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Liquid Workplaces: The Potential Implications of Virtual Reality on the Workplace

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Abstract. Recently, virtual realities or immersive virtual environments (IVEs) has gained increasing attention. Yet, IS-researchers have paid little attention to the implications of IVEs in a work context. The objective of this paper is thus to understand how the use of IVEs may impact our workplace, and how we feel present in them. Theoretically, we build on Bauman's concept of liquid modernity and the concepts of point-of-view and presence. We substantiate our literature review by analysing newspaper articles. Based on these insights, we argue that because work is performed in more fragmented workplaces we are going from a more collective to individual feeling of presence in the workplace. The first contribution is to close the knowledge gap that exists in the academic literature on IVEs in a work context. Second, practitioners will have a better understanding of the changes IVEs have on workplaces and how we feel present in them.

Keywords: Virtual reality, Workplace, Presence, Liquid modernity

1 Introduction

Virtual reality (VR), is a 3-dimensional digital space that users can access through a wide range of display technologies. Within the last 5 years VR has been gaining much attention. For example, Goldman Sachs predicts that VR, together with augmented reality, will become a $80 billion market in 2025 [1]. Roughly the same size of the desktop PC market today. In the popular press VR is often associated with immersive systems like head mounted displays. A head mounted display is an *immersive system* as it: "…deliver[s] a surrounding environment, one which shuts out [the] sensations [of the user] from the real world.." [2] (p. 560). By immersing users in a virtual environment the likelihood of feeling "physically" present in a virtual environment increases, which in turn can, among other things, increase productivity, task performance and collaboration in virtual environments [3–5]. As work and our workplaces are becoming ever more distributed, immersive systems are relevant for IS scholars to explore further.

However, IS scholars have not been giving the same attention to immersive systems in relation to work as within some other academic disciplines such as computer science and psychology, thus to a large extent overlooking the immersive aspects of *technologies* [6–8]. Instead, IS has focused on the effects that virtual

environments like for example virtual worlds, produce on the user [6]. Consequently, there is a need to explore the implications immersive systems like head-mounted displays as well as the more immersive virtual environments that these systems produce in a work setting. In this paper, we will therefore focus on the implications that immersive virtual environments (IVEs) have on the workplace.

As IVEs are a relatively new technology within IS, we will initially look at how earlier and more established concepts within IS have changed workplaces and the way workers feel present in them. By analysing the diffusion patterns of similar information technologies (IT) in the past, we aim at understanding how IVEs will change workplaces and how we feel present in them in the future, hence exploring the following research question:

RQ: *How are immersive virtual environments (IVEs) likely to change the workplace and how we feel present in them?*

To answer this question, empirical data will be gathered from newspaper articles published in the New York Times, thus limiting the scope of this paper to a North American context, primarily. By addressing this question, this paper provides two contributions. First, it closes the knowledge gap that exists in the academic literature on IVEs in a work context. Second, by building on this knowledge, we argue that practitioners will have a better understanding of the consequences of related IT in different types of workplaces.

In what follows, we start out by presenting the theoretical foundations of this paper. We then review the literature on telework, mobile work, virtual teams, and IVEs to identify how these technologies over time have changed the workplace and how we feel present in them. To substantiate the literature review and the relatively sparse literature on IVEs, we apply the concepts to empirical data to get a more nuanced understanding of how telework, mobile work, virtual teams have changed our workplaces and how we feel present in them. This in turn will help to understand how IVEs are likely to change our workplace and how we feel present in them in the future.

2 Theoretical Foundations

We build on three theoretical lenses: Bauman's [9] concept of the *liquid modernity* and the concepts of *point-of-view* and *presence,* which will be used to understand the implications that IT have on workplaces. Specifically, *liquid modernity* is useful for understanding how workplaces are increasingly becoming more fluid because of the proliferation of IT. Lastly, *point-of-view* is used to understand how workers experience *presence* in virtual workplaces.

2.1 Liquid Modernity, IT, and Workplaces

Bauman [9] uses liquidity and fluidity as metaphors to understand the ways in which IT has contributed to an increasing fluidity of our society. He argues that work is an activity in which one performs *"…[a]'bodily or mental toil'…"*, to accomplish something [9] (p. 137). During the industrialization, work was done in large scale factories that reside in big solid buildings [9]. Workers had less flexibility, but work was a collaborative effort. However, what we used to consider solid, including our workplaces, is becoming more fluid. As a consequence, we increasingly act in individual arenas leading to a more individualized form of socializing [9]. Bauman attributes this change to, among other things, IT like e-mails and mobile phones. Specifically, IT has made it possible to access all parts of space instantaneously which has made it possible to transform almost any space into a workplace [9].

With the lens of liquid modernity, we will show how the concepts of telework, mobile work, and virtual teams have fragmented our workplaces and changed the way we feel present in the past in order to understand how IVEs is likely do the same in the future.

2.2 Point-of-view and Presence

When interacting physically and/or virtually, people can perceive each other from two different *point-of-views*; i.e., from a *first-* and a *third*-person perspective [10, 11]. The first-person perspective is equivalent to how we see and interact with each other physically. When users perceive something from a third-person point-of-view, they interact through representations. For example, when employees are communicating via e-mails, they are looking *at* a virtual workplace, the e-mail client, and are represented and socialize through their e-mail address and text.

The *point-of-view* will be used to understand how telework, mobile work, virtual teams, and IVEs affect the way in which we interact. The point-of-view affects if and how users feel a sense of *presence* when socializing. In this paper, we use the following forms of presence [12]: *telepresence, social presence, co-presence,* and *self-presence*. Telepresence is about the illusion of being in a distant place – how "real" something feels. Social presence is about the illusion being *with* somebody else. Co-presence is the illusion of having access to a distant other that shares the same *place*. Self-presence is the illusion that one's virtual representation is oneself. While many other forms of presence exist, these have been chosen as they are some of the most commonly cited forms of presence, and encompass the development of the reviewed concepts in the following section [12, 13].

3 Literature Review: Telework, Mobile Work, Virtual Teams, and Virtual Reality

In the following, we will review the literature relating to the concepts of telework, mobile work, virtual teams, and IVEs. The literature review of IVEs will to a large

extent draw from literature outside that of IS, due to the lack of focus on IVEs, as mentioned in the introduction. The review will focus on how the aforementioned concepts have affected workplaces and how these technologies change the way we feel present in any given workplace. The review will not be exhaustive, but rather illustrative in order to delineate a historical trend relevant for the research questions [14, 15].

3.1 Early 1990s: Telework

Nilles [16] defined telework as something that: "…includes all work-related substitutions of telecommunications and related information technologies for travel…" [16] (p. 301) and was made possible by technologies such as local area networks, intranets, laptops, and modems [16, 17]. Lindström et al. [18] and Qvortrup [19] denoted different types of workplaces which are typically related to telework. For example, the neighbourhood work centre is a workplace in which workers from different companies can work. A satellite work centre is typically set up by a single company. Both types of workplaces aim at reducing the commutes for workers. When IT became cheaper, offices were established at holiday resorts, office resorts, and in the home, i.e., electronic home offices. IT therefore made it possible to work outside the vicinity of the main workplace.

As the workplace changed, so did the interactions and how employees perceived each other. Employees, working in the main workplace, predominantly perceived one another from a first-person view. However, as workplaces became more fragmented, many interactions between employees changed from being in person to a third person-view; e.g., through e-mail. This led to less first-person interaction thus decreasing the sense of being in a place (telepresence), the sense of being with someone (social presence), and the sense of sharing a space (co-presence) [12, 13].

3.2 Mid-1990s: Mobile Work

The concept of mobile work was first introduced when mobile technologies, like mobile phones and wireless technologies, became popular and mainstream in the mid-90s. When first introduced, many practitioners and scholars alike predicted that work would become independent at anytime and anywhere [20], while others were more careful in their predictions [21–24]. However, work activities could to a large extent now be performed when being mobile compared to telework typically done at a fixed site, see e.g. [25, 26].

Work that is done in: *"…locations such as hotel rooms, or on trains or flights when travelling…"* can thus be defined as mobile workplaces [18] (p. 249). New types of workplaces thus emerged, as technology allowed for transforming, i.e., hotels into workplaces when on the move.

As with telework, when using mobile technologies, the interactions between employees are done from a third-person point of view. When more work is performed routinely from remote locations on the go, e.g., in airports or hotels, it the degree of

one's first-person encounters with the other employees becomes less prevalent thus decreasing social and co-presence, particularly.

3.3 Late 1990s: Virtual Teams

Virtual teams (VT) can broadly be defined as: "*…an interdependent group of people working towards a common goal while separated by geographic distance, time and/or location… predominantly by using information and communication technologies…*" [27–30] (p. 1). VT became mainstream in the late 90s because of an increase in bandwidth and because of the possibilities of conducting video conferencing[31–33].

Examples of workplaces used by virtual teams are virtual workplaces and virtual worlds. Virtual workplaces created by groupware or collaborative technologies started in the mid-90s [34, 35]. When computational power and bandwidth increased in the mid-00s, virtual worlds like Second Life became popular in a work context [36]. According to Schultze, *virtual worlds, "…are multi-modal platforms that feature rich graphics, 3D rendering, high-fidelity audio and video, motion and interactivity"* [12] (p. 1). These types of virtual workplaces thus made it possible for workers to collaborate and work in virtual environments.

Just as with teleworking and mobile work, people see each other from a third-person perspective, which affects social and co-presence. However, in virtual worlds, when controlling an avatar, users become embodied and can, "…e.g., sit, smile, and dress appropriately… " [12] (p. 2). This in turn help users feel a sense of self-presence; i.e., a sense that the representation is indeed oneself, in addition to increased tele-, social, and co-presence [12] [4, 10].

3.4 2010s: Immersive virtual environments

IVEs are 3 dimensional virtual environments run on an immersive system. According to Fox et al. [8] an IVE can be defined as: *"A VE [that] can be implemented on… a fully immersive virtual environment (IVE) in which a user can move around a physical space while wearing computer equipment." [8] (p. 96)*. IVEs has been used and investigated in many different areas of research [37–40]; however, when reviewing the literature on IVEs within the IS discipline, only a handful of articles mentions IVEs and less mention IVEs in relation to workplaces. When the immersive aspects of virtual environments have been under investigation, it have often been confused with the immersive *responses* that is produced by immersive systems like head-mounted displays [6]. For example, the psychological feeling of being present in a virtual environment. IVEs can be created by many different media, though it is often associated with head-mounted displays (head-mounted display) [38]. HDMs have recently gained in popularity again, as the technological development has made them cheaper and more mobile since the first generation of head-mounted display in the start 90s.

Displays mounted to the head provides the user with greater sense of telepresence than any of the other technologies [4]. Furthermore, because one has the possibility to see oneself in a first-person view, the users in these workplaces can also experience a greater sense of self-presence [13]. Yet, it is argued that head-mounted display does not necessarily increase the social and co-presence compared to virtual teams [12].

Table 1. Overview of concepts.

	Telework	Mobile Work	Virtual Teams	Immersive virtual environments
Technologies	LANs, intranets, laptops, modems	PDAs, cellular phones, smartphones, laptops, wireless technologies	Web-cams, broadband, shared repositories and file systems, flat screen 3D graphics	Head mounted displays and panoramic displays
Workplaces/ Workspaces	Main workplaces, neighbourhood work centres, satellite work centres, and electronic home-offices	Mobile workplaces; e.g., hotel rooms, trains, airplanes	Virtual team work platforms, virtual learning environments, screen-animated virtual worlds	Immersive virtual environments (i.e. virtual worlds)
Point-of-View	1st and 3rd person view	3rd person view	3rd person view	1st and 3rd person view
Telepresence	Low	Low	Medium	High
Social presence	Low	Low	Medium	Medium/High
Co-presence	Low	Low	Medium	Medium/High
Self-presence	Low	Low	Medium	High

We provide an overview of the concepts from the literature review on telework, mobile work, virtual teams, and IVEs in Table 1. Specifically, we have seen a shift in the way in which we perceive each other and work. Work is to a higher degree performed in more fragmented workplaces that with varying levels activate certain types of presence affect the way we feel present in our workplaces. To substantiate the literature review and the relatively sparse literature on IVEs and workplaces, we apply the concepts to empirical data to get a more nuanced understanding of how telework, mobile work, virtual teams, and IVEs have changed our workplaces and how we feel present in them. We describe our approach next.

4   Research Design: Data Identification, Collection, Preparation and Analysis

The newspaper articles were obtained from The New York Times from 1990 to 2016. Newspaper articles were used because they provide easy access to a longitudinal and unobtrusive set of data [41]. The New York Times was chosen because of its relatively balanced view on technologies as it aims to provide news for a broad audience, which is in alignment with our wish to understand IT' influence on workplaces and the everyday worker's feeling of presence in the workplace. Being located in the United States, the scope of the study is naturally limited to a North American context.

The relevant articles were found by utilizing *Factiva* as it provided full access to articles in the aforementioned period and supported relevant search queries. The search and collection process were divided into two steps. First, the concepts identified in the literature review were used as search queries (see Table 1). Second, a subset of articles was chosen by screening titles. Articles with relevant abstracts were screened and included in the review if they mentioned how IT influence workplaces and the everyday worker's feeling of presence in the workplace. When new words that related to the themes were identified, they were added to the search queries. See Table 2 for an overview of search queries and number of articles.

After the screening process, we imported the articles into NVivo for subsequent analysis [42]. The data sources were named automatically when imported after the author and the date of the article. The data analysis and coding was done in inductively, with the aim of creating a codebook that could be used for thematic analysis of the newspapers [43]. We followed the following process: 1) we identified articles within each category that mentioned workplaces and the feeling of presence in the workplace; 2) we found relevant units for coding, typically between 5-10 lines of writing and put them in a high-level code, named workplaces; 3) then we made sub-codes out of the initial high-level code, workplace, to identify types of workplaces that were mentioned in the literature i.e. electronic home office. When the codebook was created, we tried to identify themes within and across the sub-codes.

Table 2. Overview of articles and search queries.

Concepts	Search Queries	Search Result	After Screening
Telework/Telecommute	Telework* OR Tele work* OR Telecommute*	378	26
Virtual teams	Virtual team* OR Virtual work* OR Virtual office* OR Virtual Organizations*	207	35
Mobile work	Mobile work*	181	31
Immersive virtual	Virtual reality* AND work	816	40

5   Analysis: From Solid to Fluid Workplaces

The analysis delineated four types of workplaces that illustrate the shift from solid to fluid work-places and the subsequent change of the feeling of presence in the workplace (see figure 1). Specifically, how telework, mobile work, virtual teams, and IVEs have made it possible to do work in fragmented workplaces and how this has changed how we feel present in them.
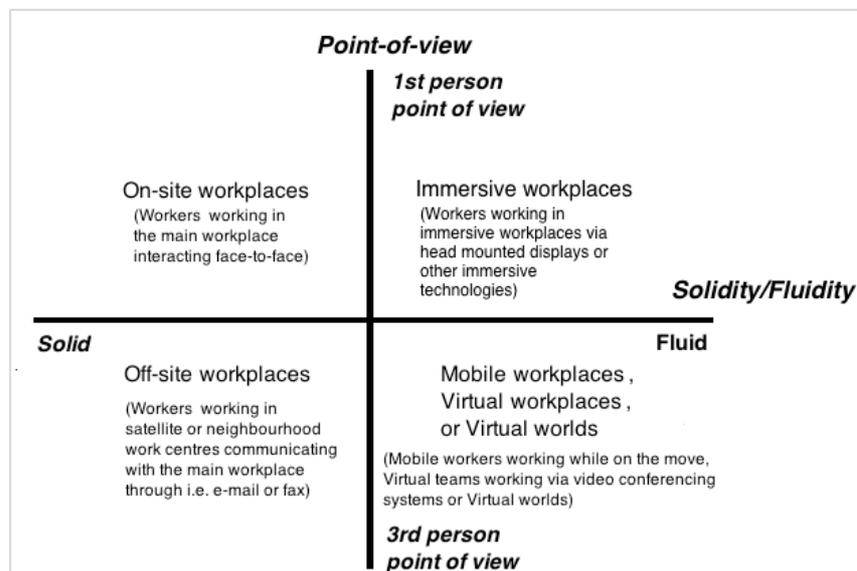

Fig. 1. Overview of workplaces

In the following paragraphs, the respective workplaces and how workers feel present in them will be further elaborated on.

5.1   Solid Workplaces

On-site Workplaces - The Main Workplace. These types of workplaces are delineated in space and were especially prevalent during the industrialization in the form of i.e., big factories [9]. Before IT became mainstream in the main workplace, people were often very reliant on the main workplaces [44]. However, many companies – especially IT-companies like Google – stress the importance of working in the main workplace, hence stressing the importance of 1st person encounters [45].

Off-site Workplaces - Electronic Home Offices, Neighbourhood, and Satellite Work Centres. When modems and local area networks became more widespread, work became more fragmented. Work, and especially white-collar work, could now be done from a distance. Pacific Bell had in 1992 more than 1 400 of its 16 000 management employees working at home, reducing the commute and increasing the flexibility of employees [46]. Another company, The Travelers Corporation of Hartford, highlighted that employees working from home could attend to family obligations, and the company was in return able to reduce the need for office space. Bigger companies made satellite work centres, while smaller companies cooperated and established neighbourhood work centres located closer to their employees as IT equipment and infrastructure was too expensive to buy and operate alone.

However, problems arose with the increasing fluidity of space, resulting in many workers going back to the main workplace or neighbourhood work centres. One oft-cited problem when working in off-site workplaces is the lack of social interaction as workers that interact in a 3rd person-view; i.e., through e-mails employees feel neither social- nor co-presence. In the 2000s, big IT-companies, like Yahoo, paradoxically revoked work home arrangements, as they stressed the importance of face-to-face collaboration and communication [45].

5.2   Fluid Workplaces

Mobile and Virtual Workplaces - Mobile Workplaces and Virtual Environments. Mobile workplaces became mainstream with the increasing use of mobile and smaller technologies like microprocessors. Apple for instance released the Newton in 1993, a Personal Digital Assistant that could help "high-tech nomads" and "road warriors" to work anytime and anywhere. The workplace was now mobile, and work could be done when on the move; i.e., in the car: "Rootless, mobile, armed with 120 megabytes in his briefcase, Mr. Cruz, a 32-year-old account executive at Travelers Insurance… has computed insurance audits in parking lots and at restaurant counters." [47]. By establishing IT infrastructures in the physical structures of hotels, vacation resorts, and cars, the on-site workplace became less important as work could now be done anywhere. In addition, work in virtual workplaces became widespread around the same period.

In 1996, the former CEO of Hitachi said: "The [physical] office as we know it is history…" [48] when asked why they did not want to focus on desktop computers. However, as with off-site workplaces, people still missed the office for socializing and to feel a part of something. Workers had become little more "…than the sum of their e-mail…" [47] or a talking head [49]. These technologies could not activate social- or co-presence. When virtual worlds like Second Life came along, users became embodied through avatars, which could increase the level of tele-, social-, co-, and self-presence [12].

Immersive workplaces. In the beginning of the 90s, digital head-mounted displays became popular mostly for gaming purposes. In this period, a head mounted display setup could cost nearly $200 000, which together with some technological limitations

hindered a widespread use [50]. However, immersive technologies, like head-mounted displays, found a foothold in some work contexts, like psychology. One important reason for this was that head-mounted displays provided patients with a level of presence unmatched by any of the aforementioned technologies. Patients could for instance be treated for different phobias like social anxiety in controlled virtual realities with virtual avatars.

However, due to among other things user friendliness and price, it has largely been regarded as a research tool [7]. In 2010, the technology had become more mobile and much cheaper which could lead to a wider use in other industries. However at present, IVEs are mainly used within the gaming industry [51, 52]. At present, psychologists use head-mounted displays as a tool, while sitting next to the patient in an office. However, if head-mounted displays become even cheaper to buy and easier to use, parts of a treatment or whole sets of treatments could move into a virtual workplace, making it possible for the patient to be treated at home. Consequently, the work of the psychologist or patient will then move from the vicinity of on-site workplaces to virtual workplaces, making the workplace of psychologists more fluid and fragmented.

In conclusion, the four types of workplaces can be delineated and categorized along two dimensions (see Figure 1). The first dimension indicates the fluidity of the workplaces, ranging from solid to fluid. Specifically, IT have fragmented the on-site workplace consequently creating new forms of workplaces. The second dimension indicates the point-of-view, from 1st to 3rd person view and thus the level of presence of the respective workplaces.

6 Discussion: From collective to individual feeling of presence in the workplace

Technologies miniaturization, increased mobility, decrease in cost, and improved level of presence have all made it possible to integrate and use technologies in the workplace and resulted in the "breaking down" of the physical walls of the workplace. Consequently, our more fluid and fragmented workplace has opened up for more flexibility for the individual worker. However, the increasing fragmentation of workplaces and workers has also changed our perception of work. As workers increasingly carry out their work in fragmented workplaces, it is harder to collaborate and act collectively. According to Bauman:

> *The novel instantaneity of time [made possible by IT] radically changes the modality of human collaboration…, or rather change the way in which they [humans] make (or do not make, as the case may be) certain affairs into collective ones* [9] (p. 126).

While the increased flexibility of workplaces and our perception of work in many cases have been of great benefit, the shift from a collective to an individualized perception of work can help to explain why it, for instance, is so hard to establish trust when working in virtual teams, see for instance Gilson [53].

7 Concluding Remarks and Outline of a Future Research Agenda

In this research in progress paper, we set out to answer the following research question: *How are immersive virtual environments (IVEs) likely to change the workplace and how we feel present in them?* By doing this, the aim is to close the knowledge gap that exists in the academic literature on IVEs in a work context which in turn can help practitioners to gain a better understanding of the consequences that IT, hereunder IVEs, can have in different types of workplaces. Specifically, by analysing the concepts of telework, mobile work, and virtual teams, we found that these technologies fragmented our workplaces and that IVEs are likely to do the same in the future. On the one hand, IT and the increased fluidity or fragmentation of our workplaces has provided workers with many benefits, including more flexibility and individualized work style. On the other hand, this change has also made it harder to work and collaborate as more and more work is increasingly done via multiple representations of one's self, which result in communication and contextualization breakdowns.

Future research could firstly expand the study to see if a similar fragmentation could happen in other geographical contexts and if so see if the implications of this fragmentation is the same i.e. a lack of trust. Secondly, future studies should look more into the consequences of the increasing fragmentation of workplaces, which the analysis shows, do not seem to slow down with the increasing proliferation of IVEs. We briefly mentioned that one consequence could be an increased difficulty in establishing trust when working through IVEs, but this needs to be investigated further. In addition, by looking at areas like psychology and the gaming industry, much can be learned, as they have experienced the effects of IVEs for a while [50, 54].

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