

Stochastic Machine Witnesses at Work: Today's Critiques of Taylorism are Inadequate for Workplace Surveillance Epistemologies of the Future

Sandy J.J. Gould

goulds@cardiff.ac.uk

School of Computer Science and Informatics

Cardiff University

Cardiff, Wales, UK

ABSTRACT

I argue that epistemologies of workplace surveillance are shifting in fundamental ways, and so critiques must shift accordingly. I begin the paper by relating Scientific Management to Human-Centred Computing's ways of knowing through a study of 'metaverse' virtual reality workplaces. From this, I develop two observations. The first is that today's workplace measurement science does not resemble the science that Taylor developed for Scientific Management. Contemporary workplace science is more passive, more intermediated and less controlled. The second observation is that new forms of workplace measurement challenge the norms of empirical science. Instead of having credentialed human witnesses observe phenomena and agree facts about them, we instead make outsourced, uncredentialed stochastic machine witnesses responsible for producing facts about work. With these observations in mind, I assert that critiques of workplace surveillance still framed by Taylorism will not be fit for interrogating workplace surveillance practices of the future.

CCS CONCEPTS

• **Human-centered computing** → **HCI theory, concepts and models.**

KEYWORDS

Metaverse, Workplace Surveillance, Work Measurement, Scientific Management, Taylorism, Neo-Taylorism, Ubiquitous Computing

ACM Reference Format:

Sandy J.J. Gould. 2024. Stochastic Machine Witnesses at Work: Today's Critiques of Taylorism are Inadequate for Workplace Surveillance Epistemologies of the Future. In *Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '24)*, May 11–16, 2024, Honolulu, HI, USA. ACM, New York, NY, USA, 13 pages. <https://doi.org/10.1145/3613904.3642206>

1 INTRODUCTION

The use of digital technology for monitoring, tracking and surveilling staff is a standard feature of modern workplaces. How has digital surveillance changed, and how might it change in the future? And critically, do we have the tools as a discipline for reasoning about

these changes? This paper takes the form of a metascientific study. It is not an empirical study in the typical ACM CHI style. I have not interviewed workers or managers for this study. I have not surveyed researchers. Instead, this is an investigation of scientific practice at work, drawing on past empirical work and contemporary theory to make an *argument* contribution¹.

I build my study in several stages. First, I will give some context on the history of measurement in workplaces and the ways that critiques of measurement practices have evolved alongside them. I focus on Scientific Management (i.e., Taylorism), its descendants, and its critiques (e.g., neo-Taylorism), but also reference the ethnomethodological tradition of workplace research. This sets up the context of contemporary workplace surveillance and the conceptual framings we use to talk about it. I then take a disciplinary turn, exploring how measurement has been constructed in Human-Centred Computing (HCC²) over time. This provides the context in which I build connections between the epistemologies of HCC research and workplace surveillance. The aim is to take a critique that is grounded in the sociology of work (neo-Taylorism) into work-based research that draws on HCC epistemological traditions.

To make the connection between emerging technologies, neo-Taylorism and HCC concrete, the next stage of the study develops a vignette of workplace surveillance in virtual reality workplaces that exist in metaverses, like the 'Metaverse' developed by Meta³. Do these workplaces, instrumented with the kinds of context sensors pioneered in ubiquitous computing and with interaction design informed by HCC, provide unlimited scope for workplace surveillance? Are they the kinds of workplaces that Frederick Taylor would have built 110 years ago, if only technology had permitted it? I suggest that a neo-Taylorist account of workplace surveillance would say yes; a VR workplace provides almost unlimited scope for observation and control.

I finish the study by examining whether the emergent changes to workplace surveillance technology really lend themselves to analysis by contemporary critiques of Taylorism. I argue that the epistemology of modern workplaces is changing, and that the science of work is increasingly part of a stochastic zeitgeist (after [15]). Data-driven science is often the norm, in contrast to Taylorism's demand for planned, controlled experimentation. I claim that observation of workplaces will increasingly be undertaken by

CHI '24, May 11–16, 2024, Honolulu, HI, USA

© 2024 Copyright held by the owner/author(s).

This is the author's version of the work. It is posted here for your personal use. Not for redistribution. The definitive Version of Record was published in *Proceedings of the CHI Conference on Human Factors in Computing Systems (CHI '24)*, May 11–16, 2024, Honolulu, HI, USA, <https://doi.org/10.1145/3613904.3642206>.

¹<https://chi2024.acm.org/submission-guides/contributions-to-chi/>

²I use the term Human-Centred Computing over Human-Computer Interaction because the literature I am drawing on, and the community that I am trying to speak to, is broader than that which is covered by 'interaction' alone.

³<https://about.meta.com/what-is-the-metaverse/>

artificial witnesses, often outside the direct control of employers. With these changes, I assert that we need to be careful about returning to Taylor, recognising that by framing workplace surveillance in early 20th century management theories (augmented as they may be), means we may not be alert to changes that fall outside the scope of such theories. If we are not alert, then we may see workplaces change in unanticipated ways, compromising our capacity to defend the right of workers.

1.1 Positionality

I have come to this work having experienced a realist, often positivist training. My empirical research has largely retained a post-positivist character across a variety of research methods. Throughout this paper, I use the word ‘measure’. I view this term as being aligned with realist epistemologies, implying that phenomena exist ‘out there’, and that we just need to find a way to access (i.e., measure!) them. I have chosen to use ‘measure’ in this paper because, I believe, it is most apt to the discussions of contemporary surveillance at work, Taylorism, datafication and HCC that follow. Ways of framing what happens in work research other than ‘measurement’ would admit more diverse interpretivist or constructivist stances, and while I touch on these, they are not the focus of this piece. I acknowledge that, though I make a substantive argument for ‘measure’ being appropriate, my training and research experiences will also have significantly influenced my choice of language and constructs in this critique.

This paper is about the nature of work and its future. My orientation in discussions of work is to centre the perspectives and needs of those assuming the role of ‘managed’ over those assuming the role of manager (this is not an uncommon perspective in the CHI community [39]). This manifests in the tenor of the paper, which is critical of management and tech-firm innovation, and undertakes its conceptual development to ‘protect the interests of workers’. I accept that there are alternative framings of what follows that could, say, centre the interests of organisations, managers, shareholders, or states. I acknowledge that choosing not to take up such framings reflects my preferences and disposition, rather than any intrinsic ‘correctness’ of a position. Other papers could be written that centre the perspectives of those actors and with them in mind enumerate the consequences of the changes I articulate here. They would be useful.

1.2 Provenance

What is the motivation for this work, and what is the need for it⁴? The original motivation for this work came from observing the increasing use (and consciousness) of workplace surveillance tools (‘bossware’) stemming from the pandemic [30]. I also noticed metaverses entering the news media consciousness [74]. Initially, I had simply planned to use critiques from the sociology of work (neo-Taylorism, digital Taylorism) to connect metaverses and bossware in a way that would be useful for a CHI audience. In attempting this critique, though, I came to the conclusion that critiques of work measurement, as commonly formulated, are premised on ideas about measurement and workplaces that may no longer hold.

⁴I am grateful to an anonymous reviewer for suggesting that this section might be a useful aid to contextualising this paper.

At this point, metaverses went from being the primary focus of this work to a vignette that supports a broader argument about workplace research epistemologies and work surveillance critiques. I hope that that has ultimately led to a contribution that is more essential than the application of a particular critique of a particular work context would be (even if this work also doubles as that).

What about the *need* for this work, beyond satisfying my own curiosity? CHI has published many critical essays (or ‘arguments’) over the years (e.g., [5, 19, 37, 49, 56, 81, 84]), including ones on work (e.g., [7]). I have valued these contributions *because* they have been able to advance arguments without being tightly bound to particular empirical results. For the parts of the CHI community that are interested in the future of work (including the computer-supported co-operative kind), virtual environments, and sensing, I felt there was a gap in the literature for a paper that related the development of new workplace tools and systems (and our understanding of them) to fundamental questions about ways of knowing (i.e., epistemologies). I have written this paper with the aim of prompting readers to consider these fundamental questions about ways of knowing as they develop productivity tools, as they capture something about avatars in virtual environments, or as they instrument working environments with new sensors. This paper should, I hope, give some ideas to readers about what they should be considering as they do so.

2 HUMAN-CENTRED COMPUTING AND SURVEILLANCE

The potential for connected digital technologies to surveil was recognised in the HCC literature as soon as networked digital technology achieved commodity status. Agre [4] offered ‘capture’ over surveillance when he discussed the potential for networked machines to measure, track or surveil. The point of the distinction was to emphasise the capacity of new technologies to actively reconstruct environments based on their capacity to sense: ‘activity is reconstructed through assimilation to a transcendent (“virtual”) order of mathematical formalism’ [4]. Agre saw this happening everywhere, including at work.

Since Agre’s work, digital technology has tremendously increased both the potential scope of workplace surveillance (or capture, as Agre would have it) and the ease with which it can be conducted [13]. Human-Centred Computing researchers have explicitly investigated the surveillance of emotion [93] in the workplace, as well as the power relations surveillance manifests [10, 95]. Perspectives are as varied as methodologies, whether researchers are using justice as a frame for understanding workplace surveillance [57], or trying to entertain the idea that workplace tracking could, in particular situations, empower workers [55, 110]. Though not described explicitly as surveillance, the HCC literature on algorithmic management and other kinds of technologies that constitute or rely on workplace measurement (e.g., [25, 68, 113]) have also implicitly been studying surveillance.

Researchers have examined the surveillance of workers in roles like public transport [87], most published work on surveillance in human-centred computing⁵ has focused on knowledge workers (e.g., [32]) or platform workers (e.g., ‘ride-sharing’, online microtask

⁵As opposed to, say, Human Factors

platforms). Sannon et al. [95], for example, found platform workers are exposed to surveillance as part of the measurement practices of platforms. They also found that, as such workers are ‘customer-facing’, they are also subject to (often gendered [10]) surveillance from their clients, too (i.e., the person commissioning a website or receiving a delivery). Altenried describes this surveillance as a way to homogenise the highly heterogenous demographic groups that these platforms require in order to maintain a sufficiently liquid labour pool [8]. Surveillance, unsurprisingly given its negative connotations, normally appears as a point of critique in these works.

These (conscious or unconscious) investigations of surveillance at work are a subset of broader work at CHI and other HCC venues that have assessed the power of technology to surveil [23] and the actors involved (e.g., [47, 69, 75, 94, 109]). The capacity of new technologies and platforms to surveil inside and outside the workplace is clearly an area of interest (or concern) for the CHI community. This paper aims to further develop the community’s thinking about workplace surveillance.

Is there anything connecting these various accounts of workplace surveillance, something that helps us to formulate some underlying principles of surveillance? With some exceptions (e.g., [4, 7, 14, 61]), the historical context of workplace measurement, control, surveillance does not feature strongly in HCC discourses on the instrumentation of workplaces for the measurement of staff. ‘Taylorism’ is sometimes used just as a synonym for workplace surveillance. In the sections that follow, I will go into some detail on Taylorism, and then attempt to connect it to epistemological preferences in HCC.

3 WORK SURVEILLANCE, SCIENTIFIC MANAGEMENT, TAYLORISM AND NEO-TAYLORISM

In the sociology of work literature, the increasing use of sensing technologies for quantification [78, 79] and the algorithmic control of work [111, 112] are, unlike a lot of HCC work, couched in the broader history of work studies. As Joyce et al. note, there can be a tendency for debates about technology in the workplace to inflate the scale of change “usually, by overstating technological novelty and understating social continuity, and ascribing decisive causality to the former” [60, p.147]. A grounding in the broader historical context can help prevent this overstatement. Work in the sociological tradition often relates the datafication of workplaces (with attendant sensors and algorithms) to Scientific Management (or Taylorism), a management theory from the early 20th century.

3.1 Scientific Management

Scientific Management has a positivist approach to epistemology, and so a positivist approach to understanding work. Taylor (the originator of the theory), in defending his ideas, claimed to have implemented Scientific Management “with the object of arriving at the exact truth as to the effect of the system upon the prosperity, wages, health and contentment and satisfactory conditions of the men working under it” [101, p.267]. The “exact truth” demonstrates his position. The importance of being able to measure as part of the process is also impressed: “The average workman must be able to measure what he has accomplished and clearly see his reward at the

end of each day if he is to do his best” [102, p.138], as is the necessity of experimentation: “A long series of experiments, coupled with close observation, had demonstrated the fact that when workmen of this caliber are given a carefully measured task”, they perform better and, according to Taylor, become “better men in every way” [102, p.106]⁶.

Taylorist approaches to understanding work can be seen as in contrast to more constructivist traditions to understanding workplaces. Garfinkel’s ethnomethodological approach, for example, resists the controlled, positivist aspirations of Taylorism and its descendants (see [106]). There is no sense of a dispassionate observer with truth-revealing measurements. The locus of where understanding comes from moves. As Rawls, puts it, “[t]he observer is not constructing the situation they are analysing, the participants are. Focusing on the observer at all is a problem in itself” [89, p.724]. Suchman’s work on situated action [98], so influential beyond work studies, takes place in this tradition.

Interpretivist approaches to understanding work have undoubtedly given us new knowledge (and new kinds of knowledge) about how work happens. The focus of this paper, though, is not on how researchers do or ought to study workplaces. The focus is on how workplaces are studied by the people that run them (i.e., managers). Whether such studies take the form of tracking, monitoring, or outright surveillance, critiques of these Taylorist-like approaches to understanding (and controlling) work are based on what is happening in workplaces. If we are talking about how work is understood within workplaces (rather than by, say, work anthropologists going into them), then, by and large, Taylorism and descendant ideas tend to dominate [17, 54]. This domination has, if anything, increased with the availability of digital tools that offer quantification and analysis of work activities.

3.2 Neo-Taylorism

Critiques like neo-Taylorism have been developed to analyse modern work that is organised along Taylorist lines. The idea is that the changes to work and workplace technology are “no more than a superficial change, leaving the essential aspects of the traditional Taylorian division of labour intact” [71, p.71], while post-Taylorism suggests changes to working practices have changed too much for Taylorist ideas to retain relevance [71]. Some neo-Taylorists argue that not only are Taylorist ideas still relevant, but that changes to work “reflect a revitalization of scientific management” [31, p.422]. Gautié et al. [45] describe the specific role of technology in this revitalization of Taylorism, writing that it “is facilitated, but not primarily caused, by the spread of new digital technologies” [45, p.777]. This implies a kind of latent Taylorism, the reactivation of which is catalysed by technology. Advocates of neo-Taylorism have focused on the decomposition of tasks into atomic units as the hallmark of Taylorism, something that has become even more apparent and specialised in gig economy work [7, 26, 111]. In this paper, I revisit the suitability of Taylorism (and so neo-Taylorism) as a lens for understanding contemporary work measurement. My target is less the structure of work implied by Taylorism, though, and more its epistemology. I will argue that atomisation and control in Taylorism is, to a significant degree, a product of its epistemology;

⁶The Calvinist Ethic, indeed!

the modes through which it seeks to generate knowledge about what is happening at work. This has implications for the suitability and applicability of neo-Taylorist critiques of workplace technology to changing workplaces.

If we are interested in the direction of travel of workplace surveillance technologies, then it makes sense to consider developments through what is ostensibly the dominant realist-positivist lens. This is the lens that is most likely to be used within organisations as they make use of these technologies. It is not about whether work *ought* to be understood in this way. Given that that work *is* being understood in this way, what are the interactions between this form of understanding and new technologies going to be? In particular, how will these changes influence the ways that measures of work are constructed?

Digital technology is at the centre of changes to workplace surveillance. Human-centred computing provides the tools to design, explore and critique these new technologies. If we are going to use HCC research methods to understand the changing nature of measurement in workplaces (and we should), then we also need to consider the epistemological approaches of HCC research traditions. This will put us in a better position to treat the neo-Taylorist and HCC traditions simultaneously as we explore change to work measurement.

4 MEASUREMENT AND DIGITAL SENSING IN HCC

CHI and adjacent HCC communities are made of up complex and varied research traditions. The publication outputs of the CHI conference suggest that we do not have a single discipline [70]. Some researchers argue this is desirable [18, 90]. These research traditions bring with them a variety of methods and epistemologies [22, 42, 52].

Work research in HCC is a microcosm of HCC more broadly. Work is understood through the ethnographic methods developed by Garfinkel, and transported into HCC by Suchman (e.g., [91]). We see controlled, interventionist, positivist studies (e.g., [72]) sitting next to those ethnographies. And we see studies in the ubiquitous computing tradition focused on instrumenting workplaces with technology, then materialising the ‘context’ as measured by those instruments (e.g., [44]). In this section, I draw connections between broader epistemological traditions in HCC research, and those that dominate contemporary understandings of workplaces by those responsible for managing them. I focus, therefore, on the more positivist experimental and ubicomp traditions in HCC research, because these, respectively, mirror the more formalised Taylorist traditions of workplace measurement and the less formal, going-with-the-data-at-hand, improvisational approach that manifests in situ.

The evolution of research in HCC has been described as taking place in ‘waves’ [21]. ‘First wave’ HCC work followed in the tradition of positivist, realist science, using the epistemological machinery of psychology and engineering to understand interactions with technology [35]. Other ‘waves’ have since arrived, but this kind of first wave work is still taking place, and still making a contribution to knowledge.

First wave research has dealt with the challenges of measurement by going through a process of rarification (or, depending on your stance, reductionism). The environment is controlled. Changes to those environments are explored systematically through experimentation. Tasks might be broken down to reduce the confounding effect of one on another. If this sounds familiar, it is because workplace Taylorism is conducted on the same epistemological basis. Planning, control, experimentation, and incentive are central to generating new knowledge, whether in an HCC study of pointing performance or a Taylorist study of a production line.

The advantage of understanding workplaces through this rarifying process is that, so long as the rarification can be maintained, manipulations of the environment can have measurable effects (or non-effects) on outcomes. So long as some productivity-enhancing intervention that has been tested in a lab stays in an environment that is like the lab, then we can be confident that it will work. Of course, the disadvantage of this approach to studying interactions with technology (or within workplaces) is that it is often not possible to maintain this rarification in practice. In most workplaces, reality returns and the interventions no longer work so well [83].

There has been another tradition in HCC that, rather than attempt the rarification of controlled experimental work, has instead opted for *reification*, to make things more concrete, and fitted to reality as it is found, rather than building rarified sandboxed realities. This ‘third wave’ has “*partly moved away from a commitment to users towards a more exploratory take-it-or-leave-it approach where designers seek inspiration from use*” [20, p.2] where “[*n*]ew technologies servicing these developments have appeared; pervasive technologies, augmented reality, small interfaces, tangible interfaces” [20, p.2]. As part of this wave, the ubicomp tradition has focused on engineering systems that develop machines, tools and systems for building context awareness [1, 33].

The advantage of conducting research or understanding workplaces through this reification is that it is not necessary to try and control the environment. The goal is to sense it as it is, to be able to measure it as it exists. It’s not this straightforward, though. First wave methods are limited by the demands of their epistemologies for control, third wave ubicomp methods are limited by technical ceilings on sensing. When engineering a ubicomp system, it is necessary to consider constraints like power consumption, system availability and processing power. These constraints influence what systems are able to sense, and how they are able to sense it. For instance, for a device with little memory and a small battery, sampling from a sensor at the maximum sample rate may deplete the battery and fill the memory so quickly as to render the device useless. The challenge for those doing this kind of research is, therefore, construct validity: you know what you want to measure, but that is ultimately inaccessible, and you instead end up using proxy measures. This is what happens in the workplace; managers want to measure productivity, but in many cases that is not a construct that can be measured directly. They instead have to rely on other measures that they *hope* will sum to productivity, even though the individual measures are hit-and-miss [100].

I have considered on two epistemological impulses in HCC research and related them to our understanding of workplaces. One is the rarifying tendency. In this tendency, control is exerted over the environment to make the environment easier to measure. This

comes at the cost of a poor understanding of reality where control is disappplied (e.g., when an experimenter or manager stop looking). The other tendency is the reifying tendency, in which researchers have favoured trying to measure reality (i.e., context) as accurately as possible with increasingly sophisticated sensors. This comes at the cost of construct validity, with the gap between an uncontrolled reality and what it is possible to measure making it difficult to be sure that what has been measured is sufficient to characterise the context. As a result, you end up not measuring the things you need to, or, worse, having what you can measure become an accidental target [103].

If you want to understand a workplace, then these rarifying and reifying impulses seem to be in a kind of contradiction. You can attempt to exert control to construct an abstract reality that you can reliably measure, but accept that if your control fails, the reality falls apart. Or you try to measure reality ‘as it is’, but accept that your instruments are inadequate to some degree and that you can’t really measure the thing you want to⁷. Could the solution to these tensions be to create an environment that yields more control (no wondering what staff are ingesting, imbibing or inhaling on their breaks) that also offers greater capacity, ease and fidelity of instrumentation (no annoying sample rates or batteries to worry about)? If such an environment exists, would it offer the aspiring ‘Scientific Manager’ a way to ‘do’ Taylorism, but without having to set up an expensive paternalistic model village next to a factory to try and control the environment as much as possible [58]? I will consider whether virtual reality workplaces, something pioneered by HCC researchers, fit this bill.

5 WORKING IN VIRTUAL REALITY WORKPLACES

The ‘Metaverse’ is the way that Meta, the company that owns Facebook and other social media platforms, has been thinking about human interaction of the future. The idea is that people will enter digital worlds through virtual reality devices, which will mediate interactions with other people. This idea is not new. Platforms like Second Life have in the past offered similar digital worlds [16].

Metaverses are useful here because it has been proposed as the venue for virtual working environments [88]. The idea is that rather than working from home or in the office and then making use of tools like Microsoft Teams or Zoom for video calls with your online colleagues, or having in-person meeting with others in your office, your workplace is in a metaverse. Regardless of where you are, you don VR equipment, and your meeting spaces are in the virtual world. Your software tools are in the virtual world, and you interact with them through your avatar. You no longer have a real workplace, you just have locations where you can join your (virtual) workplace. (Though see Richardson [92] on how infrastructures of work, rather than sites of work, are responsible work’s construction.)

Let’s set aside whether your workplace existing only in virtual reality will actually ‘work’. Most likely, it will kinda-sorta-maybe-but-not-really work. There will be some use cases where it seems to do the job, and others where its use will be catastrophic in some way.

⁷Or you conduct an ethnography and free yourself of the weight of realist concerns about construct validity and control!

As it has done for the last thirty years, research in the Computer-Supported Co-operative Work (CSCW) literature will continue to explore which contexts are best for VR work, why the things that work, and how we can translate the things that work to other domains [41, 43, 108]. I am not trying to make any determination about the efficacy or otherwise of these technologies in this work. Metaverses just provide an excellent lens through which we can simultaneously view workplace surveillance, Taylorism and its critiques, and epistemologies of HCC.

5.1 Surveillance in metaverses

An employer decides they have a problem with a business process. They decide they need to conduct a study in order to understand what is going wrong. Another employer is anxious about whether staff are productive while they are working at home. They decide they need to keep an eye on staff in order to make sure that they are working⁸. In both cases, employers will want to identify things to measure, because measurement, in the tradition of Scientific Management, is typically how evidence is created in workplaces. Measuring things about work is difficult, though [50], as we have already considered.

Metaverse technologies are often promoted by their creators as being “primarily as an extension of workers’ physical and cognitive agency over a variety of workplace materials and activities [...] rather than a more radical transformation of workplaces’ ability to monitor, track, and evaluate worker efficiency” [51, p.19]. Park et al.’s work [85, p.3], published at CHI 2023, points to a similar orientation in pre-pandemic academic literature on virtual working environments: that metaverses exist to free workers from the spatial, temporal and social constraints of the physical workplace.

Some recent work has continued to present metaverses as locations for more productive, more flexible, ‘better’ work. Adhijatma et al. [2] describe the ways in which metaverse workplaces can be ‘maximised’ to encourage productivity, flexibility and connectivity. The need to train employees so that they have the requisite skills to be productive has been identified [53]. The potential (need!) to develop new key performance indicators that are suitable for (and that leverage) metaverses are described from the perspective of productivity [104], without considering their potential for surveillance: “Immersive engaging interactive experiences can be determined in virtual recruitment by use of behavioral analytics, haptic technologies, deep and machine learning algorithms, and emotional state prediction tools” [46, p.22]. Those engaging experiences are, presumably, to the benefit of workers, given that the problems such an environment might produce for workers are not enumerated.

At the same time, researchers are also developing critiques of metaverse workplaces. Szakolczai, after Agre, describes these technologies as being part of a ‘captaverse’ [99] which normalises abuses of data. Egliston and Carter [36], coming from a Critical Data Studies perspective, focused specifically on the capacity of metaverses for mass data collection, enumerating the ways in which the capability to sense gives platforms power over those subject to them. Park et al.’s empirical work on perceptions of metaverse workspaces

⁸There is another formulation here – that they decide they need to keep an eye on staff in order to sate some desire to control their staff, rather than for any necessary and proportionate business need. But that is another argument for another paper.

yields a less consistently sunny picture, too: workers *are* concerned about the potential for surveillance and tracking, and have resisted accordingly [85].

5.2 Metaverses and HCC epistemologies

Metaverses bridge the rarifying and reifying impulses in HCC research. In this environment, there is no need to create constrained worlds in which constructs can be more reliably and robustly developed. There is no need to be constrained by the limits of what physical sensors are able to sense. Everything that exists in the virtual world can be instrumented. Things that we might normally need an experiment to be able to sense, like reaction times, become trivially accessible in an authentic working context. We no longer need to be constrained by the physical limits of sensors and batteries. We can develop complex sensors in the ubicomp tradition that allow us to sense context, but we no longer need complex, expensive and error-prone machine vision systems to keep track of where people are. We don't need to rely on proxy measures (like, say, pressure changes in a ventilation system [24]) in order to track people's journeys through environments. Arditi has described these environments as a new form of enclosure: taking the spaces through which people live their lives and subjecting them to new schemes of control and ownership [11].

Lee et al. [67] argue that while the term 'metaverse' was originally coined to refer to "a massive virtual environment parallel to the physical world, in which users interact through digital avatars" [67, p.1], the metaverse of the future will blend physical and virtual worlds seamlessly. As Wang et al. [107] put it, this kind of metaverse is "a fully immersive, hyper spatiotemporal, and self-sustaining virtual shared space blending the ternary physical, human, and digital worlds" [107, p.317]. For such shared space to exist, we'd have to conceive a way to instrument the physical and human worlds such that they were entirely intelligible to the digital world. This would mean solving the problems of ubicomp, and implies, once again, an infinitely instrumentable world that where everything that one needs to measure can be measured. (How else could the connection between those three spaces be seamless?)

The challenges of construct validity remain, of course. If you take it as read that phenomenological states are largely inaccessible by quantifying behaviours or physical attributes (e.g., using facial recognition to 'detect' emotion), then there remains plenty inaccessible to those running a metaverse. Taylorism and its descendants have generally shown little interest in being able to measure these kinds of things, though. Where they have, they have generally taken a realist position on them – that all of the world is accessible and that you can measure emotion from people's faces.

Given my analysis, metaverses seem the ideal environment for a Taylorist approach to measuring work, and consequently for surveilling staff. There are no unobserved corners for workers to take themselves to. Brain sensing isn't quite there yet [3], but it might be eventually. There are no parts of production that are too challenging to observe. Interactions between workers that might otherwise be challenging to monitor are now mediated only through a metaverse. If those interactions are hard to measure, then you can adjust how interactions are mediated to make it easier for you to

measure (e.g., through task design). Everything can be done with code. A Disneyland for an aspiring Scientific Manager.

6 RETOOLING NEO-TAYLORISM FOR A STOCHASTIC ZEITGEIST

On the surface, then, a VR workplace seems like it would be the ideal territory for Scientific Management of one kind or another. Almost unlimited potential to instrument every tool and every task means a commensurate potential for work measurement, and hypothesis testing.

There is a sense in which Taylorism has become a byword for workplace surveillance. More sophisticated technologies that permit an expansion of surveillance, means, ultimately, a reinscribing of Taylorist principles into new working domains [8, 29, 63]. I am not sure that what is happening is as straightforward as 'new Taylorism, same as the old Taylorism', though. And I am concerned that channelling critiques of workplace measurement through neo-Taylorism means that we risk applying arguments couched in older positions on the structure of work, measurement and science to contemporary contexts where there are changes in epistemology. The risk is that we miss out on important aspects of what is changing and so are in a worse position to design for (or against) it. My focus for the rest of this paper is not on whether employers seek to discipline through new digital surveillance, but is instead on what a Taylorist framing of this relation does for our ability to understand the ways in which it is changing.

6.1 The epistemology of 'true' Taylorism

As discussed earlier, Taylorism is typified by the control, planning and atomisation of work that allow it to be pushed through experiments that provide measurements for management. Following Braverman [59], it has been described as the "*appropriation of workers' autonomy and control over their work, the construction of a politics and a technology of the disciplined body at work, constituted [one of the] principle[s] of Taylor's system*" [12, p.55]. This control is then viewed as proceeding "*by acting on class and sexed subjectivity*" [12, p.63]. Without seeking to minimise these aspects of Taylorism, control in Scientific Management and its descendants is also being exercised in the most positivist sense of *experimental* control, that is to say, exerting control over people and their environments to make the workplace more laboratory-like and allowing for experiments that test hypotheses and allow causal relationships to be established.

Employers designing rigorous experiments, with clearly operationalised measures and testable hypotheses: if that was ever happening at large, is that what is happening today, and does it look like what is going to happen in the future? It is not clear that it is what is happening, or that it will be what happens in the future [61]. Instead, we are at a point where a common strategy is to measure whatever can be measured, and try and rake through what has been collected using machine learning and other statistical tools to try and work out what might be happening [82]. This isn't about the use of those statistical techniques in science: as Gigerenzer et al. [48] discuss in their history of probabilistic techniques in science, relying on the fuzziness of probability and statistical techniques has been essential to a variety of scientific endeavours for hundreds

of years. It is rather about the larger process of scientific practice, and what research communities consider acceptable epistemologies. Moves in how science is undertaken will have significant implications for ‘Scientific Management’ and critiques of it.

6.2 Data first, ask questions later

Kitchin’s [62] influential work, building on ideas by Anderson and others [9], elucidates this point clearly. It makes the point that the capacity to store and process massive amounts of data has changed the epistemology of (some) scientific practice. Kitchin notes the position of some researchers “*suggest[s] that a new mode of science is being created, one in which the modus operandi is purely inductive in nature*” [62, p.4]. The paper argues that this is not what is happening – there is no unplanned emergence of theory from a bag of data – but instead this new kind of epistemology “*is situated and contextualized within a highly evolved theoretical domain. As such, the epistemological strategy adopted within data-driven science is to use guided knowledge discovery techniques to identify potential questions*” [62, p.6]. This is more nuanced than ‘data first, ask questions later’, but it is a far cry from the heavily controlled positivism that characterised Taylorism and that provides the fodder for neo-Taylorist critiques of workplace surveillance. Can we even be said to be engaging in a neo-Taylorist critique if contemporary workplaces do not require control as an epistemological prerequisite? Employers may still crave control, absolutely, but not necessarily because control is required before scientific investigations of a workplace can take place.

Kitchin’s paper was published a decade ago, at a time when *Big Data* was the buzzword. “Artificial intelligence” appears in the paper once, and “machine learning” twice. This doesn’t dilute the significance of the contribution: the kind of data-driven science that the paper describes is increasingly influential, and, with datafication an activity seemingly promoted as something for every organisation to engage in [28], increasingly the starting point of investigations. However, the rapid advances of AI and ML technologies over the last few years is changing not just how science is being practised, but *who or what* is practising it.

6.3 Stochastic machine witnesses

Latour relates the development of empirical science to Boyle: “*Instead of seeking to ground his work in logic, mathematics or rhetoric, Boyle relied on a parajudicial metaphor: credible, trustworthy, well-to-do witnesses gathered at the scene of the action can attest to the existence of a fact, the matter of a fact, even if they do not know its true nature. So he invented the empirical style that we still used today*” [65, p.18]. The key to this invention was the acceptability of reliable witnesses as a means of producing new knowledge. Empirical science still works in this way; we have mechanisms for assessing the standing of witnesses, and we use these to decide whether we trust the way that they have witnessed phenomena⁹.

Machine learning can aid the analysis of data in ways that are not all that far from traditional statistical techniques. These kinds of statistics are an accepted part of conducting realist, positivist science. The current direction of AI technologies suggests a departure from this, though. If we are, say, to use large language

models (LLMs) to help make sense of large datasets¹⁰, then we get to the point where we are introducing new actors in the process of doing science who are now taking on the role of witnesses in the scientific process. This fundamentally changes the relationship between phenomena and their witnesses. We have established ways of establishing the credibility of witnesses to phenomena¹¹. One way is to require witnesses to complete research degrees before we assess credibility to them. Will we permit artificial witnesses, and, if so, how will we assess credibility to them? This is not just about the capacity of things like LLMs to ‘hallucinate’. Human witnesses to phenomena do the same thing. It is a more basic than that, it is about who is permitted to observe, who is permitted to ‘do’ science [66].

6.4 What this means for critiques of workplace surveillance

What does this mean for Scientific Management, or neo-Taylorism? It means that the way we are doing science has changed, and the way we might be doing science in the future might change even further. The ability to instrument everything, collect all possible measurements and work out what it means is not compatible with the Taylorist, positivist, realist approach of Scientific Management. The means to create witnesses to phenomena that are not human could fundamentally change all scientific enterprise. So what does the ‘Scientific’ in ‘Scientific Management’ actually mean? It points to a conceptualisation of science that has dominated the last hundred years. Now we’re moving into a more stochastic zeitgeist, where we rely on non-human witnesses who, just like human witnesses, can return different responses to the same stimulus, it seems that we shouldn’t take it for granted that the possibilities of a meta-verse, as interpreted in our new zeitgeist, can be properly explored with conceptual tools like neo-Taylorism that have been developed under certain assumptions about measurement and workplace science.

Manokha [73] has recently argued (after Foucault) that digital technology has fundamentally altered power relations in the workplace, and that technology affords employers a fully-featured panopticon in which their disciplining gaze is omni-present. Similar arguments have been made about the power of algorithmic management, and its capacity to disenfranchise workers [40]. I do not disagree that the trajectory of these technologies has been to change power relations in workplaces. This fits with a neo-Taylorist account of what has been happening in workplaces over the last couple of decades; more measurement, more employer control, more employer power. Given the account I have given of the changing epistemology of the workplace, though, that neo-Taylorist account feels disintermediated. The implication is that the disempowerment of workers and the empowerment of employers is dyadic. One’s loss is another’s gain. Yes, workers have lost power. And so far it *looks* like that power has transferred to employers. At this stage in the development of these technologies, it looks like this because the employers who have had the capacity to implement the most powerful AI technologies have done so in a vertically integrated way.

⁹Reading this paper, you yourself are right now engaged in this kind of witnessing

¹⁰Yes, people are suggesting this: <https://towardsdatascience.com/data-analysis-made-easy-using-llms-to-automate-tedious-tasks-bdc1fee552d5>

¹¹Albeit limited and often and easily abused.

When Uber develops new methods of algorithmic management, or Amazon builds new sensors for monitoring staff, they do so with the capacity to make sense of the data collected. They do so with more organisational understanding of the new (and still limited) artificial witnesses to phenomena it is deploying to measure the world. The power of these companies to use vertical integration is not limited to controlling consumer markets [114], it can be used internally to control labour, too.

How do the power relations look outside organisations without the capacity to vertically integrate sensing, measurement, analysis and action? Some –most, the vast majority, even– of organisations will not have this kind of capacity. Instead, they will be consumers of these workplace technologies [50]. What will it mean when organisations, convinced of the necessity to instrument their workplaces and surveil staff to stay competitive, contract-out the witnessing of phenomena in their workplace to artificial agents (leaving aside the question of whether more data can even solve their problems [105])? How will they assess the credibility of those witnesses? What would an LLM, or whatever, for surveilling staff need to do to be awarded “chartered status” like HR professionals¹²? Where does the power lie when these agents come with a monthly subscription and their proprietary nature makes it impossible to interrogate them? Yes, of course, still to the employer, but also to another set of entities not under the control of employers, the organisations selling access to the artificial actors whose behaviour is not deterministic.

For a neo-Taylorist account of work surveillance to be complete, then, it needs to be able to expand to fit these new actors. An account that considers a simple tug-of-war between employers and workers is going to end up missing critical activity that is not taking place within that relation. We will perhaps need to augment these accounts of workplace surveillance with our understanding of trust in human-in-the-loop systems [77]. We may need to look to the Business Management literature on outsourcing [64] to try and make sense, operationally, of what kinds of control systems might be established. And all of this has to be connected to the essential epistemological question of what can be measured, and how it can be measured. It's only by doing this that we will be in a position to really understand what we are talking about when we're talking about workplace surveillance. Until we have that nailed down, neo-Taylorist accounts of the erosion of good work by surveillance are not going to be adequate to critically evaluate the changes that are coming with AI in the workplace. Ironically, our capacity to defend the rights of workers at work might end up being contingent on resisting data-driven science, where employers get to decide what to investigate post-hoc, and re-embrace the upfront, controlled, planned –and potentially negotiable!– scientific practices of Taylorism.

7 DISCUSSION

Having made my argument about workplace surveillance and the ways in which we think about it, there are two things that it would be valuable to consider. The first is what people designing and building the future of work should take away from this argument. The second is to reflect on how my argument relates to the human-centred computing community beyond work and workplace studies.

¹²e.g., <https://www.cipd.org/>

7.1 The design of the future of work

Suppose that you are involved in designing, understanding and building workplace technologies. Lots of people at CHI are! And then suppose that you accept the argument that I have made here. So what? What now? I do not think there are ‘implications for design’ from this work; the argument that I am making is not specific enough to a particular context. However, I do think there are ‘implications for *thinking about* design’ that are relevant to those creating workplace technologies. To keep these implications somewhat digestible, I offer an enumeration:

- (1) **Epistemologies of work apply. Yes, your work too!** These are not remote ideas for academic-types to mull over. If you have a new workplace productivity tool that, say, monitors activity to make recommendations about when to take breaks, then the things that you are able to measure and decide to measure during development could end up setting normative expectations for behaviour in workplaces. And vice versa: what you measure is influenced by existing normative practices of measurement in workplaces. Be reflexive about the potential for these scenarios. Think about what your tools and systems will be able to ‘know’ and how that knowledge is obtained. If constraints mean that your construct validity is weaker than you’d like, perhaps think about how you can design with seams, helping prospective users appreciate these limitations (see [27]).
- (2) **Think about data, even if you’re responsible for interaction design.** Is anyone designing commercial interactive systems these days without a significant data layer? Even take out pizza companies are instrumenting their websites to track your mouse pointer¹³. If you are not responsible for that data layer, what will the affordances of your interaction design be for that layer? The Human-Data Interaction framework proposed by Mortier et al. [80] is a good tool for thinking about this. What *agency* will users have over what is ingested by your system? To have agency, what is being collected and how it will be used will need to be *legible* to users. Finally, are there ways that you can build *negotiability* into tools, systems, interactions? Can people opt to share more or less, and still enjoy a good experience commensurate with their preferences?
- (3) **Critiques scaffold thinking. We need to form habits of critique.** Critiques of workplace surveillance like neo-Taylorism or digital Taylorism provide ways of thinking about work, power and measurement in ways that are consistent over time and contexts. This is useful, given the breadth of workplaces that the CHI community is interested in; software engineering, healthcare, crowdwork, education, research. The full gamut. Applying well-developed critical perspectives provides a starting point for comparison and shared practice. Members of the CHI community have been pushing critical practice for twenty years (e.g., [34, 96]). The conference has a submission track specifically for critical research. In the same way that working with people implies a set of ethical practices and norms, I would like us to get to the same place with work research. If you design or build

¹³https://www.theregister.com/2022/10/06/papa_johns_spying_lawsuit/

workplace technologies, you would get into the habit of applying critiques. You don't have to *agree* with what those critiques say about what you've created, but if we can make reflexivity a habit, we may be able to better anticipate harm [97]. The regular application of critique keeps those critiques in good fettle, too; the more of us that apply them, the more we can hear them groan and strain as the world changes.

- (4) **Machine intelligence will mean revisiting the previous three!** If you've set up a workflow that lets you think about epistemology, critique and data when you're specifying, designing, building workplace technologies, then job done? Unfortunately, my thesis here is that machine intelligence has the potential to remake these things. New epistemologies. Critiques unmoored from the state of the art. Data produced by artificial witnesses... and we're not sure how they are witnessing. We will need to iterate as the capabilities of these machines change over time. What "collect", "process", "store", "analyse" mean for workplace data will not be static. When they change, how will the tools and systems you've built look? What assumptions are you relying on? As a discipline, we have developed ways of using speculation that might be useful for exploring these kinds of challenges [38].

7.2 Connections beyond the workplace?

This paper is about how we measure work. I have used virtual work environments as a lens with which to examine critiques of work measurement, assessing these critiques against the state of the art in workplace surveillance. How do these ideas about work connect to other kinds of HCC and HCC-adjacent research? The purpose of this paper is not to provide a generalisable account of surveillance or attendant epistemologies or critiques. The focus is specifically on workplaces. However, there are related ideas that members of the CHI and broader HCC communities have been working on, and it makes sense to consider how the argument I have made here relates to this work.

This paper is closest to publications at CHI on datafication and algorithmic decision-making. This work is often about how models of the world are created through different ways of knowing. Muller and Strohmayer [81], for instance, write about 'forgetting practices' in data science. Which data in a given context is kept. Which is thrown away. This is a critical issue in the workplace, where workers may have no control over how their organisation chooses what to 'remember' or 'forget'. How will artificial witnesses modulate the 'forgettance stack' that Muller and Strohmayer describe? Given the complexity of this stack, are our current epistemologies sufficient to even know?

There are connections¹⁴ between what I have presented here and Alkhatib and Bernstein's work on algorithmic decision-making [6]. They note that it is often the case that individuals close to decisions make 'street-level' judgements to bridge policies, laws and reality: "A police officer chooses whether to issue a warning or a traffic citation; a judge decides whether to allow a defendant to pay bail or to have them remanded to jail; a teacher determines whether to waive a course's prerequisites for a student. These decisions often involve nuance or extenuating circumstances, making it all

but impossible to prescribe the right response for all situations" [6, p.2]. The point is that algorithms are not capable of making such adjustments. This is relevant to the crowdworking context that Alkhatib and Bernstein explore, but also to workplaces more generally. Evaluating performance at work often involves street-level decisions by managers – accounting for the broader and individual context of a particular marginal case, where protocol and reality sit uneasily together¹⁵. Street-level arbitrations are not always fair. Employers often selectively enforce policies to target specific individuals capriciously, but what about where you have artificial witnesses reporting to street-level algorithms, and this is siloed in a proprietary decision-making stack? We might, as with forgettance, not even be in a position to inspect the underpinnings of workplace decisions.

This work also connects with the Science and Technology Studies work Pine and Liboiron have published at CHI [86]. Their work deals with fundamental questions about measurement and the construction of new things through measurement. The contention is that decisions about what to measure are intrinsically political, and that the ability of measurement to construct new things can be used to advance political goals. In the context of workplace measurement, this implies ontological questions alongside epistemological ones: the decisions that are made about measurement are not just about ways of knowing what is happening in a workplace. The measures themselves – of course they do – produce new *things* in the workplace. The corollary is clear: if you outsource work measurement in your organisation, you are outsourcing the creation of new things (actors? beings?) in your organisation, too. The essentially political nature of measurement (including that by artificial witnesses: their make-up is political, too [76]) means that the creation of new things will be political, too. In future work, it would be useful to consider the connection between ontology and epistemology in the workplace in more depth.

Given the interest of the CHI community in datafication and epistemologies more generally, there are almost certainly other connections to make with work already published. It may be that I have yet to encounter this work, it may be that I have but have yet to appreciate its relevance. My hope is that this paper will be of interest to a broad CHI audience and that perhaps, down the line, other authors will read and cite this work and help me make some of those missing connections.

8 CONCLUSION

The future of work is an important topic of research for CHI and CHI-related communities. A topic of such importance, especially one in which researchers are enacting change, requires a well-developed metascientific underpinning. We need to understand what it is that we as a community are doing and why we are doing it in the way that we are doing it. The purpose of this paper was to explore a particular aspect of future of work research that has growing salience: digital surveillance.

Via a vignette of infinitely instrumentable workplaces in metaverses, I have made the argument that neo-Taylorist critiques of workplace monitoring, and their focus on control, are not, at the moment, equipped to defend the interests of workers in changing

¹⁴With thanks to an anonymous reviewer for the suggestion.

¹⁵Perhaps because policy has poor construct validity?

workplaces. Epistemologies are changing. The controlled, positivist science of Taylorism is getting harder to make out in the contemporary practice of workplace science. Artificial witnesses to phenomena will change the way that we credential the actors that are trusted to observe workplace phenomena. I have sketched the limits of our current tools for critique. I hope this is another potential starting point for the collective development of our critique of work technology, a development that will help to protect the interests of workers as workplaces change.

ACKNOWLEDGMENTS

I am indebted to six anonymous ACM CHI 2024 reviewers for the attention they gave to this manuscript.

REFERENCES

- Gregory D. Abowd. 2012. What Next, Ubicomp?: Celebrating an Intellectual Disappearing Act. In *Proceedings of the 2012 ACM Conference on Ubiquitous Computing (UbiComp '12)*. ACM, New York, NY, USA, 31–40. <https://doi.org/10.1145/2370216.2370222>
- Ardian Adhiatma, Nurhidayatya, and Olivia Fachrunnisa. 2023. Issues and Challenges When Metaverse Replaces the Workplace. In *Complex, Intelligent and Software Intensive Systems (Lecture Notes on Data Engineering and Communications Technologies)*, Leonard Barolli (Ed.). Springer Nature Switzerland, Cham, 243–249. https://doi.org/10.1007/978-3-031-35734-3_24
- Daniel Afergan, Evan M. Peck, Erin T. Solovey, Andrew Jenkins, Samuel W. Hincks, Eli T. Brown, Remco Chang, and Robert J.K. Jacob. 2014. Dynamic Difficulty Using Brain Metrics of Workload. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. Association for Computing Machinery, New York, NY, USA, 3797–3806. <https://doi.org/10.1145/2556288.2557230>
- Philip E. Agre. 1994. Surveillance and Capture: Two Models of Privacy. *The Information Society* 10, 2 (April 1994), 101–127. <https://doi.org/10.1080/01972243.1994.9960162>
- Ali Alkhatib. 2021. To Live in Their Utopia: Why Algorithmic Systems Create Absurd Outcomes. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 1–9. <https://doi.org/10.1145/3411764.3445740>
- Ali Alkhatib and Michael Bernstein. 2019. Street-Level Algorithms: A Theory at the Gaps Between Policy and Decisions. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3290605.3300760>
- Ali Alkhatib, Michael S. Bernstein, and Margaret Levi. 2017. Examining Crowd Work and Gig Work Through The Historical Lens of Piecework. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 4599–4616. <https://doi.org/10.1145/3025453.3025974>
- Moritz Altenried. 2020. The Platform as Factory: Crowdwork and the Hidden Labour behind Artificial Intelligence. *Capital & Class* 44, 2 (June 2020), 145–158. <https://doi.org/10.1177/0309816819899410>
- Chris Anderson. Jun 23, 2008 12:00 PM. The End of Theory: The Data Deluge Makes the Scientific Method Obsolete. *Wired* (Jun 23, 2008 12:00 PM).
- Ira Anjali Anwar, Joyojeet Pal, and Julie Hui. 2021. Watched, but Moving: Platformization of Beauty Work and Its Gendered Mechanisms of Control. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW3 (Jan. 2021), 250:1–250:20. <https://doi.org/10.1145/3432949>
- David Arditì and David Arditì. 2023. Metaverse: Enclosing New Spaces. In *Digital Feudalism: Creators, Credit, Consumption, and Capitalism*. Emerald Publishing Limited, 113–126. <https://doi.org/10.1108/978-1-80455-766-220231007>
- Mark Bahnsch. 2000. Embodied Work, Divided Labour: Subjectivity and the Scientific Management of the Body in Frederick W. Taylor's 1907 'Lecture on Management'. *Body & Society* 6, 1 (March 2000), 51–68. <https://doi.org/10.1177/1357034X00006001004>
- Kirstie Ball. 2022. Surveillance in the Workplace : Past, Present, and Future. (Dec. 2022). <https://doi.org/10.24908/ss.v20i4.15805>
- Liam Bannon. 2011. Reimagining HCI: Toward a More Human-Centered Perspective. *Interactions* 18, 4 (July 2011), 50–57. <https://doi.org/10.1145/1978822.1978833>
- Emily M. Bender, Timnit Gebru, Angelina McMillan-Major, and Shmargaret Shmitchell. 2021. On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?. In *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency (FAcT '21)*. Association for Computing Machinery, New York, NY, USA, 610–623. <https://doi.org/10.1145/3442188.3445922>
- Katherine Bessière, Jason B. Ellis, and Wendy A. Kellogg. 2009. Acquiring a Professional "Second Life": Problems and Prospects for the Use of Virtual Worlds in Business. In *CHI '09 Extended Abstracts on Human Factors in Computing Systems (CHI EA '09)*. Association for Computing Machinery, New York, NY, USA, 2883–2898. <https://doi.org/10.1145/1520340.1520416>
- Dee Birnbaum and Mark Somers. 2022. Past as Prologue: Taylorism, the New Scientific Management and Managing Human Capital. *International Journal of Organizational Analysis* 31, 6 (Jan. 2022), 2610–2622. <https://doi.org/10.1108/IJOA-01-2022-3106>
- Alan F. Blackwell. 2015. HCI as an Inter-Discipline. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '15)*. Association for Computing Machinery, New York, NY, USA, 503–516. <https://doi.org/10.1145/2702613.2732505>
- Eli Blevins. 2018. Seeing What Is and What Can Be: On Sustainability, Respect for Work, and Design for Respect. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3173574.3173944>
- Susanne Bødker. 2006. When Second Wave HCI Meets Third Wave Challenges. In *Proceedings of the 4th Nordic Conference on Human-computer Interaction: Changing Roles (NordCHI '06)*. Association for Computing Machinery, New York, NY, USA, 1–8. <https://doi.org/10.1145/1182475.1182476>
- Susanne Bødker. 2015. Third-Wave HCI, 10 Years Later—Participation and Sharing. *Interactions* 22, 5 (Aug. 2015), 24–31. <https://doi.org/10.1145/2804405>
- Philip Brey. 2005. The Epistemology and Ontology of Human-Computer Interaction. *Minds and Machines* 15, 3 (Nov. 2005), 383–398. <https://doi.org/10.1007/s11023-005-9003-1>
- Pam Briggs, Elizabeth Churchill, Mark Levine, James Nicholson, Gary W. Pritchard, and Patrick Olivier. 2016. Everyday Surveillance. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '16)*. Association for Computing Machinery, New York, NY, USA, 3566–3573. <https://doi.org/10.1145/2851581.2856493>
- Ramon Caceres and Adrian Friday. 2012. Ubicomp Systems at 20: Progress, Opportunities, and Challenges. *IEEE Pervasive Computing* 11, 1 (Jan. 2012), 14–21. <https://doi.org/10.1109/MPRV.2011.85>
- Juan Carlos Alvarez de la Vega, Marta E. Cecchinato, and John Rooksby. 2021. "Why Lose Control?" A Study of Freelancers' Experiences with Gig Economy Platforms. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3411764.3445305>
- Marta E. Cecchinato, Sandy J. J. Gould, and Frederick H. Pitts. 2021. Self-Tracking & Sousveillance at Work: Insights from Human-Computer Interaction & Social Science. In *Augmented Exploitation Artificial Intelligence, Automation and Work*, Phoebe V. Moore and Jamie Woodcock (Eds.). Pluto Press, London.
- Matthew Chalmers and Ian MacColl. 2003. Seamful and Seamless Design in Ubiquitous Computing. (2003).
- Tomas Chamorro-Premuzic, Reece Akhtar, Dave Winsborough, and Ryne A Sherman. 2017. The Datafication of Talent: How Technology Is Advancing the Science of Human Potential at Work. *Current Opinion in Behavioral Sciences* 18 (Dec. 2017), 13–16. <https://doi.org/10.1016/j.cobeha.2017.04.007>
- Miriam A. Cherry. 2015. Beyond Misclassification: The Digital Transformation of Work. *Comparative Labor Law & Policy Journal* 37, 3 (2015), 577–602.
- Zoë Corbyn. 2022. 'Bossware Is Coming for Almost Every Worker': The Software You Might Not Realize Is Watching You. *The Guardian* (April 2022).
- Martha Crowley, Daniel Tope, Lindsey Joyce Chamberlain, and Randy Hodson. 2010. Neo-Taylorism at Work: Occupational Change in the Post-Fordist Era. *Social Problems* 57, 3 (Aug. 2010), 421–447. <https://doi.org/10.1525/sp.2010.57.3.421>
- Vedant Das Swain, Lan Gao, William A Wood, Srikruthi C Matli, Gregory D. Abowd, and Munmun De Choudhury. 2023. Algorithmic Power or Punishment: Information Worker Perspectives on Passive Sensing Enabled AI Phenotyping of Performance and Wellbeing. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, 1–17. <https://doi.org/10.1145/3544548.3581376>
- Anind Dey. 2010. Context-Aware Computing. In *Ubiquitous Computing Fundamentals*, John Krumm (Ed.). CRC Press, Boca Raton, FL, USA, 321–348.
- Paul Dourish, Janet Finlay, Phoebe Sengers, and Peter Wright. 2004. Reflective HCI: Towards a Critical Technical Practice. In *CHI '04 Extended Abstracts on Human Factors in Computing Systems*. ACM, Vienna Austria, 1727–1728. <https://doi.org/10.1145/985921.986203>
- Emanuel Felipe Duarte and M. Cecilia C. Baranauskas. 2016. Revisiting the Three HCI Waves: A Preliminary Discussion on Philosophy of Science and Research Paradigms. In *Proceedings of the 15th Brazilian Symposium on Human Factors in Computing Systems (IHC '16)*. Association for Computing Machinery, New York, NY, USA, 1–4. <https://doi.org/10.1145/3033701.3033740>
- Ben Egliston and Marcus Carter. 2021. Critical Questions for Facebook's Virtual Reality: Data, Power and the Metaverse. *Internet Policy Review* 10, 4 (Dec. 2021).
- Melanie Feinberg. 2017. A Design Perspective on Data. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. Association

- for Computing Machinery, New York, NY, USA, 2952–2963. <https://doi.org/10.1145/3025453.3025837>
- [38] Laura E. Forlano and Megan K. Halpern. 2023. Speculative Histories, Just Futures: From Counterfactual Artifacts to Counterfactual Actions. *ACM Transactions on Computer-Human Interaction* 30, 2 (April 2023), 22:1–22:37. <https://doi.org/10.1145/3577212>
- [39] Sarah E. Fox, Vera Khovanskaya, Clara Crivellaro, Niloufar Salehi, Lynn Dombrowski, Chinmay Kulkarni, Lilly Irani, and Jodi Forlizzi. 2020. Worker-Centered Design: Expanding HCI Methods for Supporting Labor. In *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (CHI EA '20)*. Association for Computing Machinery, New York, NY, USA, 1–8. <https://doi.org/10.1145/3334480.3375157>
- [40] Milena Franke and Valeria Pulignano. 2023. Connecting at the Edge: Cycles of Commodification and Labour Control within Food Delivery Platform Work in Belgium. *New Technology, Work and Employment* 38, 2 (2023), 371–390. <https://doi.org/10.1111/ntwe.12218>
- [41] Mike Fraser, Tony Glover, Ivan Vaghi, Steve Benford, Chris Greenhalgh, Jon Hindmarsh, and Christian Heath. 2000. Revealing the Realities of Collaborative Virtual Reality. In *Proceedings of the Third International Conference on Collaborative Virtual Environments (CVE '00)*. Association for Computing Machinery, New York, NY, USA, 29–37. <https://doi.org/10.1145/351006.351010>
- [42] Christopher Frauenberger. 2019. Entanglement HCI The Next Wave? *ACM Transactions on Computer-Human Interaction* 27, 1 (Nov. 2019), 2:1–2:27. <https://doi.org/10.1145/3364998>
- [43] Guo Freeman and Divine Maloney. 2021. Body, Avatar, and Me: The Presentation and Perception of Self in Social Virtual Reality. *Proceedings of the ACM on Human-Computer Interaction* 4, CSCW3 (Jan. 2021), 239:1–239:27. <https://doi.org/10.1145/3432938>
- [44] Sarah Gallacher, Jenny O'Connor, Jon Bird, Yvonne Rogers, Licia Capra, Daniel Harrison, and Paul Marshall. 2015. Mood Squeezer: Lightening up the Workplace through Playful and Lightweight Interactions. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing (CSCW '15)*. Association for Computing Machinery, New York, NY, USA, 891–902. <https://doi.org/10.1145/2675133.2675170>
- [45] Jérôme Gautié, Karen Jaehrling, and Coralie Perez. 2020. Neo-Taylorism in the Digital Age: Workplace Transformations in French and German Retail Warehouses. *Relations industrielles / Industrial Relations* 75, 4 (2020), 774–795. <https://doi.org/10.7202/1074564ar>
- [46] Gheorghe H. Popescu, Cristian Florin Ciurlău, Cristian Ionuț Stan, Cecilia Băcănoiu (Văduva), and Alina Tănase (Veisa). 2022. Virtual Workplaces in the Metaverse: Immersive Remote Collaboration Tools, Behavioral Predictive Analytics, and Extended Reality Technologies. *Psychosociological Issues in Human Resource Management* 10, 1 (2022), 21–34.
- [47] Arup Kumar Ghosh, Karla Badillo-Urquiola, Shion Guha, Joseph J. LaViola Jr, and Pamela J. Wisniewski. 2018. Safety vs. Surveillance: What Children Have to Say about Mobile Apps for Parental Control. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3173574.3173698>
- [48] Gerd Gigerenzer, Zeno Swijtink, Theodore Porter, Lorraine Daston, John Beatty, and Lorenz Kruger. 1989. *The Empire of Chance : How Probability Changed Science and Everyday Life*. Cambridge University Press, Cambridge [England].
- [49] Sandy J. J. Gould. 2022. Consumption Experiences in the Research Process. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–17. <https://doi.org/10.1145/3491102.3502001>
- [50] Sandy J. J. Gould, Anna Rudnicka, Dave Cook, Marta E. Cecchinato, Joseph W. Newbold, and Anna L. Cox. 2023. Remote Work, Work Measurement and the State of Work Research in Human-Centred Computing. In *Interacting with Computers*. iwad014. <https://doi.org/10.1093/iwc/iwad014>
- [51] Jacob Greene. 2023. Ethical Design Approaches for Workplace Augmented Reality. *Communication Design Quarterly* 10, 4 (Feb. 2023), 16–26. <https://doi.org/10.1145/3531210.3531212>
- [52] Steve Harrison, Phoebe Sengers, and Deborah Tatar. 2011. Making Epistemological Trouble: Third-paradigm HCI as Successor Science. *Interacting with Computers* 23, 5 (Sept. 2011), 385–392. <https://doi.org/10.1016/j.intcom.2011.03.005>
- [53] Mark Hawkins. 2022. Virtual Employee Training and Skill Development, Workplace Technologies, and Deep Learning Computer Vision Algorithms in the Immersive Metaverse Environment. *Psychosociological Issues in Human Resource Management* 10, 1 (2022), 106–120.
- [54] Vanessa Hill and Buren Harry Van. 2018. Taylor Won: The Triumph of Scientific Management and Its Meaning for Business and Society. In *Corporate Social Responsibility*. Business and Society 360, Vol. 2. Emerald Publishing Limited, 265–294. <https://doi.org/10.1108/S2514-17592018000002007>
- [55] Naja Holten Møller, Gina Neff, Jakob Grue Simonsen, Jonas Christoffer Vilumsen, and Pernille Bjørn. 2021. Can Workplace Tracking Ever Empower? Collective Sensemaking for the Responsible Use of Sensor Data at Work. *Proceedings of the ACM on Human-Computer Interaction* 5, GROUP (July 2021), 219:1–219:21. <https://doi.org/10.1145/3463931>
- [56] Kasper Hornbæk and Antti Oulasvirta. 2017. What Is Interaction?. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. Association for Computing Machinery, New York, NY, USA, 5040–5052. <https://doi.org/10.1145/3025453.3025765>
- [57] Lucas D. Introna. 2000. Workplace Surveillance, Privacy and Distributive Justice. *ACM SIGCAS Computers and Society* 30, 4 (Dec. 2000), 33–39. <https://doi.org/10.1145/572260.572267>
- [58] David J. Jeremy. 1991. The Enlightened Paternalist in Action: William Hesketh Lever at Port Sunlight Before 1914. *Business History* 33, 1 (Jan. 1991), 58–81. <https://doi.org/10.1080/00076799100000004>
- [59] R. Jamil Jonna and John Bellamy Foster. 2014. Beyond the Degradation of Labor: Braverman and the Structure of the U.S. Working Class. *Monthly Review* 66, 5 (Oct. 2014), 1–23. https://doi.org/10.14452/MR-066-05-2014-09_1
- [60] Simon Joyce, Charles Umney, Xanthe Whittaker, and Mark Stuart. 2023. New Social Relations of Digital Technology and the Future of Work: Beyond Technological Determinism. *New Technology, Work and Employment* 38, 2 (2023), 145–161. <https://doi.org/10.1111/ntwe.12276>
- [61] Vera Khovanskaya and Phoebe Sengers. 2019. Data Rhetoric and Uneasy Aliances: Data Advocacy in US Labor History. In *Proceedings of the 2019 on Designing Interactive Systems Conference (DIS '19)*. Association for Computing Machinery, New York, NY, USA, 1391–1403. <https://doi.org/10.1145/3322276.3323691>
- [62] Rob Kitchin. 2014. Big Data, New Epistemologies and Paradigm Shifts. *Big Data & Society* 1, 1 (April 2014), 2053951714528481. <https://doi.org/10.1177/2053951714528481>
- [63] Aniket Kittur, Jeffrey V. Nickerson, Michael Bernstein, Elizabeth Gerber, Aaron Shaw, John Zimmerman, Matt Lease, and John Horton. 2013. The Future of Crowd Work. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work (CSCW '13)*. Association for Computing Machinery, New York, NY, USA, 1301–1318. <https://doi.org/10.1145/2441776.2441923>
- [64] Kim Langfield-Smith and David Smith. 2003. Management Control Systems and Trust in Outsourcing Relationships. *Management Accounting Research* 14, 3 (Sept. 2003), 281–307. [https://doi.org/10.1016/S1044-5005\(03\)00046-5](https://doi.org/10.1016/S1044-5005(03)00046-5)
- [65] Bruno Latour. 1993. *We Have Never Been Modern*. Harvard University Press, Cambridge, MA, USA.
- [66] Francis Lee. 2023. Hybrid Scientists: Agency, AI, and the Science of Data. <https://doi.org/10.31235/osf.io/vr69m>
- [67] Lik-Hang Lee, Tristan Braud, Pengyuan Zhou, Lin Wang, Dianlei Xu, Zijun Lin, Abhishek Kumar, Carlos Bermejo, and Pan Hui. 2021. All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda. <https://doi.org/10.48550/arXiv.2110.05352> arXiv:2110.05352 [cs]
- [68] Min Kyung Lee, Daniel Kusbit, Evan Metsky, and Laura Dabbish. 2015. Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. Association for Computing Machinery, New York, NY, USA, 1603–1612. <https://doi.org/10.1145/2702123.2702548>
- [69] Roxanne Leitão. 2019. Anticipating Smart Home Security and Privacy Threats with Survivors of Intimate Partner Abuse. In *Proceedings of the 2019 on Designing Interactive Systems Conference (DIS '19)*. Association for Computing Machinery, New York, NY, USA, 527–539. <https://doi.org/10.1145/3322276.3322366>
- [70] Yong Liu, Jorge Goncalves, Denzil Ferreira, Bei Xiao, Simo Hosio, and Vassilis Kostakos. 2014. CHI 1994–2013: Mapping Two Decades of Intellectual Progress through Co-Word Analysis. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. Association for Computing Machinery, New York, NY, USA, 3553–3562. <https://doi.org/10.1145/2556288.2556969>
- [71] Cédric Lomba. 2005. Beyond the Debate over 'Post'-vs 'Neo'-Taylorism: The Contrasting Evolution of Industrial Work Practices. *International Sociology* 20, 1 (March 2005), 71–91. <https://doi.org/10.1177/0268580905049912>
- [72] Yuhang Luo, Bongshin Lee, Donghee Yvette Wohn, Amanda L. Rebar, David E. Conroy, and Eun Kyoung Choe. 2018. Time for Break: Understanding Information Workers' Sedentary Behavior Through a Break Prompting System. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–14.
- [73] Ivan Manokha. 2020. The Implications of Digital Employee Monitoring and People Analytics for Power Relations in the Workplace. *Surveillance & Society* 18, 4 (Nov. 2020), 540–554. <https://doi.org/10.24908/ss.v18i4.13776>
- [74] Matthew Ball. 2022. The Metaverse Will Reshape Our Lives. Let's Make Sure It's for the Better. *Time* (July 2022).
- [75] Dana McKay and Charlynn Miller. 2021. Standing in the Way of Control: A Call to Action to Prevent Abuse through Better Design of Smart Technologies. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3411764.3445114>
- [76] Ninareh Mehrabi, Fred Morstatter, Nripsuta Saxena, Kristina Lerman, and Aram Galstyan. 2021. A Survey on Bias and Fairness in Machine Learning. *Comput. Surveys* 54, 6 (July 2021), 115:1–115:35. <https://doi.org/10.1145/3457607>
- [77] Stuart E. Middleton, Emmanuel Letouze, Ali Hossaini, and Adriane Chapman. 2022. Trust, Regulation, and Human-in-the-Loop AI: Within the European

- Region. *Commun. ACM* 65, 4 (April 2022), 64–68. <https://doi.org/10.1145/3511597>
- [78] Phoebe Moore, Lukasz Piwek, and Ian Roper. 2018. The Quantified Workplace: A Study in Self-Tracking, Agility and Change Management. In *Self-Tracking: Empirical and Philosophical Investigations*, Btihadj Ajana (Ed.). Springer International Publishing, Cham, 93–110. https://doi.org/10.1007/978-3-319-65379-2_7
- [79] Phoebe Moore and Andrew Robinson. 2016. The Quantified Self: What Counts in the Neoliberal Workplace. *New Media & Society* 18, 11 (Dec. 2016), 2774–2792. <https://doi.org/10.1177/1461444815604328>
- [80] Richard Mortier, Hamed Haddadi, Tristan Henderson, Derek McAuley, and Jon Crowcroft. 2015. Human-Data Interaction: The Human Face of the Data-Driven Society. <https://doi.org/10.48550/arXiv.1412.6159> [cs]
- [81] Michael Muller and Angelika Strohmayer. 2022. Forgetting Practices in the Data Sciences. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–19. <https://doi.org/10.1145/3491102.3517644>
- [82] Gemma Newlands. 2021. Algorithmic Surveillance in the Gig Economy: The Organization of Work through Lefebvrian Conceived Space. *Organization Studies* 42, 5 (May 2021), 719–737. <https://doi.org/10.1177/0170840620937900>
- [83] Zeljko Obrenović. 2014. The Hawthorne Studies and Their Relevance to HCI Research. *Interactions* 21, 6 (Oct. 2014), 46–51. <https://doi.org/10.1145/2674966>
- [84] Antti Oulasvirta and Kasper Hornbæk. 2016. HCI Research as Problem-Solving. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems (CHI '16)*. Association for Computing Machinery, New York, NY, USA, 4956–4967. <https://doi.org/10.1145/2858036.2858283>
- [85] Hyanghee Park, Daehwan Ahn, and Joonhwan Lee. 2023. Towards a Metaverse Workspace: Opportunities, Challenges, and Design Implications. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, 1–20. <https://doi.org/10.1145/3544548.3581306>
- [86] Kathleen H. Pine and Max Liboiron. 2015. The Politics of Measurement and Action. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. Association for Computing Machinery, New York, NY, USA, 3147–3156. <https://doi.org/10.1145/2702123.2702298>
- [87] Gary W. Pritchard, Pam Briggs, John Vines, and Patrick Olivier. 2015. How to Drive a London Bus: Measuring Performance in a Mobile and Remote Workplace. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. Association for Computing Machinery, New York, NY, USA, 1885–1894. <https://doi.org/10.1145/2702123.2702307>
- [88] Mark Purdy. 2022. How the Metaverse Could Change Work. *Harvard Business Review* (April 2022).
- [89] Anne Warfield Rawls. 2008. Harold Garfinkel, Ethnomethodology and Workplace Studies. *Organization Studies* 29, 5 (May 2008), 701–732. <https://doi.org/10.1177/0170840608088768>
- [90] Stuart Reeves. 2015. Human-Computer Interaction as Science. In *Proceedings of The Fifth Decennial Aarhus Conference on Critical Alternatives (CA '15)*. Aarhus University Press, Aarhus N, 73–84. <https://doi.org/10.7146/aaacc.v1i1.21296>
- [91] Stuart Reeves. 2019. How UX Practitioners Produce Findings in Usability Testing. *ACM Transactions on Computer-Human Interaction* 26, 1 (Jan. 2019), 3:1–3:38. <https://doi.org/10.1145/3299096>
- [92] Lizzie Richardson. 2023. How Is the Platform a Workplace? Moving from Sites to Infrastructure. *Transactions of the Institute of British Geographers* 0, 0 (2023), 1–14. <https://doi.org/10.1111/tran.12625>
- [93] Kat Roemmich, Florian Schaub, and Nazanin Andalibi. 2023. Emotion AI at Work: Implications for Workplace Surveillance, Emotional Labor, and Emotional Privacy. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (CHI '23)*. Association for Computing Machinery, New York, NY, USA, 1–20. <https://doi.org/10.1145/3544548.3580950>
- [94] Pedro Sanches, Vasiliki Tsaknaki, Asreen Rostami, and Barry Brown. 2020. Under Surveillance: Technology Practices of Those Monitored by the State. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3313831.3376889>
- [95] Shruti Sannon, Billie Sun, and Dan Cosley. 2022. Privacy, Surveillance, and Power in the Gig Economy. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3491102.3502083>
- [96] Phoebe Sengers, John McCarthy, and Paul Dourish. 2006. Reflective HCI: Articulating an Agenda for Critical Practice. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems (CHI EA '06)*. Association for Computing Machinery, New York, NY, USA, 1683–1686. <https://doi.org/10.1145/1125451.1125762>
- [97] Robert Soden, Michael Skirpan, Casey Fiesler, Zahra Ashktorab, Eric P. S. Baumer, Mark Blythe, and Jasmine Jones. 2019. CHI4EVIL: Creative Speculation on the Negative Impacts of HCI Research. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems (CHI EA '19)*. Association for Computing Machinery, New York, NY, USA, 1–8. <https://doi.org/10.1145/3290607.3299033>
- [98] Lucy A. Suchman. 1987. *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge University Press.
- [99] Janos Mark Szokolczai. 2023. Exiting the Captaverse: Digital Resistance and Its Limits Pre and Post the Covid-19 Pandemic. *Criminology & Criminal Justice* (July 2023), 17488958231184695. <https://doi.org/10.1177/17488958231184695>
- [100] Omar A. Tapasco-Alzate, Jaime Giraldo-García, and Diógenes Ramírez-Ramírez. 2021. Productivity Metrics in the Context of Knowledge Work: Literature vs Practice. *International Journal of Productivity and Performance Management* 71, 7 (Jan. 2021), 3030–3055. <https://doi.org/10.1108/IJPPM-05-2020-0219>
- [101] Frederick W. Taylor. 1914. Scientific Management: Reply from Mr. F. W. Taylor. *The Sociological Review* a7, 3 (July 1914), 266–269. <https://doi.org/10.1111/j.1467-954X.1914.tb02387.x>
- [102] Frederick Winslow Taylor. 2012. *The Principles of Scientific Management*. Duke Classics, Cleveland.
- [103] Jeffrey W. Treem, William C. Barley, Matthew S. Weber, and Joshua B. Barbour. 2023. Signaling and Meaning in Organizational Analytics: Coping with Goodhart's Law in an Era of Digitization and Datafication. *Journal of Computer-Mediated Communication* 28, 4 (July 2023), zmad023. <https://doi.org/10.1093/jcmc/zmad023>
- [104] Elena Tsappi and George Papageorgiou. 2023. Towards Deriving Organizational Key Performance Indicators in a Metaverse Workplace: A Systematic Literature Review. In *Proceedings of the 16th International Conference on Pervasive Technologies Related to Assistive Environments (PETRA '23)*. Association for Computing Machinery, New York, NY, USA, 374–383. <https://doi.org/10.1145/3594806.3594835>
- [105] Jose van Dijck. 2014. Datafication, Dataism and Dataveillance: Big Data between Scientific Paradigm and Ideology. *Surveillance & Society* 12, 2 (May 2014), 197–208. <https://doi.org/10.24908/ss.v12i2.4776>
- [106] Stephan Voswinkel. 2018. Work and Subjectivity. In *Capitalism and Labor: Towards Critical Perspectives*, Klaus Dörre, Nicole Mayer-Ahuja, Dieter Sauer, and Volker Wittke (Eds.). Campus Verlag, Frankfurt-on-Main, Germany.
- [107] Yuntao Wang, Zhou Su, Ning Zhang, Rui Xing, Dongxiao Liu, Tom H. Luan, and Xuemin Shen. 2023. A Survey on Metaverse: Fundamentals, Security, and Privacy. *IEEE Communications Surveys & Tutorials* 25, 1 (2023), 319–352. <https://doi.org/10.1109/COMST.2022.3202047>
- [108] Alan Wexelblat. 1993. Chapter 2 - The Reality of Cooperation: Virtual Reality and CSCW. In *Virtual Reality*, ALAN Wexelblat (Ed.). Academic Press, 23–44. <https://doi.org/10.1016/B978-0-12-745045-2.50010-6>
- [109] Cedric Deslandes Whitney, Teresa Naval, Elizabeth Quepons, Simrandeep Singh, Steven R. Rick, and Lilly Irani. 2021. HCI Tactics for Politics from Below: Meeting the Challenges of Smart Cities. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, 1–15. <https://doi.org/10.1145/3411764.3445314>
- [110] F. A. Wilson and N. N. Mitev. 1996. Surveillance and the Reengineering of Commitment within the Virtual Organization. In *Proceedings of the 1996 ACM SIGCPR/SIGMIS Conference on Computer Personnel Research (SIGCPR '96)*. Association for Computing Machinery, New York, NY, USA, 181–191. <https://doi.org/10.1145/238857.238893>
- [111] Alex J. Wood, Mark Graham, Vili Lehdonvirta, and Isis Hjorth. 2018. Good Gig, Bad Gig: Autonomy and Algorithmic Control in the Global Gig Economy. *Work, Employment and Society* (Aug. 2018), 0950017018785616. <https://doi.org/10.1177/0950017018785616>
- [112] Jamie Woodcock. 2020. The Algorithmic Panopticon at Deliveroo: Measurement, Precarity, and the Illusion of Control. *Ephemera: theory & politics in organizations* 20, 3 (Nov. 2020), 67–95.
- [113] Angie Zhang, Alexander Boltz, Chun Wei Wang, and Min Kyung Lee. 2022. Algorithmic Management Reimagined For Workers and By Workers: Centering Worker Well-Being in Gig Work. In *CHI Conference on Human Factors in Computing Systems (CHI '22)*. Association for Computing Machinery, New York, NY, USA, 1–20. <https://doi.org/10.1145/3491102.3501866>
- [114] Jan J. Zygmuntowski. 2022. Surveil and Control: A Critical Review of “The Age of Surveillance Capitalism”. *IJAR – International Journal of Action Research* 18, 1-2022 (June 2022), 71–78. <https://doi.org/10.3224/ijar.v18i1.07>

Temporary page!

L^AT_EX was unable to guess the total number of pages correctly. As there was some unprocessed data that should have been added to the final page this extra page has been added to receive it.

If you rerun the document (without altering it) this surplus page will go away, because L^AT_EX now knows how many pages to expect for this document.