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<https://escholarship.org/uc/item/63s260b0>

Journal

Research in Sociology of Work, 29(1)

ISSN

0277-2833

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Publication Date

2016-08-20

Peer reviewed

Control from on high: Cloud-computing, skill, and acute frustration among analytics workers in the digital publishing industry. *Research in the Sociology of Work*. 29(1).

By

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Abstract:

This article addresses research on worker skill, technology, and control over the labor process by focusing on routine immaterial labor or knowledge work. Based on participant observation conducted among analytics workers at a digital publishing network, I find that analytics workers appear paradoxically autonomous and empowered by management while being bound by ever-evolving, calculative cloud-based information and communication technologies (ICTs). Workers appear free to “be creative,” while ever-evolving ICTs exert unpredictable control over work. Based on this finding, I argue that sociology’s tendency to take organizational boundaries and technological stability for granted hampers analyses of contemporary forms of work. Thus, sociologists of work must extend outward - beyond communities of practice, labor markets, and the state - to include ever-evolving, infrastructural socio-technical networks in which work and organizations are embedded. Additionally, research on the experience of immaterial labor suggests that ICTs afford pleasurable immersive experiences that bind workers to organizations and their fields. Complicating this emerging body of research, I find workers *acutely frustrated* by these unpredictable, ever-evolving, cloud-based ICTs.

Keywords: Skill, Technology, Organizational control, Labor process theory, Immaterial labor, Creative industries

Introduction

Audiences around the world turn on their computers, opening web-browsers. They visit YouTube, a popular blog, or another advertising supported website. As they immerse themselves in digital media content, a few advertisements graze their eyes. Preempting their desired consumption, advertisements display messages from global brands about consumer products. A variety of technological systems count and store information about the audiences’ experiences. In cities such as New York, London, San Francisco, or Los Angeles, workers analyze this information in order to sell audiences’ attention to advertisers. Through this work process, audience attention to advertising becomes a saleable commodity. In this article, I focus on this immaterial production process.

More specifically, I focus on the affective and structural relationships between workers and calculative cloud-based information and communication technologies (ICTs) that facilitate this immaterial production process. At a digital publishing network I call Obsession¹, workers use calculative cloud-based ICTs (i.e., web-traffic monitors, advertising servers, and advertising exchanges) to collect and construct information about Obsession's audiences. Within Obsession's advertising operations department (AdOps), these workers monitor audience behavior, produce immaterial inventory of "impressions" – a type of "audience commodity" (Smythe 1977; see also Scholz 2013) – and generate sales reports. Monitoring and reporting this information determines the size of Obsession's inventory of "impressions" or saleable views of advertisements.

I use the term calculative, cloud-based ICTs when referring to applications and computing systems that perform calculative procedures. My data and analysis focus on cloud systems that count and calculate measures of audience attention. Information from these cloud systems allows Obsession to sell audience attention to advertisers - claiming that online audiences spend 287,000,000 minutes per month reading these blogs and viewing advertisements. Like all cloud systems, these systems are accessed by way of internet connections to servers owned and controlled by companies located offsite and outside of the organization.

In the U.S., information, knowledge, or creative industries tend to be the most valuable in terms of corporate profits and worker remuneration². Termed "symbolic analysts" (Reich 1991), "immaterial labor" (Hardt and Negri 2001), "self-programming" knowledge workers (Castells 2010), or the "creative class" (Florida 2002), these workers produce and circulate immaterial commodities

¹ Digital publishing networks – like television networks - organize and distribute media content produced by both "O&O" (owned-and-operated) and independent production companies. As with all forms of advertising-supported media, Obsession – a pseudonym – sells advertising on those media properties in order to generate revenue.

² In the U.S., median wages for "creative" or information industry occupations (i.e. media, arts, engineering, computer, finance, and education) tend to be higher than other industries (U.S. Bureau of Labor Statistics 2013).

and experience goods (i.e. music, film, performance, etc.). Over the past several decades, work in these fields has grown as a research topic. Many studies focus on the “boundaryless” (e.g., Arthur and Rousseau 2001; Tolbert 2001) or networked careers of freelance professionals (e.g., Anderson-Gough, Grey, and Robson 2006; Barley and Kunda 2011; Damarin 2006; Osnowitz 2006) or expressive, media industry occupations (e.g., Hesmondhalgh and Baker 2011; Lingo and O’Mahony 2010; Mears 2011). In these industries, highly uncertain labor markets, ever-evolving technologies, and, in the case of media, radically uncertain demand (Salganik, Dodds, and Watts 2006) compel immaterial laborers to engage in constant skill development, social capital accumulation, and reputational maintenance. Blurring the boundaries between work and non-work due to constant social-network development inside and outside organizations, these processes form a normative type of control over work (Osnowitz 2006).

While studies of networked or boundaryless workers advance sociological knowledge regarding expressive and professionalized immaterial labor, less can be said about workers that remain within an organization performing routine, non-professional work. I address this gap by examining a *routine*, immaterial labor process. Lacking control over the abstractions through which they work (Abbott 1988), analytics workers perform non-professional, routine data analysis. The routine work described in this article requires less codified skillsets and occurs within a particular organization under standard employment conditions (i.e. full-time with benefits). This situation suggests that constant networking and skill-development *outside* the workplace appear less salient. Based on these omissions, I ask how, if at all, full-time, routine, immaterial workers *within* an organization experience constant changes in skill found in previous studies of immaterial labor?

Relatedly, research suggests that technology serves as a key source of control over immaterial labor. Embedded within dense socio-technical networks, workers experience technology as a serious constraint or source of control (Damarin 2013). Relatedly, an abundance of research suggests that

workers in “creative” or knowledge industries tend to experience high levels of immersive, “flow” states wherein worker and task experientially “merge” (Amabile et al. 2005; Quinn 2005; see also Csikszentmihalyi 1990). These moments tend to be associated with technology (Cetina and Bruegger 2000; Kaiser et al. 2007). In these cases, technology exerts control over work by structuring how workers approach problems (Rennstam 2012) and work’s sensual or “aesthetic” dimension (Siciliano 2016). Illustrating how ICTs provide pathways to meaningful social action that reinforce positive workplace affects, this emerging body of research provides few contemporary examples of everyday frustrations found in earlier studies of workplace ICTs (e.g. Adler 1988; Baker 1991; Gasser 1986). From here I ask how and when cloud-based, calculative systems elicit positive and negative affects in the context of routine, immaterial labor under the condition of relatively standard employment?

In addressing these questions, I extend research on workers’ skill and workplace control by illustrating how calculative cloud-based ICTs structure and limit the exercise of skill, thus controlling the “content of work” (Simpson 1985). In accord with theories of flexibilization (see, e.g., Harvey 1989; Sennett 2000), I find that managers demand a skilled, inventive or “creative” workforce, however Obsession’s workers lack control over the calculative processes that structure the information that they analyze. As such, cloud-based, calculative ICTs control work by exerting “power...at the level of the labor process” (Heydebrand 1989:326) and thus function as a form of technical control. Paradoxically, management allows workers to “be creative” while said creativity appears bounded by cloud-based systems. Complicating recent research on immersive technological experiences at work, I illustrate how technology offers both immersive, pleasurable experiences and what I call *acute frustrations*. Both experiences emerge from interactions between workers and cloud-based, calculative ICTs.

In what follows, I discuss worker skill and workplace control with regard to technology and recent studies of immersion and workplace ICTs. I then provide background information regarding

digital, advertising-supported media organizations, and discuss method before describing processes by which analytics workers produce audience commodities - quantified, saleable aspects of audience attention. I conclude by discussing my findings' theoretical implications.

Skill, Technology, and Control

Notoriously difficult to measure and often subject to differing, disputed definitions (Attewell 1990; Vallas 1990), worker skill may be defined broadly as learned competencies or earned certifications of competencies necessary or perceived to be necessary for particular work tasks and processes. Control over the use of skill represents a crucial source of power over the labor process. In labor process theory, autonomous planning and execution of work's procedures and processes tends to be deemed skilled (see, e.g., Braverman 1974; see also, Attewell 1990). The opposite – deskilling - tends to be linked to the implementation of new, labor saving technologies and managerial techniques that diminish workers' power and autonomy while securing low labor costs. Initially theorized by Braverman as an inherent tendency of capitalism, deskilling consistently appears unevenly distributed (Attewell 1987) and undoubtedly mediated by local workplace cultures, variations in worker power (Choi, Leiter, and Tomaskovic-Devey 2008), and the contingent effects of organizational technologies (Barley 1986).

Recent economic shifts toward logics of “flexible accumulation” (Harvey 1989) and “flexible specialization” (Piore and Sabel 1984) suggest a prevalence of upskilling and reintegration of planning and execution of tasks (Vallas 1999). Here, implementation of new technologies tends to be associated with upskilling and concurrent increases in labor market polarization that favors workers with skills demanded by said technologies (Gallie 1991). As such, deploying skill at work appears largely contingent upon industry, occupation, workplace culture, managerial strategies, worker resistance, and, most important here, technical relations at work.

These variables may mediate managerial control over skill, but including these variables does not significantly alter who or what attempts to exert control. In all cases, technologies that deskill, reskill, or upskill tend to serve management's interests. Considered as studies of fixed technologies that remain, once implemented, within organizational boundaries, these findings tell us rather little with regard to a variety of contemporary workplace technologies that find their use inside an organization but over which the organization does not maintain control (e.g., calculative, cloud-based ICTs).

For immaterial labor, skill development and reskilling appear as constant features of work (Deuze 2007; Huws 2014; Kotamraju 2002). In post-bureaucratic organizations wherein knowledge work tends to take place, management occupies a diminished role (Sewell 2005) and control over work (and thus over skill deployment) stems from the labor market (Adler 2001), professionalism (Abbott 1988), the demands of networking (Anderson-Gough et al. 2006), and the constraints imposed by socio-technical networks (Damarin 2013).

In knowledge or creative industries, socio-technical networks include technologies outside the control of organizations. This includes media distribution platforms (e.g., YouTube, iTunes, Vimeo) and “cyberinfrastructures” (Winter et al. 2014) such as research infrastructures (e.g., supercomputers, computing and hardware standards) and the calculative, cloud-based ICTs described later. These cyberinfrastructures embed “societal and field-level” interests rather than those of management (Winter et al. 2014:252). This suggests that constraint or control over skill stems, in part, from infrastructure's owners and thus a need to extend analyses beyond the aforementioned sources of control over skill.

Focusing on socio-technical networks, Cetina and Bruegger term these technologies “global micro-structures” (2002) insofar as many micro-level interactions occur through or in relation to similar, if not identical, ICT interfaces (Huws 2014). Building on Cetina and Bruegger's concept,

Damarin (2013) likens these technological microstructures to Becker's concept of conventions (1984) and argues that technology serves as a major form of control upon otherwise autonomous employees by limiting the range of possibilities afforded to workers. Conventions tend to remain relatively stable, acting as a reference that facilitates coordination (Becker 1984), yet many cloud-based infrastructures operate with proprietary algorithms that can change instantaneously and without notice (Gillespie 2014). This suggests that while technology may constrain the use of skill, the relations of production along with the temporal relations between technology, organization, and worker appear fundamentally different.

Pleasantly Immersive Technologies

Relatedly, interactions between workers and contemporary ICTs affectively “attach” or bind employees to their objects of labor (Cetina and Bruegger 2000). These technologies afford pleasantly immersive “flow” experiences (Cetina and Bruegger 2000; see also Csikszentmihalyi 1990) that elicit a “passion” for knowledge (Kaiser et al. 2007). In the case of software programmers, Chun calls this combination of pleasurable immersion and technologically-mediated social action “causal pleasure” (2005:38–39) or positive affects associated with the ability to cause changes within a screen environment. In media and entertainment, these pleasantly immersive experiences tend to be associated with creative acts that appear intimately dependent upon ICTs such as audio recording or video editing (Hesmondhalgh and Baker 2011).

Recently, interactions such as these have been theorized as forms of control. Solving the contemporary labor process problem of the “indeterminacy of knowledge” (Sewell 2005), these constitute forms of “object control” that both guide decision-making (Rennstam 2012) and enroll workers into organizational projects by modulating workers’ sensual experiences (Siciliano 2016). This dovetails with speculative theorization of immaterial labor under “cognitive capitalism” (see,

e.g., Boutang 2011; Fuchs 2011; Lazzarato 2014; Marazzi 2011) wherein workers' *desire* to learn how to work through complex ICT systems (Boutang 2011) and organizations depend upon workers' flexible capacities for the creative deployment of embodied, virtuoso-like cognitive skill in a variety of tasks (Virno 2004). Thus workers and organizations require technology in order to, respectively, deploy and appropriate skills. Using a cybernetic master/slave metaphor, Lazzarato (2014) calls this "machinic enslavement." Similar to empirical research, cognitive capitalist theory suggests that rather than exerting power by forbiddance, contemporary technical control exerts power through affordances (Zammuto et al. 2007) or loosely structured pathways to action. This suggests that ICTs afford workers the possibilities of deploying skill and enacting some personal or organizational goal (i.e. to make a transaction, to make a decision, to render a judgment, etc.) while experiencing immersive subjective states.

In what follows, I address the questions raised above by focusing on an immaterial production process: the fabrication of impressions, a type of audience commodity. I show how workers autonomously plan and execute analytic procedures and tasks and thus how management depends upon workers' virtuoso-like skills. This autonomy, however, does not extend to the planning and execution of calculation and thus workers appear controlled, partially, by ever-evolving, calculative, cloud-based ICTs – a form of cyberinfrastructure. Much like factory machines in the 19th and early 20th centuries, or even earlier ICTs, cloud-based, calculative technologies appear to employees as blackboxes. Unlike a lathe or a local mainframe, however, cloud ICTs remain outside the control of management and few if any employees understand or control the inner-workings of cloud-based, calculative technologies. Workers exercise control over analytic interpretation and data reorganization while cloud-owners control and frequently change calculative procedures and data structure. Before presenting ethnographic data, I provide background on advertising-supported media industries followed by descriptions of case features and methodology.

Background on Advertising-supported Media and the Sale of Audiences

Like traditional advertising-supported media (e.g., broadcast television, radio, and newspapers), advertising-supported digital media organizations earn revenue by selling audiences' attention to advertisers. These media organizations produce two products: media content for consumers and an "audience commodity" or audience attention for advertisers (Smythe 1977; see also Ettema and Whitney 1994). In television, radio, and digital media, the sale of the latter pays for content production. The term audience commodity refers to media audiences as they come to be constituted by and sold by media industries. The fabrication of audience commodities depends heavily upon measurement systems – forms of sense-making that structure organizational fields and decision-making (Anand and Peterson 2000).

Digital media firms depend upon measurements of audiences' media consumption in order to constitute audiences as a saleable commodity. While broadcast TV and radio continue to rely upon entrenched media rating systems such as Nielsen or Arbitron (Napoli 2003, 2011; see also Buzzard 1990; Gitlin 1983), digital media relies upon more fine-grained measurement systems in order to sell exact measures of audiences. Following a larger pattern of rationalized quantification within media industries (Napoli 2008), digital media organizations rely upon cloud-based, calculative ICTs rather than time-use diaries and other forms of self-reported data used by TV and radio. Calculative, often cloud-based, systems measure visits to websites ("pagevisits" and "pageviews"), clicking links ("click-thrus," "click-thru rates," or CTR), time spent on websites, and time spent viewing videos (minutes-watched). Notably, one of the largest providers of these cloud-based ICTs (Google) also depends, primarily, upon advertising revenue (Hern 2016) and thus has a clear vested interest in controlling and maintaining infrastructures that produce information about digital audiences.

In industry terms, these measurements constitute saleable “inventory” of audience behaviors (e.g. clicking advertisements, “sharing” or “liking” content on social media). Firms such as Obsession sell discrete amounts of audience activities to advertisers as types of audience commodities. These audience commodities include impressions (viewing advertisements), click-thrus (clicking advertisements) and conversions (click-thrus that generate an online sale). In this article, I focus on impressions. The term impression refers to the number of advertisements loaded or “served” when a media consumer views media content. For example, one visit to a website (pagevisit) may include viewing multiple portions of said site (pageviews). With each pageview, media audiences may be “served” a number of advertisements. On each page, the advertisements that impress themselves upon audience eyeballs count as impressions. Viewing three pages, each with three advertisements counts as nine impressions sold to advertisers.

In order to generate an inventory of impressions, Obsession and similar organizations rely upon cloud-based, calculative systems that provide estimates of future impressions based on past web-traffic. As such, the counting of impressions and estimates of future impression inventory constitute important, core aspects of revenue generation. Sales brochures from Obsession and similar companies highlight average audience size and estimates of audience activities along with demographic and socio-economic characteristics. Along with the active trafficking or uploading of advertisements to websites, analytics workers at Obsession provide reports of inventory to the sales team, executive staff, and editorial team. Before describing their work, I provide further details about Obsession and discuss my methodology.

Case features and Methodology

This study draws from 15 months of multi-sited, participant observation at two digital media organizations and 30 interviews with executives, managers, and employees. In this article, I focus on

five months of fieldwork conducted in 2013 within the advertising operations (AdOps) department of Obsession, a digital publishing network. Obsession publishes numerous blogs and employs 31 full-time staff members in Obsession's main office where I conducted fieldwork. In this office, people perform managerial, editorial, administrative, sales, data-analytic, and executive functions. Obsession's media content production occurs in the U.S. and around the globe in a network of freelance writers, video production teams, and web designers.

Here, I focus on AdOps's analytic workers that "traffic" or upload and integrate advertisements into Obsession's blogs while also analyzing web-traffic data in order to ensure that the company "makes good" on product sales (impressions). Obsession's mostly female AdOps employees ranged in age from 22-38 and work under standard employment conditions (i.e. full-time and salaried with benefits). All were college educated, though only one AdOps worker held a degree in marketing and advertising. Most AdOps employees held liberal arts degrees in varying disciplines such as political science, English literature, media studies, and poetry. Salaries in AdOps ranged from \$35,000 - \$60,000 with mostly male department managers earning the highest in that range. Turnover appeared quite high with only one team member having been there longer than 3 years. Highlighting the precariousness of their "standard" employment, the entire department was laid off just prior to the end of my fieldwork.

White-collar with a relatively flat hierarchy and an open-office floorplan, Obsession resembled an ideal-typical "no-collar" workplace (Ross 2004). Culturally, no-collar workplaces appear similar to white-collar technology industry workplaces (e.g., Kunda 1992) that display the broader trend of increased participatory demands upon workers (see Boltanski and Chiapello 2005) and a blurring of the boundaries between personal life and work. As such, this work environment serves as a theoretically purposive case that allows for the extension of theories outlined above. Rather than expressive, unmoored workers, analytics workers serve as an organizationally-bound

case of the creative industries' "humdrum" work (Caves 2000) or routine, immaterial labor (Hardt and Negri 2001).

Following the extended-case method (Burawoy 1998), I entered the field in order to extend theory through an examination of this particular case. Working two to three days a week, I wrote fieldnotes after each five to eight hour shift and coded fieldnotes using theoretical categories as well as inductively generated codes. Based on previous research in these areas, I expected to find a flexible, upskilled workforce. As I show later, fieldwork met this expectation, however, a portion of workplace experience exceeded extant theory. This excess serves as an anomaly to be explained.

As an unpaid intern and overt researcher, I regularly performed or supported many of the tasks described in this article. Though this granted me insight into organizational life at Obsession, my low status as an intern and the prevalence of non-disclosure agreements (NDAs) seemed to cause difficulty in obtaining interviews at Obsession. Most frequently, employees cited their lack of time, stated that they simply "did not want to be interviewed," or did not respond to multiple interview requests. Despite official permission from the organization, employees expressed concern that an interview might violate the NDAs required by many media and technology firms. As such, my analysis draws primarily from participant observation and lunchtime conversations. I supplement observational data with interviews from managers and employees at other digital media firms. I now turn to my data to describe how AdOps employees perform analytics work wherein they process information in order to describe, analyze, and ultimately sell the attention of digital media audiences to global advertisers. Technologically dense, their work requires the use of several, cloud-based, calculative systems. I begin by describing interactions between employees and these systems.

Assembling an Audience Commodity

Obsession's analytics employees engage in technically complex, routine, repetitive work that requires creative interpretation of information. Inside AdOps, analytics workers' main tasks include uploading advertisements to servers, devising new sizes and placements of advertising, tracking the performance of these advertisements over time, and providing reports to other departments regarding estimated audience size and advertising revenue. Calculating website traffic and audience size feature prominently in the majority of these tasks. In what follows, I describe the process by which analytics workers produce estimates of future impressions. After completion of these processes, AdOps workers "release" impressions to sales staff for sale to advertisers.

In order to illustrate how worker skill and autonomy depend upon technical systems, I begin by describing workers' typical interactions with these systems. A typical worker's computer screen includes an email application, an instant-messaging application, and as many as five windows of a browser, each with multiple "tabs" or layered sub-windows. These web-browsers display interfaces of multiple, cloud-based applications. At Obsession, analytics employees tended to work within a single screen and thus encountered a series of half-visible, overlaid windows that depicted charts, graphs, and tables along with messages from co-workers.

This layered work area contained three globally ubiquitous technologies within contemporary ad-supported media organizations: web-traffic monitors (monitors), advertisement servers (Ad-servers), and advertising exchange servers (Ad-exchanges). Monitors calculate the size of blog audience and time spent by audiences on blogs. Ad-servers place digital advertisements into websites ("serving," "firing," or "trafficking"). Servers calculate the number of times that an advertisement has been "fired" at or "served" to particular audience segments ("targets"), allowing Obsession to sell finely segmented impressions. For a typical advertising campaign, Obsession might sell 100,000 impressions of affluent male blog-readers aged 25-29 to a company such as Levi's jeans.

This earns roughly \$1800-\$3500 based upon cost-per-thousand or “cost-per-mille” (CPM) ranging from \$18-\$35. Ad-exchanges algorithmically calculate prices and sell impressions in real-time - often without human supervision – and these prices fluctuate from minute to minute.

In order to ensure that these technologies sell space to advertisers and display advertisements to intended audiences, employees frequently ran reports (“ad-hoc reporting”). Employees first logged into a combination of monitors, servers, and exchanges in order to perform this common task. Logged in, analytic workers generated reports by selecting from a menu of variables within the monitors, ad-servers, and ad-exchanges. Typically, employees requested information from all three types of application to gather data related to unsold impression inventory, projections of future impression inventory, realized profit, and projections of future revenue. These systems ostensibly provide redundant information, however, reports often failed to provide what should have been, according to employees, identical data. Far from providing clear, unmediated information, the data often required translation that I describe later.

User-interfaces for servers and exchanges display a series of toggle boxes for selecting variables, a time period selection box, and a “submit query” button. Upon submitting a query, employees waited for cloud-based software to generate a report. Rather than instantaneous access to information, there exists a significant, temporal gap between query and response. This gap may be as short as several seconds or as long as several hours. Often these time-delayed reports revealed discrepancies that did not become apparent until after this temporal lag. Much of the work that I performed and observed at Obsession consisted of attempts to translate incorrect information or to develop workarounds. This included labor-intensive workarounds whereby employees gathered and recombined information from each system in order to translate the data into actionable information.

This can be seen in a meeting that began with a manager explaining how a cloud-based web-traffic monitor “regularly reports inaccurately.” It is worth noting that Obsession pays tens-of-

thousands of dollars per month for use of this application. After determining that Obsession's other cloud-based systems could not provide information promised by the monitor, the manager instructed workers to "figure out how to make this work and figure out why reporting is way off." Interestingly, he asked if there was a way to know how "wrong" the system was. The AdOps workers told him that there was not and the manager agreed. As he said, "Yeah, there's no way." Impression inventory does not exist outside of the measurement system. Obsession's products (impressions) lack the "objectivity" associated with physical, commonplace, or "closed-box" commodities (Cetina and Bruegger 2000:149) such as a car or steel. Impressions, as immaterial commodities, appear as "objects of knowledge" that exist as "processes and predictions rather than definitive things" (Cetina and Bruegger 2000:149). Impression inventory is not a fixed object, but a flow of information condensed into a measurement by calculative systems (monitors, ad-exchanges, and ad-servers).

As the meeting continued, an employee displayed reports from these cloud systems on a large flatscreen display. The goal of generating these numbers was to provide information to executive staff. Executives required reports of impressions by site, advertisement type, audience operating system (i.e., Windows or OSX), and audience location. The monitors, ad-servers, and ad-exchanges gave conflicting numbers and everyone groaned. Employees decided to combine numbers from the advertising exchange with monitor data in order to construct a report that would then be used to calculate the figures needed by executive staff. After instructing employees as to how he would like the report to look, the manager jokingly said, "Imagine a future. Just imagine. There's a waterfall. The sun is shining and [this system] is generating reliable information." Here, a basic form of organizational sensemaking (counting inventory) cannot be performed by technology and so technology becomes a vehicle for skill deployment.

Inventing a workaround, employees demonstrated what Paolo Virno terms “virtuosic” (2004:54) or virtuoso-like deployments of interpretative and problem-solving skills. These skills require general, flexible knowledge of ICTs rather than codified knowledge (e.g., computer programming, woodworking, machining, etc.). Keep in mind that no AdOps workers had technical backgrounds. Rather than a technical background, analytics work requires a generic capacity for thinking and problem solving developed over the course of lives spent interacting with ICTs outside of work (e.g., smartphones, personal computers, televisions, videogames, etc.).

Statements from management confirm this need for workers with generic, yet self-directed skills. As one hiring manager stated, he seeks to find “real-time self-starters” capable of performing a variety of “ad-hoc” tasks. Illustrating a characteristically post-bureaucratic definition of “freedom as potential” (Maravelias 2003), another executive stated that he simply wanted to “empower” people to do what they wish. Workers are given autonomy to develop what he termed “innovative” solutions³ or, as several other managers said, “to be creative.” Though I have no in-depth interviews from Obsession, workers in comparable digital media jobs reported that “to be creative” and self-directed were the most enjoyable aspects of work.

Along with this invitation to “be creative,” employees experience immersion in routine tasks. I found myself staying late to solve data problems, often losing track of time and skipping breaks. Lost in the cloud, I experienced what informants called “worm-holing” or, more often, “deep-diving.” An analytics employee at another firm said that she experiences “zen” in these moments. She explained, “I just put my head down and just zoom in. It’s like I’m putting a zoom lens on my brain” and added “I’m very focused. You could say zoned out.” During these moments, I lost track of time, staying well past my shift’s scheduled end or working through lunch breaks.

³ Here I focus on reactions to technological systems, however, it was equally common for employees to discuss creative strategies for bending audiences to the company’s will by way of these same technological systems. For example, workers were also devising ways by which Obsession could generate new revenue streams by placing more advertisements into blogs.

Feeling immersed in a data-filled screen ought to be a familiar experience for quantitative social scientists that spend hours inside the windows of STATA or SPSS. For me, this felt comparable to a videogame – albeit a crudely designed one. This sort of immersion – often linked to creativity and job satisfaction (Amabile et al. 2005) among both expressive (Hesmondhalgh and Baker 2011) and routine (Siciliano 2016) creative industry workers – provides one of the relative satisfactions of routine immaterial labor⁴.

In order to secure profits, Obsession and similar organizations depend upon workers to assemble disparate data into a stable, immaterial product: impressions. After the above processes solidify impression inventory, AdOps workers “release” inventory for sale by algorithmic systems and sales personnel. The production of audience commodities requires generic capacities for problem-solving based on general knowledge of ICTs and these skills are needed to develop improvised workarounds. As such, analytics employees at Obsession appear skilled, autonomous, and free to “be creative” – albeit in a rather circumscribed way. Management encourages and expects these workers to autonomously plan and execute their immediate work tasks. Extending beyond the organization to infrastructure, however, reveals a cloud-based separation of planning and execution that runs counter to managerial goals.

Separating measurement from interpretation

Continuing to illustrate how calculative cloud-based ICTs shape this routine, immaterial labor process, I now present data that illustrates analytics employees’ perception of ICTs as inscrutable blackboxes. As above, my fieldwork suggests a paradox: workers appear empowered by management while in thrall to calculative cloud-systems. The planning and execution of

⁴ Given claims about the aestheticization of work (Hancock 2003) and “mobile lifestyles” that depend upon work technologies (Gregg 2011), it is worth noting that immersion metaphors are common in philosophical and anthropological writings on aesthetic experience (see, e.g., Adorno 2004 [1970]; Dewey 2005 [1934]; Gell 1998; Kant 2000 [1790]).

measurement occurs outside the organization while worker interpretation and improvisation remains free or “creative.” The effects of changes in calculative cloud infrastructure reveal themselves in an example of changes in measurement that occurred during fieldwork.

Like many digital firms that sell audience commodities, Obsession uses cloud-based, calculative systems (monitors, ad-servers, and ad-exchanges) owned and operated by ICT infrastructure providers. Though companies such as Amazon and Microsoft provide similar cloud infrastructures, Google is the largest of these providers,. In reference to these calculative systems, Katherine said, “Well, Google owns those.” Hanna interjected, “Yeah and they’ll probably buy the ones that they don’t own soon enough. They’re buying everything. That’s how we get screwgled!”⁵ Regardless of the truth of Katherine’s claim, these comments indicate the degree to which employees perceive their work to be bound up in forces beyond their control and the control of management.

In November 2013, Google adjusted measurement calculations for mobile internet audiences. Mobile refers to audiences that access Obsession’s blogs via smartphones and tablet computers. Google collapsed calculations of tablet and smartphone impressions into a single measure. Prior to this, Obsession sold tablet and smartphone impressions as differently priced products. In order to translate impressions generated by mobile audiences into separate products, the organization requires independent measures of smartphone and tablet impressions. This change in the cloud rendered Obsession’s strategy difficult, if not wholly impossible. Though it may seem ridiculous that such a simple figure could not be calculated separately, one analytics employee recounted her interactions with Google as follows:

⁵ Here, the informant makes reference to both her feelings about Google, but also the popular “screwgled” internet meme and “Scroogled,” an anti-Google campaign sponsored by Microsoft. In fact, the team frequently made sense of their everyday experiences by making explicit references to popular, digital media content and popular culture in general.

I asked them how tablet [pageviews] could be calculated and the woman said ‘well, this is better because it’s one metric for all of your mobile traffic’ which is fine for them I guess, they like that, but we need separate tablet reporting. Anyway, I asked how the system is tracking that information and the woman said, “Well, that’s a good question. I’ll look into that.” They have like, in their training they have specific things that they’re told to say to us in those situations [and avoid answering my question].

In the above example, the worker’s desire for information or “structure of wanting” (Cetina and Bruegger 2000:152) does not correspond to the structure of information provided by the system. These mismatches of desire and data structure tend to be associated with what I term acute frustration⁶ - emerging proximally from interactions with technology - rather than the immersive pleasure found in other studies of ICTs and knowledge workers.

Another example of employees interacting with calculative cloud-based ICTs comes from Marcus, a content-uploader and web-traffic analyst at another firm.

Say we have this [page] that gets all these crazy views, like suddenly, like out of nowhere. [The views] were low on the weekend and [then] they get all these views. We look and say, “this looks odd to us, why are they getting all these views?” We’ll look at where these views are coming from and we’ll see that there’s a large number of views coming from Kazakhstan [sic] which is odd. We’ll go to [Google-owned] YouTube and say “Hey we’re noticing [an odd trend], can you tell us if something odd is going on” and they’ll say “We can’t really tell you, but your instincts are probably on the money.”

Again, the data provided by these systems may or may not be usable. The organization and its employees have no way of knowing or gaining access to the principles that structure data production. From the workers’ perspective, this data is structured in accordance with the cloud-owner’s inscrutable interests. Obsession and its employees simply execute their interpretive and analytic tasks. Rather than immersive pleasure – disappearing into the screen - workers experience acute frustration. As another data analyst said

If we’re just talking about the interfaces that I work on, you know, there’s times when you

⁶ All work contains general, structural sources of frustration such as various forms of wage inequality, lack of benefits, or lack of career prospects to name just a few. An *acute* frustration should be understood as an interaction-present source of frustration, similar to an annoying co-worker. In this case, the technical source of acute frustration is both interaction present and a structural feature of work.

feel great about it. [The cloud provider] finally put all the proper tools in there and it's functioning properly and it's easy and it's great. Then two weeks later, [the cloud provider] goes 'Hey, check out our new interface' and it's a mess. Functionalities are gone! Names have changed. You know, those times can be frustrating.

In other cases, workers experience cloud-level changes as positive. As another informant said, "Yeah, those changes happen. Usually it's because it's better. It's always changing, always getting better." Positive or negative, these illustrate an affective connection to technology *and* a dynamic experience of work linked to ever-evolving ICTs that enable and constrain the deployment of skill while increasing uncertainty. As described earlier, workers improvise and develop workarounds for unexpected situations such as this one.

Grappling with upstream, metric reconfiguration, Obsession's analytics workers attempted to translate restructured traffic data into saleable inventory. Hanna decided to use data that tracks particular models of smartphones and tablets in order to generate counts of tablet computer and smartphone users. This requires the generation of reports that list mobile device model identification numbers for devices used by mobile media audiences. These reports often contain more than 3000 rows and require employees to research and determine whether the identification numbers correspond to smartphones or tablets.

After translating these reports, data may become usable estimates of smartphone and tablet audiences. At this point, the data remains unsellable as inventory. In order to turn these data into saleable inventory, analytics employees instruct a different system to interpret the above-mentioned identification numbers as either "smartphone" or "tablet" users. This requires labor-intensive, non-automatable, manual entry of this information rather than the instantaneous, non-mediated use of "big" data that has so often been depicted in popular industrial discourse and news media.

In another instance, Isaac, a sales supervisor asked Jamie, an analytics employee, how to use another calculative cloud system to properly track impressions. The system should generate targeting "tags" that track and calculate impressions, however, AdOps employees stated that this system does

not typically work as expected. They explained that attempts to fix this issue came to nothing. Isaac said "...the person that had emailed me from Google, telling me to call them for training on the product, that person doesn't even exist there. [Google] just said 'that person, that name doesn't exist here'." Jamie responded to Isaac's comment and said, "That company is too big. I think someone should take them down and get rid of like, a few hundred, 150,000 people. Right?" Isaac, the manager, said "I called [Google] Adwords and they asked me if I was an advertiser, 'you're an advertiser, would you like to place ads with us?' I was like hold on Google, hold on with that. No." Jamie sympathetically said, "Yeah, they're terrible." Worth mentioning again is Google's dependence upon global advertising sales as a primary source of revenue (Hern 2016) and Google's position as owner of much of the cloud infrastructure used to sell online advertisements. As such, Google's revenue structure and position within the field suggest an obvious vested interest and a disproportionate power to structure this data.

In another conversation, Isaac (sales manager) and Hanna (AdOps supervisor) discussed common discrepancies between these multiple, equally "perfect" data sources. In the following excerpt of typical office chatter, Hanna and Isaac briefly discuss two conflicting reports from one of the monitors and one of the ad-servers.

H: It says 700,000 [impressions] here and 250,000 here. This 700 is right, but...

I: Damnit!

H: Right.

I: Well if that continues we'll be asking for our money back [from the cloud software provider]

Here, Hanna refers to reports that measure impressions that Obsession sells to advertisers. Her statement regarding the correctness of one figure over another may appear puzzling insofar as neither of these figures can be linked to physical objects. Instead, Hanna's statement refers to the triangulation of this figure with multiple reports from other systems. Obviously, the higher figure is

preferable because a larger saleable inventory possesses more potential revenue. Conflicting measurements call Obsession's inventory into question and thus confound the organization's ability to sell product. Similarly, another analytics worker stated, "[Google and YouTube] didn't use to do that, but [now] they're constantly re-evaluating. So you could have a 100,000 views today and check back tomorrow and it's down to 50,000." In a heated exchange among analytics and sales employees, Isaac emphatically suggested that the employees simply "lie" about the impressions in light of contradictory information. Though in all likelihood no one provided false information, the manager's response highlights the difficulties produced by temporally delayed and conflicted data. This data tends to be structured by technologies that have been configured by actors external to the organization. Control over the labor process lies, partially, in the cloud – not as technologically embedded convention (i.e., Damarin 2013), but as perpetually in-flux measurement planned and executed upstream.

Competing measures fluctuate from day-to-day and thus further confound the employees' and organization's capacity for economically rational action,. Fluctuation occurs frequently with measurements differing by as much as $\pm 300\%$. An historical example of improper ICT inventory measurement seems comparatively small with variations being under 20% (Gasser 1986). At Obsession, cloud-generated inventory calculations refer to immaterial objects and improper measurement cannot be easily confirmed. Even reports of past impression sales and blog-traffic tended to yield different results depending on the day on which the report had been generated. As one employee said, "The impression estimates are always changing because [the systems] are sampling. It doesn't stay the same from day-to-day." Katherine, another analytics employee, explained her understanding of this situation as follows:

K: Those don't even pull numbers correctly! Like, it should be able to tell me how many people viewed an advertisement, but it varies. It should give a static number! It's not a projection! How many times was the ad accessed by the ad-server? It's a simple thing and still

it gives me different numbers for the same time period every time I access it. If I pull Q3's [3rd fiscal quarter] numbers today, it might be different next week and there's no reason for that.

Author: So it's sampling and estimating then?

K: Yeah, yeah it must be, but how?! I don't know. We don't know and [the cloud-owners] don't tell you!

This excerpt highlights employee experience of these technologies as blackboxes. While enabling calculability of immaterial objects, these technologies frequently do so in unpredictable, unreliable, and acutely frustrating ways. Thus employees experience unpredictable fluctuations in data as raw material and data as product (inventory) - as if workers' tools and the definition of pieces in a piece rate system were both subject to change from moment-to-moment. These fluctuations cannot be easily linked to actions of other humans or technology's internal practices. Above, the proximal cause of employees' acute frustration (bad information) stems from changes in cloud-based systems located upstream, autonomous from workers and management.

A manager at another firm recounted a similar experience: "This one time, we had been getting a lot of views from this one module that was on YouTube and then [Google] deleted that. They said 'well we don't need that anymore, so we deleted it' and all of our views left with that module. Yeah, that happens all the time." These fluctuations in calculative cloud-based ICTs reduce workers' ability to sell immaterial inventory and so these changes reduce Obsession's ability to produce revenue. At the organizational level, workers may autonomously and inventively analyze data, however, the planning and execution of measurement remains separate, in the cloud. In this case, the technical microstructures of information gathering - planned and designed elsewhere - complicate, if not thwart economic action.

A concluding example comes from a tumultuous week that included executive-level changes and heavy lay-offs. Directly confronted with the precariousness of their standard employment, many workers cried in the open office. An AdOps manager yelled, "All of our revenue comes from the

sale of ads!” This came after she had explained a recent technological problem resulting from the algorithmically controlled ad-exchanges. These systems indicated that Obsession had sold all estimated impressions for the fiscal quarter. Despite this, the company had not achieved its estimated level of profit. Hanna suspected that the algorithmically managed system had been using up inventory for less profitable advertisements.

Rather than selling more profitable advertising space to global brands, Hanna suspected that the system sold impressions to “remnant” sources. Remnant refers to common, text-based advertisements found on blogs and other portions of the internet such as web-based email. Remnant advertisements take up little space on a website and lack images or video components. Impressions sold to remnant advertisers earn only fractions of a cent as opposed to nearly two cents per impression for other advertisements. Still, Hanna and the rest of the analytics team had no way of knowing why or how this had occurred. More importantly, the employees had no way of fixing or adjusting the process because algorithmically controlled ad-exchanges sell impressions autonomously. Here, the actions of blackboxes heighten uncertainty as managers hold employees accountable for unacceptable gaps between revenue projections and actual earnings.

Controlled from on high, employees experience algorithmically controlled processes as blackboxes located upstream. These calculative, cloud-based ICTs structure measurement calculations in accord with cloud-owners’ interests and so cloud-based, calculative systems directly affect both an employee’s capacity to perform work and the organization’s ability to produce revenue. These technologies that rationalize the measurement of audiences (Napoli 2008) produce uncertainty. Insofar as Obsession’s impression inventory depends upon these systems, employees experience acutely frustrating, rapid change within the labor process that adds to already precarious, standard employment.

Discussion

I now briefly restate my argument before highlighting contributions to discussions within the sociology of work regarding technology, skill, autonomy, and management/worker relations. In the workplace described above, technology – as microstructure that both enables and constrains skill – controls work by separating the planning and execution of measurement from autonomous, creative interpretation conducted downstream. The calculative procedures embedded in cloud-based, calculative systems remain unknowable to the organization and its employees. The blackboxed technical content of these calculative systems appears to serve the interests of the cloud-owner (Google, in this case) or the ideal-typical users for which the software has been configured (Grint and Woolgar 1997).

Calculative cloud-technologies enable workers to engage in inventive or “creative” acts of information processing. While the necessary skills for work (cognitive capacities, problem-solving) may be forever a part of the worker, organizations require ICTs in order to activate these skills. Without these systems they cannot “be creative” and as such, creativity at work appears bounded by ICT affordances.⁷ By “being creative” and negotiating these technologies, employees render the information provided by calculative cloud ICTs usable for the organization by translating information as raw material into information as saleable immaterial product (impressions, a type of audience commodity). Additionally, workers appear affectively bound at all times to their glass screens. Insofar as upstream decisions affect their working day, analytics workers lack control and instead appear in thrall to cloud-based, calculative ICTs. While my findings may not be probabilistically generalizable, these findings appear theoretically generalizable to a wide range of

⁷ All work might be said to be dependent upon technology or techniques. Certainly, one might argue that the nail that sticks up cannot be hammered down without a hammer and yet, a resourceful person may use a rock for the same task. Here, cloud technology appears qualitatively different insofar as the raw materials and products only exist inside of the technology.

workers and organizations that appear structurally similar vis-à-vis calculative cloud-based ICTs.

Below, I highlight theoretical implications of these findings.

Labor Process Theory and Control over Skill

Labor process theory tends to presuppose relatively stable technologies that control work by regulating tasks (e.g., Edwards 1979) or surveilling workers (e.g., Aneesh 2009). Recent studies suggest new modes of technological control predicated upon employees' intellectual, affective, and aesthetic attachments (Cetina and Bruegger 2000; Rennstam 2012; Siciliano 2016) and the constraint of skill (Damarin 2013). Though similar, my findings suggest crucial differences with regard to studies of labor processes and relations between ICTs, skill, autonomy, and labor/management relations. These differences lie in the *source* of control, the *quality* of negotiation, and the *speed, scope, and scale* of change.

This case suggests that the *source* of control over worker skill lies neither in some inherently capitalist tendency, nor in organization-level variables (i.e. workplace culture, relations in production, unionization, etc.). Instead, skill appears affected by organization-level variables as mediated by the structural relationship between an organization and owners of technology. Thus control stems, in part, from the interests of cloud-based ICT providers. From the perspective of the worker and the organization, cloud-based ICT providers' interests appear inscrutable and often in conflict with worker and organizational interests.

While workers may still appeal to management for more autonomy or control over work, power over technology lies outside the organization. Thus organizational and worker autonomy appear always already bounded by a socio-technical network in constant flux. Others have noted the role of technology's designers (see, e.g., Grint and Woolgar 1997) and the uneasy, conflicted relationships between management and new technology. Zuboff (Zuboff 1989), for example, quotes

a manager struggling with technology vendors to “...leave the design flexible enough so that it does not preclude the uses we want to make of it” (1989:414). As my data suggest, cloud-based, calculative ICTs appear as blackboxes to workers and system owners appear inscrutable.

In terms of the *quality* of these relations, control does not appear as a relatively stable “convention” (Damarin 2013) to which workers may refer or even a stable object that can be clearly resisted. Based upon observed conflict between cloud-based ICT providers and Obsession, organizations and workers do not appear to possess a power of appeal. For theories of labor mobilization wherein autonomy and constraint affect the militancy of labor (e.g., Low-Beer 1978), it no longer appears clear whom workers would, should, or could mobilize against in efforts to gain control over technology.

Neither the separation of planning and execution, nor the negotiation of technology’s implementation is “new” to the study of work, technology, and skill (see, e.g., Adler 1988; Gasser 1986). Similar to classic deskilling (i.e., Braverman 1974), planning and execution appear separate. Analytics workers do not plan how the raw information is generated and algorithmically controlled measurement systems act autonomously. Illustrating the paradoxical quality of work, management explicitly seeks out “creative,” autonomous, and flexible workers and the organization depends upon worker creativity in order to bring technology in line with organizational interests.

With regard to *speed, scale, and scope* of change, calculative cloud-based ICTs differ fundamentally from ICTs of previous decades. As stated by scholars in the neighboring field of communication, technology that operates with proprietary algorithms “can be easily, instantly, radically, and invisibly changed” (Gillespie 2014:178; see also Gillespie, Boczkowski, and Foot 2014). The ethnographic data presented above illustrates how the rapidity and invisibility of such changes affect a routine, immaterial labor process. Relatedly, unstable technologies problematize coherent documentation of particular work processes, potentially circumventing codification associated with

professionalization (Bridges and Villemez 1991). This suggests a state of perpetual learning or “permanent pedagogy” (Sallaz 2015), but not the skill extraction found in the study of workplace “wikis” or web-based task documentation (Griffith, Sawyer, and Neale 2003).

Affectively Binding Technology

Empirical research suggests that ICTs focus attention and elicit passionate attachment to work by way of pleasurably immersive experiences associated with acting within ICTs (e.g., Cetina and Bruegger 2000; Kaiser et al. 2007; Rennstam 2012; Siciliano 2016). More speculative theories of cognitive capitalism suggest that interactions with ICTs affectively binds employees to work, providing pathways or “vectors” that “suggest, enable, solicit, prompt, encourage, and prohibit certain actions, thoughts, and affects” (Lazzarato 2014:30). Above-presented data support, yet complicate these descriptions of worker experience by showing how positive affects associated with ICTs depend upon the provision of useful information that afford pathways to action. Above, technology focuses attention upon particular kinds of information while placing limits upon work processes. No less affectively bound to technology, pathways afforded by cloud-based, calculative systems acutely frustrate Obsession’s workers due to the aforementioned speed and invisibility of technological change. This case highlights how socio-technical networks shape the everyday experiences of immaterial labor and how experiences of immersion or “flow” are shaped by structures of ownership within these networks.

Measuring Skill

This study suggests that the aggregate measure of skill may be more complicated than previously thought. In the case presented here, workers may appear autonomous and skilled based on job descriptions and daily task-content. Simultaneously, they lack control over and knowledge

regarding technical processes that structure work. While there have already been criticisms of aggregate measures of workforce skill (see Vallas 1990), my findings suggest that the aggregate measure of skills may cancel out or simply go unmeasured. Relatedly, this presents a problem in measuring the effect of calculative cloud-based ICTs similar to problems noted by Barley (1986) in measuring the effects of technology upon social structures at work. In contexts wherein the demands of technology and management differ, it may be difficult to observe technology's effects outside of participant observation.

Conclusion

This article presented a case in which a structural source of post-bureaucratic control lies outside the organization – serving the interests of cloud-based ICT providers. Rather than being normative, reputational, or strictly social (Anderson-Gough et al. 2006; Barley and Kunda 2011; Kunda 1992; Osnowitz 2006), control over skill stems from socio-technical networks in which work and organizations are embedded. I make three key points. First, as organizations exteriorize and digitalize calculative and immaterial production processes, managers' and workers' interests appear subordinate to the interests of ICT providers. Thus, technology alters the relations between capital and labor by establishing a hierarchy based on a political economy of information flows. Second, pleasurable immersion found in other cases appears interrupted by control imposed from outside the organization. Supporting aspects of theories of cognitive capitalism, technical control over skill and the subjective experience of work descend from the cloud to the firm rather than from managerial offices to the shopfloor. Last, findings suggest that labor process studies must continue to extend further outward – beyond the community, the state, the organizational field, or even stable ICTs – to the ever-evolving, dense socio-technical networks of infrastructures and human actors in which contemporary work is embedded.

Acknowledgements

For encouraging, thoughtful, and critical comments on earlier drafts of this article, I would like to thank Ching Kwan Lee, Christopher Kelty, Edward Walker, Pat Reilly, Alexandra Lippman, Christine Williams, Steven Vallas, Hannah Landecker, Kyle Nelson, Neil Gong, Steven Tuttle, and anonymous reviewers at *Research in the Sociology of Work*.

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