints are, however, not always absolute, but something that can be negotiated and developed in a process. The instrument can also be an active subject that communicates and co-produce the process with others on the platform, including peer-producers and crowdsourcers such as civil servants in crowdsourced law-reforms. Likewise, the development of OpenStreetMap takes place in discussion forums and conferences.

Worker and the consumer

The relation between the worker and the consumer varied a lot in the analysed cases. One position was to not provide any means of communication or information about users, like in the citizen science project where this was avoided for ethical reasons. In Amazon Mechanical Turk, users are seen as competitors, and the tool a market mechanism that distributes the work provided by a client. Another position is that communication means are not provided, but users' reputation is known, and users might participate due to a common denominator. Also in the application every edit is negotiated in comment functionality. In the PartS tool, participants are also consumers, having the option to create empirical studies by their own, which capture as well as analyse mobile device data, thus taking the role of owner/researcher controlling the process. In PartS the researcher can also communicate directly and anonymously with the contributors. Other tools put a lot of effort into developing bonds between workers, and workers and consumers.

Workers and workers

In Waze, in addition to the map there are a discussion forum that provides support to a large community of Waze workers, and it also enables Waze users to bond with users in other social networks. Workers have a public profile that shows their activity on the discussion forum. On the actually map it is all about helping strangers, and thus to contribute to an abstract common.
In Waze, even though anyone can contribute to the map, there is an idea that people with real experience of a site are more experts that others. The products of the work can best be described as position recordings, reports and edits, where the editing is a potentially deliberative dialogue with everyone else that contributed to the post. In the case of the crowdsourced law reforms the production of data takes

place in idea and comment submissions and in the dialogues and negotiations that develop knowledge about the consequences of the law reforms. In these deliberative processes transparency is important, the OpenStreetMap for example describe every edit in history and conflicts are handled after an open protocol. However transparency might hinder participation in some cases where there is need for privacy for some reason. In PartS secrecy is for example essential for participation.

These different worker relations to the work, to oneself, to the consumer, and to other workers, can be described as different ontologies or modes of productions. From an idea of *crowd capitalizing* where the worker as a random *passive object* from which bits and pieces are sourced, to *crowd instrumentalisation* where the crowd provides data from multiple realities, to *crowd deliberation*, and finally to a performed reality of the *relational crowd* where the worker also is the consumer and the owner of the means of production, and the product is an expression of self realisation. Table 2 summarizes these relations with corresponding modes of productions.

Table 2 Typology of worker relations with corresponding modes of productions.

Mode of production	**Worker – consumer**	**Worker – work**	**Worker self**	**Worker – worker**
Crowd capitalizing	Separation	Bits and pieces	Passive object	Alienation
Crowd instrumentalising	Reputation	Contributions	Instrument	Common denominators
Crowd deliberation	Recognition	Dialogues	Expert	Public
Relational crowd	Bond	Agenda	Subject with agency	Community

Concluding reflection

In this exploratory paper, we have examined the role of the crowd workers, the crowd work consumers, the nature of their relations and the crowd-produced work, using Marx theory of alienation to identify a typology of worker relations in crowdsourcing.

We suggest that these types of relations can be described as different levels of alienation whereby the worker, the consumer, worker's self, and the work are connected in four modes of production:

- *Crowd capitalizing:* A functional mode of participation, where the crowd worker is viewed as a random object that provides facts and lends legitimacy to the process. There are no channels of communication.
- *Crowd instrumentalising:* In this more instrumental mode of production is enabled by the tool, and workers are instruments that make contributions for a certain cause. There is a common interest and the worker is aware of the other workers in the crowd.
- *Crowd deliberation:* In a more consultative mode of participation, workers are viewed as experts and production is a way to get in tune with public views

and values, garner good ideas, and develop consensus through deliberative dialogues. The worker has a communication channel to the other workers, they share a public; be it a newspaper, a mailing list or similar forum that makes communication with the other workers possible.

- *Relational crowd:* In a more performative transformative mode, workers both are producers and consumers, as well as owner of the means of production, peers that co-produces new theories and have political capabilities. There is communication support for community and participants are connected in mutual relations.

These different modes are, as our cases show, not mutually exclusive, but co-exist within the same tools and processes. However, these concepts express different aspects of participation and levels of relations. These modes and corresponding typologies might be useful as a way to discuss participation in crowdsourcing in a more nuanced way, and to develop tools with a better awareness of how different types of relations can be supported. Especially in cases of public policymaking where a diversity of perspectives are needed this can be useful.

In Marx's vision self-fulfilment through participation in a relational economy was the aim. However, self-fulfilment is also close to self-exploitation, and maybe the online instrumentalisation of our relations will lead to a situation where the self is the new work that is produced and consumed on the relational market. Just as Boltanski and Chiapello (2005) demonstrate this relational communism can just as well turn into a new internalised form of capitalism, where the workers are commodifying their relations exploiting their selves. This can be seen as Berardi (2009) suggests as a way for a capitalist economy to control the workers “souls”. In this paper we have provided a reinterpretation of the concept of alienation based on how alienation takes place in crowdsourcing contexts. By exploring how the capitalization of relations takes place in practice and in more detail, we provide a better understanding of these processes and how to support the use of such participatory methods in different aspects of policymaking.

In our on-going work, we will expand the case base to more realms and develop our model further, to identify similarities and differences between contexts. Another issue that needs to be addressed and incorporated into the model is data surveillance, which adds to yet another layer of alienation.

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Fedosov, A., Ojala, J., Olsson, T., Väänänen, K. and Langheinrich M. (2017): From Travel Plans to Magic Wands: A Cross-Domain Study of Practices and Privacy Requirements for Sharing Emerging Types of Online Content. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017-2

From Travel Plans to Magic Wands: A Cross-Domain Study of Practices and Privacy Requirements for Sharing Emerging Types of Online Content

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Abstract. Online social networks have made sharing photos and other digital content a common activity. Recently, a range of novel online services and connected devices have expanded the set of "things" to share – ranging from new types of digital content like music preferences and workout data to physical things like household items ("sharing economy"). To understand user needs, concerns and preferences in such emerging sharing domains, we collected 200 responses about participants' experiences with sharing six categories of "things": music preferences; travel plans; sports activity; real-world items (e.g., rooms and vehicles); virtual items in online games; and dietary preferences. For each category, we systematically describe what our participants share and with whom. Additionally, we asked 56 "non-sharers" to describe their reasons to refrain from sharing personal content from these categories. Using qualitative analysis methods, we use information from both "sharers" and "non-sharers" to identify privacy concerns that frame content sharing, and we discuss how factors like audience perception and sharing controls should inform the design of newly emerging sharing services.

Introduction

Today, vast amounts of user-generated and user-mediated content populates social networks. Current research has focused extensively on needs, practices, and concerns surrounding the sharing of photos and videos, textual information (e.g., status updates), and documents. However, in recent years the scope of what is "shareable" has greatly increased, comprising not only audio-visual content but also preferences and tastes (e.g., playlists, food), physiological data (e.g., workouts), trips, and even information about and access to real-world artifacts (e.g., "couchsurfing"). To the best of our knowledge, no study so far has extensively investigated and compared such emerging types of shared content.

Using an online survey tool, we invited participants who had used one or more of such emerging sharing services to share their individual experiences, needs, preferences, and concerns with us. We have focused our investigation on six emerging types of content: (1) music preferences and playlists; (2) travel plans and trip details; (3) details of physical exercises and sports activity; (4) personal physical possessions such as apartments and vehicles ("sharing economy"); (5) virtual possessions in video games and virtual social worlds and (6) personal culinary and dietary preferences. The particular choice of content types is based on an initial literature review (see Related Work) and covers the wide range of online sharing services beyond traditional messaging and social media platforms. For each type, we asked participants what content they share, with whom, and whether they would like to share some content that a service does not provide.

This exploratory work reports our results related to privacy issues, while also reporting overall practices within six different sharing domains. Specifically, we

(1) Unveil common practices regarding sharing of emerging types of content.
(2) Identify common privacy concerns that frame the sharing of novel types of content.

After discussing related work below, we will describe our study design in detail. Our study description will suggest how these different types of content can be conceptually grounded and categorize them with respect to the sharing discourse in communication and media studies. We will then present our participants' practices of sharing different types of content, followed by our findings regarding privacy concerns across the six categories listed above. Finally, we conclude with a discussion on how to enable user control in emerging sharing services.

Related Work

Sharing Preferences and Personal Digital Content

The relevance of sharing for supporting social relationships has been well explored. Belk (2010) defines "sharing in" and "sharing out" as two types of interpersonal interactions, based on the relationship with and attitude towards the counterpart of a sharing transaction, and distinguishes the process of sharing from other consumer behaviors as gift-giving and reciprocal exchange of goods. John (2013) distinguishes two logics behind the term "sharing" – *distributive* and *communicative*. Sharing as an act of distribution (*distributive* sharing) means dividing a piece of something to someone, i.e., a shared item is a limited resource, e.g., an apartment that is rented to other person for a time it is not in use. Sharing can be also an act of communication (*communicative* sharing), where the shared item is not a limited resource, e.g., online photo sharing. John (2012) describes sharing as the fundamental and constitutive activity of Web 2.0 in general, and online social networking services in particular. He argues that sharing phenomena in Web 2.0 are not necessarily novel (sharing is seen as a type of communication). However, rebranding these activities under the term "sharing" (e.g. photo sharing) and using networked technologies within these activities – are new phenomena (John, 2012). Hence, we see the value in studying sharing practices in Web 2.0 to further our understanding of this emerging terrain. For our study, we selected six different types of emerging content sharing categories, which manifest both distributive and communicative logics of sharing (see Figure 1).

Olson et al. (2005) find that the willingness to share different types of meaningful information depends on who one is sharing that information with. Wiese et al. (2011) add that "willingness to share" is also dependent on the frequency of collocation, communication, and the overall closeness of the sharing participants. While these studies informed our initial categorization of personal content that people share, they nevertheless only inquired on participants' willingness to share a particular piece of information. In contrast, we focus on actual experiences (self-reported) of sharing individual types of content.

A large number of studies on sharing focus on personal digital data, e.g., files (Voida et al., 2006), photos (Miller et al., 2007), and videos (Lange, 2007). Equally wide attention is given to sharing (textual) information through social networking sites (SNS). Of particular relevance to our research is, e.g., the work by Acquisti and Gross (2006) on attitudes and privacy concerns among Facebook users and non-users within an academic institution. They found that students joined Facebook regardless their concerns about privacy. Given the amount of prior research on photo and video sharing, in particular on SNS, we explicitly focused on emerging content.

Studies of Emerging Types of Content

The content categories that we have examined have been studied individually with different levels of attention. However, so far no study has attempted to compare sharing across those different domains. In our previous work, we have investigated the device selection criteria to access six content sharing service categories (Fedosov et al., 2016), however, descriptive accounts of shared content in those domains and concerns of privacy are yet to be analyzed.

Sharing music preferences (i.e., not actual files but things like playlists) has been studied extensively. Well before music streaming services became popular, Voida et al. (2005) studied how users share their listening preferences using iTunes. Silfverberg et al. (2011) studied how users employ "profile work" to shape their online profile in a service that automatically shares their played music with others. Extending this previous work, we focus on emerging music preference sharing services that allow the sharing of self-made playlists with followers (e.g., Spotify).

Sharing travel information has seen somewhat less research. Aizenbud-Reshef et al. (2012) studied the sharing of travel information by interviewing employees regarding their willingness to share their past and future travel plans. Gretzel and Yoo (2008) studied how online reviews affect user travel decisions.

Sharing one's physiological data (e.g., workouts) is probably one of the most covered categories among those we have looked at. Ojala (2013) discussed motivations for tracking and sharing details of training routines and physical exercises in online sports communities. Prior work confirmed that social sharing contributes to the overall user experience and enjoyment of workouts (Mueller et al., 2010, Munson & Consolvo, 2009). A range of work has also looked at privacy concerns (Klasnja et al., 2009), associated risks (Raij et al., 2011) and preferences (Prasad et al., 2009) regarding the tracking (and potentially sharing) of personal health data. Epstein developed social sharing design framework in personal informatics (Epstein et al., 2015).

A very recent trend is the sharing of physical possessions, initially rooms and apartments (e.g., Airbnb), but more recently also rides (Uber), cars (Getaround), and household items (Snapgoods). Several researchers have studied such "sharing economy" services, in particular motivations to participate (Bellotti et al. 2015, Ikkala and Lampinen, 2015). Lampinen (2014) studied users on couchsurfing.com, focusing on reputations problems among users of shared accounts.

Somewhat more on the fringes lies the sharing of virtual goods in virtual social worlds (e.g. Second Life) and video games (e.g., World of Warcraft). Bakshy et al. (2009) examined an interplay of social networks and social influence in adoption and transfer of user-generated content among friends and strangers in massively multiplayer virtual world. Neustaedter and Fedorovskaya (2009) explored capturing and sharing memories through the medium of photos, conversation logs, diaries and landmarks in virtual social world. Odom et al. (2014) investigated the emotional attachment to virtual possessions, including online game avatars.

Sharing information about food and dietary preferences has grown in popularity ever since Grimes and Harper described design opportunities in the spaces (Grimes and Harper, 2008). Davis et al. (2014) investigated the design space for recipe sharing practices.

While the six different content categories we are describing here have thus individually been investigated with various degree of attention to sharing, user preferences and concerns were usually not the primary subject of inquiry, perhaps due to the complexity and ambiguity of the phenomenon itself (Kennedy, 2016). Our exploratory work suggests a possible direction to start a deeper discussion on sharing emerging content.

Selected Work on Privacy in Social Media and Beyond

Our empirical categorization on privacy draw on a number of prior publications. Palen and Dourish (2003) describe disclosure, identity and temporal boundaries as central characteristics of privacy management. Olson et al. (2005) provide guidance on how sharing services can incorporate personal privacy preferences. We incorporated those principles in our data analysis that appraised our findings.

Stuart et al. (2012) presents a "transparency framework" that articulates a continuum of identity from anonymous to real name, which informed our selection of target audiences. Furthermore, previous research identified how people address audience challenges while sharing on social media: they think of more general abstract audiences or imagined targeted audiences (Litt and Hargittai, 2016). In fact, these ambiguous audiences in SNS raised the issue of *context collapse*, where self-presentation and the distribution of information to distinct social groups (e.g. personal, professional) became difficult, that is "people from different context become part of a singular group of message recipients" (Vitak, 2012). Social media scholars identified several coping mechanisms to address context collapse through boundary regulation (Wisniewski et al. 2012) and suggested that control over the audience to access personal information is critical to address privacy concerns in SNS (Ellison et al., 2011). Tufekci empirically illustrates that undergraduate students in order to manage unwanted audiences adjust the visibility of their profiles on Facebook, but not regulate their level of disclosure with exception of phone numbers (Tufekci, 2008). Boundary regulation in online worlds has become challenging due to the context collapse. Hence, the designers of emerging sharing services need to account for audience control. Our work addresses this problem by eliciting the privacy needs and concerns for emerging types of data ranging from metadata about physical artifacts (e.g., apartments) to personal digital data (e.g., music preferences). Furthermore, we discuss four design themes stemming from privacy concerns across these six sharing domains.

Study Design

The selection of content types is based on the *communicative* and *distributive* logics of sharing (John, 2013) described above. The categories we selected cover a large area of personal content and differ in several sharing dimensions, e.g., type of audience or level of disclosed details, as well as encompasses wide range of personal possessions (Odom et al., 2014) in digital and physical realms. Hence, we selected both physical types of sharing (e.g., cars and apartments) and immaterial types of content within digital sphere (e.g., travel plans, workout data). Even though the different forms of sharing we selected might seem to be categorically at different levels, exploring sharing in different spheres helps us to unfold its "polysemic homonymity" , i.e., its diversity of uses and logics (John, 2017), as well as better understand the emerging sharing practices and their relations among each other.

To unfold this ambiguity of contemporary sharing, we followed John's descriptive account of sharing for Web 2.0 (John, 2012). Figure 1 shows how our six emerging content sharing categories can be classified using *communicative* and *distributed* logic of sharing (John, 2012, 2013). Note that both types of sharing foresee prosocial behavior that promotes openness, trust, commonality and understanding between people (John, 2017). Food and music preferences, as well as travel plans or physical exercise data, are mostly shared as an act for letting people know. In contrast, virtual possessions and even more so sharing economy services clearly represent sharing as an act of distribution. We deliberately left out traditional and popular content items such as videos, photos, documents and audio files, as sharing them has been studied widely. Similarly, due to the amount of previous studies, we also did not want to cover popular sharing platforms in our survey, such as social networks (e.g., Facebook) or messaging services (e.g., Twitter). For each of the six content types we selected, we created a set of survey questions to explore personal sharing practices and asked about privacy concerns that inhibit sharing.

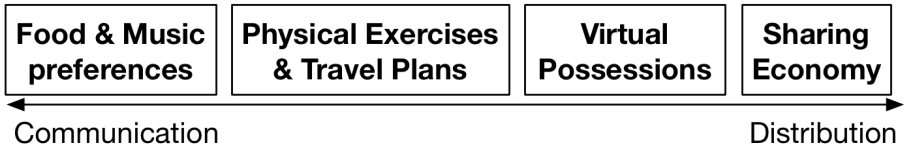

Figure 1. The communicative and distributed logics of sharing of selected emerging types of content.

Data Analysis and Methodology

We launched our online survey in spring 2015 and collected data for three months. We used Typeform (http://typeform.com) to administer the survey, as it features a modern design and a responsive (i.e., cross-device) interface. We distributed the survey URL through social media channels, mailing lists and forums, personal contacts, and by distributing printed flyers in our respective universities.

We collected 256 responses from 246 participants of our online survey. We particularly wanted to use an online survey as a method for collecting data since it can cover a diverse sample of sharing and non-sharing populations. Exactly 200 responses described participants' previous experience on sharing content in one (180 participants) or with exactly two (10 participants) of the six categories we listed (see Table I), while 56 participants did not have any such experience. For those without any experience, our online survey form branched to a single free-form text field, asking them why they did not yet use such services. All 56 provided this information, which helped us understand the privacy concerns and needs of non-sharers. Table I describes the survey demographics on all six content sharing categories, as well as for the 56 non-sharers. Of the 200 respondents who indicated prior experience, 125 (63%) were male and 75 female (37%), with the largest age group being adults of 25-34 years. Their occupations spanned a wide spectrum, including ICT jobs, researchers, educators, marketing professionals, and students; 84% of them have academic degrees (Bachelor, Master, or PhD). Note that 10 participants who completed the survey more than once are listed in Table I as an independent instance in a respective sharing category. In this exploratory work, we do not use collected data for identifying causal relationships or for doing statistical hypothesis testing, otherwise we would have needed to treat those instances accordingly, e.g., through repeated-measures experimental design or by using an individual profile as a covariate.

Following the approach in Olson et al. (2005), we first examined what content people share per category, and with whom such sharing takes place (see rows and columns in Figure 2). However, in contrast to Olson et al., our study focused on actual sharing behavior (self-reported), rather than "willingness to share". Participants selected several content items from a comprehensive list, which we extracted for each category from modern online platforms and services that facilitate sharing six types of content. For sharing workout statistics we examined popular smartphone apps like Endomondo, Runtastic and Sports Tracker; for food preferences sharing, we used the content from dish-finding apps such as Foodspotting and Yelp; for sharing music preferences, we evaluated music streaming (e.g. Spotify) and hosting services (e.g. Bandcamp); for sharing travel details with others, we looked at TripIt; for the "sharing economy" category, we used services such as Airbnb and Uber to build content items; and for the "virtual possessions" category, we looked at several examples of virtual social words and

game platforms that afford sharing digital artifacts. Participants were also able to provide their own examples in an "other items" field.

Table I. Survey demographics

	Music Prefe-rences	Travel Details	Physical Activity	Sharing Econ.	Virtual Posse-ssions	Culinary Habits	Non-sharers
Avg. Age	25.9	28.4	31.4	28.6	35.3	26.6	31.3
# Males	47	22	22	11	14	9	31
# Females	20	25	11	10	4	5	25
Total #	**67**	**47**	**33**	**21**	**18**	**14**	**56**

After collecting participants' demographic information and identifying the content items they have experience with, we subsequently asked more detailed questions about sharing these content items. For example, for a participant that had shared their travel plans with others we asked "What are your main privacy concerns about sharing these personal details, such as travel itineraries?". We further asked participants to describe any positive or negative experiences sharing this information in a free-form text field. Furthermore, we asked participants to specify an online service they are currently using (or have previously used) to share this type of information and indicate tools they access this service. For 'non-shares' we asked: "Why did you (so far) decide not to share that type of information?" Overall, we collected 340 instances related to participants' privacy concerns and needs. Two researchers on the team employed an open-coding technique from grounded theory (Glaser & Strauss, 2009) to analyze all open-ended survey questions. To draw out common privacy issues across our categories, we used affinity diagramming (Holtzblatt et al., 2004). In addition to counting instances of each factor, we also collected respondents' quotes to support each emerging empirical category.

Results

We first report statistics and other general findings about each content category, followed by a more comparison-oriented section that discussed differences and similarities of target audiences across the categories. We then report the needs and concerns of our participants regarding privacy. Note that we describe tools or services that support the sharing of emerging content in a separate publication (Fedosov et al., 2016).

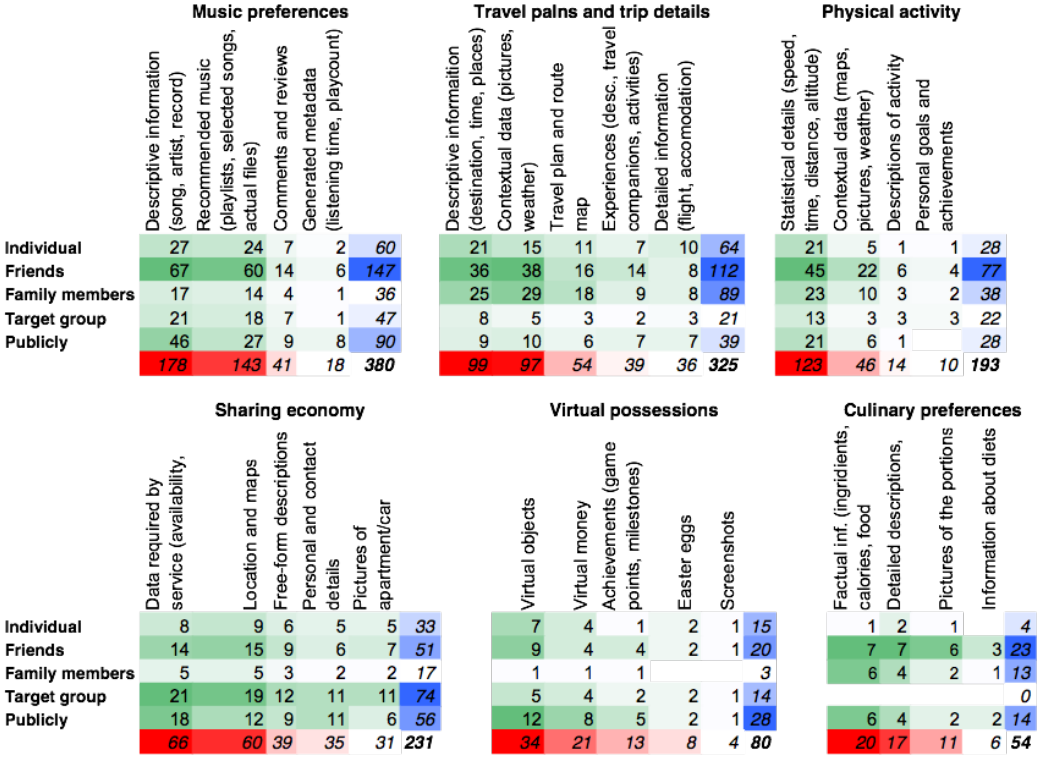

Figure 2. Aggregated table of content shared across different sharing categories

In Figure 2, each inner cell in a table gives the number of participants that reported to share a given content item with the respective recipients. Multiple selections were possible. In addition, participant could add items not covered in our set of choices using a text field. To facilitate visualization, we clustered similar content items in categories: descriptive information, metadata, contextual data etc. Then we ordered the clusters (columns) from most to least shared, and color-coded them in darker shades for higher item counts.

In the music preference category, most of the sharing happens with friends, followed by public sharing and sharing with other individuals. The most shared information were descriptive details, such as song title, record, and artist name.

The most shared content in category “travel plans and trip details” was pictures and names of destinations, followed by travel plans and descriptions of destinations. Recipients were mostly friends and family. Respondents preferred to share specific accommodation information mostly with individual recipients, though also sometimes published this publicly. Targeted sharing to a certain interest group or community was the least selected option.

Participants shared information about physical exercises (i.e., workouts) mostly in the form of duration, distance covered, and routes. Information such as heart rate, altitude drop or step counts was shared more rarely. Occasionally participants shared pictures, exercise descriptions, or general fitness goals. Physical exercises are primarily shared with friends, then with family members. In some cases, people

preferred to share data with individual people and publicly. Sharing with target groups with a common interest was rare.

Our "sharing economy" questions primarily asked about accommodation and car sharing experiences. Figure 2 shows that a description of the item to be shared, its availability, as well as its location are among most shared content, though the distribution among items is fairly even, including pictures, descriptions of conditions, maps, and contact details. Not surprisingly, participants shared such details with targeted groups and/or publicly, rather than with friends or family members. This might also be because these services usually enable only sharing with all other service members, in order to give a wider exposure. Participants complained about certain artificial constraints imposed by these services in order to anonymize listings, such as not being able to share an external URL that would describe the item in more detail, not being allowed to embed video, or not being able to provide personal contact details to directly follow-up with interested parties.

The most shared items in videogames and online worlds were virtual objects (hence the "magic wands" in the title of this paper) and virtual money, both actively shared with specific target groups and publicly. The fact that family members are the least frequent sharing audience might stem from the fact that few of these games are played within a family context. Participants would furthermore like to share videos and replays, as well as being able to export content from other services and virtual worlds.

The least used category of information being shared among our participants was food related information. Most participants reported sharing food-related descriptions and comments in this category, followed by pictures of portions and ingredients. Similar to music preferences, content in this category was most frequently shared with friends. This suggests that such information is considered less private, but instead is used for self-representation and to actively engage with others.

Across all sharing categories, respondents most often shared factual and descriptive information around shared artifact, with an exception of online games, where the most shared item were virtual possessions. Contextual details such as maps, pictures and supplemental information are being shared moderately. Personal details are being shared less frequently, and sharing of such details are usually dedicated only to some selected audiences.

Our empirically-collected data thus confirms our initial grouping of the six categories along the "two logics of sharing" (see Figure 1): We observe that sharing private information about trips and physical exercises, as well as personal preferences in food and music, are acts of communication that aim to inform, engage and stay connected. Instead, sharing content from "sharing economy" services and virtual possessions from videogames is clearly used to distribute a shared resource. Our findings also suggest that sharing for communication and

distribution not only vary across different motivating factors but also with respect to which audiences they target.

Privacy Concerns and Needs

The privacy concerns and needs that our 200 "sharers" articulated were mostly formulated around the concept of "content that is shared with a particular audience". However, some of our participants also mentioned privacy issues with respect to the actual service provider, in particular concerns about a less established provider (i.e., a startup) being acquired, or not being able to protect stored data to the same extent as a large company would.

When it came to concerns about the actual content being shared, our respondents were quite conscious about sharing information revealing their identity (such as phone number, email address, pictures etc.):

> [Concerns?] None, as long as the game prevents real identity and "real world" financial data from connecting to the actual sharing/transaction with other individuals and vice versa. (Male, 50, about sharing virtual possessions in a virtual world).

Additionally, participants also considered information that has embedded location in it to be critical (e.g., home address, map with current location, travel route). Some concerns related to a fear of being stalked, especially from respondents that shared data about physical exercises, travel details, and accommodation listings:

> [I fear] that people would know where I live or where I usually go when I go for a run. (Female, 20, sharing physical exercise data).

With respect to concerns about the recipient (audience) of a particular piece of information, our respondents stated three main issues: (1) that a particular individual or an unwelcomed group would gain access to the shared data:

> I don't like some specific persons [to] know about my ads. (Male, 32, sharing accommodation listing);

(2) concerns about misuse and violation of personal data as a result of fraud or safety issues (e.g., identity theft); (3) and acquisitions by a third party:

> This is why I no longer use a fitness tracker. I don't like wondering about who will get to use my data and why – one of the companies that had access to the data was purchased by another company I don't trust. (Female, 49, sharing physical exercise data).

We also found that self-representation to the wider audience and disclosing personal details too broadly also contributed to privacy concerns of being misjudged or laughed at:

> There have been some cases when I've shared too intimate information to too wide an audience. I slightly regretted after sharing. (Female, 28, sharing travels plans and details).

Olson et al. (2005) pointed out the need for various controls over content that would enable anonymous, coarse- and fine-grained sharing of details. Our findings confirm that this need also holds for emerging types of shared content:

> I try to eliminate information that makes me concerned about privacy beforehand. (Female, 23, sharing accommodation listing).

As anticipated, participants mentioned that audience control mechanisms should allow them to decide what audience can access shared content within a service. For example, having the ability to easily remove professional contacts from the list of recipients of a post would help with the following concern:

> Main concern is posting pictures of food during working hours, which may imply that I am not at work. (Male, 34, sharing culinary preferences).

On the other hand, participants also mentioned their willingness to share openly information that would be beneficial to some individuals and community:

> Information about production of foods and important foods that substitute meat and fish. (Female, 26, sharing dietary habits).

Finally, users mentioned an issue with overly flexible privacy policies and mechanisms to protect their sharing choices

> [I fear a] change of privacy policy that would allow a wider circle of people to see what I have shared without my consent. (Female, 32, sharing travel plans and details).

	Music preferences	Travel plans and trip details	Physical activity	Sharing economy	Virtual possessions	Culinary preferences	
Privacy concerns							
Misuse and violation of the shared data	1	10	2	1			*14*
Revealing identity and location	1	7	10	3		3	*24*
Unwanted access and unwelcome crowd		12	4	7			*23*
Acquisitions by a third party	2	1	1	1			*5*
Disclosure of personal details broadly	5	2		2	6		*15*
Self-representation to the wider audience	5	3					*8*
	14	35	17	14	6	3	**89**
Privacy needs							
Controls over the content	14	3	2	4	4	1	*28*
Access control mechanisms	4	10	1		1		*16*
Flexible privacy policies and mechanisms		1			1		*2*
Willingness to share openly	3				2	1	*6*
	21	14	3	4	8	2	**52**

Figure 3. Privacy concerns and needs of active sharers that inhibit sharing across different novel content categories.

Some of the aforementioned privacy needs and concerns were more present in one sharing domain than another. Figure 3 describes privacy needs and concerns on a per-content category basis. Each cell in the table gives the number of instances we encountered during our content analysis. Darker shades represent higher counts. We conducted a two-way contingency table analysis to test the dependency of these privacy concerns across different sharing categories, and found that there was a significant association – Pearson $\chi^2(25)=84.661$, $N=89$ and $p<0.001$. Similarly, we

found significant association among privacy needs and sharing categories – Pearson $\chi^2(15)=25.743$, $N=52$ and $p=0.041$. Looking further into this, we found that concerns related to revealing one's own identity and location, as well as a need to control the distribution of shared content, were most crucial across all emerging sharing domains. Preventing unwanted access is most important for services that share travel plans, physical possessions, and biometrical data. Looking at the detailed list of content categories presented in Figure 2, we can speculate about how specific content types prompt the needs and concerns listed in Figure 3. Sharing pictures, location, and descriptive information could prompt privacy concerns about the misuse and violation of the shared data in "travel plans", while triggering fear of unwanted access in the "sharing economy" category. Sharing descriptive information about songs or self-made playlists ("music preferences") may entail concerns about being misjudged by others, while information about personal workouts may lead to concerns related to revealing one's identity.

We also prompted the 56 respondents that did not report any experience of sharing emerging content to explain the reasons why they decided not to do so (information in this paragraph is not shown in Figure 3). For 16 of them, this behavior related to personal safety and their preference for limiting the spread of private information. These reasons match our above findings on privacy concerns related to misuse of the shared data and fear of revealing one's own identity or location.

> I don't share those [details] to anywhere. I like to keep most of my things private, even when it requires some work. I share some stuff to my friends, but even that is really limited. (Female, 30, not active sharer).

20 out of 56 "non-sharers" reported that they only share impersonal information (e.g. news, educational materials, useful tips), resonating with our findings on concerns over revealing identity and self-representation to a wider audience. Few participants found that sharing personal information offers no benefits to their community:

> It's information that none of my friends should have a practical use for. At times, I use such online services to keep track on my own, for myself. I don't consider my exercising private, just info no-one is interested in and thus I should not bother others with it. (Male, 27, not active sharer).

Implications for Design

Based on a qualitative analysis of our survey's open-ended answers across different content categories we distilled four initial design themes for designers and developers that are interested in building content sharing services for the distribution of emerging content types. Our design themes address the privacy concerns and needs identified in the Results chapter. In particular, we review (1)

different angles of access control; (2) privacy mechanisms; and (3) quality of controls; and (4) accessibility of shared data.

Firstly, our survey results show that people tend to share different personal content with various levels of details. Mechanisms that enable anonymization or vagueness can be useful in this context. For content related to sport activities, this could be an aggregated overview of a physical activity over a certain period (Epstein, 2013), with generic information that cannot be traced back to an individual.

> [Service] allows to remove any training as you want and to provide a border area. (Male, 30, sharing physical exercise data).

Furthermore, similarly to unwanted audience concerns in social media (Tufekci, 2008), users of emerging content services should be able to easily select the right target audience for a given piece of content, in order to prevent unwanted content access. Gradually unfolding shared content upon gained trust is another strategy to consider when sharing sensitive data. Some "sharing economy" services such as Airbnb are using this strategy already during their matching phase. This was brought up in the open-ended answers as an example of good practice.

> Couch surfers. If they are interested in staying and I with them, more details are shared (Male, 26, sharing accommodation listing).

Secondly, services should maintain easily comprehensible privacy policies. Information that articulates where and how content will be used, and whether and to whom collected data is sold, traded or exchanged should be provided.

> I do not wish to become a free agent for advertisers. Almost all services we use to share stuff use the data for companies to improve their advertising. If I wish to be utilized as a subject for marketing studies, I wish to control the data I share and get some kind of compensation of it. So I use social media to update quite vague stuff, however I'm aware I'm still sharing more to companies than I actually would like to (Female, 40, not active sharer).

Recent research has explored if short, standardized privacy notices (Kelley et al., 2009) can simplify this process (Kelley et al., 2010; Cranor, 2012), as standard free-form policies are typically difficult to read and comprehend (McDonald and Cranor, 2008). Also, obtaining explicit user consent is a good practice to follow when updating or making changes in the existing privacy policy, even if local laws do not require this. Note, however, that many scholars have started to question if consumers are actually able to take meaningful decisions based on privacy policies (Solove 2013; Acquisti et al., 2013; Acquisti et al., 2016).

> I understand its [service's] nature, functions, and policies and can choose how to use the service (Male, 52, sharing virtual possessions in a virtual world).

We found a need for providing adequate sharing controls for content sharing services. Our participants were easily frustrated when data was being automatically shared without their consent. To prevent such behavior, services periodically could help users review their automatic sharing settings. Furthermore, our respondents

were cautious about being marked as "spammers" if they would share too often or to the wrong audience. A service could offer certain policies that would allow only a limited amount of content to be shared within a certain period, protecting both posters (from oversharing) and recipients (from being spammed).

> I want to be in control of what I share to who. None of it should be automatic as such without my explicit consent (Male, 30, sharing music preferences)

Lastly, in order to amplify engagement with – and increase the attractiveness of – a service, designers should consider presenting certain shared content within the service to non-users. Potentially this technique will convert them into users of the service. Users would also benefit from sharing data openly for public use, e.g., for information that has a substantial value to a community. Examples of this type of shared content might be information about ingredients and substances of products or foods.

> Like McDonald ingredients, I like to explain to my cousins why it's dangerous (Male, 27, sharing dietary preferences).

Discussion and Limitations

In studying emerging sharing practices online, we were motivated by John's non-prescriptivist approach that inquired 'What do people call sharing?' rather than puristically interrogating 'What should we call sharing?' (John, 2017). Hence, our focus on practices let us explore the 'everydayness' and ubiquity of sharing. Drawing on John's communicative and distributed interpretation of sharing (John, 2017), we have classified six spheres of sharing into these two logics. We have adopted a pragmatic approach studying various emerging sharing practices enabled by networked technologies, from distribution of digital content (e.g., in the form of the metadata about real-work apartments and cars, and virtual possessions in videogames), to communication of personal achievements in sports, to individual preferences in music and food. We did not reveal the different logics of sharing to our participants and left the term 'sharing' up to their interpretation, allowing them to freely include any content items they shared under each category. Nevertheless, our analysis shows that the empirical data we collected supported our initial classification of emerging content into "two logics of sharing". While we have incorporated both material and immaterial objects of sharing in our survey, we have occasionally observed non-rivalry qualities of the content. For example, perceptions and privacy attitudes of sharing a car (where sharing is seen as an act of division) may differ from sharing digital information about the ride using that car (communicative model). Hence, the results we have presented here, albeit rich and descriptive, are rather exploratory and have to be interpreted with great caution while developing each sphere of sharing further. Future empirical work that aims

to compare and contrast "material" (zero-sum) and "immaterial" (non-zero sum) sharing should account for this difference in quality.

In a first step, we extracted factors surrounding privacy concerns surrounding emerging content sharing. Some of our findings about privacy concerns are in line with earlier work on traditional content, such as photo sharing practices. In our study, we expand the prior findings from Miller and Edwards (2007), which state "[photo sharing] solutions should also offer flexibility in the ability to control privacy and sharing", by illustrating several strategies for access control for novel content sharing services. We also extend prior work by Olson et al. (2005) (on how sharing services can incorporate personal privacy preferences) by including novel content categories. Finally, we augmented findings on privacy concerns about personal sensing (Klasnja et al., 2009) by providing design themes for emerging content sharing.

Our empirical data about emerging content suggests several insights that may merit further discussion in the community. For example, participants that shared music preferences and playlists specifically expressed the need for controls over the content. We speculate that online streaming platforms does not provide adequate mechanisms to ensure users control such sharing decisions. Furthermore, modern music streaming services (e.g. Spotify) often share content automatically without providing additional granularity, e.g., only music of a particular genre. These findings are comparable to sharing workout details from tracking devices and apps, where the balance between tracker-initiated and manually triggered posts has yet to be found (Epstein, 2015). Another example relates to privacy concerns of revealing identity or location while sharing trip details and travel plans. Similar to findings from social media research (Tufekci, 2008), our participants were very concerned about the potential misuse and violation of the shared data, and preferred to adjust their visibility to limit unwanted audience access.

It is important to note that our findings cannot be easily generalized: most of our participants were under 35 years of age and male. Moreover, online surveys also are known to bias towards highly educated populations (84% of our respondents have one or more academic degrees). However, this choice of method allowed us to reach a very international set of participants: our survey received replies from 15 countries across four continents. We also believe that our account of these new phenomena can still help researchers and practitioners reflect on current practices with respect to existing sharing conventions, especially regarding privacy. While we attempted to reach a wider community of sharers (especially in the "sharing economy" category, where, e.g., accommodation owners are usually older), most existing online platforms in these domains (e.g., Airbnb) do not allow one to contact an individual user without the aim to initiate a business transaction.

Finally, given the wide range of content items considered within the scope of our analysis, there were obvious differences in audience perceptions. For example, in culinary and diet preference sharing, the notion of a "target group" was not

present, while in the "sharing economy" category it was one of the largest recipient of shared content. Additionally, respondents argued that the concepts of "friends" in a social network service and "friends" in real-life differ. This was particularly visible in the travel category, where sharing to friends was frequent, but sharing to a "target group" was rare. From related work on social media, we know that determining audience perception is a complex task. Current research examines wide clusters of imagined audiences (Litt and Hargittai, 2016) or suggests to use computational techniques to define distinct sharing groups (Vitak, 2012). This question clearly merits further discussion when it comes to emerging online content.

Conclusions and Future Work

In this exploratory work, we discussed a set of six emerging types of content that is increasingly being shared online, based on self-reported behavior of 200 "sharing" responses from an online questionnaire. The selected domains not only represent different logics of sharing, communicative and distributed (John, 2013, Kennedy, 2016), but also diverge in the amount of disclosed details and types of audience. Also, they cover a variety of shared things from personal digital content to physical possessions (through their digital representations and contextual metadata). We identified content items that are being shared across various audiences within each individual domain. We also offer a descriptive comparison of those sharing categories, outlining similarities and differences. To further inform our findings regarding privacy concerns and needs, we also asked 56 "non-sharers" within our six emerging sharing categories about their reasons for not doing so.

Based on our empirically-collected privacy concerns we synthesized four design themes for emerging content sharing: holistic access control, privacy and safety, quality of controls, and open sharing. Our analysis showed that audience perception and sharing controls are key issues in successful service design – across all sharing categories we examined. We do not claim that those design themes are exhaustive. However, we believe they do provide a good starting point for discussion among researchers and practitioners interested in this space.

We plan to continue our qualitative analysis in order to develop more detailed design recommendations from the four "design themes" presented in this paper. We particularly believe that evaluating social and psychological complexities concerning privacy should benefit this initial attempt to map the emerging terrain of sharing services. Following research on social media, disclosures and privacy settings can be used in conjunction with one another (Ellison et al., 2011) to deal with boundary regulations online (Wisniewski et al., 2012). Therefore, as a next step, we see value in relating our findings to audience and disclosure management on SNS (Tufekci, 2008). Furthermore, future research could also explore the impact of content collapse on emerging sharing domains by utilizing computational

measures to determine audience diversity (Vitak, 2012). Eventually, we hope to be able to create an empirically validated cross-domain content sharing model. A useful point of departure could be extending Epstein's social sharing framework beyond personal informatics (Epstein, 2015).

We hope that our descriptive mapping of the emerging terrain can help with the design of future content sharing platforms and further frame design explorations in sharing beyond personal experiences to a broader sense of sharing things.

Acknowledgments

This work was supported by Swiss National Science Foundation grant 156406 "SHARING21 - Future Digital Sharing Interfaces".

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Bjørnstad, C., Christensen, B. and Ellingsen, G. Medication, integration and practice. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017-18

Medication, integrations and practice

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Abstract. To ensure quality in medication management, the electronic medication management system (EMMS) must communicate and collaborate with other IT systems in the hospital, particularly the electronic patient record (EPR). To achieve those integrations is not purely a technical task, and the aim of our paper is to contribute to the development of a socio-technical understanding of integration in health care, and to to conceptualize infrastructures with the help of boundary work and translations. Empirically, we have studied the implementation of a new EMMS in the Northern Norway Regional Health Authority. Our case shows that the integrations are affected by the existing IT systems in the region. Work tasks that had originally been planned for inclusion in the EMMS were shifted to the EPR due to existing functionality. In addition, differences in the contracts with the two vendors of the systems played a role. Most of the patient pathways and treatment plans extend across both the EMMS and the EPR and the boundaries between the two systems are sometimes blurred. To achieve integration based on this is hard. In addition, some integrations lead to additional work for clinicians, because data from one system to another must be translated between the different contexts, and the clinicians have to approve each translation. Integrations include crossing boundaries, which implies translation and negotiation. These concepts thus need to be considered to achieve successful integrations in health care.

Introduction

Medication management is an iterative and complex process that encompasses all steps in providing medication to a patient: how medicines are selected, procured, delivered, stored, prescribed, prepared, administered and reviewed. The process includes a collaboration between different health care providers and the patient

him(her)self. Ensuring high quality in medication management is a pressing issue for health authorities. In a 2000 US Institute of Medicine report, the Committee on Quality of Health Care in America estimated that medical errors (e.g., errors in administering drugs or planned treatments) were the leading cause of death in the United States (Kohn et al. 2000). Such errors are generally associated with an increased burden of illness for patients and increased expenditures for hospital treatment (Roughead & Semple, 2009; Governmental report, 2005). In Norway, 5-10 % of admissions to internal medicine wards are caused by improper use of drugs (Governmental report, 2005), and medication errors occur in 20 % of all patient treatment pathways, which is associated with expenses estimated at NOK 5 billion each year (Governmental report, 2005). At least 1000 patients die each year from adverse drug reactions and improper drug use in Norway (Norwegian Pharmacy Association, 2014).

Due to the complex and collaborative nature of medication management, it would be difficult for one single stand-alone IT system to incorporate all the needed data, information and processes involved in medication management. Therefore it is crucial, to ensure quality in medication management, for an EMMS to communicate and collaborate with other IT systems in the hospital. It is particularly important to have well-functioning integrations between the EPR and the EMMS, because much of the data collected from the patient is needed in both systems, and because the border between medication management in the EMMS and other treatment that should be documented in the EPR is sometimes blurred.

A principal aim of our paper is therefore to contribute to the development of a socio-technical understanding of integration in health care. Particularly the paper aims to conceptualize infrastructures with the help of boundary work and translations.

We proceed with the following research question: What characterizes integration between an EMMS and an EPR? First, we analyze the different meanings associated with integration in healthcare. Second, we discuss how the existing ICT portfolios and stakeholders' interests and policies shape the process of establishing integrations. Third, we analyze how integrations do not happen by themselves come freely, but depend on the commitment of skilled health personnel.

Empirically, we have studied the formative stages of a large-scale electronic medication management system (EMMS) project in the Northern Norway Regional Health Authority that was initiated in 2012. We focus particularly on the integration challenges between the EMMS and the existing electronic patient record (EPR) system in the northern healthcare region.

Theoretically, we draw on the concept of information infrastructures (Hanseth and Lyytinen 2010; Bowker and Star 1999; Star and Ruhleder 1996). In the rest of this paper, we begin by conceptualizing integration in health care. We then elaborate on our methodological approach. Next, we describe the large-scale EMMS project, followed by some empirical case vignettes. We conclude with a discussion.

Integration of medication data in hospitals

Patients' drug treatment is increasingly complicated. Hospitalized patients generate high volumes of data that are challenging to compare and evaluate. These might include physiological data (blood pressure, body temperature, etc.), results from various blood tests (C-reactive protein (CRP), blood counts, electrolytes, drug plasma concentrations, etc.) or data from medical devices (infusion pumps, etc.). Presently, an overview of medication linked with such data is lacking. This makes it difficult and time consuming for health professionals to make well-founded decisions regarding patients' treatment.

Today, medication management in hospitals is often handled by a paper-based system, and this leads to some obvious issues. Data is either handwritten or stored in another system, for instance the laboratory system, hence the relationship between data entries and medication can be difficult to uncover. The handwriting may be difficult to decipher. The paper with the data and information, in which the clinicians, too, are supposed to document their actions, needs to be available to several clinicians at different places at the same time.

There is a general perception both from most health care professionals and from authorities that information technology could help improve the issues mentioned above and thereby improve the quality of patient treatment (Governmental report no 28 2015, Governmental report no 9, 2015). An EMMS could collect data and present it in a straightforward way, and it could easily show the relationship between different data, such as a fall in CRP due to a change of antibiotics. Several studies also suggest that the use of an EMMS as part of the electronic patient record (EPR) can reduce the incidence of serious errors (Poon et al. 2010, Day et al. 2011, Reckmann et al. 2009, Ammenwerth et al. 2008), due to improved prescription legibility, dose calculation and clinical decision support.

However, the EMMS is not a stand-alone system. An EMMS needs to play along with a great many other systems and technical equipment in hospitals. For instance, data needed in the EMMS is typically harvested from bed monitors and devices that automatically monitor vital signs (e.g. electrocardiography (ECG) leads, automatic blood pressure cuffs, oximeters), which is a routine procedure for patients who have undergone surgery/anesthesia.

Most of the data that is collected in either the EMMS or the EPR could also be useful in the other system. And various patient pathways would normally include processes both in the EMMS and the EPR. So if the aim is systems that provide process and decision support for clinical pathways, there must be integrations between the two systems.

However, EMMSs seem hard to achieve in practice as such systems have not yet become widely available (Meum 2012; Emergis 2006; Aarts et al. 2007; Aarts and Koppel 2009). One reason is that the roles, tasks and responsibilities of different professionals are in practice much less clear than system designers believe. The models the designers use to understand the work processes are often too naïve. For instance, the prescribing of medication is seen as a task performed by physicians, while the work is usually supported by collaborative work practices (Aarts et al., 2007). The boundaries between which tasks and responsibilities the

different professions have in the medication process are often blurred and often include informal delegation from one profession to another (Allen, 1997). The result is mismatches between the EMMS and the workflow processes.

Another issue is that several EMMS do not include information on all patients or on all drugs. For instance, it is common not to include chemotherapy in medication systems and it is common that only some wards at a hospital use the system. This means that users lack the total picture of the patient's medication and the system is not able to follow patients transferred between different wards, implying that users do not get the information needed through the complete patient pathway. Similarly, there may be inadequate integration and communication between the EMMS and other technology systems in the organization. Inadequate integrations lead to lack of needed information in the system and poor clinical decision-making based on incomplete information.

In addition, it has been observed that clinicians may assume that just because the information went into the computer, the right person will see it and act on it. This change in communication patterns could challenge patient safety (Ash et al. 2007.

Another reason is that increased quality of care is often the main reason to introduce an EMMS, but due to the complexity in the work processes and the interdependencies with other systems and collaborative constellations, it is extremely difficult to measure the impact on quality.

These might be some reasons why a successful implementation of an EMMS is hard to achieve.

To summarize, "healthcare is a complex, uncertain environment and there are a great many processes involved in medications management" (Health-e-Nation 2014). To be able to perform those processes in a satisfactory way depends on several different IT systems. And due to the complexity and uncertainty in the processes, the interaction of those systems is challenging. Hence, the establishment of robust integrations between the systems may be hard to achieve. In addition, integration typically implies interconnecting systems developed with different tools that reside on a variety of technological platforms (Tun et al. 2001) and that have been developed for very different purposes.

Healthcare is still a late adopter of integrated systems (Cross 2006). Several studies on integration have suggested that a more organizational and socio-technical approach is necessary for understanding and managing integration in healthcare. Along these lines, Berg (2009) points out that getting such technologies to work in concrete healthcare practices appears to rely on politically textured processes of organizational change. Aarts et al. (2007) focus on how the implementation of a Computerized Physician Order Entry System (CPOE) affects the roles and responsibilities of healthcare workers and that it must fit the workflow in hospitals to enhance quality of care. If socio-technical aspects of the use of such systems are not understood, there is a danger that they may lead to adverse events instead of mitigating them. A key lesson learned from these and other socio-technical studies is that one needs a thorough understanding of the

clinical practices involved when implementing new technology (Silsand and Ellingsen 2014; Aanestad and Jensen 2011; Hanseth and Lundberg 2001).

Looking more closely at the information that is transported across different information infrastructures, we imagine the information as relatively standardized and stable or as an immutable mobile (Latour 1987). For instance, what is sent as a laboratory requisition remains the same when it is received and processed in the laboratory. However, we challenge the apprehension of stable information objects in interconnected large-scale infrastructures. Information is shared across many contexts, and needs to be adapted to particular settings. By applying the notion of translation rather than transmission, Winthereik and Vikkelsø (2005) underscore how the recipient of a discharge letter plays several roles and how different users adapt the letter to their own context. They provide an example of how a general practitioner (GP) modified the discharge letter by highlighting different sections to emphasize important points. Green was used to mark the reason for hospitalization and red was used to mark medications prescribed for the patient (ibid, p. 56).

Furthermore, given that there are several stakeholders involved, the strategies toward integration may vary depending on whether these strategies serve the interests of each of the stakeholders (Latour 2005). Existing systems (for instance legacy systems) and practices may also come into play and shape what is possible to achieve (Edwards 2009). Many of these systems have different vendors and users, who potentially have varied agendas that may diverge from the overall goal in new projects. In total, this may influence the extent to which integration is possible (Johannessen and Ellingsen 2012).

The theoretical framework of information infrastructure has been used to study the design, implementation, and use of large-scale information systems (Aanestad and Jensen, 2011; Hanseth and Lyytinen, 2010; Star and Ruhleder, 1996). These systems are never seen as stand-alone entities, but are integrated with other information systems and communication technologies, and with non-technical elements (Aanestad and Jensen, 2011. p. 162). Therefore, analyses of information infrastructures need to consider a broad range of socio-technical issues shaping the implementation process.

A basic principle of an information infrastructure is that it is never built from scratch; rather, it evolves from the installed base, the existing information system (IS) portfolio in specific contextual practices. As a part of this, the infrastructure shapes and is shaped by the work practice in an ongoing co-construction process between technical and social elements (Monteiro et al. 2012; Star and Ruhleder, 1996). During the progression of an information infrastructure in any given context, the installed base may become very large and will shape its environment to an increasing degree. Similarly, the size and complexity of the installed base means that it becomes difficult to replace or change. Therefore, newer versions are adjusted or changed carefully in order to maintain backward compatibility with previous versions (Bowker and Star, 1999). This is a process of ongoing negotiation and compromises for achieving stability or alignment (Latour, 1987).

A crucial part of such negotiation is to establish and maintain the boundary between the new system (the EMMS) and the installed base (the EPR). These

boundaries are not fixed, but may be renegotiated and redefined (Hernes 2004; Barrett et al. 2007) as the implementation process emerges. The task of establishing and maintaining these boundaries resembles what many researchers in the STS field refer to as boundary work (Gieryn 1999; Barrett et al. 2007). The concept is widely used in organizational settings to describe the strategic behavior and the circumstances related to engaging in work to sustain boundaries between different communities of practice. "Generally, when privileged groups engage in boundary work it would mean (…) constructing and maintaining distinctions between themselves and others" (Barrett et al. 2007, p.8). In implementation of a new system, this might include negotiating the boundaries with the larger IS portfolio or clarifying the scope of the system in relation to the users. However, what is particularly interesting in developing new systems is how these boundaries may be expanded (Barrett et al. 2007; Gieryn 1999) due to added functionality, integrations, increasing numbers of users and new requirements. In this sense, we may observe an increasingly influential role of the system, which is in accordance with Lee's (2007) argument that "artefacts can be used to push boundaries" (2007, p.308).

Method

The study is based on an interpretative research tradition (Klein and Myers 1999; Walsham 1995), where reality is socially constructed among the participants. The epistemological position in interpretive research emphasizes the understanding of social processes by getting involved inside the world of those generating them, and not by hypothetical deductions or predefined variables. The approach also assumes that social realities are not discovered, but interpreted, meaning that a phenomenon is looked at from different viewpoints. In line with an interpretive approach, the authors have collected the empirical data in the EMMS project and in the users' practice by participant observation, document studies, participation in workshops and project meetings and formal semi-structured interviews.

The purpose of the data collection was to learn about the medication process, to be able to understand how new technology could influence the work practices. Furthermore, we wanted to gain insight into the process of deciding, developing and implementing integrations between the EMMS and other systems used in the hospital.

In total the authors have conducted 14 interviews with nurses, physicians and project members. The duration of the interviews varied from 30 minutes to 1 hour. We used an interview guide, but let the informants choose the direction of the conversation. The interview guide served as a checklist to ensure that the questions of interest were covered. A digital voice recorder was used to record the interviews. Afterwards, the interviews were transcribed. The data collection started in January 2015 and is still ongoing. Table I is an overview of the data collection.

Table I. Data collection

Data collection	
Observations	2 nurses doing reconciliation 2 physicians admitting patients
Documents studied	Plans for the EMMS project Plans for the EPR project
Workshops and meetings	8 workshops in the EMMS project Several meetings in the EMMS project
Interviews	6 physicians from three different wards at the University Hospital of North Norway (UNN) 6 nurses from three different wards at UNN 4 project members (project leader, leader for integrations, representative from the vendor, physician (clinical member)) 1 representative from the EPR vendor

The EMMS project

In January 2012, the Northern Norway Regional Health Authority decided to start a bid for tender process for a common EMMS for the health region. There were several reasons for this: a) A fundamental problem was the prevalence of paper-based medication charts as well as a risk of medication errors, b) the lack of efficiency in the overall medication cycle and c) a lack of functionality for decision support and medication management in patient pathways. The cost of the procurement, the implementation and 15 years of use is estimated at EUR 114 million. It has been decided that the EMMS will cover emergency units, intensive care and anesthesia departments, operating rooms, outpatient clinics and clinical wards. To support the needs of health personnel at every step in the patient's pathway, the EMMS is intended for use wherever the patient is located. The aims were: 1) A standardized and integrated system that supports complete patient pathways. 2) Automatic data acquisition from medical technical equipment and devices. 3) Overview of drug interactions, dosages, adverse effects, mixing, administration. 4) Access to the patient list of medications through the whole patient pathway. 5)Clinical decision support.

Like EMMS projects internationally, this project is recognized as having an extremely high degree of complexity. This complexity in turn requires a very flexible technology, as the EMMS project group recognizes: "The system must possess a high degree of flexibility to be able to collect data from different sources and digital resources (…) [this includes] development of modules, configuration, adjustments, integrations and interconnecting medical instruments". Likewise, the system is intended to have a large inter-departmental scope (intensive/anesthesia wards, ordinary bed wards and outpatient clinics). In 2014, the Norwegian ICT vendor Evry won the contract for the delivery of the EMMS MetaVision. The project continued working together with the vendor Evry on configuring the software to adapt to the Northern Norway Health Authority. The work is ongoing, and the implementation is planned to start in 2018.

As stated above, the EMMS needs to be tightly integrated with other key systems in clinical practice, most notably the EPR from the vendor DIPS ASA. The DIPS EPR has been running in the northern healthcare region since 2004. In 2015, the management in the EMMS project ordered several integrations between the EMMS MetaVision and the DIPS EPR from the vendors. These are as follows:

From DIPS EPR to MetaVision:

1. Patient information (demographic)
2. Contact and localization information including the patient's bed
3. CAVE (list of allergies) and critical information
4. Reconciled Medication list on admission to the hospital

From MetaVision to DIPS EPR:

1. Active medication
2. Context synchronization between DIPS EPR and MetaVision (to ensure that the same user and the same patient are activated in both systems at the same time

The integrations were contracted to be delivered before December 31, 2016. After that the integrations will go through a verification test with clinicians in May 2017. Other planned integrations were put on hold, such as integrations related to surgery planning and patient pathways. However, in the integration efforts, it became increasingly clear that the EMMS project was facing serious socio-technical integration challenges. In the following sections, we offer a few vignettes that highlight these challenges in detail.

Case

Admitting the patient – using the EPR for medication reconciliation

When the patient is admitted to the hospital, the content in the medication list should be quality assured. Medication reconciliation is the process of creating the most accurate list possible of all medications a patient is taking — including drug name, dosage, frequency, and route — and comparing that list against the physician's admission, transfer, and/or discharge report, with the goal of providing correct medications to the patient at all transition points within the hospital. This includes asking the patient about his/her medication and checking different information sources. This process results in a medication list that represents documentation of what the patient actually used when admitted to the hospital.

Because the hospital has a paper-based medication chart today, the checking against other information sources must be done manually. The goal in the future is that this could be done partly automatically by comparing the drug list at admission to information from other electronic sources such as the national core record, the e-prescription database or the medication list from the general practitioner, home care service or nursing home. The one with the easiest electronic access and most updated information today is the e-prescription

database, and the plan for the Northern Norway Regional Health Authority was to develop functionality where the drug list in the e-prescription database is compared to the medication list at admission.

The EMMS project group (including representatives from the vendor Evry) and DIPS ASA discussed whether reconciliation should run in the EPR or in the EMMS. In one way, the EMM was preferred because it is a task closely related to medication management. However, the EMMS project decided that this process should run in the EPR because the EPR, unlike the EMMS, had good functionality for the task and because a reconciled medication list represented a historical document that had to be time stamped, signed and stored in the patient's EPR. Based on this, the project decided that the EPR was better suited for this process. Figure 1 shows what the reconciliation looks like in the EPR.

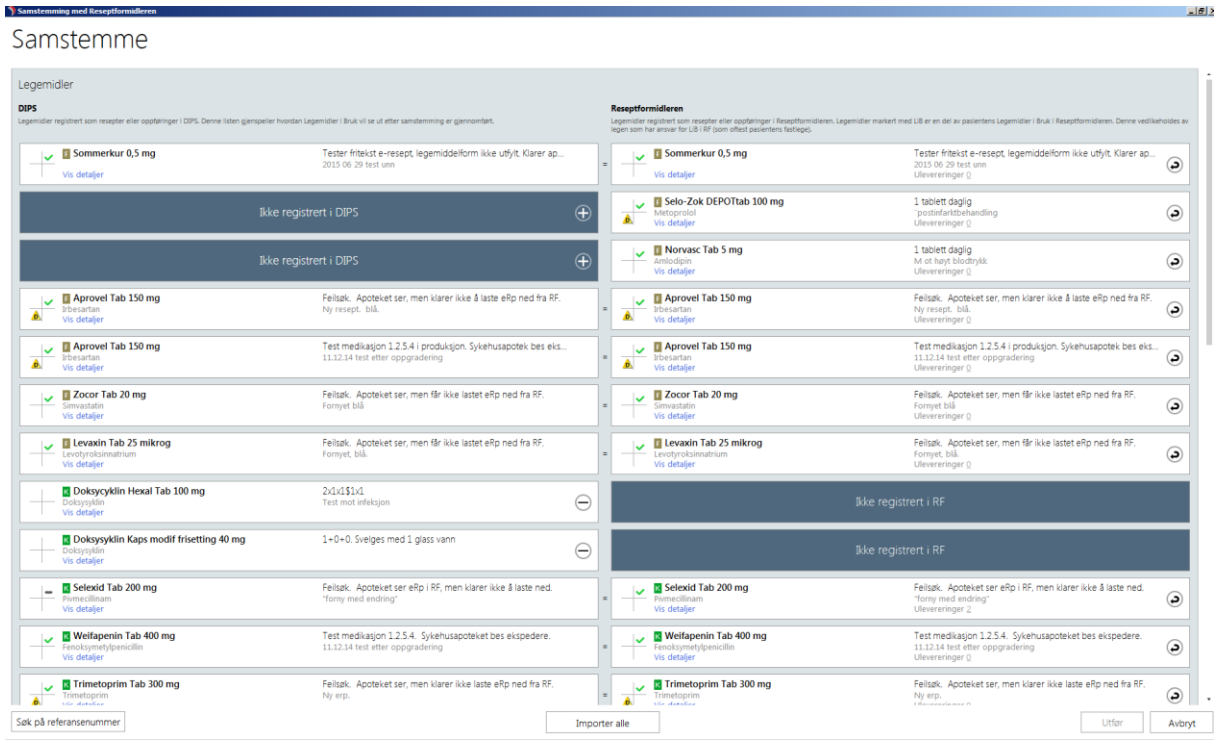

Figure 1. Reconciliation in the EPR. The list to the left is from admission. The list to the right is from the e-prescription database. The dark blue areas show deviations between the two sources. It is easy to indicate discontinuation or addition of drugs by clicking on the plus or minus sign.

Hospital stay - the EMMS takes over responsibility for medications from the EPR

In the EMMS, the clinician can request the medication list for the specific patient from the EPR. This list represents the starting point for any medication management during the patient stay in hospital.

In the EPR the drugs are denoted by their brand name while the EMMS uses the international non-proprietary name of the active substance(s). For the latter, it means that each international non-proprietary name (active substance) could match more than one brand name.

This is a problem when a medication list is transferred between the EPR and the EMMS because there is no one-to-one relationship between the brand name and the international non-proprietary name (see the example in table II). This came as a surprise to the EMMS project members. One of the members said:

> I was surprised that the relationship between international non-proprietary name and brand name lacked uniqueness, i.e. when patient had been admitted to the hospital and had a medication list that contained some brand products, the lists could not be translated uniquely to international non-proprietary name without a human touch. Everybody was very disappointed by this.

The effect of this is that there has to be a translation between the brand name in the EPR and the international non-proprietary name in the EMMS. Therefore, the physician must carefully examine each translation of medication between the systems. The integration will suggest a mapping, but the physician using the EMMS must check whether this mapping looks correct and potentially make changes before the process is considered complete. When this is done, the medication list is ready for use in the EMMS.

Table II. Example of a non-proprietary name and its brand names

International non-proprietary name	Ibuprofen
Brand names (Non-complementary)	• Advil • Ibux • Bufen • Motrin

The patient stay – the user juggling between the EMMS and the EPR

While it was obvious that medication data should be transferred from the EPR to the EMMS, it was not so when it came to CAVE information. CAVE specifies what kind of treatment a patient should avoid. The concept may include drugs, drug excipients and food preparations. CAVE is normally registered through the Anatomical Therapeutic Chemical (ATC) code, which refers to the international non-proprietary name of the medicine. Based on the ATC code, it is then possible for the EMMS to provide decision support to the physician in form of warnings if (s)he tries to prescribe medication that the patient is allergic to. Along these lines, in the acquisition phase of the EMMS, the project took for granted (and decided) that the EMMS should serve as the main database for CAVE because it is so closely connected to medication. In this regard, the EMMS would store the master data for CAVE. Other systems that needed CAVE information should then access the EMMS database to get it.

This was easier said than done. For several years, the EPR had served as the master storage for CAVE. And over the years, several other systems had been integrated with the EPR and could get CAVE information through these integrations. These systems included Imatis, which delivered electronic boards to the emergency rooms in the hospitals, and Sectra, the radiology picture system. These systems used the EPR as the master system for CAVE. If the EPR in turn was to use the EMMS as its master system for CAVE, things started to become complicated. As a project member put it:

> Automatically, it becomes more risky if the EMMS should be master for DIPS EPR and DIPS EPR should be master for the other systems. Then you increase the potential for complex risk scenarios.

Another point was that the EMMS project had several integration options in the newly established framework contract with the vendor, but not corresponding options with the EPR vendor. This limited the possibilities, especially because the EPR vendor was reluctant to let the EMMS store the master data for CAVE.

Based on this, the project members changed their plans and decided that the EPR should continue to store the master data for CAVE. In this process, integration 3 (see above) was ordered, where CAVE could be imported from the EPR into the EMMS. At the same time, it was considered crucial that the physicians working in the EMMS should be able to update CAVE information when needed. A two-way integration was considered, implying that the physician could both read and update CAVE information in the EPR from within the EMMS software. However, because the EPR and the EMMS organized their structures for medication substances differently, there was a risk of errors. Consequently, the physicians had to do any update to CAVE directly in the EPR because this was the master system for CAVE.

The patient stay – the EPR needs EMMS data

The Northern Norway Regional Health Authority has decided that the EMMS should be the master for medication data during the patient hospital stay. An overview and information about the medication – including drug name, dosage, frequency, route, and missed doses – will only exist in the EMMS during the stay. Currently the EPR has no access to this data prior to the discharge. The reason for this has been to clarify roles and responsibilities between the systems. However, this is problematic as there are several instances where EMMS data may be very useful to have in the EPR during the patient stay.

First, the EMMS will integrate with medical technology. Such equipment includes bedside monitors and devices (e.g. ECG leads, automatic blood pressure cuffs, oximeters) that automatically monitor, store and feed vital signs continuously into the EMMS. Connecting patients to such devices is a routine procedure for patients who have undergone surgery/anesthesia, intensive care patients, and unstable patients. This data could be useful in several instances in the EPR. An example would be that if the blood pressure increases, one could see any correlation with an increase in the dosage of a particular drug, or if the patient

is vomiting, whether this might be caused by the medication. Another example would be that data from bedside monitors and devices (data collected in the EMMS) compiled with additional data in the EPR could help the clinicians to interpret symptoms.

Second, an important functionality that was asked for in acquisition for the EPR was process support for clinical pathways. Specifically, this would be the possibility of setting up a pathway template according to a clinical protocol and from this preparing a treatment plan for the patient. This plan will display all the activities that are planned for the stay. Documentation will be much faster for clinical personnel, as they can easily tick off for actions performed. Updated status is hence more easily achieved, and other involved personnel can see when their contribution is needed. The transparency of patient status that such functionality would provide is among the features that the clinicians want most:

> A good visualization of the patients' trajectory - his status, what is done and what is to be done – would help us to optimize in-house resources and plan for discharge early on, hence reduce length of stay. Actually, the visualization in itself would be a kind of decision support (physician in workshop)

This plan in the EPR represents the overall plan for the patient. Data on vital parameters coming from bedside devices and the EMMS is needed in the treatment plan, because it provides information critical to deciding on actions, for instance deviations from the plan, but also in documenting actions and effects of actions. For instance, if a rising temperature indicates that an infection is progressing, steps need to be taken.

To enhance patient security, Health Care Governments has initiated a "patient safety campaign". Part of this campaign involves using scorecards to assess patients' conditions in a structured manner, so the data can be used to produce reports and quality assessments. Patients who are evaluated to be at risk of malnutrition, falling, developing bedsores, or declining should be scored. One of these tools is the Modified Early Warning Score (MEWS). The scorecard makes use of the heart rate, systolic blood pressure, conscious level, temperature and hourly urine output (for previous 2 hours) in a calculation that results in a numeric score as shown in figure 2. The score indicates how soon a new assessment is recommended, to enable early intervention in patient deterioration. For instance, if the score is 4, a new assessment should be performed in 30 minutes.

Modified Early Warning Score

Score	3	2	1	0	1	2	3
Respiratory rate (min^{-1})		≤ 8		9–14	15–20	21–29	> 29
Heart rate (min^{-1})		≤ 40	41–50	51–100	101–110	111–129	> 129
Systolic BP (mmHg)	≤ 70	71–80	81–100	101–199		≥ 200	
Urine output (ml/kg/h)	Nil	< 0.5					
Temperature (°C)		≤ 35	35.1–36	36.1–38	38.1–38.5	≥ 38.6	
Neurological				Alert	Reacting to voice	Reacting to pain	Unresponsive

Figure 2. Modified Early Warning Score

All the vital parameters that go into the scorecard will be entered and stored in the EMMS, as this will be the main system for monitoring patients. However, this system has no functionality for the calculation, so if the score is to be displayed in the EMMS, a manual calculation and entry of the score is needed. The risk of error caused by manual procedures in calculation and data entry is evident as well, as it represents duplication of registration since the score is also needed in the EPR. If the data on vital parameters is transferred to the EPR system, the score can be calculated automatically.

Third, operating theaters are among the most costly resources in hospitals. Hence, well-functioning routines for planning and performing surgical procedures are important to utilize the theaters maximally. In the surgery planning module, the EPR has functionality for estimating the time for the surgical procedures, based on previously accomplished procedures. Based on the nurse's recording of "start incision" and "stop incision" in the EPR during surgery as part of documenting the actions, the EPR calculates and estimates the time for procedures with the same code. This is an important feature because it helps the coordinating nurse to make the most of the very costly resource "operating theater". Being able to estimate how long an intervention will take might make it possible to schedule three patients for surgery instead of two in a day.

However, in configuring the EMMS, personnel working in the theater want to register procedures in the EMMS instead of the EPR, so that procedures can be connected to the recorded actions during the continual monitoring of the patient during surgery. To be able to combine and aggregate data of this kind is important to them for quality assurance, and for documenting effects. For instance, if a patient has a fall in blood pressure during a procedure, the connection between these incidents can be indicated, whereas if blood pressure and procedure are recorded in different systems, the data must be linked manually, or must be entered into an analytical tool. Additionally, since the monitoring of the patient makes the EMMS the primary user interface during the operation, theater personnel see this as the most convenient system to do all the recording during surgery. This means there must be several integrations for both the EMMS and the EPR to work: for procedures, for actions during surgery such as time start, time stop, but also patients' position on the table, what tool was prepared for the intervention, and how the intervention proceeded (complications or as planned). The data is needed in the EPR as this is the main tool for documentation of treatment, and because it is the system that communicates to the patient and to caregivers outside hospital, such as homecare nursing and general practitioners.

Discharging the patient - Medication reconciliation once more

Similarly, when the patient is in the process of being discharged, the project team considered it most suitable to do the reconciliation work in the EPR due to the closeness of the discharge documents that were produced in the EPR, i.e. the discharge report and e-prescriptions. The medication list is then transferred from the EMMS to the EPR. Drugs that are not supposed to be used after discharge should be discontinued in the EMMS prior to the transfer. Then the EPR software

maps the two lists: the reconciled medication list from admission and the medication in use during the stay, and automatically brands each drug in the list as "as before", "new", "changed" or "discontinued". However, the whole process is not straightforward, as the lists are sorted in accordance with the international non-proprietary name and brand name respectively.

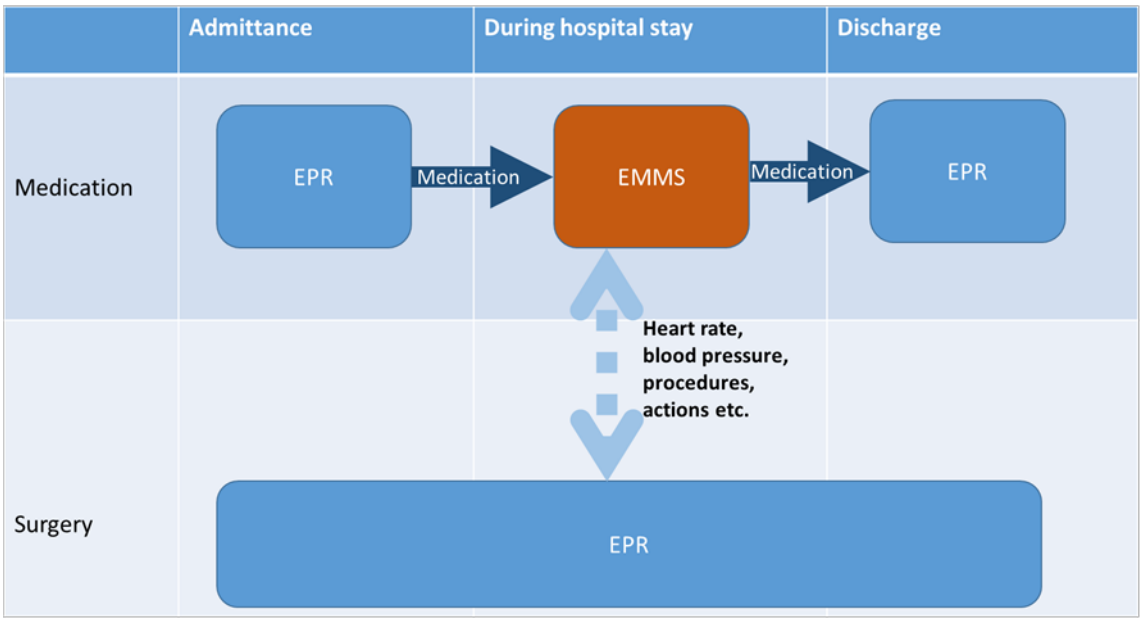

Fig. 3. The figure shows two patient trajectories: the medication pathway and a surgical pathway. The medication pathway is documented both in the EPR and in the EMMS. The drug list will be transferred via two integrations between the two systems. The surgery pathway is documented in the EPR. Both pathways need information from both the EPR and the EMMS during the patient`s hospital stay. Integrations that ensure sharing of data during the stay are not planned in the near future in the EMMS project in the Northern Norway region. Illustrated by the dotted arrow in the figure.

Discussion

We frame our discussion around three conceptual themes, namely the existing installed base (Bowker and Star, 1999; Hanseth and Lundberg, 2001; Pipek and Wulf, 2009), boundary work (Barrett et al. 2007, Pollock and Williams 2008) involved in integration efforts and translation of data (Carlile 2004; Latour 1987) from one context to the next.

First, a key point from the information infrastructure literature is that new technology is never built from scratch; it always builds on and extends the installed base. In that way, it is possible to keep the original user base relatively intact while new users are attracted to the installed base by adding new functionality to it (Hanseth and Lyytinen, 2010). In this regard, our case illustrates that the existing practices and systems play a crucial role in the decisions that are

taken in a project (Silsand and Ellingsen 2014; Hanseth and Lundberg 2001). That is, decisions are not taken freely, but depend on the existing context and what is feasible when designing a new EMMS. In our case, the existing EPR had been running for many years and therefore it made sense to exploit some of the functionality that worked smoothly with it, particularly the functionalities that in turn were integrated with other existing systems and work practices, such as e-prescriptions and discharge routines. You may also consider how the project decided to keep the master data for CAVE in the EPR even if it was closely connected to medication information and therefore should have been placed in the EMMS instead (as the project also considered). In this situation, there existed good functionality in the EPR that was useful in relationship to CAVE. Also, the CAVE served as master data for several other systems that were integrated with the EPR. Through this, we may conclude that the portfolio of existing systems with the associated work tasks both enable and hamper action for new implementation and integration efforts. Hence a large-scale component becomes a stakeholder in its own right (Latour 2005).

Second, traditionally, integration of information systems is considered to be a task to identify the data elements that need to be integrated across two or several systems and then develop the implementation. This approach is too simplistic, reflecting a view that integrations are a clear-cut technical task where the boundaries between the work tasks can be easily identified and structured (Ellingsen et. Al. 2012, Singletary 2004, Giuse 2003, Berg 2001). This was illustrated in our study where six different integrations were ordered from the vendor of the EMMS and the vendor of the EPR. And where a clear-cut boundary (and thus responsibility) between the systems was established: The EPR should take care of medication management at admittance and discharge, and the EMMS should take care of medication management during the patient stay. Clearly, this does not take into account the implicated organizational work that is associated with the integrations.

Several studies underscore how boundaries are intrinsic to organizations (see Barrett et al. 2007; Pollock and Williams 2008) and integrations are used as a means to overcome the boundaries. However, a key point in this literature is how boundaries are continuously produced and reproduced, countering claims in the management literature related to boundaryless organizations (Ashkenas et al. 1995) or clear-cut boundaries to support a seamless information and process flow (Davenport 1993).

Along these lines, the boundary between the EMMS and the EPR had to be negotiated for various use situations, for where to store master data for CAVE and for which system should deal with the work task of conducting reconciliation. For delimited use scenarios such as admission and discharge of patients, this could be done after some negotiation through the assignment of the responsibility to the EPR. The EMMS should then take care of all medication management during the patient stay.

Still, this strategy seems to fail when taking into account that integrated data needs to be continuously shared between several systems. For the full support of decision support and other planning activities in the EPR when patients are

hospitalized, the EPR would need some data from the EMMS. According to the traditional way of developing integrations, several new ones need to be ordered to accomplish the ambitions. This is enormously complicated, requiring identification of every possible use situation, and thus, these issues are not resolved. The lack of strategies for these problems has spawned suggestions that the EMMS should take some responsibility for planning and decision support from the EPR, thus illustrating a shifting boundary for responsibilities between the systems.

Third, echoing Latour (1987), Winthereik and Vikkelsø (2005) suggest that data is translated between different contexts, not transmitted. In our case, this was reflected in how the integration needed to be manually maintained on a routine level by the users. It was the responsibility of the physician working with the EMMS or the EPR to check whether the integrated data is correct, to make the necessary modifications and then sign off that everything is in order. This has to be done both when the patient is admitted to the hospital and as part of the discharge process. This requires a lot of work for the physicians in their daily routines, which was difficult to foresee in the project start-up phase. Accordingly, the integration is not purely technical or the transmission of data from A to B; it rather implies a socio-technical engagement and effort to keep things running (Ellingsen et al 2012). This suggests that many integration projects actually create more work for the users than what they save and may therefore be a cause of failures of many integration projects.

Conclusion

Integrations are not solely a technical task. An organizational and socio-technical approach is necessary for managing integrations in health care. The process in developing integrations depends on the installed base, the stakeholders` interest and the work practice, and it involves a great deal of negotiations. To reach decisions and achieve good integrations requires effort and resources, and is not something that can be is done in haste.

New IT systems like the EMMS always build on the existing systems and work practices in the hospital. This installed base and the existing work processes shape the process and outcomes of the integrations. For instance, existing functionality in the installed base affected the originally planned work practices and thus also the integrations.

In addition, the different stakeholders' interests influenced the integration work. Content in the different contracts with the vendors affected their willingness to adapt to particular integrations. This shows that the portfolio of existing systems with the associated work tasks both enable and hamper action for new implementation and integration efforts. Moreover, large-scale components become a stakeholder in their own right.

Data from one system to another is not always easily transmitted, but must be translated between the different contexts. This may lead to additional manual

work, as in our case where clinicians have to approve the translation. This shows that integrations are not purely technical, but depend on a socio-technical commitment.

Patient pathways in hospitals would normally include processes in more than one IT system. Sometimes the systems have overlapping functionality, and the boundary between them is not clear. The same data and information may be needed in several systems, and to reach full process and decision support integrated data needs to be continuously shared between them. To complicate the issue further, the boundaries are not fixed, but constantly produced and reproduced. When planning the patient pathways, the trajectories are often seen as straightforward processes that follow a determined timeline. In reality, the pathways are not always chronological; they take detours and the direction changes.

This shows that integrations include crossing boundaries, which implies translation and negotiation. These concepts thus need to be considered to achieve successful integrations in health care.

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Computer-supported patient involvement in heart rehabilitation

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ABSTRACT. Two of the five Danish regions, covering close to half of the population, are in the process of implementing a new EHR system. One of its sub-systems is a patient portal. The work-in-progress reported here is an exploratory study and a first level of analysis concerned with why, how and with which effects patients start to orient themselves towards this subsystem, and the degree to which this has an effect on the clinicians' work. The overall approach is a multi-site ethnographic study involving 5 patients and 3 nurses responsible for a rehabilitation program for ischemic heart patients. Data are being collected through artifact and document analysis, and by interviews and observations in patients' homes and in nurses' offices over so far 6 months. The analysis is informed by medical phenomenology and by conceptual frameworks developed in earlier projects conducted by the author's research group. The preliminary findings include that patients and clinicians do see the potentials of the portal, but in order to harvest these potentials we recommend rethinking the functionality and the implementation strategy, including training of patients and clinical staff.

Introduction

It is becoming common to stimulate patients to get involved in their own treatment and care. This is also the case in the rehabilitation program for ischemic heart patients at a Danish hospital that is the focus of this study. The instruction that guides rehabilitation nurses prescribes: "The consultation is organized to meet the patient's needs and wishes" (Rehab, 2014). As we shall see below, the nurses take pride in doing so, because they know from experience that it helps in obtaining the purpose of the consultation. The nurse is trained to look for certain biological phenomenon indicated by lab results, to listening to the patient's own

account, and to the replies to her questions. The most important part of the job is to encourage patients to do their part in seeing to that problematic tests results get as close to clinically recommended boundaries as possible.

The degree to which patients are invited to – and is interested in – taking part in their own care may be described in terms like involvement, participation, and empowerment. It is outside the scope of this paper to go into a discussion of these concepts, but the order in which they appear above indicates a progression.

The Capital Region of Denmark and the Region Zealand joined forces in a call for tender and the subsequent procurement of a new EHR system. The winner was the American EPIC systems, which has widespread use in the US, e.g. at Kaiser Permanente, and which lately also has been implemented e.g. in UK, The Netherlands and now Denmark. Currently 4 of the regions 18 hospitals have started to use the system, called the Health Platform (HP). The main parts of the system are the usual modules for clinicians' notes, lab tests, ordering, and medication. The exploratory study reported here however, focus on one of the subsystems called My Health Platform (MHP). It is a portal meant for outpatients.

Patients, who e.g. take part in a rehabilitation program after hospitalization, are able to communicate with clinicians, access parts of the clinicians' notes, fill out and send questionnaires, access lab results, and receive reminders about news from the clinic. Parents are able to do the same on behalf of their children, and so is a relative to e.g. a frail person, who has given consent (MHP, 2017).

So what type of system is the Danish version of MHP? One sees that it shares some of the characteristics of the Markle Foundation's definition of a Personal Health Record: "An electronic application through which individuals can access, manage and share their health information, and that of others for whom they are authorized, in a private, secure, and confidential environment" (Markle, 2003). So far however, information is managed by hospitals rather than by patients.

Careyva et al (2016) and Santana et al (2014) show that improved patient-physician communication may improve patient outcome. They report on integrating patient-reported outcome measures, which so far is not part of the system studied here. However, their results bear indications that given certain circumstances - that has to be researched further - even MHP's limited modes of involvement hold potentials for improved patient outcomes.

Otte-Trojel et al (2015) report on a study of the Kaiser version of MHP, which has evolved over 15 years and is used by clinicians, administrative staff and patients. Their study is based on interviews with "eighteen physician leaders and executives particularly knowledgeable about the portal to learn about how they believe the patient portal works and what organizational factors affect its workings." (ibid). Among their finding the following are especially interesting as to our study: 1) "…the portal's ability to ease access to services improves some patients' satisfaction as well as changes the way patients seek care". 2) "…the transparency and activation of information enable some patients to better manage

their care." 3) "…care management may also be improved through augmented patient-physician interaction." Further, they found these organizational factors of particular importance, which have affinity to this paper's focus: 4) "…synergy with existing IT infrastructure and operations", 5) "…inclusive decision making and knowledge sharing, and 6) "…emphasis on patient-centered design." (ibid). Here we note that even though we share research interests with the Otte-Trojel study, our methodology differs in mainly two ways. We worked with nurses and patients rather than physician leaders and executives. Secondly, rather than being based solely on interviews, this study in addition builds on artifact and document analysis, and on observations in patients' homes and in nurses' offices.

This exploratory study provides a first level of analysis of 3 research questions:

- RQ1: Do patients start to orient themselves towards MHP? How and why?
- RQ2: What do patients get out of using MHP?
- RQ3: Do patients' use/non use have an effect on the nurses' work?

Research setting and method

At the end of May 2016 the first two hospitals went live with the new EHR over night across all departments. This exploratory study was conducted at a heart rehabilitation clinic at one of the hospitals. It started after 5 months of consultations and easy negotiations of terms in parallel with the implementation process. The clinic is responsible for rehabilitation of ischemic heart patients, who have recently been discharged after treatment for a blood cloth. Every 6 weeks during a 3 months period patients are offered consultations with a nurse, who has specialized in rehabilitation, and to whom certain rights of prescription is delegated. Further, she coordinates with other involved personal at the hospital and in the municipality. That includes doctors, who see the patient for stratifying and up-titration purposes; lab-technicians, who draws blood before each session; physiotherapists, who conducts a so-called bike-test, and various other therapists and nurses in the municipality. The municipality is responsible for the last part of the rehabilitation program that includes a course on being a heart patient, on alcohol and smoking cessation, on heart diet, and an exercise program. The consultations with the nurse are scheduled for ½-1 hour covering orientation about the rehabilitation program, teaching about the heart, blood cloths, and medication as well as patient initiated life style changes. The main part however, takes the form of counseling - emphatic listening to the patient' concerns while zooming in on what might be relevant for this patient. Other issues dealt with include: Mental reactions, job and family situation.

Long before the introduction of the new system nurses were given an instruction for the rehabilitation program that stresses the importance of patient involvement, which MHP has the potential of enhancing. Politicians and hospital management found it important that HP from the very start should include even

minimal features for patient involvement. But so far that part of the system has not been given priority, neither as part of the clinicians' teaching program before the implementation of HP, nor in terms of actions to get patients involved. However, the patients included in this study were given a leaflet on MHP together with the participant information and consent material produced for the study.

Data collection

Data for this study has been collected through initial meetings with staff at the clinic and staff responsible for the implementation, artifact and document analysis, and recorded and transcribed interviews and observations in patients' homes and in nurses' offices. Initial interviews of 45-60 minutes were conducted in each patient's home, or at a place of their choosing. So far 5 patients and 3 nurses have been interviewed separately for 15 minutes before and after each consultation, which in addition have been observed (30-75 minutes). All in all some 40 hours of audio recordings are in the process of being analyzed.

Analytical frameworks

The following conceptual frameworks were guiding the analysis.

Toombs' medical phenomenology: Toombs explains how and why patients and clinicians fundamentally live different lives and therefor have *divergent concerns* when it comes to health and illness. She explains why and how patients experience illness as a unique, personal event that transforms their bodily awareness and disrupts their everyday practices, roles and relationships with others. Instead physicians understand disease as an entity in itself, a biological phenomenon that can be categorized as an instance of a known type, for instance as a particular case of ischemic heart disease, that may be treated according to scientifically tested procedures (Toombs, 1993). In Andersen et al (2014) we point to that this crucial difference is rarely acknowledged in the literature on eHealth nor in the design of it-systems launched to augment patient-clinician interaction.

Alignment of concerns: In Andersen et al (2014) we further suggest that "when designing eHealth systems to support collaboration between patients and clinicians it is particularly important to identify and align the concerns that are *meaningful* to patients and in turn which can be made (clinically) actionable and organizationally feasible to clinicians." And here I want to add that for patients to play an active part in their own rehabilitation process, data need to be *actionable* and *organizationally feasible* to them too.

Clinical accountability: Emanuel and Emanuel (1996) define accountability as being "about individuals who are responsible for a set of activities and for explaining or answering for their actions." They distinguish between three models

of accountability in healthcare: Professional, political, and economical accountability. The *professional* model consists of two primary loci of accountability: Physicians to their professional colleagues and organizations and to their individual patients. Traditionally professional accountability has focused on competence and legal and ethical conduct. The *political* accountability refers to the decision-making process within an organization, and the fundamental locus of accountability is the relation of providers to some version of a governing board (here e.g. the local instructions for the hearth clinic's rehabilitation nurses). *Economical* accountability has to do with consideration for adequate use of resources.

Results

In this section we use the analytical frameworks briefly presented above to show emerging relations among clinicians' and patients' practices; infrastructures like clinical guidelines and IT-systems; and the potential and achieved outcomes of rehabilitation consultations. We do that based on quotes from the observed consultations and the research interviews.

Alcohol consumption and the triglyceride count

A good example of what Toombs calls divergent concerns and how they may slowly become aligned is illustrated by quotes from a patient's two consecutive rehab consultations with a nurse (with an interval of two months) and the accompanying interviews with me before and after each consultation.

The patient, P1, is reluctant to change behavior, although he says to both of us that he is currently drinking too much.

The below quotes further show how the nurse demonstrates her professional accountability, as she keeps explaining and motivating the patient to change behavior. They also show how a certain scientifically tested procedure – cutting down on alcohol consumption through monitoring the level of triglyceride – becomes meaningful, actionable and feasible for the patient. And finally, the development of the conversation shows that the new system has potential for helping patients becoming more active in their own care processes.

At first P1 wonders why the clinicians consider him a patient. In fact he has not had a blood cloth, but was hospitalized due to ongoing chest pain. He is invited to the rehabilitation program to prevent his situation getting worse. During the first interview in his home he says:

> P1: "I'm impressed that they consider me a patient – I don't do that myself"

And at the start of the first consultation he asks the nurse N1:

> P1: "Am I a patient?"

Later on N1 asks P1 (in a tone indicating that this might be a delicate issue)

> N1: "Is it right when the notes have that you drink 42 units a week?

P1: "Yes, and that's about twice as much as it should be … currently it is a habit that I drink a bottle of wine each night."

The nurse tells him that actually this is triple the amount recommended, and she then asks if he has done that for many years, and if he plans to continue doing that. He replies:

P1: "It depends on the situation, e.g. when we travel, my wife and I share a bottle for the dinner."

When the nurse asks if he needs a bottle each night, he explains:

P1: "For instance last night I was home late and drank only two glasses of wine before I went to bed."

Later in the conversation the nurse explains that alcohol makes the triglyceride count raise, and that his triglyceride count is almost double as high as it should be. In the interview after the consultation one of my standard questions is "What did you get out of the consultation?" Then P1 replies:

P1: "Of course I'll embrace the offers about diet and exercises."

But he does not mention alcohol. Later on he acknowledges that

P1: "I'm not 100% healthy."

He explains that normally he looks up all kind of issues on Google, but that his hesitation to see

P1: "… myself as a patient has caused me not to check even my new type of medicine. …But I need to realize the situation as it is."

Then to my question if he got any tasks from the nurse that he intend to take on, he does not get back to the issue of alcohol. It seems that he is hesitant to let the heart incident disrupts this everyday practice.

However, in the following consultation N1 reminds him that the only blood count that is too high is his triglyceride. In the subsequent interview with me he explains that this is due to his alcohol consumption. Then when I repeated the question from the last interview - if he was given any tasks that he wants to take on – the he replies:

P1: "Yes, I'll drastically reduce my consumption of alcohol."

And then he mentions that he will start using HMP for monitoring the level of triglyceride as he changes his drinking habits.

In a supplementary telephone interview a month after P1's last consultation he explains that in fact he does use MHP to monitor the triglyceride count. Finding a piece of paper where he keeps track of the readings, he says:

P1: "It is decreasing, which is fine. But of course, I don't know if that is because of the medication or me changing my diet."

Missing functionality and unhelpful modes of interaction

Both patients and nurses request other types of data and modes of interacting with the system. The patients find that there are limitations that need to be dealt with in

order for them to find the information meaningful, actionable and feasible. Instead, patients, with a few exceptions, are generally even impressed by the clinicians' willingness and ability to keep them informed while they were hospitalized, and also by the ways in which the rehabilitation nurses provide information. But they wonder why MHP does not do the same, and when it does give access to e.g. lab test results or parts of the clinicians' notes, the content and the format is often neither meaningful, actionable nor feasible. Further, they often find the modes of interaction cumbersome.

A patient, P4, was very impressed by the type and form (oral, text and drawings) of the information she received from the clinicians before, during and after her treatment at the hospital. When she was sent home she read about MHP in the material she was given by the nurse, who recruited her for this study. So she accessed MHP, but did not find it very helpful:

> P4: "I did find the lab test results and parts of the physicians notes. But I want to read all of the doctors' notes. And as to the blood tests, they were not well arranged. It would have been easier to see them all in one picture. Instead, I had to click on each test to see the value. Also, I missed to see the normal values. I can't recall what they are."

Another patient, P2, sees himself as "an info-freak" as he often looks up all sorts of information on the net. He wonders why the system does not contain information about what the rehabilitation program is all about. Further, P2 says:

> P2: "I would like to see the X-rays ….. to compare my X-rays with what I find on the net. How bad was my situation? And what is the amount of fluid in my lungs?

Patient P4 also wonders why a lot of information about the disease and the treatment is not available trough MHP:

> P4: "For instance why is there not information about known side effects of the medicine they prescribe. I looked up the side effects of beta blockers on the net. But why is not in MHP? Or a link? Likewise with the leaflets I received today on diet and physical training."

These, and other issues raised by the patients, may be rather mundane things to fix. However, they carry evidence that MHP is not based on a proper understanding of patients' concerns, and this does not increase the patients' motivation to take advantage of the potentials of the system.

Education and training

MHP was not given much attention during the implementation. The clinicians went through an education and training program on HP before "go-live". It focused primarily on the technical parts of the system intended for their use, instead how to integrate the system into their work practices, and how these might have to be changed in order to obtain the intended effects was left to the clinicians to figure out. MHP was mentioned, but clinicians were not instructed how to use that part of the system, and patients only learn about the system when they are invited for consultation or when e.g. new lab results are ready. So it should not come as a surprise that MHP's potentials for augmenting patient-clinician interaction is still to be harvested.

In an interview with P2 before a consultation I learned that he had used the system to fill out a questionnaire that the system prompted him to answer. Asking the nurse after the consultation if that was helpful to her, she replies:

> N1: "How should I be able to see that? Interesting, the system has him as inactive… I checked just before you arrived. Hmm, now his status is active, do you know if he used the system this morning? ... I wonder which questionnaire that is? I havn't received it, and I havn't send him one. … I might be able to look it up, but then I have to learn how - it was not part of the training we received."

The patients involved in this study were given brief descriptions about MHP when they were recruited, and some of my interview questions mention the system, but without directly promoting it or providing a tutorial. The nurses sometimes suggested to patients that they might start using MHP, if they think that the patient is ready for that.

> N1: "Have you used My Health Platform to look at the physicians notes?"
>
> P1: "Yes, but I couldn't figure it out. But I did try to look for the blood tests this morning, but they were not there yet."
>
> N1: "… The system was down this morning - that might be the reason. If for instance you get in doubt of for how long you shall take the medicine, and how much, or if the note I gave you gets lost, then you can look up my note in the system."

(Inter) organizational issues

N3 finds the platform helpful in smoothing cross-sector communication since her notes on a patient are made available in the general practitioner's system as a basis for the subsequent monitoring of the patient. But there are still some issues to be taken care of:

> N3: "It is much easier than before when we used email for such purposes. Inter-disciplinary communication has become easier, like referrals. However, we are not always sure who gets them. E.g. when a physician refers a patient to heart rehabilitation, it doesn't always go to the right clinic. The responsible nurse at the right clinic might not see it. It might end up at another hospital. We are working hard on getting it right, but it is very difficult."

Physicians are not always aware of the responsibilities of the different rehabilitation clinics,

> N3: "…the system doesn't make it easier for them."

Reflecting on the templates offered by the system for her notes, she tells:

> N3: "I'm not sure if it is faster than making them from scratch as I used to. But since our last interview where you asked if I used the templates, I actually started using them. But they irritate me as I have to delete something, but then again other issues are transferred automatically from other sub-systems like the blood pressure. But something is still not validated properly."

The templates may help nurses to be professional accountable as a template works as a reminder of all the issues she needs to cover and the different type of data she needs to type in.

Inter organizational issues are also important to patients, who often see clinicians at different parts of the hospital as well as at different hospitals.

Further, they see their GP and meet clinicians and other staff from the municipality, and they are concerned about coordination among these, and they are not always sure about who is responsible for what.

P4: "MHP should involve my GP and the specialists too."

It actually does, but she is not informed about that, and P1 touch upon the same issue when he asks me:

P1: "My GP and the department at the hospital, do they know about each other?

And he asks the nurse:

P1: You give me medication to lower the cholesterol, and my GP for lowering my blood pressure … and something to lower my pulse. It is related, and it should be coordinated.

N1: Yes, unfortunately we don't monitor you blood pressure, that has to be checked too often for us to do that, so it is taken care of by your GP."

Other patients have asked for MHP to contain information about the overall rehabilitation plan, including who is responsible for what and when.

Conclusion and further work

The preliminary analyses may be summed up as answers to the research questions.

RQ1: Do patients start to orient themselves towards MHP? How and why?

The study indicates that the patients tried out MHP more than once. Some times when prompted by e.g. an alert via the system for their next consultation. Other times they are motivated by a specific concern. Some looked for general information like side effects of medication or an overview of the various rehabilitation services provided by the hospital and the municipality. Others looked for information specific to their health like their own rehabilitation plan, blood tests and X-rays.

RQ2: What do patients get out of using MHP?

Patients appreciate that MHP offers information, but they do not always find the type of information they look for, or in a format that to them is meaningful, actionable and feasible. They find that MHP seems not to be designed based on a proper understanding of their needs and concerns. They all see that MHP holds such potentials, but it requires rethinking the functionality and the implementation strategy, including training of patients and medical staff. Some patients find motivations to change lifestyle by monitoring medical parameters, when they learn about their relations.

RQ3: Does patients' use/non use have an effect on the nurses' work?

This is too early to say, but again the study indicates that it would require revisiting the functionality and the implementation strategy, including training of patients and medical staff. Ideas that came up during the interviews include the possibility to store and refer patients to information specific to the clinic, and features that would support a patient and a nurse in settings goals and monitor how the patient fare in meeting the agreed upon goals.

In conclusion, this study supports that clinicians and patients also have divergent concerns (Toombs, 1993), as well as our own proposal that when designing support for their collaboration it is important to identify and align their concerns. Further studies will dig deeper into an understanding of the practices of patients and clinicians, and how these practices may be enhanced by developing further the potentials of MHP and by remedying some of its negative consequences.

Acknowledgments

I thank the patients, the nurses and the heart clinic for their cooperation.

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Building Information Modeling: The Dream of Perfect Information

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Abstract. Over the past decade, Building Information Modeling (BIM) – an advanced modeling technology and associated set of processes to create, develop, and analyze digital building models – has emerged as one of the most promising approaches for improving the performance of building projects. It has been heralded as a 'digital revolution' and it is expected to improve collaboration, productivity, and product quality throughout the building life cycle by providing 'perfect information' on which to base the design and construction (Crotty 2012). However, little is known about the use of BIM in practice, and it has so far not been studied from a CSCW perspective. In this paper we present preliminary findings from a field study of a large hospital construction project in Denmark. The project is in its early phases, so the focus is on the role of BIM as a platform for collaboration among client, architects, engineers and future users regarding the *conceptual design*. Our findings suggest that recurrent reviews of the evolving digital model played a key role in the collaboration. We identified three kinds of design reviews: clash detection, scenario-based reviews and embodied reviews – each focusing on specific aspects of the conceptual design.

Introduction

The architecture, engineering and construction (AEC) industries are on the verge of a fundamental transformation towards digitized construction. This is, at least, the picture that emerges from the growing body of literature on Building Information Modeling (BIM). Its proponents often describe it as a digital revolution: "This is digitized construction; building with *perfect information*. This form of construction will be as different to today's analogue industry, as today's digital manufacturing and retail industries are different to their 1970s analogue predeces-

sors" (Crotty 2012, p. xiii). There is broad agreement that BIM is "not just a technology change, but also a process change" (Eastman et al. 2011, p. vii).

Collaboration is at the core of BIM. It is seen as a means to overcome the fragmentation of the building process, which often causes unanticipated cost overruns, delays, and lawsuits, by providing a foundation for effective collaboration between the different actors involved from the early design phase through project handover to facility management. BIM is also expected to facilitate user participation in the building process, because "building models are far more communicative and informative to lay people than technical drawings" (Eastman et al. 2011, p. 363). BIM may, for instance, allow users to interactively review a building design in an immersive virtual environment such as a CAVE.

Meanwhile, little is known about the use of BIM in practice and the effects this has. Much of the existing literature on BIM can be characterized as having a promotional agenda, of a somewhat utopian quality (Miettinen & Paavola 2014). There are few in-depth empirical studies of the practical use of BIM technologies and processes in building projects and, despite the fact that collaboration takes center stage in the approach, BIM has not yet been studied from a CSCW perspective.

To begin to address this gap, this paper presents preliminary findings from an ongoing field study of the use of BIM in a hospital construction project in Denmark. The project is still in its early phases, so the focus here is on the role of BIM as a platform for collaboration amongst the client organization, architects, and future users around the conceptual design.

We found that recurrent *design reviews* of the evolving digital model were key to the process. We identified three different types of reviews: clash detection, scenario-based reviews and embodied reviews – each focusing on specific aspects of the conceptual design. While the first two types of reviews relied mainly on the digital building model, the embodied reviews allowed future users to experience the proposal 'for real,' for instance by exploring full-scale mock-ups or by participating in site-walks together with the architects.

The remainder of this paper is structured as follows: The next section briefly reviews prior CSCW research on architectural design; section 3 presents the concept of BIM and discusses the notion of parametric modeling; section 4 introduces the case; section 5 present our findings; and section 6 summarizes our conclusions and provides suggestions for future work.

Related work

There are relatively few studies of architecture and building construction within CSCW. However, although the CSCW literature on architectural work is not extensive, there are some important insights that may be derived from previous studies that we briefly present in the following section.

First, it is well documented that creating and interpreting representational artifacts are at the core of building design and construction. Modern building projects are notoriously complex and intensely collaborative, involving not only architects and engineers, but also building contractors, clients, user representatives, local government authorities, and other external stakeholders. To manage this complexity and diversity, architects and engineers rely on a bevy of representational artifacts ranging from informal and imaginative sketches, scale models and 3D visualizations intended to convey an idea or a concept to precise and very detailed CAD plans and technical drawings serving the needs of engineers and builders (Büscher et al. 1999, Christensen 2008, Harper & Carter 1994, Schmidt & Wagner 2005).

Second, as Schmidt and Wagner (2005) have pointed out, representational artifacts play a special role in architecture and building design for the simple reason that "architectural work is different from many other types of work insofar as the 'field of work' does not exist, that is, does not exist *objectively*, in advance, but is constructed in and through the process of design and planning and, ultimately, construction" (p. 363).

Third, representational artifacts have different affordances, and a recent study by Retelny and Hinds (2016) has documented that architects intentionally created different representations for different actors and purposes throughout a project. In some cases they even "duplicated effort by generating similar drawings for different audiences" in order to facilitate interactions with clients and contributors (p. 1320).

Fourth, it is important to understand that the various representations do not stand alone, but are highly interrelated. As the building project progresses, new representational artifacts are created, collated and interwoven to form a 'corpus' of 'texts,' which supports the collaborative work effort (Christensen 2015). The individual representations do not 'make sense' unless they are understood in association with other artifacts and their position in the 'taskscape,' that is, the ensemble of tasks that, taken together, constitute the project (Christensen 2008).

Finally, it should be noted that, except for the study by Retelny and Hinds (2016), much of the sparse CSCW literature on architectural work and building construction is based on empirical studies carried out a decade or more ago. Although theses studies provide valuable insights into the complex and collaborative nature of modern building projects, they do not reflect the profound changes underway in the architecture, engineering, and construction (AEC) industry driven primarily by digitization.

Building Information Modeling

Increased collaboration and better communication across organizational boundaries play a key role in the BIM rhetoric (Miettinen & Paavola 2014). According to

Eastman et al. (2011), the hope and expectation is that BIM will move the AEC industry "forward from current task automation of project and paper-centric processes" toward "an integrated and interoperable workflow where these tasks are collapsed into a coordinated and collaborative process that maximizes computing capabilities" (p. 17).

Eastman et al. (2011) emphasize that "BIM is not a thing or a type of software but a human activity that ultimately involves broad process changes in design, construction and facility management" (p. xi). More formally, they define it as "a modeling technology and associated set of processes to produce, communicate, and analyze building models" (p. 16). In this context a building model is a digital 3D representation using object-based parametric modeling to represent building components and their associated properties. According to the National Institute for Building Sciences (NIBS) in the U.S., the vision is to have an "information model for each facility, new or old, which *contains all appropriate information created or gathered about that facility in a format useable by all throughout its lifecycle*" (NIBS 2008, emphasis added).

The concept of parametric modeling – that is, the ability to construct building models by assembling and linking parametric 3D objects, which represent the physical components of the building, such as walls, windows, ducts, and pipes – is key to understanding BIM. A *parametric object* is a digital representation of a building component defined by rules and parameters that determine the geometric shape as well as nongeometric properties and features, e.g. relations to other objects, physical properties, price and delivery date. An object is always an instance of a class, where a class can be defined as a template or blueprint that describes the geometry, properties and behavior of a specific type or 'family' of things, e.g., slabs or beams (Eastman et al. 2011).

Objects (or properties) can be specified as being related to other objects (or properties). For instance, "it is possible to stipulate that a particular wall must be parallel to and a specified distance from another wall; that it is attached to a third wall at a particular angle, that it is perpendicular to the floor it rests on, and so on" (Crotty 2012, p. 84). Changes made to one object (or property) will therefore automatically be reflected in related objects (or properties). In this way, parametric modeling allows for "effective low-level automatic design editing" (Eastman et al. 2011, p. 39).

Another often claimed advantage of parametric modeling is that the 3D-model can be used to easily create design visualizations in various formats, and for various purposes. The expectation is that visual simulations can be used to elicit input from stakeholders unaccustomed to reading architectural drawings (Eastman et al. 2011, pp. 158-160).

BIM applications come with a set of predefined parametric object classes "meant to capture the standard conventions in the area of building that the application targets" (Eastman et al. 2011, p. 54). In addition, users can define their

own parametric object classes, either by modifying a predefined class or by creating a new custom object class. Object classes can be defined at different levels of aggregation, so it is possible to model composite building components (e.g., an interior wall composed of a steel or wood frame, fiberglass insulation, and drywall).

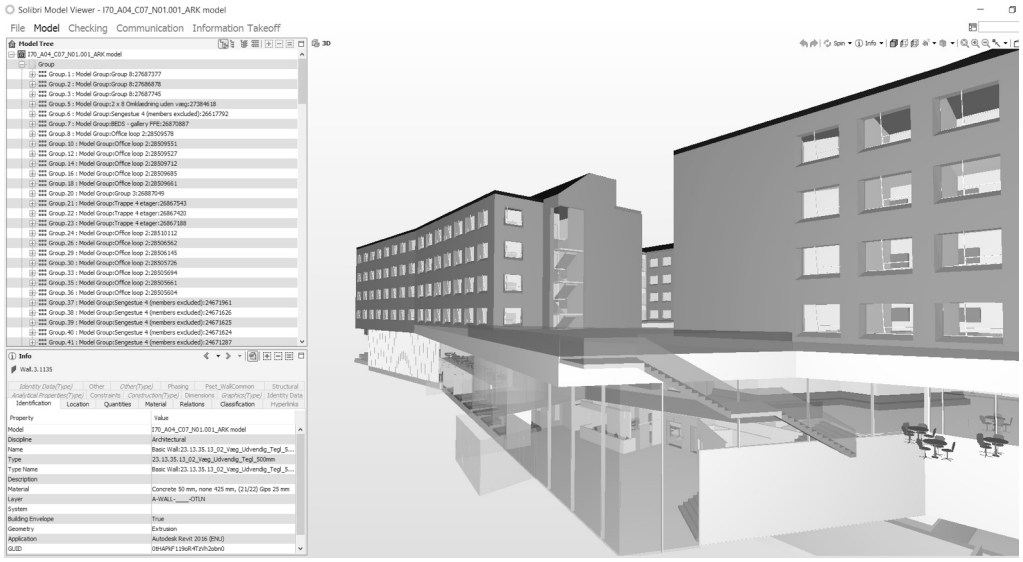

Figure 1. The digital building model: The model is interactive meaning that when marking an object, e.g., a door, specifications of the door appear from the database in the left side.

A multiplicity of models

This sounds great in theory, but in reality the vision of incorporating all relevant building information into one, unified model is not (yet) possible (Crotty 2012, Törmä 2013). Large construction projects involve numerous different specialists, such as architects, structural engineers, MEP (mechanical, electrical and plumbing) specialists, contractors and fabricators. Each group provide specialist input at different points in the design and construction process, and each group has its own discipline-specific BIM design tools and models. Therefore BIM-based projects will always involve multiple *partial*, but *interrelated* models which "represent the building from a particular perspective" (Törmä 2013, p. 412). In daily practice these discipline-specific models are often referred to as 'native models' (the architectural model, the structural model, the MEP model, etc.).

The fact that each group of specialists creates their own native model, more or less independently of all the others, opens up for gaps and inconsistencies – so-called 'clashes' or 'collisions' – in the design that need to be addressed. As a consequence, periodic design reviews and clash detection is an important and integral part of the BIM modeling process. In practice, this is often done by bringing the

native models together at key points to create a single, complete 'reference' or 'master' model of the building, which will then be reviewed for omissions, clashes and other inconsistencies. Clash detection can in principle be performed 'automatically' using specialized design review software.

It should, however, be noted that this master model will only contain a *subset* of the data in the native models and that it can only be used in a *read-only* mode. Each of the discipline-specific design tools store its model in a proprietary data format, but can also export data in a standard format, typically IFC[1]. However, important information, particularly all parametric information, is lost in this process "since it cannot be represented in IFC" (Tölmä 2013, p. 414). This, of course, also means that any changes that need to be made after a review, for instance as a result of the identification of a 'clash,' must be done in the respective native models.

The case

We are studying a large hospital construction project, which aims at extending and refurbishing an existing general hospital located in Copenhagen, Denmark. The project involves the design and construction of a new main hospital building of 75,000 m^2 and the refurbishment of 12,000 m^2 of the existing buildings. The new hospital will serve approximately 450.000 citizens in the central part of the Capital Region of Denmark.

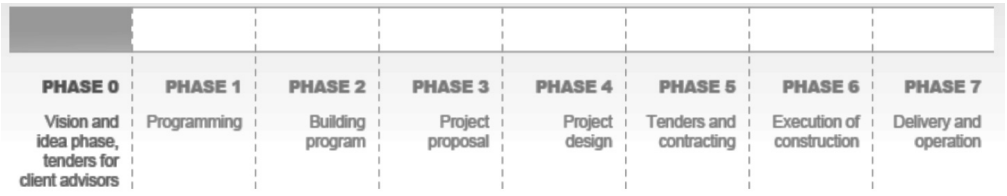

Figure 2. Project phases throughout the 'design-bid-build' process running from 2010-2025. The project is currently at the beginning of Phase 3 'Project Proposal'. (Accessed 08.02.2017 from Danishhospitalconstruction.com)

The building project started out in 2010 (see Figure 2) where the client advisors were appointed (Phase 0). Then followed a process of putting together the competition brief. The actual 'competition' of who would design and built the hospital was organized as a tender. The winning project was announced in the end of 2015, which was also the time where this study was initiated (Phase 1). The

[1] IFC stands for 'Industry Foundation Classes' and it is an open data standard developed by the BuildingSmart consortium (http://www.buildingsmart-tech.org).

study was conducted within the client organization with particular focus on the collaborative work around BIM amongst the user groups within this setup.

There are many project partners and they change in the course of the building project. There are, however, some partners engaged throughout the majority of project phases. These partners are 1) the client organization 2) the hospital 3) the project consortium (in Danish *Totalrådgiver* or *TR*) 4) consultants specialized in BIM, and 5) the client's advisor. These partners all represent larger organizations. Below is a brief description of each partner and their interdependence.

1) Client organization: The client organization consists of a mix of people with various professional backgrounds who collaborate in managing and reviewing the building project throughout the design and construction process. The professional composition of this group is changed in order to accomodate the competencies needed in the different phases of the project. At the beginning of the project emphasis is given to the conceptual design, whereas later it will be the tender process.

2) The hospital organization: Users (healthcare practitioners) play a crucial role in the initial design process by providing input as part of the conceptual design review. User participation was organized as a series of workshops, in which mostly nurses and doctors were invited to attend. Occasionally, other types of healthcare practitioners were invited. Different 'user groups' were formed to develop sub-concepts for 'day clinics', 'bed wards' and 'the ED' etc. The current hospital vice-president also heads the client organization (but formally the organizations are separate).

3) Project consortium: The consortium that won the tender process is a temporarily constituted group of firms, established solely for this tender. The project consortium consists of a Danish architectural firm and an American architectural firm, a Danish engineering firm and their sub-contractors, as well as a consultancy company specialized in hospital planning. The consortium is jointly and severally liable for project delivery, as stipulated in the contract that forms the basis for their collaboration on the design and construction of the future hospital.

4) Consultants specialized in BIM: The consultants are hired in to ensure compliance with technical requirements in terms of how to model in BIM. They are responsible for clash testing the BIM model throughout the process of design; relying on specialized software for clash detection. This also means that they define, for example 'clash rules'. The BIM consultants provide monthly reports of clash tests and create a prioritized list of collisions. Finally, the BIM consultants negotiate with the project consortium what are the important clashes to correct.

5) Client advisor: The client advisor is hired in to assist the client in developing the competition brief and continues to act as an independent advisor throughout the building project. The client advisor assists the client organization in reviewing the design in relation to, for example, sign-offs. The client advisor is

considered to be a general advisor rather than a specialized one such as the BIM consultants that are hired in.

Data collection and data analysis

The Danish government has stipulated that from 2013 all public construction projects must use BIM (BEK no. 118 of 06/02/2013) and, accordingly, BIM has played a key role in the building project. BIM has been a clear priority from the beginning of the study, initiated in December 2015, at the same time the winning proposal was announced. Ethnographic studies were conducted (ongoing) and include 112 hours of observations on site.

The study is conducted in agreement with the client organization. Our prime focus is the design reviews that take place on-site, and/or with representatives of the client organization present. However, members of both the project consortium and client organization acted as our peers throughout the iterative process of collecting and analyzing data.

First, to collect data on BIM we began by mapping every time there was mention of or indication of a connection to BIM: We participated in sessions planned by the client organization where e.g. the managerial principles were outlined. We conducted informal interviews with consultants, architects and others working on the hospital project and collected various types of documents to understand, for example, the materiality and size of a BIM model. Eventually, the first digital building model was submitted as part of the design proposal (outline proposal) and we could follow how it evolved through 'sign-offs'.

Secondly, given our focus on the practices around the design reviews of the digital building model in between sign-offs, we decided to study and analyse the relationship between digital and physical representations. Based on our literature review, in which the advancements of BIM and the apparently omniscient possibilities of this type of digital building modelling are herealded, we were puzzled by the seeming importance of 1:1 scale mock-ups and site-walks, and so they serve as another focal point in our analysis that we turn to next.

Findings

A digital building model (BIM) does not come into existence 'out of nowhere'. It is developed after months and months of preparations where architects, advisors and the client organization negotiate the managerial principles, e.g. the appropriate level of detail in the BIM model and when deliveries (sign-offs) are required. At the same time, the *concept* for the future hospital has to be consolidated in the sense that decisions on main flows, size and functions have to be in place in order to begin the BIM modeling. Once these decisions are in place the project consortium begins work on collating the BIM model.

As previously mentioned the digital building model consists of a 'master model' and several native models, e.g. an architectural model, a structural model, a MEP model, etc. Thus, the various specialist groups (architects, structural engineers, MEP specialists, landscape architects, etc.) create and develop their own native models using discipline-specific authoring and analysis tools. The information links up to a room database that collects all information for each type of room in the model hospital. At regular intervals, the native models are integrated into the composite 'master model' using specialized aggregation software.

An architect from the project consortium explains the qualities of the 'master model' by making an analogy to a library.

"Building Information Modeling is like a library due to the amount of knowledge that can be kept and leveraged about a project. Each user (architects, engineers etc.) can see the full library and contribute by 'checking out' different books. By this I mean that when we add something or change something in our local files we literally have that knowledge to ourselves. Then, when we save our local file back to the central file, we give that knowledge back to the library by checking in our books. That's where the magic happens, previously the other systems would not let two people access the same information. So, two people could not be in the same level 2 floorplan), but now 10 people can be in the same floorplan and making changes. People can be making changes in their local [native] model at the same time and they can actually save [these changes] to the central [master] model at the same time. The software [Revit] will pick who goes first as a part of their full save to central. It also updates all of the other content that has changed from other people's saves. This way we are all sharing the same information, because although we have our own copies they are always tied to the master/central file"

(*In situ* interview with architect 07.04.2016 *and* 09.02.2017).

What the architect points out here is one of BIM's important qualities, namely that it allows for *synchronous* work by several different people at a time. Working in parallel is, however, not without its problems.

A common flaw in a digital building model is, for example, 'double modeling' (Exigo 2017). This flaw is typically provoked by simple mistakes, for instance, a new deck is added but the 'old' one is not erased from the digital building model. The architect explains:

"The double modeling, typically happens when [there is a] misunderstanding [as to] who really owns it [e.g. the deck]. In the example of the floors, the architect owns the floor finish (i.e., tile, wood etc.) but engineering really owns the structural concrete. In terms of who gets into BIM first, there has to be different stages of that floor. So in the beginning, we [architects] might not know how large or how deep, but we know we need a floor. The Architectural team will put in a predesigned/ typical floor for reference until we give that element to the Engineering team where they will put the pans and joists and design in - and we, the Architectural team, get more comments and feedback from the

client to understand flooring finish. It is all a dance between both designers, client and users".

(Architect elaborating on *in situ* interview 21.04.2017).

The organizational setup around the 'master model' ensures, in principle, that work is coordinated at all times; even though it is clearly still important, as the example of double modeling illustrates, to review every aspect changed or added in the BIM model. Hence, 'reviewing' is essential for BIM modelling to be effective and so we turn our attention to practices concerning design review or 'testing'.

Reviewing the digital building model

We have identified three different types of reviews in the initial process of conceptual design that are essential to practitioners' collaborative use of BIM: 1) clash detection 2) scenario-based reviews, and 3) embodied reviews.

Clash detection (automated): As the digital building model is being created it consists of several discipline-specific native models, for example, an architectural model, a structural model, an MEP model etc. – that together come to form a 'master model'. The master model is submitted to clash detection testing approximately once a month (*In situ* interview with project leader 09.02.2017) to make sure that the native models do not clash. BIM consultants conduct the clash detection by applying specific analysis software (e.g. Solibri). The results of the clash detection test are then discussed with the project consortium, based on a prioritized list of clashes. It makes a huge difference what the rules of clash detection are: One example of a 'clash rule' identified in the project is that surfaces of walls should stop 10 cm. above the floor (*in situ* interview with project leader 09.02.2017). To be able to effectively clean and wash the floors in the future hospital, the floor material continues 10 cm. up the wall. This clash rule resulted in almost 5000 clashes (counted as the number of rooms where the flaw was detected). This is, however, considered as a non-important clash, because it is commonly known amongst the professionals that the painters would never paint those 10 cm. of floor material. What this example also illustrates is how the clash detection test is not strictly automated but based on a collaborative practice of deciding what are the important clashes that need to be corrected. Decisions on which clashes are the most crucial take time; time during which the design continues to be changed in the BIM model. Thus, another dilemma with clash detection is that the entire process around negotiating the importance of test results is sometimes slower than changes made in the master model. To avoid clash detection becoming redundant, it is crucial that BIM consultants and the project consortium agree on what is a reasonable level of 'testing' in terms of clash rules and on the results that follows from the automated tests.

Scenario-based reviews: Another aspect that we identified in the study as being important for how the BIM model is recursively checked, is reviews for omissions related to *functionality*. To check for omissions and functional design flaws likely to only be discovered by practitioners working in the hospital, scenario-based reviews are conducted: For example, one design flaw identified by a user group focusing on the standard patient room was that the bathroom 'space' seemed too small (*In situ* interview 15.08.2016). User groups were organized around 3 workshops to inform the conceptual design on different topics, for example, the standard patient room (and associated private bathroom). The client organization ran the workshops where project architects and the client advisor also participated in facilitating reviews of the conceptual design. A projector and prints of 2D-floorplans were provided in all 3 workshops to help focus the discussions (BIM allows for both 2D and 3D visualizations). Thus, architects were able to manipulate the design in this case of the standard patient room 'live' using the projector and guided by the users' input. The observation in the first workshop – that the bathrooms seemed to be too small – was supported by formal guidelines[2], one of the project leaders of the client organization noticed. Taking decisions on, for example, the size of a bathroom is something that has significant consequences for costs when more than 600 standard patient rooms (and bathrooms) are to be built. Therefore, the outline of the standard patient room was 'taped' on the floor in the second workshop. As a result of the discussions at this workshop, the size of the bathroom was adjusted prior to the third workshop with users; even though further exploration of the conceptual design with a planned 1:1 scale mock-up of the patient room was still needed.

Embodied reviewing: 'Testing' or reviewing digital building models involves more than detecting 'clashes' and teasing out omissions and functional design flaws. Another important aspect in making BIM effective in practice, is the users' 'unfiltered interaction' with design. The notion of 'unfiltered interaction' is an empirical category that emerged in a process consultant's description of the difference between reviews of 2D floorplans with users and reviews that take place in the actual context of the 'hospital'. By 'unfiltered' the process consultant wanted to highlight how users interact differently with a mock-up when considering the use scenario *vis-à-vis* simply interacting by 'using' a space (*In situ* interview with process consultant 30.01.2017). Thus, according to the process consultant, the 'unfiltered interaction' with a mock-up lead to different types of reflections. There is a difference, the process consultant explains, when hospital practitioners sit in, for example, a couch in a 1:1 mock-up rather than just thinking about how they would probably sit in the couch. The input is richer compared with the input that users provide when interacting with, for example, the 2D-floorplans in the user groups or even when interacting with a mock-up 'taped' on the floor (*In situ*

[2] Capital Region of Denmark 2011

interview with process consultant 30.01.2017). Drawing on Dourish' (1999) notion of *embodied interaction*, we call this type of testing 'embodied reviewing'. Embodied interaction, according to Dourish, describes "*both a physical presence in the world and a social embedding in a web of practices and purposes*" (1999 p. 1). Taking the importance of 'embodied reviewing' seriously, in the following section we take a closer look at the use of physical representations such as mock-ups and site-walks in order to deepen our understanding of how BIM is made efficient in practice – and we also consider the qualities of these artifacts.

The role of embodied reviews

What does it mean in practice to carry out an 'embodied review' of an architectural design and what role does it play in relation to the digital building model? What are the different representations involved in 'unfiltered' embodied reviewing? And what are the qualities of these representations that make embodied interaction or testing different from direct interaction with the BIM model? The following section explores two specific examples of embodied reviews, namely 1) a carefully planned *site-walk, guided by sticks* to simulate the layout of the future Emergency Department (ED), and 2) a *mock-up* of a standard patient room built within the existing hospital's medical department.

Site-walk: Comprehending the *size* of a 'space' is not straightforward. Even people who have worked in AEC for years are sometimes puzzled by size issues. The challenge is how to realize in advance what it means to work in a space of a particular size. The users – the hospital practitioners – were not used to 'reading' 2D and 3D floorplans and translating size into something with which they were familiar. This also raises the question of what it means to review a design with users. This is exactly the point of learning people how to interpret digitized representations.

The users' understanding of size evolves together with the project: Similar to architects that rely on certain rules of thumb, such as 'space' being estimated from the number of ceiling tiles, users also have to learn about the size of a 'space' in a way that makes sense from their perspective (*In situ* interview with process consultant 02.02.2017). To assist users in developing their sense of 'space', a site-walk with users was organized as part of reviewing the conceptual design of the ED. The concept of the ED in the new hospital will be significantly different from the existing. It will be the main space where patients are admitted to the hospital. Patients are expected to spend up to 48 hours in the ED in the future.

Through simple measures, including the positioning of sticks labeled with the names of particular 'spaces' in the future ED (triage, treatment rooms and trauma), a senior architect and process consultant marked out the exact size of the future ED and how the various functions would be situated. Hospital practitioners (nurses and doctors primarily) were invited for a tour in the future ED to reflect on the layout of the future department and what it would mean if the department was located on a single floor rather than on two floors. Walking through the future ED the hospital practitioners, for example, counted the *number* of patient treatment rooms they imagined passing.

Figure 3. Mock-up of the future ED to evolve users' sense of 'space' and the conceptual differences in the layout if 'stacked' horizontally vis-à-vis planned in a straight line vertically.

The site-walk provoked a number of issues and questions, e.g. the doctors imagined that it would be difficult to pass through the different zones of the ED without being stopped on their way to, e.g. trauma. Moreover, this example illustrates how learning about the size of a space by interpreting floorplans and the *embodied interaction* with a particular space are very different phenomena. The site-walk allowed hospital practitioners to connect the familiar experience of walking and the floorplan of the future ED to explore issues of space and size.

Mock-up: In the case of the 1:1 scale mock-up of a standard patient room, the interest was also mainly to review the conceptual design in the digital building model. The final layout will be copied more than 600 times in the future hospital, making this one of the most important rooms to review as even the smallest change will have significant effects when scaled up to the entire hospital.

The mock-up of the patient room was initiated at the same time as the digital building model, and ran in parallel. Thus, the mock-up and the BIM model are

closely related as illustrated in the example of bathroom design. When the users found that the bathroom was too small during the scenario-based workshops, the mock-up became an important alternative means for reviewing this space.

Figure 4. First version of the mock-up of standard patient bathroom that will become a fully functional patient room for 'embodied reviewing.'

This simple, rough 1:1 scale mock-up in plywood allowed hospital practitioners to experience and explore the bathroom 'for real', and this gave more credibility to the conclusions reached at the previous workshops with users. In the 'taped' version of the room on the floor, users had to think about where the walls would be. In contrast, the 1:1 scale mock-up allowed users to step into the bathroom without thinking about how the walls were represented. This is what we suggest conceptualizing as 'embodied reviewing'.

Discussion and conclusion

There is no doubt that BIM is an important technological innovation that will be driving fundamental changes in the AEC industries over the next decades. It is,

however, not yet possible to project exactly how these changes will play out in practice.

The vision of BIM is to improve collaboration and coordination amongst the many different parties involved in large construction projects by replacing the plethora of traditional representational artifacts such as floor plans, section views, detail drawings and scale models (Christensen 2008, Schmidt & Wagner 2005), with a single, unified digital model, which "contains all appropriate information created or gathered about [the building] in a format useable by all throughout its lifecycle" (NIBS 2008). However, even the most optimistic proponents of BIM have realized that this is hardly possible in practice due to both technical constraints as well as to the many different stakeholders' specialized information needs (Retelny and Hinds 2016, Törmä 2013). For the moment, it is generally accepted that instead of a single unitary model, the building information model "is more likely to take the form of a federation of separate, but interconnected, discipline-specific sub-models" (Crotty 2012, p. 81).

Against this backdrop, we set out to explore how BIM is implemented in practice by studying the creation and use of a (federated) building information model in the early phases of a large hospital construction project. We found that the model played a key role in the development of the new hospital building's concept design, but also that the integration of the input from the various specialists into a coherent 'master model' proved to be more complex and challenging than one would expect from the literature. According to one of the architects this process works out best, "when the design team and the client can *make designs as early as possible and try not to change them"* (Architect elaborating on *in situ* interview 21.04.2017, *emphasis added*).

More specifically, we discovered that recurrent *design reviews* played a key role in facilitating collaboration amongst the architects, engineers, and user representatives involved in the development of the model. We identified and examined three different types of reviews in use in this project, namely (1) reviews based on automatic clash detection, (2) scenario-based reviews with users, and (3) reviews involving users' embodied interaction with physical mock-ups and spaces. The first type of review focused on detecting *clashes* between the native models produced by different specialist groups; the second type of review focused on identifying omissions and *functional* design flaws as seen from the perspective of future users; and the third type of reviews focused on exploring aspects of the users' *embodied* experience when navigating the design space.

There are two important points worth highlighting about these reviews. First, the so-called 'automatic' clash detection (Eastman et al 2011, p. 272-3) seems to be not-so-automatic after all. BIM-based clash detection is no doubt easier, faster and more reliable than the traditional approach of overlaying 2D drawings (or 2D CAD layers) and visually identify potential conflicts, but it nonetheless requires the specialist groups' concerted effort and collaboration. They have to agree on

what aspects of the design to focus on, and they have to define appropriate clash rules before running the clash detection software. If used without first defining precise and relevant search criteria, the software will identity tens of thousands of clashes; the importance and relevance of which need to be assessed (depending on the project stage and task at hand). Given the importance of clash detection for large building projects, an obvious area for further research would be detailed, qualitative investigations of the tools, techniques and practices of BIM-based clash detection.

Second, it is interesting, and seen from a BIM perspective perhaps surprising, that the client organization found it necessary to conduct what we, inspired by Dourish, refer to as 'embodied reviews,' as a complement to clash detection and scenario-based reviews. It is interesting, because the BIM literature suggests that digital building models will make the use of traditional scale models and physical mock-ups superfluous. This is because digital building models "are far more flexible, immediate, and informative than computer-renderings of buildings produced using CAD technologies" (Eastman et al. 2011, p. 362). Furthermore, they allow for the creation and testing of virtual mock-ups in immersive VR environments. Such virtual mock-ups or VR models are supposed to offer the same advantages for user feedback as physical mock-ups and, in addition, be much faster and cheaper to create and, perhaps in particular, to modify. However, whether these optimistic claims can be substantiated in practice remains very much an open question (Leicht et al. 2010).

Seen from a CSCW perspective it is, we would argue, less surprising that the digital building model cannot stand on its own. Previous studies have shown that architects and building engineers rather than using a single uniform representation employ a vast range of representational artifacts, each of which is specialized for a particular purpose and audience (Christensen 2008, Christensen 2015, Retelny & Hinds 2016, Schmidt & Wagner 2005). The reason for this is, of course, that "representations are not the real thing (…); they are always fundamentally 'underspecified' with respect to that which is represented" (Schmidt & Wagner 2005, p. 364). In other words, every representation emphasizes a set of properties while ignoring others. Seen in this light, it is not so surprising that site walks and full-scale mockups can be useful as supplements to digital representations, because their 'physicality' accentuates other aspects of the proposed design such as the experience of space and size.

The hospital project, we are studying, has so far chosen not to invest in VR technology, but they are in the next phase of the project considering testing the use of desktop VR and immersive VR models to validate conceptual design and obtain user feedback. This will give us the opportunity to more fully explore issues of representation, embodied interaction, and spatiality by comparing and contrasting the performance of physical and virtual mock-ups. Thus, it will be interesting to explore if VR models can support 'user testing' of proposed building

and room designs related to, e.g., work processes and patient safety. These are issues of practical concern as well as theoretical importance for understanding architectural design and construction from a CSCW perspective.

Acknowledgments

We are indebted to people working in the New Hospital Bispebjerg and in particular we wish to thank Behdad Bakhshaie, Hilde Schroll Jespersen, Sara Shumbera, Per Sams, Kristian N. Kiørboe, Louise M. Kofoed and Karen Grønkjær Kjeldsen for providing valuable support. We also wish to thank people working in New North Zealand Hospital (our 'sister' study) who played an important role in helping us understand the issue of study across sites. In particular, we wish to thank Sune From, Henrik Schmidt, Mette Stokholm, Karina Skog Nielsen, Rasmus A. Bang and Louise Lykke. This research was supported by the Velux Foundations award number 33295 and conducted as part of the Computational Artifact research project.

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The Hackerspace Manifested as a DIY-IoT Entity: Shaping and Protecting the Identity of the Community

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Abstract. This paper explores how cooperative identity is produced and preserved within a Hackerspace in Denmark. Specifically, we explore how the cooperative identity emerges conceptually and physically as a 'DYI-IoT' entity shaping the activities in the space. We argue that the cooperative identity of the Hackerspace was created through participants' interests and ideas expressed through their commitment to the space, which turns into productive dependencies demonstrating individuals' attachments to the space. Our data demonstrates that an exclusive mechanism was inherent in the collaborative dynamics producing the identity of the Hackerspace. While the participants were open and welcoming, the exclusive nature of the cooperative identity emerged in their practices, and was fundamentally about protecting the cooperative identity of the space. Hacking of the physical surroundings serves as affective bonds between the participants, artefacts, and the Hackerspace. People who could not participate in the hacking activities were not able to create these affective bonds, thus failing to contribute to shaping the cooperative identity of the Hackerspace.

Introduction

The cooperative practices within Hackerspaces (also referred to as Makerspaces or FabLabs) are receiving increased attention in the CSCW community (Fuchsberger, Murer et al. 2016). In example, studies of Hackerspaces related to innovation (Lindtner, Hertz et al. 2014), cultural production (Fox, Ulgado et al. 2015), peer learning (Moilanen 2012), and public life (Taylor, Hurley et al. 2016) have provided interesting insights. Our interest is to extend prior work by investigating the basic nature of the cooperative practices taking place in a Danish Hackerspace named CoLab. In particular, we want to explore *how the cooperative identity is produced and preserved in a Hackerspace?* The cooperative identity of a Hackerspace plays an important part in defining what kinds of activities that can take place in the space. Clearly, hacking activities in a refugee camp (Stickel, Hornung et al. 2015) have different conditions than hacking activities in a public place (Taylor, Hurley et al. 2016). In Fall 2014, we initiated an ethnographic study of CoLab in Copenhagen, Denmark. CoLab is fundamentally egalitarian in nature, has a decentralized power structure, and the borders between work, leisure, and friends are blurred and seamlessly intertwined. It is not grounded within educational, activist, or commercial interests – instead it is a space for grassroots hackers, who share a common interest in technology and in making 'cool stuff'.

We identify two sets of activities, which are constitutive for how the cooperative identity of CoLab is produced and preserved, namely shared commitment towards 1) continuously innovating the physical surroundings (e.g. doors, floors, refrigerators, and bathroom); and 2) constantly re-negotiating the cooperative characteristics of the space protecting the fragile community of conflict-averse participants without stating explicit policies and rules for interaction. Furthermore, we argue that the cooperative identity is manifested in participants' joint dedication towards innovating the Hackerspace into a comprehensive 'DIY-IoT' ('Do-It-Yourself-Internet-of-Things') entity. The DIY-IoT entity guides and structures the collaborative engagements. It is through this joint project that participants' commitment to CoLab turns into productive dependencies expressing individuals' attachments (Dantec and DiSalvo 2013) to the space as a concept and physical facility. Innovations of the physical surroundings serve as bonds between the participants, artefacts, and the space, and are thus constitutive for the cooperative identity of the Hackerspace.

The paper is structured as follows: First, we present existing research on Hackerspaces and introduce our focus on cooperative practices. Second, we outline our methods and the data sources. We then present the results of our ethnographic work examining routines and practices. Finally, we discuss our findings and present our conclusions.

Cooperative work in Hackerspaces

Looking across previous literature on Hackerspaces, cooperative engagement related to knowledge sharing and expertise (Wang and Kaye 2011, Bardzell, Bardzell et al. 2014, Wakkary et al., Schilling et al. 2015), care work and marginalization (Weibert, Marshall et al. 2014, Fox, Ulgado et al. 2015, Sun, Lindtner et al. 2015) have provided interesting insights into the cooperative practices, which take place in Hackerspaces and shape the social organization of work (Ames, Bardzell et al. 2014). Knowledge sharing, skills, and expertise are important parts of the cooperative work in Hackerspaces and the way e.g. self-made digital tools are created (Bardzell, Bardzell et al. 2014) and documented as innovations for others to use through tutorial authorship (Wakkary, Schilling et al. 2015). Knowledge sharing and expertise is a community effort across both locally shared spaces as well as global networks of individuals. A central element in this community effort is meaning-making and identity development in the community of practice (Lave and Wenger 1991). Identity in a community of practice is accomplished through the dual activities of participation and reification in the everyday interaction. The duality of meaning between participation and reification, comprises "[...] two constituents intrinsic to the process of negotiation of meaning, and their complementarity reflects the inherent duality of this process." (Wenger 1998, p. 52). Reification as an activity thus refers to the way of making something real by bringing it into being in concrete ways such as artefacts. It is important to note that the duality of participation and reification is not a distinction between social structures and physical representations. Instead, it suggests that when it comes to meaning-making, people and things cannot be defined independently of each other.

In cooperative work artefacts play an important role, since they potentially take form of reifications in the work. Reification is the objectification of shared knowledge and meaning related to a particular community (Wenger 1998). Often reifications are embodied within artefacts, which pose additional spatial information within the community by embedding certain meaning developed by the community (Wenger 1998). Artefacts often support routines in cooperative work, and therefore exploring the use of artefacts in routine work can assist us in identifying important patterns for how actors balance stability and variation in the common field of work (Feldman and Pentland 2003). By recognizing routines as

a part of the cooperative practices (Esbensen and Bjørn 2014), it becomes possible to consider how generative patterns of the mundane activities become manifested through concrete artefacts and projects. When we study the cooperative practices in the Hackerspace, we thus need to explore processes of participation and reification as they are manifested in artefacts, and in particular their relation to the meaning-making process, which shape the identity of the Hackerspace (Avle and Lindtner 2016). Cooperative work takes place in situations, where multiple actors are mutually dependent in their work (Schmidt and Bannon 1992). This means that individual activities do not only impact the work of individual actors, but also alter the state of the common field thereby thereby impacting others. It is the extra effort of articulation work caused by the mutual dependency, which makes the situation cooperative. In some cooperative engagements there are less strong dependencies also referred to as attachments in work (Dantec and DiSalvo 2013). Attachments characterize the process by which participants develop their identity by being committed to a specific course of action that ultimately challenges the community, which participants depend upon to actually take action. Attachments thus provide an alternative way to theorize about dependencies in cooperative work.

Method

Investigating how identity is produced within an egalitarian grassroots Hackerspace, we conducted an ethnographic study (Randall, Harper et al. 2007) within a Danish Hackerspace over a six-month period between October 2014 and March 2015. CoLab was founded by a group of makers in 2009, who had an interest in creating a hub for hacking and tinkering. The Hackerspace currently has 100-150 active members as well as 700+ members on their e-mail list. The empirical data consists of 119.5 hours of participatory observations and informal interviews in CoLab. Over the course of the study, we did not encounter female participants in the space, but interacted with 37 male participants. While CoLab at this time was male dominated, we chose not to focus on gender ratio as such, but instead on the identity of the space to unpack the cooperative engagement that takes place in the space. Most of the members are between 30 and 50 years old and possess technical and creative skills. In total, 7 researchers took part in the data collection. Collecting data included conversations with the participants concerning projects as well as everyday topics, but also matters of the Hackerspace. During these interactions, we sought to take part in their daily routines as well as reach different types of participants, ranging from founding members to newcomers. In example, we participated in three Tuesday's open house events and once in their regular Thursday meetings, which is where formal decisions are made. Furthermore, we attended an extraordinary general assembly

to further investigate the decision-making processes in the space. We documented all activities through field notes, audio, and photos, which were typed up immediately after the observations.

Results

When entering CoLab, a distinctive smell of wood and basement hits your nose and you see a vast number of electronic devices and equipment taking up the space. The Hackerspace is located in a low-ceilinged basement with modest lightning, which makes it feel like a cave. The space consists of eight interconnected rooms organized as a maze (Figure 1).

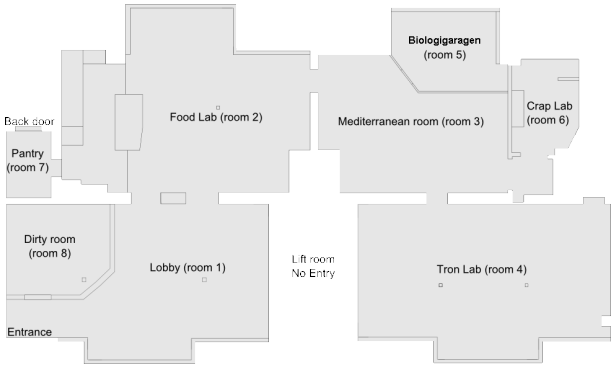
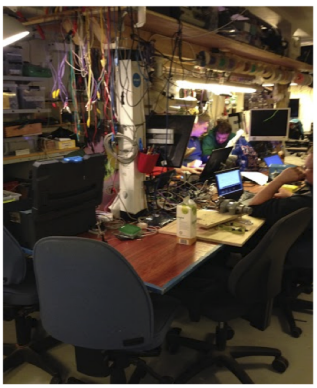


Figure 1: Floor plan of CoLab

The primary room is Tron Lab (room 4), which holds a large, oblong table surrounded by old, used office chairs. The table is the participants' preferred meeting point. Above the table are ceiling shelves with numerous variants of cords and electronic measuring devices (Picture 2). Along the walls are tall shelving units filled with small widgets, gizmos, and electronic equipment contained in boxes. Amongst these are several unfinished, ongoing projects stored and tagged with the owners' names (Picture 3).



Picture 2: Tron Lab desk

Picture 3: Shelving units

The physical frame and expression of CoLab emphasize how the Hackerspace has developed through years of use, and how the participants' interests and ideas have shaped the functionality of the individual rooms.

Temporal patterns

The routines in CoLab have been developed over the years and are fundamental to the collaborative practices. Two regularly occurring events are the weekly open house and the bi-weekly Thursday meeting. The open house events take place every Tuesday between 7pm and 9pm and are well-attended and buzzing with activity. The purpose of the open house events is to promote the space and acquire new members. Thursday meetings function as the main organizational entity, where important decisions are made. The meetings are hosted every Thursday in odd weeks and begin around 7pm. This is where potential disagreements and issues are resolved and different topics are discussed such as how the space should participate in cultural events like Copenhagen Culture Night. CoLab also has a board of directors, but only because the Hackerspace is subject to the associations act in Denmark, which means that having a board of directors is a mandatory requirement by law. The board of directors does not make any decisions without acceptance from the other members, and this approach is important for the culture. In practice, the Thursday meetings act as the ruling entity for decision-making – or rather consensus-making, since the members of CoLab want to uphold an open organizational structure. This is also why the Hackerspace only has two defined rules: Guideline 0 and Rule 0. The latter of the two demands that participants do not act in a way that would require them to create new rules, and Guideline 0 asserts that membership is free, but to use the Hackerspace you have to add value by participating in projects of maintaining the space by painting the floor, cleaning, or cooking.

Shortening your Google search

A central aspect of the cooperative work within CoLab is characterized by sharing knowledge and expertise. Knowledge sharing is core to the cooperative work in CoLab, and participants explicitly articulate how knowledge sharing is a main part of the space identity. All members of CoLab are expected to contribute by sharing knowledge. One of the founding members, Alex, explains knowledge sharing in CoLab as follows:

> "[CoLab is a] place that can shorten your Google search from three hours to three minutes" (Observation, March 17th 2015)

According to Alex, being part of CoLab provides participants with qualified and detailed access to highly technical information. By comparing the participation in CoLab to a Google search, he explains how Google does not necessarily provide

useful answers to inquiries due to the one-way interaction when searching for answers. It is often in cases where people experience difficulties in phrasing questions that they need the most help. CoLab facilitates such support through interaction, while Google only answers questions that you know how to phrase. The expectation is that all participants in the space remain open and willing to share knowledge and engage in conversation with others. Henrik and Christian explain in more detail:

> "The Hackerspace is all about sharing knowledge, which I like a lot: [...] of course we exchange quite a lot of knowledge, and this is actually a characteristic of the space" (Observation, March 11th 2015: Observation, March 18th 2015)

The participants' ways of sharing knowledge are crucial to the manners in which they interact and collaborate. By being collocated, while working on individual projects, informal knowledge sharing becomes the main interaction in the space. When observing Tron Lab, it was clear that the oblong table enabled participants working on their own projects, to share and help each other out in a highly interactive and communicative way. Whenever someone encounters a problem they articulate it explicitly by asking for help out loud in the room. Often such questions trigger a conversation among the participants and different possible solutions are discussed subsequently turning the topic into more general conversation or initiating new conversations or discussions.

These interactions serve to support the creative construction of knowledge within CoLab in different ways than if participants work on a shared project. The members value interaction and knowledge sharing although they generally encourage newcomers to try solving the problem themselves before asking for help. Several members directly articulate that they do not merely want to serve as a Google search for novices, but instead consider the interactions during discussions among peers as valuable ways of constructing new knowledge. The interplay between obtaining and sharing knowledge is thus very important to the members, and it is central that all involved gain from the interaction.

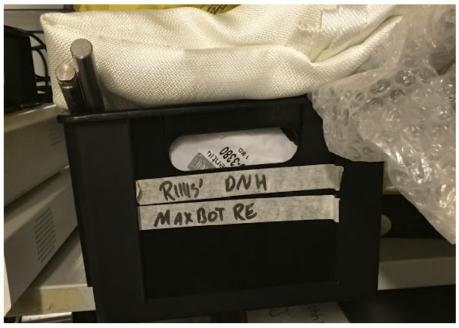
Do-Not-Hack

There are many diverse types of expertise gathered in the Hackerspace, e.g. in areas such as constructing 3D printers, soldering, coding, and making circuit boards, just to mention a few. This expert knowledge related to concrete skills and qualifications is an important asset in CoLab, and expertise is often articulated as knowledge about particular tools, devices, and machines. The experts, known as super-users of specific equipment, are made visible for others through practices of labeling. The majority of devices, tools, and equipment in CoLab are labeled with QR codes, which name the tool while providing a way to locate additional information about its functionality (Picture 4). When scanning a QR code, participants are directed to a webpage listing the super-users of the specific device or tool. In this way, newcomers can get information about who to

contact to learn more about how to use a particular device or tool. The fact that CoLab is home for a sizeable group of experts in diverse domains means that it attracts other knowledgeable individuals wanting to participate in the Hackerspace.

Picture 4: QR code on device

The proficiency of constructing knowledge together is also manifested in the Do Not Hack rule (DNH). This rule prescribes everything within the physical boundaries of CoLab to be free to hack by anyone, unless the project or device has a label with the abbreviation DNH on it (Picture 5). Participants recognize the DNH label as a guiding coordination mechanism, since the artefact and its location in particular serve to guide participants to act accordingly towards other's work. Therefore, the DNH label on devices reduces the effort of articulation required for the loosely coupled cooperative work in CoLab.



Picture 5: DNH label

As a novice to CoLab it can be difficult to notice and interpret the meaning of the different labels (QRcode or DNH) and thus act accordingly to the official yet unarticulated organizational structure, which serves as the foundational ground

for the Hackerspace. This leads to difficulties in the organization of cooperative engagement, as some participants fail to follow the organizational structure, and thereby not apply the correct use of the coordinative artefact:

> "[...] Jens once left a computer in CoLab that he had to repair for a colleague without putting a DNH label on it. When he returned, both battery and screen were missing and he had to reimburse his colleague." (Observation, March 4th 2015)

The DNH rule linked to an artefact helps guide and coordinate participants' behavior. However, it is interesting how the labeling of the artefacts does not make a coordinative mechanism by embedding the protocol for work within the artefact. Instead, we saw how the organizational protocols were enacted through artefactual manifestations (the labeled artefact), which required certain skills in interpretation of the common understanding of labeling – as well as the meaning of none-labeling. Clearly, the labeling practices of artefacts are enforced, however the interpretation of the required protocols is not set in stone, therefore causing situations of misunderstanding like in the case of Jens. It can appear drastic that someone would hack Jens' computer just like that, but to the participants this action serves as a completely legitimate practice. To the question of why there are no DNH labels on the tables in Food Lab, Henrik, one of the members, explains:

> "[...] it is a common resource and you don't just change something like that." (Observation, March 11th 2015)

The none-labeling of the tables indicates that the concept of DNH labels stretches beyond the physicality of the label itself. There is thus a common understanding that some items are free to hack while others are not. Through the DNH labels and the concept that stretches beyond these, the participants coordinate and ensure a mutual understanding, where they act accordingly to certain rules of interaction. This mutual understanding strengthens the interactions in the space and therefore supports the construction of knowledge.

Knowledge sharing as social glue

There is a widespread technical know-how and expertise inherent in CoLab that builds upon a common language shared between the participants, which is characteristic for the ways in which they socialize. In order to communicate in the space it is important to share the technical lingo, which often is based on their educational background, but also from constantly keeping up to date on technical discussions on the Internet or by simply continuing to perfect their expertise through practice. Socializing springs from discussions and conversations of technical matters, and therefore knowing and expanding the technical language is required to participate properly in these practices, as it is highly related to the cooperative engagements and identity of the Hackerspace.

Getting to know the language takes time and effort as one of the members, Peter, experienced early when he first joined CoLab. Peter is a magician, and his interest is to develop new tricks for his magic shows using technology. Peter

experienced a clear barrier related to the technical language when he first joined CoLab. He did not know much about technicalities, but he joined the space anyway to get help with one of his technical magic tricks:

> "Peter says he found it difficult as a new member to get help sometimes. People would often answer "Google it" when he asked for help if they did not have the patience to explain it to him." (Observation, March 9th 2015)

Peter explains that if you do not possess technical knowledge it is difficult to receive help from others since, as we saw earlier, the users do not wish to merely function as a Google search, but rather they value the two-way communication in knowledge sharing. Interestingly, our data shows how knowledge sharing and socializing are highly interlinked and can only be divided analytically. Sharing knowledge serves as social glue, and socializing serves as a motivation to engage in knowledge sharing. To contribute to the practice of socializing it is important to have a technical knowledge and to be able to cooperate with other members. In order to learn how to participate, spending time in the space is crucial. The members articulate how they feel highly attached to CoLab:

> "Robin says that the Hackerspace is his second home, and Alex answers with a smile: My home is my second Hackerspace." (Observation, March 3rd 2015)

Several of the participants discuss how their homes resemble the Hackerspace as they keep different artefacts and objects everywhere. However, socializing and building the strong sense of community is important, which is why they choose to spend many hours each week in the space. In this way, the Hackerspace works as a haven for technically skilled individuals; meaning that socializing practices in CoLab supports peaceful tinkering, which also creates a breeding ground for newcomers to gradually perfect their technical language that ultimately enables participation.

DIY-IoT gimmicks

Maintaining and caring for the space are central parts of the activities in CoLab, which include cleaning up after Thursday meetings, as well as sorting boxes, painting the floors, or facilitating the open house events. Maintaining the space is a collaborative task that all members participate in. Even though most of the participants have their own individual projects, they are also part of a larger common project referred to as Project CoLab. In Project CoLab, participants' interests and ideas are expressed through technical gimmicks and gadgets and exemplify the ways in which the rooms in CoLab are hacked. In example, the participants make several technical hacks, like turning on lamps when the toilet is occupied, while counting the minutes people are in the restroom and displaying the numbers on the wall. Another hack is an old-fashioned landline telephone built into an old phone booth hanging on the wall, which exemplifies an important characteristic of the space:

> "There is a large variety of technical gimmicks that the members of CoLab have made

themselves. […] the small gadgets make the space more fun to be a part of and use [...]"(Observation, February 4th 2015)

While the gimmicks are clearly based upon the participants' interests and gadgets they find entertaining, other activities also characterize the Hackerspace. In example, repairing and cleaning up after the space was flooded due to a thunderstorm, is seen as part of Project CoLab. Other activities are more repetitive, such as emptying recycling bins, buying utilities, such as soap and toilet paper, and filling up the shared fridge with drinks and snacks each week. It is considered a substantial part of maintaining the space to continuously care for CoLab and keep the physical surroundings intact and up to date with new technical features. Since the participants invest a great deal of their time in the space, they take part in shaping its identity.

As part of Project CoLab three of the members, Henrik, Mikkel, and N. Clausen, collaborate on an electric backdoor for entering the Hackerspace. The front door of CoLab has an automatic door opener, which allows participants to enter with a card and the members also want similar functionality on the back door. To solve this task, they decide to split up the project into smaller sub-tasks to be executed by participants with the necessary skills and expertise. Mikkel is in charge of the design work, where Henrik is responsible for hammering and drilling activities, while N. Clausen write the required the code. When participating in such a joint project, the members shape the Hackerspace towards desired values of creativity and social community. It is interesting to note that they rarely set deadlines for joint projects in Project CoLab, as seen with the backdoor. Projects are not to be finished within a certain timeframe; instead participants work on the projects when it is convenient. Acknowledging each other's talents, expertise, and skills is key, as it also encourages contribution to shaping the space:

"Henrik explains that Mikkel is very meticulous and that he would not have bothered doing a test-print for the door himself [...] Henrik believes that cooperation works well because projects become better prepared and planned". (Observation, March 9th 2015)

Project CoLab is a dynamic manifestation of the identity of the space and the characteristics of the type of collaborative practices participants wish to encourage. Projects that help maintain the Hackerspace create a sense of community as teamwork and collaboration make participants feel as part of something larger.

Freedom of Negotiation

The majority of the Hackerspace's financial support comes from monthly fees paid by the participants. Fees are kept low to ensure that participants with little income can still join. If members do not have the financial resources to pay the fee, they are still welcome and can contribute in other ways by making food, cleaning, or helping with similar chores as these activities are equally appreciated

in CoLab. The freedom to participate independently of income is thus an important characteristic of the Hackerspace's identity. Another significant part of the Hackerspaces' identity is the members' insistence on having having a decentralized organizational structure, which allows frequent open-ended discussions among all members. All who participate take part in evaluating and discussing the current situation and make decisions concerning potential changes in CoLab. During our study, we encountered multiple instances, where participants continuously negotiated the organization and its structure. In example, during one of the board meetings, the conversation moves from discussing topics on the agenda to questioning the very role of the board itself. A member, Mikkel, makes a comment:

> "He thinks that the term 'board of directors' has a negative ring to it, and it does not necessarily need to be a 'board of directors' as such. Mikkel thinks that it is naive to believe that CoLab can function without anyone being able to make quick decisions" (Observation, March 14th 2015)

The continuous discussions of the organizational structure in CoLab are frequent within the space, not only during board meetings, but also in general. Often, discussions of topics are initiated and continued even if they are not on the agenda. Interestingly, the cooperative practices in CoLab demonstrate how preserving the freedom to debate the organizational structure of the space at all times is critical for the identity of the Hackerspace. Members spend a lot of of time on these discussions even if it interrupts the agenda for a meeting.

In the everyday interaction the consequences of the open-ended organizational structure are opaque and blend into the background. However, the egalitarian nature of the space also causes problems, which becomes evident when conflicts between participants arise. Conflicts causing the members to create additional formal rules and policies are rare, but we encountered one episode that clearly illustrated how the members deal with conflicts. A small group of members wanted to allow investors to finance new facilities and expand the community with a substantial number of new members. They were hoping to gain funding and commercialize an open-source product, which they built in the space. However, this change would risk making the outside investors part of the board of directors. Existing members were anxious about how such changes would affect the community. This was the core disagreement, as Henrik, one of the involved members explains:

> "[…] a Hackerspace must be a haven for those who are conflict-averse. It is therefore important for members of the community not to be trumped by new members and thereby lose the community […]. (Observation, March 9th 2015)

When conflicts arise, the Hackerspace becomes very fragile, as the members do not have the necessary tools to handle conflicts according to themselves. The choice to either include or exclude investors, who could transform the identity of the community in critical ways, could lead to radical changes in the community's values and principles. Usually, the participants strive to reach consensus when

experiencing conflicts and disagreements. They use the Thursday meetings to discuss and negotiate conflicts, and it is a joint responsibility to develop the organizational structure in the space. However, in conflicts like the example above it is challenging to arrive at a definitive decision when having a decentralized organizational structure. This example indicates that the freedom of negotiation is contingent on an overall agreement that CoLab is not guided or affiliated with formal institutions or organizations, why some topics in reality remain non-negotiable. Most of the discussions are open-ended and interestingly, the point of the discussions is not necessarily to support decision-making. Rather, the discussions are motivated by a continuous effort between the participants to collaboratively develop CoLab as an organization. The fact that CoLab only has a board out of legal necessity emphasizes how the role of the board is constantly up for debate. They are eager to discuss the organizational structure, but reluctant to formalize. Their insistence on keeping a decentralized organizational structure with a board with no resoluteness is a protected characteristic for the space. Clearly, keeping the current culture based upon the open-discussions and a minimum of formal rules is hugely important. As Henrik explains:

> "[...] CoLab is fragile as a community. It doesn't take much to ruin the dynamic that exists and we therefore try to protect the place. It is important that there is some acceptance of norms and policies that shows respect and tolerance towards others." (Observation, March 9th 2015)

The identity of CoLab is not characterized by any formal guidelines. Instead, the structure preserves freedom of negotiation by not formalizing the Hackerspace, and thereby securing the existing values and principles of the community. Interestingly, this is not only practiced during the formal meetings such as the board meeting. Instead, it is closely interlinked with knowledge sharing, socializing and caring for as well as innovating the space, as debate and discussions on how to develop the Hackerspace takes place continuously across all these activities.

Discussion

The cooperative identity in CoLab is primarily constituted by two intertwined activities. The first activity is the ways in which the participants hack the physical surroundings through technical gimmicks on e.g. doors and refrigerators. The hacks are highly valued by the community and help participants demonstrate their technical skills and competences through imagination and participation. The hacks are constituted in technical gadgets, which transform into reifications (Wenger 1998) for how the cooperation is organized and structured e.g. as seen with the DNH labeling. Here, the members of CoLab manifest their rules through tangible artefacts, and the artefacts thus play a central role in shaping the identity of CoLab. The different artefacts also provide a foundation for cooperation in the space, but it is interesting how it is not the technical gadgets or artefacts as single

entities that are important, but rather the relations and infrastructure created across these artefacts that are central for the collaborative activities. The relational infrastructure of the different artefacts transforms the physical facilities within the Hackerspace into one shared DIY-IoT entity consisting of multiple smaller projects. The physical facilities of the Hackerspace are turned into an ecology of artefacts, which guides the collaboration between members. Participants, who regularly spend time in CoLab develop mutual interpretations and related meanings of the ecology of artefacts, and the physical facilities therefore become a manifestation of the cooperative nature of CoLab through reifications (Lave and Wenger 1991). Infrastructuring the Hackerspace is an essential vehicle in shaping innovation and making (Ahmed, Mim et al. 2015, Stickel, Hornung et al. 2015) and the interrelation between the social organization of work (e.g. knowledge sharing) and the physical manifestation of the joint projects (hacking the space) co-constructs the identity of CoLab.

The second activity constitutive for the cooperative identity in CoLab is the ways in which participants re-negotiate the structure and organization of the cooperative engagement in the space e.g. during Thursday meetings, open house events, or when managing conflicts. The constant insistence on keeping a decentralized organizational structure in CoLab requires ongoing attention to negotiating meaning through participation and reification. The open-ended structure enables cooperation and makes it possible for the participants to develop the cooperative identity (Avle and Lindtner 2016) of the space. This means that the identity of CoLab is continuously being interpreted and negotiated through routinely practices. We found that the artefacts within the Hackerspace form manifestations of the organizational structure through reifications for practice (as we saw with the categories DNH label or none-labeling), rather than fixed coordinative mechanisms (Schmidt and Simone 1996) with embedded protocols. If the artefacts were functioning as coordinative mechanisms, they would possess an explicit unequivocal meaning, but in CoLab this is not the case. Artefacts in CoLab are continually being interpreted and negotiated through several routine practices, and it is in these practices that the meaning of artefacts emerge as reifications for the cooperative work. The interpretation of reified artefacts is continuously being developed and they never become formal objects with clearly defined protocols. Instead, the structure and protocols are changed accordingly to match the cooperative identity of the Hackerspace. This demonstrates how the intertwined practices of social and material production both produce and preserve the identity of the Hackerspace. To some extent, all Hackerspaces have unique features – and CoLab is no different. It requires interpretation work and insider knowledge to understand the intention with the reified artefacts, and negotiating the meaning of these artefacts is a fundamental part of CoLab's organizational structure.

It is not only social and material production that evolves through one another,

but also the production and preservation of the cooperative identity. The cooperative identity of CoLab is produced through the participants' commitments to the space. Participants perform productive attachments (Dantec and DiSalvo 2013) to CoLab by on one hand transforming the space through re-negotiation and innovation, while on the other hand being dependent upon the structure to be able to take action and do hacking. The cooperative nature of the Hackerspace is based upon these productive attachments, which drive constant iteration leading to new configurations of the relations between the people, artefacts, and the physical space. The practices create flexible and dynamic cooperative structures, where dependencies in work do not rely upon the work task, but rather on the dynamics between hacking and re-negotiation. Interestingly, these practices do not only produce the identity, but also help preserve it. While subscribing to values characterized by the associations act in Denmark such as being open towards new participants and their beliefs, the participants simultaneously expressed a need to preserve the Hackerspace and its identity. In this way, the activities of hacking and re-negotiating both produce and preserve the identity of CoLab and serve as both inclusive and exclusive mechanisms of the space.

Conclusion

The cooperative identity of the Hackerspace is produced and preserved through the participants' demonstrations of commitment to the space reflected in the continuous hacking of the physical surroundings and constant re-negotiation of the cooperative characteristics. The appropriation of technical competences through the joint transformation of the physical facilities is not simply about improving the physical surroundings, but also includes the essential work of establishing the cooperative identity of CoLab. The participants' collaborative engagement is structured and guided by their hacking activities of the physical surroundings, which are instrumental in producing the identity of the Hackerspace. Maintenance and repair work are inherent parts of the collaborative work transforming not just the tools, but also the entire space to preserve the existence and identity of the Hackerspace. Furthermore, the continued re-negotiation of the cooperative characteristics is part of shaping the identity of the space. The implicit rules and policies of the space are critical to preserve the fragile identity of CoLab. While the work of demonstrating commitment by innovating the physical surroundings and re-negotiating the cooperative characteristics appears as 'behind the scene' work – the invisible work – it is truly these cooperative practices, which are central in both producing and preserving the identity of the Hackerspace.

Acknowledgments

We want to thank the participants from CoLab for welcoming us. Furthermore, we want to acknowledge Lærke Elmén Pedersen, Sofie Amalie Anker, and Tina Cecilie Schultz, who took part in the data collection.

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From the Internet of Things to an Internet of Practices

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Abstract. In his ground-breaking work on the *habitus* Bourdieu (1977) understands practices as the permanent internalization of the social order in the human body. Others have taken this idea and described practices as 'normatively regulated activities' (Schmidt, 2014). Our own interests here arise from the fact that during the performance of all of these various activities, which may implicate and draw upon the material environment, the surrounding context, their own capabilities, interests and preferences, people often use supportive devices and technologies that help to enable and support their realization. Where these supportive technologies make up a part of the Internet of Things (IoT) they are usually small, interconnected cyber-physical devices and are typically used in social/collaborative settings. As a consequence, the (re-)appropriation of these new devices and technologies is not only a technical, but also a social process. Within this exploratory paper we focus on the potential of IoT technologies for supporting collaborative appropriation within Communities of Practice (CoP) from a practice-oriented perspective. We outline the vision of an Internet of *Practices* (IoP). This vision encompasses and addresses a range of phenomena that has been associated with how CoPs evolve and the resonance activities that can arise as specific bodies of practice adapt, by adding integrated support for the documentation of practices and the sharing of relevant representations such that mutual improvements in practice may take place. Based on our vision of the IoP, we outline some directions CSCW research could take regarding the potential of the IoT and new emerging technologies, thereby expanding the scope of CSCW's areas of interest.

Introduction: Learning Technology Practices

Imagine you are a new photographer within a well-established photographic agency and you've got a new expensive camera for starting your job. The

photographic agency demands that all of its employees use a consistent style for each photo set. You've already used the camera a lot and it has encouraged you to think that you might one day become a more professional photographer. However, having compared your pictures with those of your colleagues who have been in the company for a long time, you've had to acknowledge that their sets of photos always look better than your own. Yet your colleagues and you are both using the same camera, the same tripods, even the same lenses. So you ask yourself: How will I ever be able to take such perfect pictures? This has driven you to search online for lighting conditions, angles for holding the camera and which lenses are best to use in different situations. You've also asked your expert colleagues for help and they have actually described for you how they go about taking pictures. Although you've really appreciated your colleagues' hints, your pictures are still not as good as theirs. The problem is it's just not easy adapting your own activities so they are closer to the established practices of the experts when you only have their explanations to go on, not to mention having to do that alongside of other compounding elements such as the hardware, software and the physical context in which you are using the camera (as well as your own physical abilities). So you continue to struggle to appropriate your camera effectively – or at least the practice of taking good pictures.

But what if the camera was itself able to mediate your colleagues' professional camera-handling practices? What if you were able to perceive expert photographic practices directly when taking your own pictures? What if the cameras were equipped with multiple sensors and were connected through the internet so that they could enable the gathering as well as the sharing of practices of other camera users? Or, to put it another way: What if we could make use of the Internet of Things (IoT) to move beyond just the 'things' and towards an Internet of *Practices* (IoP)?

In this exploratory paper we expand yet further the existing discussion around the potential the IoT as a set of new emerging technologies may have for extending the scope of CSCW's areas of interest (Robertson & Wagner, 2015). We do this by introducing the vision of the IoP as a new theoretical framework that can encompass a variety of complementary interests: 1) the socio-technical (collaborative) concept of appropriation; 2) the technological possibilities of sensors and actuators; and 3) an integrated concept of sociable technologies that can be connected through the IoT to support the mediation as well as implicit learning of technology practices. In doing this we outline a socio-technical perspective on the IoT with regard to CSCW and how the design of IoT technologies could be used to inform appropriation and infrastructuring (Pipek & Wulf, 2009) practices.

Theoretical Framing

Our vision of the Internet of Practice is a conjunction of two discourses. The first of these relates to both the concept of practice itself and communities of practice. The second is on the other discourse relates to IoT-enabled (collaborative) appropriation infrastructures – what we refer to here as 'sociable technologies' (Ludwig et al., 2017).

The Concept of Practices

Our entire life encompasses various kinds of variably tool- or technology-based practices: whether preparing dough in a food processor; playing soccer with a ball; or – as discussed above – taking photos with a digital camera using a consistent style for each set of photos. From a 'practical' perspective, practices are applied heterogeneously – some people bake tastier bread than others, some people are better at playing soccer than others.

From a theoretical perspective, practice is also often understood heterogeneously (Corradi et al., 2010) and can be described as "routines consisting of a number of interconnected and inseparable elements: physical and mental activities of human bodies, the material environment, artifacts and their use, contexts, human capabilities, affinities and motivation" (Kuutti & Bannon, 2014). This perspective is based on early practice theories that often conceptualize practices as "routinized, oversubjective complexes of bodily movements, of forms of interpreting, knowing how and wanting and of the usage of things" (Reckwitz, 2002). This understanding is itself based on Bourdieu's (1977) Theory of Practices in which he developed the notion of 'habitus' to capture

> "the permanent internalization of the social order in the human body". With this idea, Bourdieu understands practice "as the result of social structures on a particular field (structure; macro) where certain rules apply and also of one's habitus (agency; micro), i.e. the embodied history that is manifested in our system of thinking, feeling, perceiving and behaving. The habitus assures the collective belief in the rules of the social game (illusio) and that actors act in accordance with their position on the field (doxa), which depends on their relative amount and structure of economic, cultural (and social) capital" (Walther, 2014).

As Kuutti & Bannon (2014) point out, although practice theories differ in many ways, there are also a number of common features. By referring to Nicolini (2013) they list these common features as follows:

1. A process and performative view on social life: structures and institutions are realized through practices; practices are local and timely and they have histories.
2. The critical role of materiality of human bodies and artifacts; there are no practices without them.

3. A different role of agency and actor than in traditional theories: 'homo practicus' is both the bearer of practices in his or her mind and body, and the one who produces the practices in action.
4. Seeing knowledge as a capability to act through practices in meaningful and productive ways.
5. The centrality of interests and motivations in all human action and a corresponding focus on power, conflicts and politics.

Schmidt (2014) positions these perspectives in work contexts by saying that a practice is not just any kind of activity, but a regular activity, whereby the regularity is a normative application of general principles. A practice can therefore be understood as a *normatively regulated activity* that differs from some other practice by the body of rules that govern it (Schmidt, 2014). Work is not simply the following of preordained rules, but necessarily involves the local interpretation of these rules in the light of the evolving situation (Kuutti & Bannon, 2014). So, performing the activity of taking pictures by using the photographic agency's demanding consistent style of for sets of photos is understood as a specific type of practice (for now!).

Kuutti & Bannon (2014) argue that lasting recent years a new 'practice' paradigm has emerged in the field of HCI. Instead of simply considering the role of design intervention as changing human actions by introducing novel technology, it needs to be understood that human actions and interactions are just a part of entire practices. Practices emphasize the fabric of action, the knowledge and reasoning that surrounds that action and the context in which it takes place (Castellani et al., 2009). "For some time it has been supposed that context influences what happens in interaction and how it is experienced, resulting in attempts to define richer and richer contexts. But 'practice' can be interpreted as the ultimate context: practices are where interactions take place in real life" (Kuutti & Bannon, 2014). So how should we understand the context of practice when taking good, consistent pictures with a new camera?

Internet of Things

In the early 90s, Mark Weiser and his colleagues from Xerox PARC came up with the concept of Ubiquitous Computing, envisioning that "the most profound technologies are those that disappear. They [technologies] weave themselves into the fabric of everyday life until they are indistinguishable from it" (Weiser, 1991). The vision of interconnected small computers, which Weiser described in the early 90s, coupled with the penetration of the internet as well as the miniaturization of computers and electronic assemblies is now commonly known as the Internet of Things (IoT) – a term firstly coined by Kevin Ashton (2009). The "things" are often summarized as cyber-physical systems meaning

> "physical and engineered systems, whose operations are monitored, coordinated, controlled and integrated by a computing and communication core. Just as the internet transformed how

humans interact with one another, cyber-physical systems will transform how we interact with the physical world around us" (Rajkumar et al., 2010).

Although the 'things' offer new possibilities and functionalities that have come along with (and will continue to come along with) the interest in the IoT (Atzori et al., 2010), they will also increase the complexity of the practices associated with the ecologies of technology they encompass. This will be a result of: (a) increasingly complex devices; (b) an increasing number of less obvious connections and dependencies between IoT devices and things; (c) more and more changes that ensembles of IoT technologies will need to undergo in order to fully integrate the most recent technological options and advances (e.g. depth sensors in cameras); and (d) a new interweaving of the 'digital' and the 'physical' world – such as the one our opening example of the camera sought to illustrate.

By taking the cooperation between cyber-physical things within the IoT seriously, Robertson and Wagner (2015) have already outlined issues from a CSCW perspective with regard to how IoT applications may associate with practices. These arguments in turn are built upon the discussions around the "issues people had with not understanding and/or not trusting the ways in which their sensors worked, as well as the practical realities of location and timing and false alarms that render them less useful" (Stringer et al., 2006). Within this paper we develop a notion of an Internet of Practices that builds upon the IoT and tries to make sense of the IoT from a human-centered perspective to perform practices using IoT.

Infrastructuring and Sociable Technologies

When handling the 'things' or the 'cyber-physical assemblies' do not meet users' intended practices (e.g. the camera during taking pictures), either people with specialized knowledge are needed who know how to make them work again or explain the handling (Crabtree et al., 2006; O'Neill et al., 2005; Robertson & Wagner, 2015) or, as is often the case with sophisticated 'new' technologies, users will discover new ways of handling them by attempting to manage their understanding in the context of their existing (and changing) practices (Dalton et al., 2012; Ludwig et al., 2014; Pipek, 2005; Pipek & Wulf, 2009). The new photographer starts thinking about how to take better pictures and tries new configurations or different positions regarding the angles or lighting conditions. "The recent interest in how people take ownership of artifacts and shape them to their own purposes and practices clearly relates to this practice turn, as it examines the ways in which designed "things" become assimilated into an ongoing set of routines" (Kuutti & Bannon, 2014).

Broadening the focus a little, we want to relate this process of adaptation to the notion of 'intrastructuring'. Star and Ruhleder (1996) consolidated the socio-material aspects of an infrastructure by relating technological infrastructures to the practices they were meaningful to. This approach, which referred back to

previous work in Science and Technology Studies (STS) on 'large technological systems' and infrastructures, was further transformed when Star and Bowker (2002) and later Karasti and Baker (2004) started to widen the design-oriented and product-focused lense of traditional technology development to the concept of infrastructuring.

Infrastructuring can be understood as the reshaping of a work infrastructure and practices of use by "re-conceptualizing one's own work in the context of existing, potential, or envisioned IT tools" (Pipek & Wulf, 2009). Encompassed within the concept of infrastructuring (ibid.) are all (appropriation) activities that lead to discovering and developing the usage of an entire infrastructure and to the successful establishment of a device or system in use.

The relation between an artifact and the practices it supports can be viewed as the trajectory of a artifact when it is confronted with people's practices of 'appropriation' (Dourish, 2003). It can equally be viewed as the trajectory of a practice where breakdowns or innovation lead to the kinds of exploration of technological possibilities and improvements captured by the notion of 'infrastructuring' (Pipek & Wulf, 2009). Pipek (2005) conceptualizes appropriation as the discovery of, and the sense making entailed in, using a device or artifact in practice. This understanding has its roots in established CSCW literature, where appropriation is associated with the process of fitting new technologies to users' practices in situ by both the adoption of, and adaptation to those technologies (Balka & Wagner, 2006; Dourish, 2003; Mackay, 1990; Salovaara et al., 2011; Stevens et al., 2009) and is therefore an important aspect of infrastructuring .

One of the major characteristics of infrastructuring is the "Point of Infrastructur(ing)" (PoI). This is the moment in which a (group of) practitioner(s) understand(s) that the current use of a technological infrastructure needs to be reconsidered (Pipek & Wulf, 2009). The PoI started out as an analytical figure. It sought to capture the moment where people become aware of infrastructure problems or opportunities. This moment can (a) happen at an individual, organizational or even societal level. It is (b) the moment in which the political, social, organizational and technological dimensions of an infrastructure become tangible for the practitioners that depend on it. It (c) initiates a set of activities amongst a variety of stakeholders, which target the infrastructure problem or opportunity. And (d) it may ultimately result in a modified infrastructure and/or a modified (use) practice (Pipek, 2005).

The concept of infrastructuring is usually associated with processes of exchange and interaction in networks of co-users where experiences and stories are shared between actors involved in the appropriation process (Gantt & Nardi, 1992; Mackay, 1990; Pipek, 2005; Pipek & Kahler, 2006). The new photographer starts searching for help, asking professional colleagues or just has some kind of interchange with other camera users who have similar issues. These processes of

exchange and interaction require a variety of communication and cooperation practices, but often come with the burden of being cumbersome and hard to adapt to pre-existing practice (Crabtree et al., 2006).

As Pipek (2005) suggests, appropriation and its encompassing collaborative activities around things defines a Community of Practice (CoP). This is in Wenger's (1998) original sense of a CoP as a social compound in which technological practice can be observed, passed on and further developed. CoPs are viewed by many in business settings as a means of capturing tacit knowledge, or know-how that is not easily articulated (Nonaka & Takeuchi, 1995; Wenger, 1998). Jean Lave and Etienne Wenger's theory of legitimate peripheral participation sees learning within a CoP both related to, and a specific form of, a particular practice (Kuutti & Bannon, 2014). It is therefore obvious that considering the IoT on a purely technological basis misses important points that practitioners (and CoPs) have to consider when developing, re-inventing and 'infrastructuring' their practices (Ludwig et al., 2017; Pipek & Wulf, 2009; Robertson & Wagner, 2015; Star & Bowker, 2002).

In a first test of using improved functional components that are grounded in this way of thinking we turned to 3D printing and argued that new IoT-based technologies are particularly capable of supporting the (collaborative) appropriation activities of their users by making the devices more 'sociable' (Ludwig et al., 2017). In relation to this we coined the term 'sociable technologies' to capture the kinds of hardware-integrated affordances for communicating, documenting and sharing practices of use that can arise through the adoption of new IoT technologies.

Taking network printing technology as a case in point it is worth noting that, in previous work, Castellani et al. (2009) uncovered a number of dislocations between various aspects of technology-based CoPs. Here their focus was on the work of troubleshooting where there was:

> "1) a physical dislocation between the site of the problem and the site of problem resolution; 2) a conceptual dislocation between the users' knowledge and the troubleshooting resources and 3) a logical dislocation between the support resources and the ailing device itself" (Castellani et al., 2009).

For the purposes of our own argument here we would build upon these observations by noting that sociable technologies need to operate on three contextual levels: (1) The *internal context*, where they provide information about their inner workings and current state as well as about their component and behavioral structure; (2) The *socio-material context*; which encompasses things like their location and surroundings, environmental data like room temperature, and maintenance or user/usage data; (3) The *task/process context*: which will relate to things like the purpose and goal of device use (Ludwig et al., 2017, 2014).

Sociable technologies aim to lower the burden of documenting and sharing insights about practices by encompassing the IoT and by gathering as well as

communicating sensor information. With the idea of sociable technologies we follow the idea about the mediation of practices by artifacts (Kuutti & Bannon, 2014). In the case of 3D printing, the printer itself communicates captured sensor information such as print temperature or the movements of the extruder in association with the model and its material characteristics, to give details of use practices (Ludwig et al., 2017).

Resonance Activities

In order to (semi-)automatically sense the actual use practices of a 'thing' in a certain situational context and support the sharing of this information, and its visualization to users with similar practices within a CoP, new design approaches are required that transcend the notion of technology as a product. How might the new camera user experience the practices and infrastructuring activities another experienced camera user has already made? How might a novice learn about new ways of taking pictures with a camera when they've just acquired new lenses?

As we have already pointed out, one of the major characteristics of infrastructuring, understood as a technology development methodology, is the "Point of Infrastructur(ing)" where a (group of) practitioner(s) understand(s) that the current use of a technological infrastructure needs to be reconsidered (Pipek & Wulf, 2009). Now Pipek and Wulf (2009) suggest that points of infrastructuring do not happen arbitrarily during the course of performing a practice. Instead, they argue, there are specific factors which are likely to trigger this reconsideration and that there is a strong dependency between a practice and its supporting infrastructure that, having developed previously, will have become largely invisible to the actors who are engaged in the practice in question.

Here, the concept of infrastructuring suggests that, based on this initial impulse, there is a period of technology (re-)configuration, tailoring and development of conventions, in which the 'last mile of technology development' will be mainly performed by (not necessarily technologically skilled) practitioners. This will continue until the point has been reached at which a new technology usage has been successfully established (Pipek & Wulf, 2009). In terms of infrastructuring, the work infrastructure has been further developed and may "sink into the background" again, re-establishing and strengthening the dependency between the (work) practice and work infrastructure (Pipek & Wulf, 2009).

Infrastructuring occurs in ways that are based upon the nature of the dependency between a practice and its work infrastructure, and as Pipek and Wulf (2009) argue, it is difficult to suggest a general model that would help to describe or suggest details of infrastructuring activities. They adopt the position that activities relating to the 'last mile of technology development' are less about a predefined division of labor and rather more about the development of a network

of cooperation between practitioners (and developers). As Pipek and Wulf (2009) argue, this network of cooperation is inspired and driven by other PoIs that have happened earlier in related practices.

Inspired by this perspective, we can identify processes of infrastructuring that surface to connect 'global' infrastructures to their 'local' usages. Here the appropriation of an infrastructure becomes a part of designing it and putting it to use. As Pipek and Wulf (2009) argue

> "each point of infrastructure does not only provoke in-situ design activities and makes visible prior preparatory activities, but it also creates *resonance activities* of observing and communicating aspects of what has become visible within the work environment or to other work environments."

The concept of resonance activities is understood to be all of those kinds of activities that may become visible to people engaged in other, related practices, or to technology developers who laid the technological foundation of an ongoing practice innovation (initiated by points of infrastructure).

The concept describes the connections between different points of infrastructuring. Through such resonance activities, the changes that emerge around the PoI become accessible to others engaged in practices that have a connection with the one where the PoI occurred. Taking a step back from the IoT as it is currently conceptualized, expertise-sharing platforms like photographer forums cover a lot of the interactions that might count as resonance activities and that might therefore serve to extend infrastructuring around a single PoI. But the limited depth these discussions are able to reach in terms of addressing the relation between infrastructure technologies and a concrete situated practice where a PoI has occurred, show that there is much room for improvement to support these kind of interactions. By examining resonance activities "the social appropriation of certain technology usages can be captured, and the relations between different points of infrastructure become clear" (Pipek & Wulf, 2009).

The Internet of Practices

So, how could a new photographer who is struggling with the practices involved in taking good pictures be supported by professional photographers? How could appropriate bodies of practice pertaining to particular needs mediated through technology?

The purpose of shifting towards the notion of an *Internet of Practices* is to re-consider the IoT and the cooperating cyber-physical systems that characterize it in ways that will allow us to move beyond a limited technological point of view and towards something that recognizes us more strongly the practices and communities that surround its use (Pipek & Wulf, 2009; Star & Bowker, 2002). The position we are arguing for here is that we start to work towards

understanding how the Internet of Things is also an Internet of Practices – or, perhaps more accurately, an evolving Internet of Practices (Figure 1).

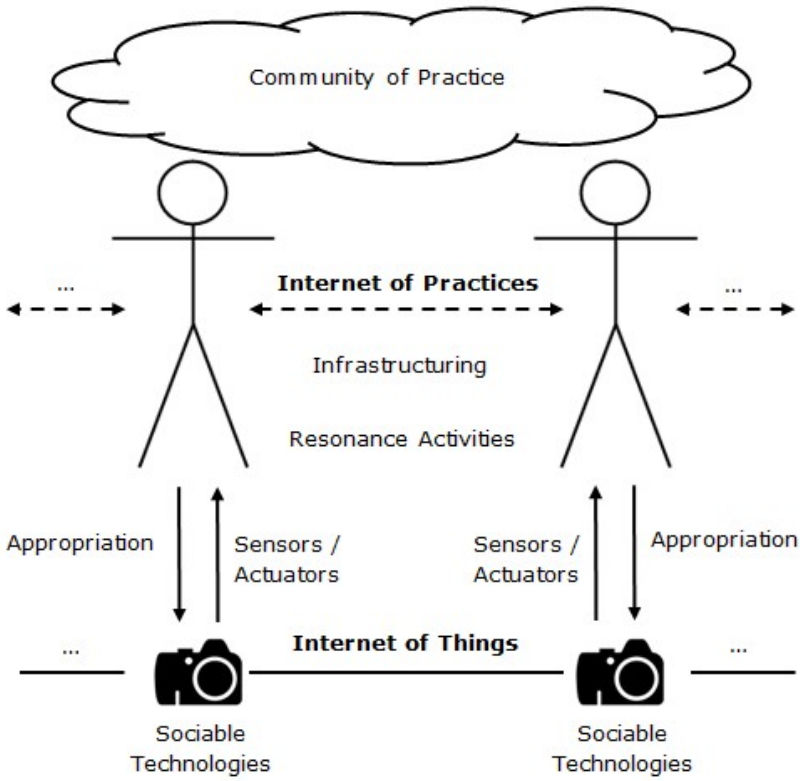

Figure 1: Internet of Practices (IoP)

The IoP encompasses the socio-technical (collaborative) aspects of appropriation and infrastructuring coupled with the technological possibilities of actuators as well as sensors and the integrated concept of sociable technologies connected through the IoT to support the practices of artifact users and therefore (evolving) Communities of Practices by documenting, sharing and communicating their practices.

Adapted to the practice of taking pictures, a camera, when designed as a sociable technology, is also able to gather information about the width of a wide-angle lens or the resolution of a high-contrast display (internal context); the lighting conditions and the position in which the camera is being held (socio-material context); and current interests such as acquiring a sharply focused image of a specific object in a broader landscape (task/process context). All of this documented information can then be shared via the IoT and suggested to another camera user who has similar interests and who is working in a similar socio-material context directly in situ. In these ways the digital cameras of other users can themselves be adapted to meet the shared internal context.

This perspective supports the Practice paradigm by encompassing bodies, artifacts, performances, and routines as a more encompassing frame (Kuutti &

Bannon, 2014). This begins to illustrate how the dependencies of practices on new and complex layers of technologies might be managed by continuous infrastructuring efforts and appropriate methodologies that not only address the development of an IoT product, but the preparation and reflection of how it is used and situated in practice. In relation to the theoretical framework we articulated earlier, documented aspects regarding the practices through which a technology is used are able to create resonance activities to users using the same technology (or where there are similar practices), thereby helping other users to appropriate similar bodies of practice.

So returning to our original example, by making use of the IoP, the new photographer is able to not just acknowledge the expert colleague's *explanations about the practices* best suited to that camera, but also to *directly appropriate these actual practices* in situ. Drawing upon the IoT as a resource, the new photographer's camera is able to give feedback and suggestions to its user, such as when the camera has been positioned at the right angle with regard to the actual lighting conditions; when a specific lens would be much more appropriate with regard to the distance of an object; or when the optimal distance between an object and the camera is reached.

In their own discussion of the future possibilities for the IoT Robertson and Wagner (2015) suggest that "in due course we will have opportunities to study people's practices that include the everyday use of IoT technologies". We argue that in the future we will not only be able to study people's practices and their particular use of IoT technologies, but also, by applying the concept of sociable technologies, users themselves will be able to *harness the IoT to detect, share and mediate these (use) practices* – or, as Schmidt (2014) would have it, they will be able to share the norms of their regulated activities.

Conclusion

Practices are not just any kind of activity. Based on early practice theories, they might be understood as "routines consisting of a number of interconnected and inseparable elements: physical and mental activities of human bodies, the material environment, artifacts and their use, contexts, human capabilities, affinities and motivation" (Kuutti & Bannon, 2014). Within work contexts they could further be described as normatively regulated activities, whereby the notion of 'normative' refers to the application of general principles (Schmidt, 2014).

Schmidt's (2014) argument is that it is possible to observe and determine the normative make-up of a practice, e.g. when people are making excuses for particular actions, when they are asking for guidance, when they are instructing novices, and so on. Within this exploratory paper, we have sought to explore the potential of IoT technologies for mediating the normative character and the collaborative appropriation of the bodies of practice from a practice-oriented

perspective. To accomplish this we have outlined how the Internet of *Practices* might address phenomena relating to evolving Communities of Practice and resonance activities by adding an integrated support for the observation and documentation of practices. This can be further reinforced through the sharing of relevant representations for mutual practice improvements. In our view the concept of an IoP has a great deal of research potential for the CSCW community. Here are just a few avenues that might be explored:

- As Schmidt (2002) has argued awareness is not the product of passively acquired information, but rather a feature of highly active and highly skilled practices. In relation to this Robertson and Wagner (2015) raise the question of how technology-provided and technology-focused awareness could inform, complement and support the people using such applications so that they are aware of relevant issues. With the IoP one could also ask: how could one become aware of other members of a CoP as well as (potentially) interesting activities through the technology? And how to detect similar practices as well as how to compare kinds of practices?
- Devices or cyber-physical systems are often situated within highly collaborative settings and often serve as enablers and mediators for communication (whether co-located or remote). However, if people's practices are connected through IoT technology and they are performing collaborative tasks, the question is how could the activities be aligned or structured at a physical level? This is especially pertinent when almost every tool or device (e.g. a hammer or drill) might count as a cyber-physical system that could be connected through the internet.
- Practice-based research agendas and researchers are usually interested in real-life practices. The practices must therefore be studied where they occur including the natural setting. Suchman (1987) outlined that the aim of research should be an exploration of "the relation of knowledge and action to the particular circumstances in which knowing and acting invariably occur". However, when moving from laboratory studies to in-the-wild studies and understanding the full context (and not just the most immediate one) this becomes challenging and is (right now) all but impossible. So, how to examine the entire practice as the ultimate context?
- As already outlined by Kuutti and Bannon (2014) we are nowadays increasingly faced with digital ecologies and at the same time every practice has a particular set of artifacts that make it possible. We therefore need to broaden the viewpoint on the world about us. How to detect media disruptions and changing artifacts during a practice? How to detect the co-evolution of practices and an entire ecology of artifacts?

- Through the IoT there are increasingly new types of inter-connected devices that are able to further support the mediation of practices such as virtual reality or augmented reality technology. New smart glasses such as Microsoft HoloLens, for instance, could support the mediation of practices between people or the technology (learning) practices within CoPs. However, new technologies require new types of methodology for researchers to examine the distributed practices that are facilitated through those new technologies. A question is if and how qualitative research methods will need to change to cope with studying the use of new types of connected data resources such as sensor data about lightning conditions or information about people's movement patterns.
- Due to the diverse inter-connectedness of infrastructures, their socio-material relations, and the heterogeneous practices associated with the use of technological tools, one question remaining is how to capture related resonance activities across communities? Furthermore, if this can be done, how might one approach designing technological support for them?
- The IoP also requires taking into account the privacy issues that surround CoPs and how they may seek to document and share practices. There is work to be done in that case regarding how best to support the effective negotiation of privacy and security interests within groups of users.

Within this exploratory paper we have introduced an initial vision of an Internet of Practices and how it could evolve from the existing Internet of Things. For this initial foray we have framed our concept theoretically and have related it to existing discourses in CSCW. We have adopted a quite pragmatic view upon how the IoP might serve to support things like CoPs. We are aware there are bleakly portrayed dystopias of a technocratic future, whereby everyone is augmented and adapted to a point of equal competence and capability. In such dystopias differences and the heterogeneity of people are typically devalued and this can also be seen to relate to older debates about de-skilling (Braverman, 1974). However, the position we adopt here is that the IoP may preserve or even enhance the diversity and skills of people, perhaps even cross-culturally.

In future work we expect to work on much finer specifications of the IoP and will be conducting design case studies (Wulf et al., 2015) in different application areas in order to examine the scope, applicability, and potential consequences of using this concept in practical settings. Our primary hope at this stage is that this exploratory paper will inspire researchers to think about other possibilities for the IoT that have not previously been articulated as IoT technology becomes more clearly established as a feature of our everyday lives, thereby expanding – as Robertson and Wagner (2015) requested – the areas of interest to which CSCW research might actively contribute.

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Ackerman, M., Kaziunas, E. (2017). A New Generation of CSCW: Reinvigorating CSCW Field-based Researcg Through a Theory-Inspired Reboot. In: Proceedings of 15th European Conference on Computer-Supported Cooperative Work - Exploratory Papers, Reports of the European Society for Socially Embedded Technologies (ISSN 2510-2591), DOI: 10.18420/ecscw2017-26

A New Generation of CSCW: Reinvigorating CSCW Field-based Research Through A Theory-Inspired Reboot

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Abstract. There are those who feel that the CSCW work studies and other interpretivist research streams need to be reinvigorated; they find many CSCW interpretivist studies to be small incremental elaborations over previous studies or studies that elaborate known findings. This paper argues that CSCW has already begun to make intellectual moves that will reinvigorate itself and that others need to be made. The paper traces how Symbolic Interactionism has kept itself vital and alive, noting how it has incorporated modern intellectual turns in the social sciences. The paper then argues that CSCW as a field and as a community needs to make similar moves, updating its theoretical concerns. We feel it is important for the CSCW community to find a communal understanding of the intellectual desirability, if not necessity, of these moves.

Introduction

Many of the important themes that have sustained CSCW field-based research for the last 25 years have been mined heavily. To be sure, there are still great studies, such as [those that will be at ECSCW'17]. Yet, the many papers on awareness,

online norms, and so on were exciting initially but have declined in number and vigor more recently. There are those who feel that the CSCW work studies and other interpretivist research streams are in decline; they find many interpretivist studies to be small incremental elaborations over previous studies or studies that elaborate known findings in new subject domains (such as medicine or education).

Over the last 25 years, CSCW as a research field uncovered and explored a number of theoretically-based assumptions and findings about socio-technical systems, and did a remarkable job of it. Ackerman (Ackerman 2000) summarized a number of these to its date of publication. For example, they include:

- "Social activity is fluid and nuanced, and this makes systems technically difficult to construct properly and often awkward to use. A considerable range of social inquiry has established that the details of interaction matter (Garfinkel 1967; Strauss 1993) and that people handle this detail with considerable agility (Garfinkel 1967; Heritage 1984; Suchman 1987)."
- "Members of organizations sometimes have differing (and multiple) goals, and conflict may be as important as cooperation in obtaining issue resolutions (Kling 1991)."
- "The norms for using a CSCW system are often actively negotiated among users. These norms of use are also subject to re-negotiation (Strauss 1991)."

There were quite a number in Ackerman 2000; we call out these for a reason to be discussed shortly.

These findings and the working-through of the underlying assumptions were largely, or entirely, the result of field-based research. As Dourish (Dourish 2014) points out, a most CSCW field-based research, until recently perhaps, has been interpretivist in nature. What did this mean in CSCW? CSCW took on implications of interpretivist work. (As always, not everyone will agree with the assertions about interpretivist work or its implications throughout this paper, especially across schools of thought. However, we suggest to readers that they read the paper through, and decide whether the general ideas hold for them.)

First of all, it became normative in CSCW that findings about a class of problems needed to be empirically grounded in fieldwork. These problems would be studied and the best analyses would come from immersion in work settings and other sites. Second, it was understood that these studies resulted in what Strauss (1993) called sensitizing concepts rather than empiricist findings. Instead of interpretivist results being required to be statistically generalizable; it was largely enough for them to be theoretically generalizable. That is, the results - or some variant - are likely to be true in any given social or design situation. It was widely believed that further investigation or further system construction should

watch for these sensitizing concepts, and searching for sensitizing concepts has become the norm for CSCW interpretivist studies.

Finally, CSCW allowed interpretivist studies to be more tightly wrapped around their theoretical assumptions than is the norm for empiricist (hypothesis-testing) studies. Clarke and others (e.g., Clarke 2005, Clarke and Star 2008) talk about theory/method packages. In CSCW, the interpretivist, field-based research has been almost entirely based in micro-sociology. Various flavors of micro-sociology, with its studies of social interaction and the construction of meaning through interaction, proved to be the most useful for requirements analysis and system design, especially when the users were within a small group or organization.

Dourish (Dourish 2014) also points out that a fair amount of CSCW field-based research has been ethnomethodological. These ethnomethodology-based findings include, for example, the quite critical concept of awareness (e.g., Heath et al. 1994, Dourish and Bly 1992, Dourish and Bellotti 1992). However, in this paper, we point towards another micro-sociological theoretical stance[1], that of symbolic interactionism (also called social interactionism or the Chicago School). Sensitizing concepts and findings from SI include the three called out from Ackerman 2000 above: the importance of nuance of social interaction (also found in ethnomethodology); the issues in differing goals and meanings; and, constant negotiation over meanings, goals, and resources. Yet another, articulation work, is a key concept in CSCW. Articulation work (Strauss 1993) is, in short, coordination work among actors in a work or other social setting.

Below, we work through one way to reinvigorate the CSCW interpretivist research agenda; we want to use symbolic interactionism (SI) as a case study of sorts.

First, we will trace through some of the basic assumptions of SI, and briefly show why these have been valuable in our research group's work. Then, we provide an overview of recent theoretical developments in SI. There has been a move to update "classic" SI (which would correspond to, roughly, updating the so-called second Chicago School) with the postmodern and practice turns. It has been argued, successfully we think, that SI is particularly amenable to this update because it had already contained many seeds of post-modernism (as used by the social sciences) and practice theory. We find the moves in this update important; they nicely generalize to CSCW socio-technical considerations as well. Next, we consider why extending a standard CSCW micro-sociological basis is likely to be valuable to CSCW interpretivist work by expanding our previous understandings and opening up new questions.

Many, if not all, of these moves are already known in CSCW. We do not claim to have invented anything new here theoretically. There are certainly those

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[1] This is the time in the paper to recognize the difficulty over the term “theory” for ethnomethodologists. While other micro-sociological schools use the term, ethnomethodology is quite pointed in its rejection of

whose work not only reflect all or aspects of what we argue here, but who have been arguing in similar directions, perhaps for years. This paper's argument may merely reflect our idiosyncratic path, especially the first author's, towards these understandings. Nonetheless we feel it important for the CSCW community to find a communal understanding that CSCW is moving in this direction and emphasize a common understanding of the intellectual desirability, if not necessity, of these moves. These moves bring an analytical power not only for social studies but also for the design of new collaborative systems that are critical for CSCW as a community. Basically, we would like to argue for coming to understand the necessity of moving together in an intellectually coherent manner towards new objects of inquiry as well as recognition we are already doing so.

Symbolic Interactionism

We begin with a quick overview of SI because the changes to it in the last 20 years are critical to the argument, and so it is important to understand its premises. Symbolic interactionism came out of the so-called Chicago School of Sociology; it is a micro-sociological theoretical position that has now existed for roughly 100 years in some form. It cannot be held to be a uniform theoretical position: it was and is a collection of individual researchers. SI's tenets have been contested and debated, and its practitioners have varied in their interests and stances. Researchers are often claimed or dis-claimed depending on the particular theoretical issue or history. Regardless, the themes and interests have been roughly consistent, necessarily evolving over time. It is upon this evolution that we wish to focus.

We want to begin by analyzing why this perspective, based in many heterogeneous and differing authors, has been useful. We then want to draw a parallel between the intellectual evolution that is occurring within SI and with the overdue update of interpretivist CSCW. We need to make it clear that we are not arguing for the supremacy of SI. Other schools of thought have had and will have their own paths and evolutions. Instead we want to take a deliberately autobiographical stance, showing why SI has been useful to us along with other micro-sociological interpretivist positions, and show why the current revision and evolution of SI points to paths CSCW must consider and, in fact, is considering so as order to revitalize its analyses of social computing, collaborative computing, and socio-technical systems of all sorts.

We will omit many aspects of SI in the interests of space. Indeed, we will largely ignore the entire "first" Chicago School, except to note that American Pragmatism and the emerging urbanization at the turn of the 19th century heavily influenced its interests and tenets. Mead was the most important Pragmatist for SI, contributing the concept of the "generalized other" and that the individual is emergent in "the dynamic, ongoing social process" (Mead 1934; Mead 1964).

First Chicago School writers also had a rudimentary sense of social ecologies and social worlds (to be explained further below), and a deep interest in the ongoing constitution and reconstitution of social groupings.

Instead, we will jump to the so-called second Chicago School (SI-2), the generation that included Anselm Strauss, Herbert Blumer, Howard Becker, and others. Everett Hughes, with his interest in work and work settings, was also influential in the second Chicago School, although he preceded it somewhat. Erving Goffman is sometimes claimed either as a member or a fellow traveler. SI-2 argued for the following sensitizing concepts:

- Based in Mead and the first Chicago School, various second Chicago School sociologists argued that meaning is constructed in and understood through social interaction with others and in social settings (Blumer 1986). This harkens back to Mead's "generalized other" and to Thomas' "definition of the situation" (Thomas 1923). One can also see this as a reaction to and a conversation with social constructionism (e.g., Berger and Luckmann 1966).
- SI-2 researchers began (again) to explore so-called social worlds, which are collectivities with shared understandings, common vocabularies, norms, and local knowledge. The boundaries of these social worlds are porous and fluid (even overlapping), and individuals may belong to many (Strauss 1991, 1993). Social worlds exist in a rich ecology; Becker's Art Worlds (Becker 1982), a wonderful book, explores the many social worlds that together create high art. One can see social worlds as an extension of a more rudimentary form of "social worlds" in the first Chicago School (e.g., Cressey 1932 but also in other students of Park) and also in conversation with social constructionism trying to understand how process continues and creates structure.

For the SI-2 generation, structure and process were not completely separable (except analytically), and were understood as fluid and constantly re-constructed. Especially for Strauss, collectivities are constantly (re)organizing; any resultant order is temporary and is ongoingly re-negotiated (Strauss' negotiated order) (Strauss et al. 1985; Strauss 1991, 1993).

The second Chicago School generation also had a strong interest in work, where "work" was of two sorts. One kind of work was interaction work, as in Strauss et al. (Strauss et al. 1985) and Becker (Becker 1963). If one includes Goffman in the second Chicago School, the emphasis on the work involved in interaction becomes even clearer (e.g., Goffman 1961). The interest in work also included organized work and organized settings, with an emphasis on what allowed for a collectivity to be an "ongoing concern" (Hughes 1971). (This may have been a reaction to more mainstream forms of sociology of the time.) There was an enormous interest in medical settings as one kind of ongoing concern, based in Strauss' move to UCSF's medical school. SI-2 researchers also had

interests in dynamics and temporality as seen in Strauss et al.'s (Strauss et al. 1985) trajectories, or how illness or other situations changed and evolved over time. Strauss' explanation of trajectory shows the connections to context and contingency, harbingers of practice theory in the future. Strauss pointed out, within a trajectory:

> ...acts do not simply unfold but are shaped in interaction between actors and environments. Environments include contingent events while interactions are of course social, and often collective. So actions, especially of long duration, may be planned, directed, guided, but are at least partly unpredictable, only loosely determined, open-ended, and even may ultimately reach quite unwanted destinations (Strauss 1991, 25).

While other second Chicago School researchers studied social movements (including fashion), delinquents, urban spaces, and so on, we will limit ourselves to the basic tenets so as to move on to current trends in SI.

On a more personal note, the SocialWorlds Research group has found SI to be extremely helpful in understanding socio-technical systems from a social analytic position and in constructing them from a systems development position. The standard HCD (human-centered design) cycle as applied to CSCW, where understanding is validated with people's social settings, fits nicely with the Pragmatists' agenda and therefore with SI. We have used SI, occasionally supplementing its sensitizing concepts with other theoretical positions (distributed cognition, ethnomethodology), in order to understand informal information use, knowledge sharing, and expertise sharing. The basic tenets of SI were useful in understanding specific social worlds - an early social Q&A system in Ackerman and Palen (Ackerman and Palen 1996) and an online game community in Muramatsu and Ackerman (Muramatsu and Ackerman 1998), with the goal of understanding what needed to be incorporated in systems work. Lutters and Ackerman (Lutters and Ackerman 2002; Lutters and Ackerman 2007) looked at the tensions and connections between social worlds, and how these were worked through. We discovered that boundary objects, information or other objects that mediate between social worlds (Star and Griesember 1989), had to be supplemented through constant negotiation. Users' construction of meaning and identity were examined in Ackerman and Palen (1995) as well as in Lutters and Ackerman (Lutters and Ackerman 2007). The nature of interaction work, especially care work by nurses, was examined in Zhou et al. (Zhou et al. 2009,Zhou et al. 2010). Finally, the duality of structure in information objects and process in knowledge practices was key for the analysis in Ackerman and Halverson (Ackerman and Halverson 1998, Ackerman and Halverson 2004).

The Third Generation of SI

The section above was prelude to a discussion of the changes underway in the third generation of SI. There are many members in this third generation of

Symbolic Interactionists, but here we mainly follow Kathy Charmaz and Adele Clarke in their efforts to "grow" symbolic interactionism. Clarke has an explicit agenda of moving SI towards the post-modern turn and practice theory, and in her writings, Charmaz has agreed with this agenda (Charmaz 2008a, Charmaz 2008b). For them, the required moves are a matter of elaborating and updating themes already in SI. (A certain amount of borrowing from other theoretical perspectives is ignored by them at the same time, perhaps to highlight both the feasibility of the moves and to differentiate SI.) Bringing the post-modern turn and practice theory into SI imparts a certain viewpoint and structuring to all three in analyses.

As Kools states about Clarke:

> Her suggested renovations of grounded theory [and in Clarke's view, also symbolic interactionism] include acknowledging both situated knowledges and the situatedness and embodiment of the researcher, expanding the analytic ground of the phenomenon under research to the broader situation where the actions occur, shifting the focus from achieving coherence and commonalities to integrating complexities and heterogeneities, and appreciating the analytic sufficiency of sensitizing concepts and grounded theorizing. (Kools 2008, 82)

However, this set of expansions was foreshadowed in the second school, according to Charmaz:

> Anselm's [Strauss'] sociology is rooted in pragmatism, nurtured by empiricism, and developed through interaction. Action always occurs within a context. Social life consists of processes. Everyday actions, negotiations, interpretations create stable social structures; they do not merely exist. Actions give rise to reconstructing meaning; in turn, meaning and symbol inform action. (Charmaz 2014, 127)

Clarke argues for three specific evolutionary moves pushing SI, so as to incorporate the postmodern and practices into SI's thematic foci. We cover these in some detail because they are central to our larger argument. Charmaz' three moves are:

1. SI analyses had to move towards the post-modern turn by "making the broader situation of the phenomenon under research the analytical ground. (Clarke, 2005, 21)" Understanding any given situation is inherently limited, and "[p]artial perspectives [must] suffice. (Clarke, 2005, 22)" Analyzing the situation with a postmodern turn, however, allows one to examine the differences and complexities instead of looking for only the commonalities. Rather than seeing context as the static background in which action takes place, for Clarke and Charmaz, "[t]he important so-called contextual elements are actually inside the situation itself. They are constitutive of it.... (Clarke, 2005, 30)"

   Charmaz focuses primarily on individuals and the partialities and complexities in their interactional work. Her move is towards the partialities and complexities in individuals' interactional work. For both, actions and interactions must be co-constitutive with and of situations, moving SI towards the situatedness of actions in practice theory. While

Clarke focuses on social worlds/arenas and discourses as the locus of action, Charmaz focuses on how situated interaction can be understood as kinds of interactional work. Practices, then, are bound to individuals' interactional work and to the situation, and by extension, interaction work can be understood through practices.

2. Social worlds[2] must become the prime loci of examination, since this is where one may find the "constellation of constraints, opportunities, resources, and other elements" that must be unpacked "in 'the situation' at hand. (Clarke, 2005, 56)" This a direct invocation of practice theory. This is more salient for Clarke than Charmaz, but in any case, social worlds necessarily include the negotiated orderings that mediate these constraints and opportunities, provide for resources, and distinguish among the potential trajectories of their activities. For Clarke the orderings necessarily include the social worlds' discourses, since social worlds are places of language, commitments, and (partially) shared understandings, moving towards the post-modern turn. Clark's interest in meso-analyses (fitting between the micro-scale analyses of interaction work and the macro-analyses of other sociological work) moves her towards the importance of the sites of practice. Charmaz is not opposed to this theoretical move, but she is not as engaged with it.
3. Nonhumans must be considered in the situations under examination: "[the] new root concerns taking the nonhuman explicitly into account.... (Clarke, 2005, 38)" The nonhuman includes various sorts of materialities as well as computers and by extension, software. Including non-humans provides a better analytical stance. Quoting Schatzki, Clarke argues "By acknowledging nonhumans as components and determinants of the arrangements that encompass people, this line of research problematizes the social and challenges traditional renderings of it as relations between people. (Schatzki in Clarke, 2005, 93)"

The premise that situations involve both people and nonhumans also leads to the position where one must also consider the ecology of actors or implicit actors. Indeed, for Clarke (following Haraway 1987 and others), some actors could be hybrids, such as cyborgs, combinations of human and nonhuman. (In CSCW terms, one might consider a hybrid to be a user and her many machines.) Clarke argues SI analyses must be changed accordingly: "...processes of coconstruction and coconstitution can be studied through using the situation as the locus of analysis and explicitly including all analytically pertinent nonhuman (including technical) elements along with the human. (Clarke, 2005, 63)"

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[2] Clarke, following Strauss' inclusion of additional meso-layers, looks at a more nuanced set of loci, but we simplify her argument slightly here.

SI investigations, in this new view, should now include the examination of dense ecologies of interaction work and actors in dynamically changing situations.

These important steps towards new thematic themes in SI point to SI being a living theoretical viewpoint. One way to keep a school of thought vigorous is to respond, incorporate, extend, and even challenge important theoretical moves in other areas of the social sciences. To repeat, SI-3 has moved to include:

- ❒ Incorporating post-modern social science by including the multiple perspectives of different actors as well as their narratives. This allows one to see differences instead of merely the commonalities preferred by earlier social analyses. It also focuses on situations.
- ❒ Incorporating practice theory by focusing on actors within social situations and their interactions.
- ❒ Incorporating non-human actors, including processes of co-construction and co-constitution.

We believe they can, as theories do, both provide inspiration and motivation towards new empirical work as well as new support for field-based analyses.

What Might a Similar Shift Look Like in CSCW?

We believe that CSCW must also fully incorporate these intellectual shifts in its evolution to remain vibrant. As we worked out what this shift in Symbolic Interactionism might suggest for CSCW, we began to create two separate agendas. One is more evolutionary, an extension of current intellectual trends in CSCW. The conservative agenda highlights these trends, and pulls them together in a more coherent fashion. The other is more radical. It suggests new directions, jumps past what is considered as a normal course of investigation in CSCW. The directions, however, do *not* radically alter CSCW's intellectual mission, as we understand it (Ackerman, 2000). Instead we offer the radical agenda to suggest new, but quite possibly unexpected, avenues of inquiry that we believe will fruitful.

We want to make it clear that we understand that these agendas are currently present in CSCW and HCI. CSCW and HCI, like Symbolic Interactionism, are not in isolation from general intellectual trends. People in CSCW are already oriented towards these concerns and their research reflects it with greater or lesser publishability in CSCW (especially the American CSCW). Yet others are already inching towards incorporating these concerns. We hope here that an understanding of how the efforts are connected will bring a higher degree of collegiality, if not a greater intellectual coherence.

The Initial Agenda for CSCW-NextGeneration

The initial agenda we outline here follows roughly the three changes in Symbolic Interactionism we outlined above.

CSCW researchers have consistently pushed for a view that system requirements must be based in a thorough understanding and appreciation for the users' activities within their social context. The analysis leading to system requirements must be based in immersive field research, as much as possible, in order to understand what people actually do and what that social context actually is. There has always been an uneasy tension between the specificity required for organizationally-adopted systems (such as IT efforts) or those systems focused on particularly tasks and occupational groups (such as air traffic control) and those required for cross-sector or mass-market software products (such as early groupware efforts or later, social media applications). This tension is not easily resolved, as the specificity required for adoptable IT systems must be suitably abstracted for mass-market systems. Viewing practices as practices has the same issue – without abstraction, they are specific to situations and contexts. The issue is made even worse with the decentering moves of the post-modern turn.

The initial agenda attempts, in the same manner as Clarke and Charmaz, to find a way of both embracing this tension and creating a structure for partially resolving it for any given design or study. There are three research implications as part of this agenda:

First, Clarke and Charmaz are moving towards the centrality of interactional work in activity. For Strauss, the types of interactional work were a basis of activity. Strauss and colleagues detailed interactional work, showing this work was central to the tasks that occur in a hospital (Strauss et al. 1985). They observed in medical care basic types of interactional work, at least for that setting: They saw comfort or care work, emotional work (although they called it sentimental work), and of course, articulation (coordination) work. They also detailed biographical work, or the work one does of creating and maintaining an identity, and machine work, the work that clinicians do to handle medical devices. They also briefly discussed, but did not elaborate, information work, the interactional work required to communicate and understand information.

Although others in SI looked at new types of interactional work (in particular, Star and Griesember 1989's boundary work) Charmaz reopened the examination of and extension to interactional work. Her canonical book, Good Days Bad Days (Charmaz 1993), is an in-depth examination of how people live with chronic illness. Framing illness socially as "interruption, intrusion, or immersion," Charmaz explores the ways in which people's identity and the meanings of life events are shaped by the everyday actions and routines around managing medical care. The book details the biographical work involved in changing one's identity from a healthy person to someone with a chronic disease. Part of this biographical work is disclosure work (what Goffman 1961 might have called face work), or

how people choose to present themselves to others. Charmaz in this book also deals with the care work involved in maintaining oneself in the face of a chronic disease.

CSCW researchers have already identified additional types of interactional work in collaborative settings. Implicitly, although not named as interactional work, there have been explorations of care and emotional work (e.g., Preece 2000, Preece 1999) as well as identity or biographical work (e.g., Farnham and Churchill 2011) in online support communities. Jackson and Chen have been more explicitly examined forms of interactional work. Jackson and colleagues examined repair work (Jackson et al. 2012), which combines articulation work and machine work. Chen and colleagues (Park et al. 2013) explored three types of work in informal documentation practices, which she called memory work, abstraction work, and future work. We have investigated how people with chronic diseases must engage in translation work as the medical practices are adapted to the messiness of everyday life (Kaziunas et al. 2013). People often take clinical treatments, such as instructions on taking medication, reinterpret and tailor them to local contexts in order to lead healthier lives. This translation work is important for understanding the differences between the formalized medical practices and people's situated health practices. Similarly Kaziunas et al. (Kaziunas et al. 2015) noted the caregivers of pediatric bone marrow transplant patients engage in reflection work as they negotiate between the social worlds of institutionalized medicine and their everyday lives.

There are, no doubt, many more forms of interactional work that are important across differing social contexts waiting to be uncovered. We in CSCW should open ourselves up to uncovering new, important forms of interactional work and have this be an agreed-upon part of our intellectual agenda. Strauss and colleagues' analysis of hospitals is bound up in the technical milieu he studied in the 1970s. We have new forms of technology, new socio-technical environments, and new labor arrangements to explore.

Second, while the Symbolic Interactionists were always interested in the social contexts in which people live, the third generation centralized activities as being co-constituent with the multiple social worlds in which they occur. CSCW researchers are already investigating how people communicate and interact within a specific social world. For example, how are social identities created and ongoingly re-enacted within social media platforms and online communities? Bryant et al. (2005) showed how identity was co-constituted with the Wikipedia socio-technical world.

Of course, people also coordinate and manage their varying social worlds. How do they create and use practices garnered from others in their varying social worlds? Understanding the interaction with differing social worlds is important for not only health but also all kinds of information flows and informal knowledge sharing.

Research in scientific collaboration (e.g., Cummings and Kiesler 2008, Olson et al. 2008, Sonnenwald 2007), and team work (Hinds and Kiesler 1995), at its core, has this concern. The work of ongoingly managing multiple social worlds also exists in both everyday life and online life. For example, it is particularly important in the practices of health management. We are currently looking at how people interact with varying medical social worlds and try to make sense of them. As mentioned, Kaziunas et al. (2015) examined pediatric bone marrow transplant, describing how parents end up living partway between the medical social world and their previous social worlds of everyday home life, and yet are outside of both. As a result of this and earlier studies, we are currently building a health application that allows people to explore the intersections and effects of the different social worlds of which they may be a part. For example, a person living with diabetes may want to understand the tradeoffs and tensions between the clinical view for insulin management and everyday health practices, like taking herbal supplements to manage glucose levels, common amongst alternative and holistic medicine online communities. In our studies, we have found substantial tensions, as well, between faith-based social worlds and the medical world. In our view, people can use help reconciling the sometimes discrepant and conflicting information from different social worlds. We also want to understand how to provide a "patient" voice, coming from other social worlds to the social world of institutionalized medicine.

We expect to see more work within CSCW designers in how users understand specific social worlds so as to act appropriately within them, but also how they move through and negotiate among many different social worlds. People do so in a nuanced and largely seamless manner (Ackerman 2000).

Finally, Symbolic Interactionism is coming to consider the non-human and the human. For us, users increasingly live in dense collaborative ecologies of machines, collectivities, and social apps. People manage their ecologies, often with the help of others in their varying social worlds. There are new forms of interaction work being created as these ecologies change and grow. CSCW needs ways to talk about the forms of these ecologies, distinguish what kinds of ecologies have systemic effects, and understand how collaboration and social interaction change with differing ecologies. The first hints of this kind of research exist within CSCW in the form of studies of cyber-infrastructure (Ribes and Lee 2010). Bodker and colleagues have started looking at artifact ecologies (Bodker et al. 2015).

Each part of the initial agenda takes CSCW towards dealing with new phenomena, as well as old phenomena of interest in new ways. As a community, we can come to a rough agreement on how it is likely we will extend prior directions in CSCW.

New Directions for CSCW-NextGeneration

A more revolutionary agenda, on the other hand, pushes the implications of the moves within Symbolic Interactionism much further. It begins to challenge some of the ways we do our analyses. CSCW researchers are already heading in these directions, and as a community, we should encourage these moves. Neither of these new directions find uniform acceptance in program committees currently; they should.

We see three parts to this agenda. First, Clarke admonishes Symbolic Interactionists to view "sites of heterogeneity/difference. (Clarke 2005)" In this, she reminds researchers that sometimes difference is as important as similarity. Law (Law 2002) and Mol (Mol 2002) do the same for a wider audience.

Traditionally, CSCW has been most interested in understanding the general design space for a collaborative task. Attention has always been paid to tradeoffs and tensions, but largely in the service of determining specific workable systems. These working systems are optimal points in a charted design space for specific user groups.

In seeing that differences cannot be always reconciled, if ever, and differences do not need to be 'fixed' or cleaned-up, a new way to look for generative design spaces appears. Dourish, in particular, has been concerned for many years with changing the logic of finding specific design points by investigating both system-driven tailorability (e.g., Dourish 1995) and user-driven appropriation (e.g., Dourish 2003). Others have as well. Nonetheless, the complexity of design spaces has hardly been fully embraced in studies or designs.

This move could involve, on the one hand, in Suchman's view, noticing the "long standing feminist concerns with (orderings of) difference. (Suchman 2008, p. 140)" Alternatively, this move could uncover new types of interactional work that deals with the differences (e.g. our translation work and reflection work). It might even subvert the notion of simple difference by examining assemblages, patterns of arrangement that gain stability or change over time through their ongoing enactment (Suchman 2008, Clarke and Star 2008).

Second, Clarke would push an analyst to not only include non-humans in analyses, but also to extend to non-binary framings. This is not just a matter of including people and systems; viewing differences as part of a whole leads to non-binary framings. Suchman (2008) includes as binary framings, "divisions of subject and object, human and non human, nature and culture, and relatedly, same and other, us and them. (p. 140)" Following this, one might consider health, for example, not then about a doctor and a patient with information transfer between the two. Health might, instead, encompass a multiplicity of clinical and patient perspectives, where "the doctor" is part of ever-shifting ecology of doctors, nurses, dieticians and pharmacists, medical equipment, and laboratory processes, and "the patient" includes not only an individual person and body, but her family, Facebook support group, and medical documentation.

Third, if we follow Clarke's push toward the incorporation of the social world and its social context within meso-structures – part of her extension of Grounded Theory in Clarke 2005 – we should also be considering socio-technical systems and their design. CSCW researchers are only now beginning to push on the social part of socio-technical design especially at large scale. Wulf and colleagues for a sustained program that does so quite well (e.g., Wulf et al. 2013). Lewkowicz and colleagues have been considering the meso-social structures of health in their designs (e.g., Tixier and Lewkowicz 2015).

The combination of the three "revolutionary" moves creates new kinds of outcomes for CSCW interpretivist work. In addition to sensitizing concepts, such as new forms of interactional work, there may well be sensitizing relations, contingent on context.

Why do this?

There are numerous arguments for and against post-modernism and the practice turn. They do not matter in the abstract for CSCW. CSCW research is moving in the directions outlined in this paper, but we are doing it slowly and haphazardly. We jeopardize junior faculty's careers when they seek to place work that seems "out there." Instead what this paper argues is that CSCW as a community recognize the intellectual merit of these moves within an implicit community agreement (where of course the agreement is ongoingly negotiated and "good enough" rather than total).

It is hard for us to see why CSCW would not incorporate the social science moves from the last twenty years. The agendas outlined above enlarge the space of *potential* viewpoints for design; they only enlarge the ability to uncover useful designs and design spaces.

"Classic" CSCW, with its ethnographically-based studies such as the control room studies or the PARC information studies, was once criticized for overly complicating system design. Within CSCW and HCI, this kind of analysis now seems normal, and it has become almost mainstream in Computer Science. Similarly, studies using the practice turn or post-modernism are more complex and difficult to incorporate within designs. Practitioners may or may not adopt the insights fostered by these agendas, or adoption may lag considerably. However, regardless of whether these new moves are quickly adopted by practitioners, research should move towards new themes. These new moves let us tackle important issues such as understanding computational ecologies, incorporating multiple viewpoints, and designing for new forms of social activity or interactional work. Incorporating these moves in a community-wide intellectual agenda akin to that of "Classic CSCW" should nurture new possibilities for design, and seek better ways to understand their constraints, possibilities, and limitations.

Conclusion

Interpretivist theoretical perspectives such as Symbolic Interactionism must necessarily change and update to stay living and vibrant schools of thought and intellectual communities. Incorporating additional theoretical considerations allow new problems to be considered and old problems to be reconsidered. Similarly, CSCW should not keep its theoretical concerns static. Accordingly, in this paper, we have pushed for theoretical moves within CSCW with the hopes that these will lead to new design insights and new empirically-based studies. These system designs and field-based, interpretivist studies can, in turn, serve to examine the utility of these new theoretical moves.

We should emphasize that SI is only one micro-sociological theory that has been of value in CSCW. Each theory/method package illuminates areas of core interest to itself. We personally find SI to be of interest, especially now the core interests of CSCW along with its socio-technical context, have matured and expanded. In this paper, though, we have been much more interested in noting how updating SI in terms of more recent theoretical developments in the social sciences might lead to new theoretical extensions and areas of interest in CSCW. Similar developments in other micro-sociological theories could well show additional paths. We hope these will occur.

We also need to emphasize that these moves are already present in CSCW. Many researchers have taken in some or all of these themes and concerns. We are not arguing that we have invented anything here; if anything, we have been slow to understand the utility of these moves. However, we are arguing that these moves create a new intellectual agenda and a new generation of CSCW research.

To conclude, we believe that pushing towards these new considerations is likely to renew and reinvigorate CSCW's interpretivist research stream by expanding our previous research and opening up new questions. It is time to form a communal understanding of the desirability, if not necessity, of these moves.

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Cities of Otherness: the smart city as a heterotopia

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Abstract. This paper provides an exploratory dimension to the current smart city discussion by regarding the smart city as a heterotopia space – a space of otherness. By adopting a Foucauldian approach, this paper briefly describes the 'discursive formation' of the smart city by analysing its 'surfaces of emergence', 'authorities of delimitation', and 'grids of specification', in order to capture the smart city discourse trajectory. It then focuses on analysing the smart city as a heterotopia space by applying Foucault's six principles of heterotopias to the data gathered through twenty-seven ethnographic interviews with the smart city experts. In so doing, the paper intends to explore the possible implications for design – and 'design' in its widest sense – in the smart city context.

Introduction

The expression 'smart city' has recently become a leitmotiv in the vision of future city and urban development. However, the current smart cities concept can appear decidedly ambiguous, since it seemingly leaves its definition up to considerable interpretation. This paper does not intend to provide any simple definition of what a smart city is, as it is unlikely to be a simple, or even single, authoritative and uncontested, definition. In Law's (2004) words: "Simple clear descriptions don't work if what they are describing is not itself very coherent. The very attempt to be clear simply increases the mess." In various discourses the 'smart city' appears predominantly as an 'other' kind of city – efficient, technologically advanced, green and socially inclusive, and it has attracted increasing attention from

academia, industry, and government. In this exploratory paper, I adopt a Foucauldian approach to explore the smart city as a heterotopic space. By providing this rather different and exploratory dimension in understanding the 'smart city', I attempt to document and understand the nature and essence of the 'smart city' through its otherness. I propose this unique approach in order to stimulate more discussions on the relationships between technology, design and policy thinking, specifically focusing on the impact they have on each other, which echoes and enriches Hommels's (2008) discussion on the dynamic of such negotiation in modern urban developments.

The paper draws on data from twenty-seven semi-structured interviews conducted with (generally accepted) experts on smart city research and development, mostly from UK, and some others from smart cities across the globe (Dublin, Barcelona, and Beijing). The experts all hold senior roles in their organisations, their involvement in smart city projects covers a wide variety of works and expertise in smart city development, including policy making, public administration, academic research, industry based research and development, and technology development and sales. Most of these interviews lasted around 45 minutes, with the longest one over 70 minutes long. Due to the sensitivity of their work and for protection of their anonymity I cannot share more specific details in relation to smart city developments. Nonetheless, I have chosen these experts based on their experience (at least three years' involvement in the smart city and five years holding a senior position), expertise (through publications, invited talks and interviews, and recommendations) and influence (the positions they hold and the recognition they have in the field). These experts were asked questions regarding their understandings of what it means for a city to be 'smart', their involvement and work in the 'smart city' and what other potential innovation areas (i.e. policy, knowledge mobility and inter/trans-disciplinarity etc.) they've perceived in the smart city. Having already analysed the emerging data using an inductive, 'grounded', thematic approach, in this paper, I apply Foucault's six principles of heterotopia (1984) to the synthesis of the responses collected throughout the research, allied with an understanding of the current literature and discussion concerning the relative proximity and realization of the smart city vision, in order to understand the structuring and ordering of a 'smart city'. But this paper does not aspire to simply produce a total critique of the smart city either, or deny its utility theoretically. As Grudin and Poltrock (2012) formulate the general issue: adopting a Foucauldian approach may, or may not, help to formulate testable hypotheses; but it certainly provides a vocabulary and a motivation for any debate on the 'smart city' and, in the process may contribute to design ideas and recommendations. Ultimately the analysis and ideas discussed in this exploratory paper seek inform and impact any future thinking around smart city design and development; or, as Foucault suggests, to question, challenge and inform debates about the 'smart city' that might currently appear as self-evident.

The Foucauldian Approach

> The role of an intellectual is not to tell others what they have to do. By what right would he do so? The work of the intellectual is not to shape others' political will: it is, through the analyses that he carried out in his own field, to question over and over again what is postulated as self-evident, to disturb people's mental habits, the way they do and think things. (Foucault 1997:131)

After delving into my initial analysis, I soon realised that the expert interviews suggested the value of adopting a Foucauldian 'archaeology of knowledge' approach (Foucault, 1989), by explicating some understandings, and misunderstandings surrounding the idea of the 'smart city'. In this section I briefly outline how I adopted the Foucauldian approach in unpacking the 'smart city'– both in terms of his general methodological, genealogical and archaeological, approach; his cogent ideas on the appropriate relationship between knowledge and power and specific concepts related to notions of 'discursive formations', 'heterotopias' and the idea of the 'gaze'.

Foucault's genealogical analyses challenge traditional practices of history, philosophical assumptions and established conceptions of knowledge, truth and power; displacing the primacy of the subject found in conventional history and targeting discourse, reason, rationality and certainty. It seeks to illuminate the contingency of the taken for granted, to denaturalise what seems immutable, to destabilise seemingly natural categories as constructs and confines articulated by discourse, opening up new possibilities for the future. Foucault's archaeology similarly concerns contextualising and historicising notions of truth, knowledge and rationality. He examines the conditions of emergence, how and why a given society/era recognises certain things as knowledge, how and why some procedures are considered rational and others not. In short, genealogy and archaeology are two halves of a complimentary approach, alternating and supporting each other. This approach has very important methodological implications; leading me to unearth and examine a variety of data, to review a range of documents, and to interview a varied and interesting collection of people.

This leads me to the exploration of the smart city discursive 'formation' (Wang, 2017), which is a coherent discourse possessing common objects, concepts and arguments. The components of a Foucauldian 'discursive formation' include: 'surfaces of emergence', 'authorities of delimitation', and 'grids of specification'. In application, 'surfaces of emergence' point to specific discursive and institutional sites – conferences, exhibitions, magazines and books, where arguments about the 'smart city' have emerged or been re-configured. For example, due to the presumed technological nature of the smart city, the Internet of Things (IoT) has become central in defining and describing an understanding of smart cities. That means one major site for smart city research and development publications are IoT conferences, summits and journals or computing conferences with an IoT interest, such as CHI and CSCW in the USA

and British HCI in the UK. 'Authority of Delimitation' refers to the experts interviewed, who possess the the ability to use their comments, publications and books etc. to define and shape the ongoing debate of the 'smart city'. 'Grids of specification', are the classificatory dimensions of a discursive formation, how it is, for example, related to other important ideas, i.e. ideas about urban life, governance and citizen empowerment in my case. As a particular way of talking about, of constructing, a topic – the smart city – and its relations with other topics, such as technology, urban development, data science, etc. – the discourse inevitably limits other ways in which a topic can be constructed – of what effectively it 'makes sense' to say. It is, at least partly, in identifying this 'discursive formation' that the merit of a Foucauldian approach can be found.

In my understanding, heterotopia is Foucault's effort of replicating the analysis he has done with the structuring of 'discourses' in places and living spaces. He conceptualises a heterotopia as a site that is defined by its absolute perfection, surrounded by spaces that are not so clearly defined as such (Foucault, 2002). Soja's work (1995) adopted the heterotopia concept and demonstrated that a heterotopia is also a site that is ambivalent and uncertain because of the multiplicity of social meaning that is attached to them. Both understandings of a heterotopia echo the characteristics of a smart city. On the one hand, there is the assertion that smartness stands for being efficient, healthy, and technologically advanced, therefore, the 'smart city' is intended as the ideal and perfection of a future city without acknowledging there are more to a city than simply achieving efficiency. On the other hand, the smart city discourse is used by the city managers and policy makers to support specific development strategies and policies. For instance, there are many links between neoliberal urban developments and smart city imaginaries: the construction of a clean, green and intelligent city image is in fact useful to attract investments, leading sector professional workers and tourists which changes the social meaning of a smart city whenever necessary. The experts I interviewed, who work as public administrators for city councils, all expressed their appreciation of the funding and investment opportunities that smart cities brought to their cities. Meanwhile, the incongruous forms of writing and text in the 'smart city' realm make the 'smart city' resemble a heterotopia even more. That is the smart city as a heterotopic space highlights the conflicts and tensions between discursive formations that are readily visible in my 'smart city' experts' experiences, attitudes and opinions.

What on earth is a heterotopia?

> We are in the epoch of simultaneity: we are in the epoch of juxtaposition, the epoch of the near and far, of the side-by-side, of the dispersed. (Foucault, 1984)

> They are set up to fascinate and to horrify, to try and make use of the limits of our imagination, our desires, our fears ad our sense of power/powerlessness. (Hetherington, 1997:40)

The term heterotopia originally comes from the study of anatomy. It is used to describe part of body that's alien. Foucault, who then further developed this concept in his book The Order of Things, and in a lecture he gave to a group of architects which was then turned into an essay – Of Other Spaces. He defines a heterotopia as, either a textual or a geographical site that allows the ordering of things inside not through resemblance but rather through the process of similitude. In this sense, heterotopias would only exit in relations, that is, they are established by their difference in a relationship between sites rather than their otherness deriving from a site itself. Therefore, a place is seen as heterotopic only from the outside but not from the inside perspective. Hetherington (1997) echoes this argument by suggesting that heterotopia does not exit in the *order* of things, but in the *ordering* of things. He suggests a certain amount of neutrality needs to be taken into consideration while defining a heterotopia, for him, it is a place of alternate ordering. He also argues that a heterotopia is a space where freedom and control extend beyond their own limits and mingle with one another (Hetherington 1997). In this sense, heterotopia is a passage, one that's between freedom and control. It is a place where different or alternate social ordering is performed.

Genocchino (1995) characterises heterotopia as a self-refuting concept as he believes that heterotopia has been misread; the notion itself is problematic; and it should be read more carefully. He argues that heterotopia is an idea about space rather than the actual places or a practice challenges the factional ordering while refusing to be part of that order even in difference. However, Hetherington (1997) on the contrary, provides a convincing argument that:

> No matter how much we wish to be free, we will always create conditions of ordering if not order itself.

And this argument became very evident when looking at the 'smart city', i.e. the way 'smartness' is often conceptualised as some form of new social/technological ordering. Most importantly, heterotopia, in my opinion, encapsulates the contrasting characteristics of both utopia and dystopia and highlights the contested nature and the plurality of futures. This is the main rationale behind this paper and its analysis of the smart city as a heterotopia.

Smart city as a heterotopia

> It would be wrong to just associate heterotopia just with the marginal and powerless seeking to use Other places to articulate a voice that is usually denied them. An Other place can be constituted and used by those who benefit from the existing relations of power within a society as in the case of the establishment of the workhouse or prison as a place of otherness that

> becomes a site of social control though the practices associated with it and the meaning that develop around it. (Hetherington, 1997:52)

In this paper, the Foucauldian approach that I would like to introduce and apply to the analysis of 'smart city' is looking at the 'smart city' as heterotopia, rather than a utopia or a dystopia (a utopia that has gone wrong).

In *Of Other Spaces* Foucault summarises the six principles of a heterotopia. In this section, I apply these six principles to the 'smart city' to demonstrate how 'smart city' could be seen as a heterotopia.

His first principle says that there is probably not a single culture in the world that fails to constitute heterotopias, but they take varied forms, including what he would call heterotopias of crisis[1] or deviation. The 'smart city' appears to be an interesting example of a heterotopia of crisis or deviation. Cites, throughout the history have always continuously been contested spaces and it contains, embraces and nurtures various kind of deviations. Contrary to ordinary cities, one of the greatest promises of the 'smart city' is that it is designed to free cities from crisis and deviation. One of the experts pushed this idea even further, suggesting that perhaps 'Disney World' was a visionary exemplar some notions of a smart city. So to paraphrase Foucault's description of a crisis heterotopia in the smart city context, it is a space designed for the cities that are in crisis per se or facing various challenges ranging from urban ones to societal ones. The basics of being smart means a city would regulate deviation and push for normality by following a certain standard whether that leads to the resilience against disasters, security against crimes or the ultimate efficiency. However, efficiency, simplicity and formality are a problematic assumption and maybe an illusionary goal in an urban setting. Roy (2005) encourage urban planners must embrace the urban informality in order to work with the challenges of dealing with the "unplannable" — exceptions to the order of formal urbanization. Law (2004) critiques simplicity,

> If the world is complex and messy, then at least some of the time we're going to have to give up on simplicities.

And they are not alone, one of my experts, who has been involved in many smart city developments, particularly appreciates the 'messiness' of a city:

> There's a bunch of things baked into it as assumptions that … like efficiency is a good thing, which I was trying to unpick, say that many of the great things about city, cities are totally inefficient. So, how do you deal with that? Explain to me, how efficiency is going to help with those things, it's not.

Another way is viewing a smart city as a heterotopia comes from the conflicts and tensions between *the old* and *the new*. It can be unpicked in two levels, in the physical level, a 'smart city' is an attempt at marrying the cutting edge technology system to the well established and often Victorian age urban infrastructure. This creates tremendous design and development challenges for many cities to become

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[1] Foucault originally used boarding school as an example of a crisis heterotopia to demonstrate that what he meant by a crisis heterotopia is a reserved space for who are in the state of crisis.

'smart'. On the cultural level, a smart city proposes a new way of city governing and an alternative management and communication model in councils that are still following the 19th century structure. When asked what is the real challenge in implementing and pushing forward a smart city plan, one expert concluded it as a question about organisational culture. The challenge and crisis that a smart city project crystallises is a "cultural change" fundamentally. It is not just in people but in the process, in how organisations work. "What does the city council of the 21st century look like", for him should be at the heart of a smart city quest. And these conflicts, challenges and even development crisis, are the attributes that makes a smart city heterotopic.

The second principle mainly suggests that heterotopia is a contextualised concept that its function and meaning would adapt accordingly to the time and situation. Foucault used the cemetery in his original text to elaborate this principle. The cemetery was moved from the heart of a city to the border, from the 18th to the 19th century as death, once regarded in sacred terms increasingly became associated with illness. The 'smart city' is also a highly flexible and adaptive concept. Though it is designed for the future but also designed to be future-proof (as if the future is to be prevented from occurring). It derives from some pre-exiting urban imaginaries. In the smart city context, the core idea of 'smart' is often seen as a shiny new concept and the approach to the next of urban futures. In adopting the genealogical way of thinking, I contend that the smart city is neither new nor the only way to construct thinking around urban futures. Smart city discourse, in our perspective, is an assemblage of several pre-existing urban imaginaries. The 'smart city' emerged in the wake of the narratives of the sustainable/resilient cities and of the informational/intelligent city (Vanolo, 2013; Kitchin, 2014). The early digital network of local businesses and activities in a city in mid to late 90s in both Manchester and Amsterdam,[2] aiming at connecting the physical business through digital network, was identified by one expert as the earliest form of a smart city at that time (late 90s), and is still perhaps the essence of many modern smart city developments. On the one hand, there is the assertion in the smart city discourse that smartness stands for being good, healthy, and technologically advanced, therefore, the 'smart city' is intended as the ultimate goal for urban development projects. However, this is not a distinct urban promise that a 'smart city' intends, it is a shared promise that a 'resilient city' (Vale, 2007; Chelleri, 2012) and a 'sustainable city' (Satterthwaite, 1997; Haughton and Hunter, 2003; Bulkeley and Betsill, 2005, Jenks and Dempsey, 2005) have yet to deliver. On the other hand, the smart city discourse is used by the city managers and policy makers to support specific development strategies and policies. One of them is the emphasis on citizen empowerment and the promotion of the term 'smart citizen'. It takes a range of forms including e-voting, online-pooling (see

[2] This refers to the early network of creative industries in Northern Quarter region in Manchester and Amsterdam Digital Straat which is a website for the cultural activities going on in Amsterdam.

the example of after election survey on both Twitter and Facebook), and civic participation (i.e. smart street).

The following principles characterise heterotopia as being capable of juxtaposing in a single real place, several different spaces, several sites that are in themselves incompatible. Foucault, used Oriental Gardens and their representation of the totality of a world to demonstrate this point. In the smart city context, this could be unpacked on two levels. Currently when developing a smart city (especially in the UK) the common practice is to develop smart parts in a city and hope by connecting and joining these parts together, we'd have a smart city. In so doing, these smart parts represent the totality of a smart city. Secondly, the smart city embodies the totality of the future world we are building for ourselves. On the one hand, the 'smart city' conveys not only one person's vision of what a future city should be like. It in fact accommodates many parallel yet contrasting and contested views on what the urban future is and should be. Taking MK: Smart as an example, there are seven different working streams on turning Milton Keynes in to a smart city, even though there is some shared vision in these seven streams, each of them is working under its own aims and objectives to realise their version of 'smartness'. And previously, these priorities and working streams were never brought together and categorised side by side in such manner. Similar situation could be found in the Manchester smart city project CityVerve, the Smart Dublin project and the Future City Glasgow project. In other words, this is a debate about whose smart city is the real smart city, whether that is the citizens', the communities', the councils' or other stakeholders' smart city. On the other hand, the 'smart city' rhetoric is often based comparing and contracting the present and the future, the status quo and the ideal, the real and the fictional. Going through the smart city blue prints and strategy, there's always the beautifully rendered futuristic city images symbolises the 'smartness'. They feature the driverless cars, the skyscraper forest and the people-less street whereas the city we live in has traffic congestions, real forest and traces of residents (such as street littering). And this embedded desire and longings for an alternative reality (whether better or not) give a smart city the quality of being surreal and marks it a heterotopia. The smart cities' fascination and obsession of future brings us to the next principle.

Heterotopias are often linked to slices in time. This fourth principle when applied to the 'smart city' helps us to unpack another feature in the urban smart city process – time or temporality. Foucault marks this link with time by contrasting heterotopias that are oriented towards the eternal (e.g. museums and libraries) with the ones oriented towards temporal (e.g. fairgrounds). One shows the accumulations of time, whereas the other portrays time's more transitory aspects. When talking with the smart city experts, one thing that they recognised and acknowledged was that every smart city would have a project on traffic management. Wiring the streets up with sensors and cameras in order to achieve

the ‘real time’ response to either congestion issues and traffic pressure in general, or to calculate and predict the best route. When applying this concept to a place with the potential of big crowds, we have the ‘smart parks’ that are dedicated to monitoring, predicting and managing crowd movement during large gatherings such as the crowd movements before and after events (i.e. a football match or a music festival). It seems that the city has to develop this capacity and ability to respond in ‘real time’ and any latency would be viewed as ‘not smart’ or potentially ‘dumb’. Under the overarching theme – efficiency, the ‘time’ in a smart city has to be at least in real time if not in the future. As one expert put it, “we may not know what to do with these data sets yet but we need to collect them and keep them in case one day we figure out what to do.” This quote captures many smart cities’ obsession with data gathering as an act of archiving. Apart from Beijing, every other smart city in my study has endorsed this obsession by having their own data dashboard. The ‘smart city’ design we see from the smart cities (London, Manchester, Dublin, Glasgow, and Barcelona etc.) is not only trying to enable a city with immediate actions and responses, but also with the survival strategies against the challenge posted by time, hence being “future-proof”.

Foucault then talks about the opening and closing of a system in heterotopias in the fifth principle. In the ‘smart city’ context, this means the silos and isolation created by the technology we introduce to the urban system. Open data and government transparency are two major components of a smart city agenda, it opens up what used to be closed data to people who possess the knowledge, power and capacity to access it. However, people who does not have digital literacy, who cannot afford smart technology, and people who are not ‘smart’ enough then would be locked out of the ‘smart city’. During the interviews, I asked the experts what they think the current smart city is serving, some of them think it is serving no one and some has pointed to the technology companies, government who bought into the smart city vision and us researchers who base our work in this realm but none of them answered citizens. This leaves me wonder that does this mean the smart city heterotopia only opens to the privileged but not to the ones it promises to ‘empower’?

The final principle, the last trait of heterotopias identified by Foucault, is that they have a function in relation to all the spaces that remains. Holland (2008) argues that there isn’t a single city that stands unchallenged as a smart city. Some experts I interviewed have argued differently. There may not be a city that is unequivocally smart, but there are many parts of the city that are smart as demonstrators or experiments. These demonstrators in the city, such as the ‘Smart street’ (Tenison Road in Cambridge), ‘Smart district’ (Merchant city in Glasgow) and ‘Smart park’ (Queen Elizabeth Park and Hyde Park in London) they exist to help the smart city developments to “walk the walk rather than talk the talk”, and they also resonate the experiment nature of the smart city projects that Tironi and

Criado (2015) has pointed out. Such an existence helps to showcase how some smart city technologies work, and, more importantly, work to convince. Technology companies uses them to convince the city managers and cities use it to convince their citizens being 'smart' is the way (if not the only way) to move forward. In this way, the smart city indeed has a function to all the surrounding spaces as a pioneer, as an exemplar and as a standard. For research, it is the test bed, the living lab and the experiment field. For technology companies it is the major market to produce and vend their cutting edge technologies. For city managers and councils, it is the buzzword and the vision that attracts funding for developments (whether it is smart or not).

'Smart city' is paradoxical, it simultaneously is a city and is not a city. It means different things to different people in different context. It imposes a rather simplistic and singular moral order on cities, that being 'smart' means good without much discussion of why. It presents a future that social, societal and urban problems are so amenable to technological solutions. However, despite all these paradoxical natures of the current 'smart cities', more cities are catching up with their own smart city agendas.

So what? - Final Remarks

> Parts of the world are caught in our ethnographies, our histories and our statistics. But other parts are not, or if they are then this is because they have been distorted into clarity. (Law, 2004)

For decades, urbanists worldwide have been calling upon a different mindset while imaging and designing future cities (Jacobs, 1961; Lefebvre, 1991; Harvey, 2003; Soja, 2011). The purpose of adopting a Foucauldian approach is, to explore the alternative implications for design – and 'design' in its widest sense. This is also an attempt to continue and broaden the notion of 'implications for design' that has already been both explored and challenged by Paul Dourish in his 'Implications for Design' (2006) and 'Responsibilities and Implications: Further Thoughts on Ethnography and Design' (2007). The contribution I make here is to advance theory, specifically on how theory can motivate and catalyse technological and the urban developments in a process of co-production and co-envisionment. That is, to argue in essence that 'theoretical development' can also become a form of 'implication for design'.

Continuing this theme, there are all kinds of important questions we might reasonably ask of any theory or concept: notably, what 'work' does this theory or approach or category actually do? That is, what analytic work does it do? As Halverson (2002) suggests, the value of any approach or theory resides in how well it can frame the object of study, how the approach determines and highlights relevant issues. When viewed as tools for helping people understand a phenomenon, theories or concepts or approaches should possess particular

attributes: descriptive power, to help us describe (rather than misdescribe) the world; rhetorical power, to facilitate exactly how we can talk about the world; inferential power to enable us to make inferences and linkages between the theory and the 'real world', that in turn will hopefully lead to insights for both practice and policy, for example, offering some clues as to the likely effect of introducing change into a particular setting or a smart city - to help us choose between alternative prospects, to give us some purchase on which approach might yield results; and 'application' power that links the approach to policies and some form of 'design' in the world. Of central concern is the problem of relevant description, inference, rhetoric and application, and how we go about deciding them. When we use conceptual frameworks or theories to talk about the smart city and its intersection and inter-relationship with a host of other social and technical variables, how relevant are the issues we point to, both in describing the phenomenon and in informing policy and practice? Do they provide us with a conceptual framework for deciding which behaviours and activities, what pattern of regular and unusual events, we should be attentive to? Can it result in positive and relatively definitive statements about particular aspects of smart city settings (of housing, transport, empowerment, etc), about social policy and about social practice? Above all, and somewhat beyond the clearly serious concerns expressed by Halverson and Dourish, accepting that (social or cultural) theories rarely contribute much in the way of predictions or even concrete proposals for design, then maybe the criteria for evaluating the worth of a theory should change, towards the idea that a theory is valuable if it is 'interesting', if it makes us think in new and different ways (or just at all). And so I turned to Foucault.

> A critique is not a matter of saying things are not right as they are. It is a matter of pointing out on what kinds of assumptions, what kinds of familiar, unchallenged, unconsidered modes of thought the practices that we accept rest. (Foucault, 1988:155)

I don't consider this to be an especially persuasive defence of theory or 'theoretical frameworks' and so I intend to conclude this paper by considering how this Foucauldian theatrical approach plays out in terms of the attributions of theory that Halverson documents, whilst also suggesting that such an approach is 'interesting' and intellectually 'fertile'.

The first power or attribution Halverson calls 'descriptive power', which refers to a conceptual framework that helps us make sense of and describe the world. She notes how this can include both a description of the context and a critique of technology in that context. Relatedly, Halverson describes how a theory can have power in terms of "application" — that can be used to guide system design through describing the world at the "right level of analysis": this right level of analysis has to include both technical or technological levels as well as social and cultural levels. The Foucauldian notion of discursive formation has helped me draw out contextual features – how the smart city discourse emerged from a process of absorbing features of other urban imaginary came into existence. How

the nature of this smart city discourse made it hard to pin down a universal definition and thereby made it possible for many different technologies, disciplines and topics to rub shoulder with the smart city. Halverson continues to describe how a theory needs 'rhetorical power' or the capacity to "talk about the world by naming important aspects of conceptual structure and how it maps to the real world". I suggest that the genealogical and archaeological way of analysing assisted me to argue that from the shared 'important aspects' between the smart city discourse and other discourses (e.g. intelligent city, sustainable city, green city etc.), that the smart city emerges as neither new nor unique. Though the smart city does not exit to be an exact embodiment of any singular urban imaginary but a refined and updated collective of several rhetoric that makes it even more fitting, promising, and attractive. Similarly, a Foucauldian heterotopia perspective provides great 'inferential power' to understand the smart city, as being a heterotopia that none has claimed to have fully decoded. By introducing the Foucauldian way of thinking into the smart city research and analysis, I try to understand the features, unpack the discourse and describe it 'better' (or at least providing a counter perspective) so that the next set of design, development, research and policy decisions can be made with particular groups of people and citizens in mind, anticipating a future we are heading towards with the current smart city discourse.

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