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Protocols of Production: The Absent Factories of Digital Capitalism

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Contrary to dominant theories of postindustrial society, this article advances an alternative account of digital capitalism that repositions the factory—so often associated with industrial manufacturing—as a defining yet largely overlooked feature of the internet economy. I pursue this claim by interpreting data centers and microwork platforms as digital embodiments of the factory system through a historical theory of the factory model that reconstructs the consistent mechanisms of control and extraction that have distinguished factories as consolidated infrastructures of production since their inception. I define these "protocols of production" as formal rules deployed by a combination of technological systems, spatial arrangements, and management regimes devised to fragment tasks, discipline workers, and supervise production. By probing the socioeconomic consequences of the factory's algorithmic redeployment and adaptation to global data production, I contend that these absent factories have amplified alienation and precarity as structural social qualities of the digital labor process.

INTRODUCTION

Since the Second World War, one consistent and unifying premise of theories concerning technological development and socioeconomic change has been the conceit that advanced capitalist societies were on the verge of a historical break with their industrial past (Andersson 2021; Brick 2006, 186). Traversing a variegated intellectual, political, and disciplinary landscape composed of techno-futurist scientists, neoclassical economists, liberal sociologists, New Left critics, and Marxist theorists, this—still ongoing—literature amasses a multiplicity of related and competing narratives about a looming society caught up in an age of discontinuity, variously designated as "affluent" (Galbraith 1958), "overdeveloped" (Mills [1958] 1963), "post-capitalist" (Dahrendorf 1959), "post-modern" (Mills [1959] 2000), "super-industrial" (Toffler 1970), "post-industrial" (Bell [1973] 1999), "post-Fordist" (Virno 2007), "networked" (Castells 2010), or "cognitive" (Hardt and Negri 2017)—to list but a few. Despite offering contrasting interpretations of the promises, perils, and political significance of this rupture, these heterogeneous projections of the future and diagnoses of the present converge in their portrayals of an emerging social formation distinguished by swelling levels of growth, unprecedented rates of technological change, and a structural occupational shift from industrial production to informational services (Brick 2006, 186–218). In particular, most adherents of what I call the "postindustrial paradigm" agree that, within advanced capitalist societies, the organization of production and the character of work have been radically transformed in a direction that ran counter to the disciplinary management regimes, fragmented tasks, and manual work routines that symbolized the industrial factory system. In place of the staple elements of Fordism, these thinkers identify immaterial forms of production steeped in knowledge, information, and technology as well as the ascendancy of a creative and skilled workforce as the defining structural features of postindustrial society. Today, it may seem as though such portrayals of a postindustrial age have come to pass; not only are affluent capitalist economies significantly structured by digital, knowledge-based, and informational cycles of production and valorization, but the ubiquitous postwar feeling of living through a "historic metamorphosis in Western society" (Bell [1973] 1999, 164) remains as prominent now as it was among mid-century intellectuals (Schwab 2017).

Yet, certain salient realities of economic life in the internet age cast doubt on accounts of a categorical postindustrial break with industrial processes of production, disciplinary regimes of control, and the manual toil of assembly line work. Even within the most technologically advanced sectors of our economy, those in which artificial intelligence and automation should have prevailed, human bodies, brains, and emotions continue to bear the brunt of digital drudgery (Gillespie 2018; Roberts 2019). Part of a vast, largely invisible yet indispensable workforce, human data workers are the backbone of a global internet economy "powered by media transcription, spam farms, and data entry" (Irani 2013, 735). Some of these workers perform the work of "cleaning" the obsolete, duplicated, or inaccurate bits of digital information called "dirty data" (Drai 2018). Others are employed in completing small, atomized online tasks known as "microwork," a term that epitomizes the extreme division of labor in the high-tech economy (Dalle et al. 2017). Microwork platforms such as Amazon Mechanical Turk (MTurk), TaskUs, Freelancer, Upwork, and the aptly named CloudFactory offer their clients—from freelance programmers and new media artists to LinkedIn and Google—the service of delegating an assignment to a massive cohort of online workers among whom work is parceled into

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minute clusters of short and simple tasks, including categorizing data, transcribing audio and text files, participating in surveys, and recording videos (Kost, Fieseler, and Wong 2018).[1] As a digital expression of "subemployment" in the global economy, microworkers—numbering anywhere between twenty to seventy million people, mostly in the Global South—face high levels of unpaid labor, underemployment, and in-work poverty (Altenried 2022, 97; Jones 2021, 25, 5).

Global data workers in flexible and contingent employment arrangements are not only underpaid and overworked, but also largely sourced from precarious labor pools that include a disproportionate number of people of color, undocumented migrants, and displaced refugees (Jones 2021, 11–8; Munn 2022, 75–8, 93–8). In Silicon Valley, for instance, content moderators and microworkers are known as "data janitors" (Irani 2015b; Lohr 2014). Insofar as the region's custodial services have been historically and unevenly performed by racialized and immigrant populations (Zlolniski 2006), the moniker is a marker of the structural inequalities that undergird Silicon Valley's record of wealth. Taken at face value, however, the term conveys the character and substance of low-wage data work. It suggests an analogy between the services that janitors provide in physical space and those that content moderators and microworkers perform on and to the internet—the work of cleansing our digital culture from its impurities, of organizing and cleaning the mess left by others, of mopping beneath our screens and clearing the ground, as it were, so others may create and play (Gillespie 2018, 121). In short, data workers compose a new global class of digital wage-labor employed in the manual, physical, fragmented, and repetitive tasks of organizing, transcribing, labeling, categorizing, digitizing, and moderating massive streams of data that incessantly besiege the internet.

In light of their prodigious number as well as the importance of their work to internet companies and users, data workers and the infrastructures in which they work amplify long-held, global patterns of alienation and racialized precarity in advanced capitalist societies that speculative accounts of postindustrial capitalism as an unmitigated rupture with industrial regimes of control, production, and valorization cannot fully explain. By turning to the covert ways in which data centers and microwork platforms rely on the political cycles and technical systems of production characteristic of the factory system to organize a massive workforce, this article advances an alternative account of contemporary capitalism that centers the factory's adaptation to the global demands of data production as a defining characteristic of the digital economy. While scholars have begun to expose the digital immersion of industrial regimes of control (Brown, Lauder, and Ashton 2011, 65–82; Crowley et al. 2010) and the factory system (Altenried 2020; 2022) as significant trends in data production, these analyses tend to rely on conventional depictions of the factory system distinguished by the central application of technology to production and limited to twentieth-century models of industrial organization. On my view, such narrow definitions and periodizations tend to elide the means through which the factory's extractive operations and mechanisms of control have systematically reproduced alienation and precarity as structural conditions of its labor process independently of technology, as much before as after the rise of Taylorist regimes of scientific management and Ford's assembly line.

By contrast, I put forth a theoretical account of the factory based on a long-range historical reconstruction of the consistent social and political mechanisms of control and value extraction that have distinguished it as a consolidated infrastructure of capitalist production since the early modern period. In doing so, I argue that the unique feature of the factory system is not the application of a centralized source of inanimate power to production, as it is traditionally defined, but its implementation of an organizational framework specifically devised to subsume the labor process under capital's command through what I call "protocols of production": formal codes and rules of control deployed by a combination of diverse technological systems, spatial arrangements, and management regimes to fragment tasks, discipline workers, and supervise production. I further claim that, although these protocols are regular elements of the factory model, the infrastructures through which they can be deployed are malleable, thus allowing the factory to adapt its form across a range of physical and technical embodiments in order to overcome new challenges, perfect its control over labor, and continuously attain its goal of capital accumulation. By probing the global socioeconomic consequences of the factory model's digital redeployment, I contend that its particular organization of production systematically reproduces alienation and precarity as social qualities of its labor process, which, as I demonstrate, depends upon a vast and replenishable pool of precarious workers whose labor is meticulously divorced from the cultural, informational, and intellectual content of their work, the materials they employ, and the commodities they help to forge through the imposed conditions of fragmentation, discipline, and supervision that define the mass production of data in the internet age.

By reconceptualizing the factory's digital embodiment, this article foregrounds capital's opaque—and deliberately erased—sources of value: a global class of contingent digital workers; an endless stream of data that never reaches our screens; and a repetitive, manual routine of digital labor that, while indispensable to creative, cultural, and intellectual production, is seldom seen or heard. The predatory regimes of discipline, supervision, and fragmentation within these "absent factories" are as central to digital capital's techniques of extraction and accumulation as to its reproduction of alienation and precarity on a global scale. Throughout,

[1] MTurk workers, in particular, earn an average hourly wage of less than $2, with most tasks being paid less than $0.10, while nearly a third of all completed tasks on the platform go unremunerated (Gray and Suri 2019, 90; Jones 2021, 5–6, 45).

the labor of data workers emerges as an essential yet unpronounced specter of digital capitalism and algorithmic automation: a mute, invisible, and omnipresent form of human exertion, eminent in every search engine result and tacitly presumed in every unconscious scroll down social media feeds.

THE POSTINDUSTRIAL PARADIGM

Although the term "post-industrial" was coined sometime between 1913 and 1914 by art historian Ananda K. Coomaraswamy and later developed by architect Arthur J. Penty (Rose 1991, 21–4), the context for the mid-century surge in theories of "post-industrial society" began to form in the late 1940s, a period distinguished by breakthroughs in computer and machine technology that, in the business realm, resulted in new solutions to pressing problems of automatic control in production (Leaver and Brown 1946) and, in the intellectual sphere, helped to propel the cybernetics (Wiener [1948] 1961) and automation (Diebold 1952) movements, which captivated the minds of such influential mid-century thinkers as Martin Heidegger and Hannah Arendt (Simbirski 2016). Beginning in the late 1950s, as the development of automation continued apace, a range of social scientists turned their attention to a plurality of transformations that ran the gamut from the economy and culture to politics and technology as a means of unraveling the distinctive character of an emerging society set apart by staggering affluence and a sweeping occupational shift from industrial manufacturing to informational services (Brick 1992, 350–62; Kumar [1995] 2005). Whether they chose to describe this new social formation through the qualifier "leisure" like David Riesman (1958), "affluent" like Kenneth Galbraith (1958) and Gunnar Myrdal ([1963] 1965), "post-industrial" like Peter Drucker (1969) and Daniel Bell ([1973] 1999), "technetronic" like Zbigniew Brzezinski (1970), or "informational" like Manuel Castells (1989), they all agreed that this new society—whatever it was called—ushered in "an age of discontinuity, marking an end to the industrial era" (Jones 1982, 11).

Among these theoretical exercises in social forecasting, Daniel Bell's *The Coming of Post-Industrial Society* was arguably the most representative and comprehensive treatment of what I call the "postindustrial paradigm." His rigorous discernment of the social transformations that defined this impending society indexed a pervasive feeling among liberal and Marxist thinkers of being caught up "in the midst of a vast historical change" ([1973] 1999, 37) characterized by a dramatic departure from industrial capitalism in terms of the presiding occupational structure of society as well as the prevailing regimes and general qualities of work within affluent economies structured by knowledge, information, and technology. Specifically, then, my argument builds on two central views espoused by liberal and Marxist theorists of postindustrial capitalism alike: first, that the organization of production and the character of work in a postindustrial society are diametrically opposed to the disciplinary management regimes, manual work routines, and fragmented tasks characteristic of Fordism; and second, that immaterial forms of production based on knowledge, information, and technology are the dominant sources of value in postindustrial economies, while a skilled, technical, scientifically trained, and culturally fluent intellectual workforce permeates and reshapes the class structure.[2] To be sure, most adherents to each of these frameworks were careful to stress that postindustrial society did not displace factories, manual labor, and disciplinary management practices entirely, but fundamentally altered their foregoing circumstances by circumscribing their socioeconomic dominance wherever knowledge and information took command.

According to Bell, the factory had lost its pervasiveness in postindustrial society while the void left by the dislocation of manufacturing and manual toil gave way to the communicative, social, and affective encounters between skilled individuals who mediate knowledge-based services (Bell [1973] 1999, 15–7, 126–8, 162–3, 488). And although explanations for the erosion of capitalism's industrial structure vary considerably, from the widespread outsourcing of manufacturing to the Global South and the displacement of assembly-line labor by automation to the neoliberal assault on organized labor, recent liberal (Cohen [2006] 2009, 33–4, 87; Kelly 1999) and Marxist (Berardi 2009, 88–94, 192–3) scholars have upheld Bell's assessment that the new, postindustrial economy represents a paradigmatic rupture with Fordism in terms of the prevalent non-hierarchical organization of production and the predominantly informational character of work. For Bell, the main catalyst for this "revolution in the class structure of society" (Bell [1973] 1999, 125–6) lay in the preeminence of a new kind of *theoretical* knowledge, which replaced "trial-and-error-tinkering" and empiricism (487), as a governing source of power and capital that spawned innovations in technology, employment, and social relations alike (18–20, 343–4). To the extent that theoretical knowledge could be codified and embodied in automatic machines, a new form of *intellectual* technology brought to bear the prospect of replacing human judgment by algorithms capable of solving complex problems through automated decision rules (29–31). While such a division of labor between humans and machines exemplifies the fragmentation of microwork today, for postindustrial thinkers, the promise of automation was rather to relieve workers from the drudgery of routine and repetitive tasks in clerical and manual work (Castells 2010, 257–8). In short, even if postindustrial thinkers acknowledge that factories

[2] The first point can be traced to mid-century arguments about the ennoblement of work purveyed by automation (Diebold 1952). The second point speaks to postindustrial depictions of a knowledge society in which information and knowledge had become the dominant socioeconomic resources (Brick 2006, 191–7). Regarding the transformation in the class structure of postindustrial societies, liberal social scientists tended to emphasize the dominance of a scientific and technical workforce while Marxists highlighted the ascendancy of cultural and intellectual workers (Rose 1991, 31).

are as large and important as ever across numerous industries and regions of the world, they agree that the forms of work and regimes of control characteristic of the Taylorist assembly line have become "an historical relic" in postindustrial societies in general, and especially within the knowledge-based, information-driven, and technological sectors of advanced capitalist economies, such as those engaged in the production of digital commodities (258).

For a cohort of Marxist thinkers, the dominance of emerging postindustrial forms of work, workers, and workplaces set the stage for a renewed critical theory of capitalism that uprooted the conventional focus of classical Marxism on factories and industrial workers in favor of the discovery and analysis of new working-class subjects, new spheres of work, new forms of domination, and new possibilities for collective political action within cultural and intellectual cycles of production (Deleuze 1992; Marcuse [1964] 1991, 12, 35; Mills 1963, 236).[3] For C. Wright Mills ([1959] 1963), in particular, a critical theory of postindustrial capitalism required dislocating Marxism from its industrial footing in the factory and anchoring it instead in what he called the "cultural apparatus," an immaterial labor process scattered across the realms of art, science, learning, and entertainment (406). Echoing Bell's ([1973] 1999) claim that the structural features of postindustrial society were no longer labor and capital but knowledge and information (xci–xcii), Alain Touraine ([1969] 1971) and André Gorz ([1980] 1982) took up Mill's project by centering cultural and intellectual workers as the backbone of an evolving class formation, while Serge Mallet's ([1963] 1975) study of the labor process in France's technological and chemical sectors confirmed the postindustrial hypothesis that knowledge, cooperation, and affective bonds had become standard attributes of work even in the least skilled occupations, thus displacing the disciplinary management regimes, manual toil, and fragmentation that typified the Fordist factory (59–60, 66–7, 113).

Another influential contribution to a critical theory of postindustrial capitalism came from the Italian autonomist thinker Antonio Negri. Through an imaginative reading of Marx's *Grundrisse*, Negri challenged the most fundamental categories of Marxist thought—from the labor process to the wage form—while offering an expansive account of social relations, processes of valorization, mechanisms of exploitation, and practices of resistance beyond factories, industrial workers, and material production (Negri 1988; 1989, 215; Wright [2002] 2017, 86–92, 150–3). The widespread uptake of autonomist ideas in the late 1990s and early 2000s, especially by Anglo-American Marxists, coincided with the extensive outsourcing of manufacturing, the escalation of venture capital in the technological sector, and the rise of the internet (Virno and Hardt 1996). Largely prompted by Negri's collaborations with Michael Hardt, this current of critical thought inaugurated a conceptual grammar fit for understanding and critiquing "cognitive capitalism" as an unmitigated departure from Fordism marked by the erosion of its "industrial and disciplinary regime" (2017, 171) and the rise of immaterial production, which had become "hegemonic over all the other valorization processes" (2009, 25).[4] This autonomist critique of cognitive capitalism can be summed up in three related claims. First, the ascendancy of immaterial labor as a biopolitical transformation of capitalist production characterized by linguistic, affective, intellectual, and cultural forms of work generative of subjectivities, capacities, and knowledge (Hardt 2006; Lazzarato 1996). Second, the proliferation of a collective stock of intellectual assets, such as linguistic, affective, and cultural competencies, known as "the general intellect" (Hardt and Negri 2017, 117; Spence and Carter 2011). And third, a shift in the planning of production away from capitalist centralization and toward indirect forms of value extraction—what Marx dubbed "formal" subsumption—in which capital is released from the onus of directly organizing, controlling, and disciplining the labor process (Hardt and Negri 2017, 133, 143, 171–2, 222; Vercellone 2007). These qualities of cognitive capitalism lay bare the intimacies between liberal and Marxist theories of postindustrial capitalism in terms of their corresponding views about the organization of production, the character of work, and the primacy of knowledge in cycles of valorization, which my theory of the factory model and the protocols of digital production call into question.

More recently, a growing scholarly literature on the digital labor process has offered a robust set of empirical and theoretical resources for critically re-examining the central postulates of the postindustrial paradigm (Altenried 2020; Betancourt 2016; Gray and Suri 2019; Jones 2021; Munn 2022). By contrast to the speculative theorization and social forecasting prevalent among theorists of "post-industrial society" and "cognitive capitalism," the general orientation in recent accounts of digital capitalism has been to anchor theory and critique on rigorous studies of existing social relations, working conditions, and lived experiences of both workplace domination and collective resistance (Christiaens 2022) across an ample realm of productive activities within the internet economy, from logistical operations (Allison and Reese 2023) and content moderation (Roberts 2019) to gaming (Woodcock 2019) and data work (Miceli and Posada 2022; Muldoon et al. 2024). The result is a far-reaching rendering of economic life—of domination and agency—under digital

[3] In 1960, Herbert Marcuse argued that industrial society was entering a new phase defined by "the transformation of the laboring class under the impact of rationalization, automation and, particularly, the higher standard of living" (2001, 219). Throughout *One-Dimensional Man*, he draws on primary and secondary sources from the automation debates of the 1950s, as well as key aspects concerning post-industrial society foregrounded by C. Wright Mills and Daniel Bell.

[4] Representative autonomist theories concerning the collapse of the Fordist factory include Negri's concept of the "factory without walls" (1989, 89) and Lazzarato's idea of the "diffuse factory" (1996, 135–6). On the development of the term "social factory" within Italian autonomist thought, see Campbell (2018). For a critical genealogy of "cognitive capitalism," see Caffentzis (2013, 95–123).

capitalism starkly at odds with earlier theories of post-industrial society as much in regards to the toilsome and precarious character of digital labor as to its estrangement from the cultural, intellectual, and informational content of digital production. In the last two sections, I build on key insights from this literature as a means of grounding my theory of the factory model and the protocols of production on the social realities of the digital labor process.

PROTOCOLS OF PRODUCTION: A THEORY OF THE FACTORY MODEL

Traditionally, the factory system has been defined as a large, unified production unit where workers are assembled and supervised by a common authority and work is commanded by a central source of mechanical power, which most economic and social historians agree only came into vogue in eighteenth-century Britain (Freeman 2018; Landes 1998, 186). While manufactories—where the labor process was similarly combined and controlled—predate the factory system by centuries (Safley and Rosenband 1993), these workplaces are often distinguished from factories insofar as they did not employ a central system of power-driven machines in production (Landes 1986, 603). This association between technology and the factory system is a widely accepted rendering of the meaning and periodization of factories that continues to hold sway among critics who recognize the factory's fundamental organizing power in digital production (Altenried 2022).[5] But if we consider the long-running history of large-scale, consolidated industrial production, which goes back at least to the sixteenth century (Peacock 2006), it is clear that the use of automated or "self-acting" technologies is a relatively recent development. In this sense, the factory system—as it is conventionally understood—is one particular historical instantiation of unified production delineated by its use of centralized mechanical or, more recently, electronic and algorithmic power.

My own interpretation of the factory resides in the consistent sociopolitical factors shared by these models of amalgamated production, irrespective of the technology they employ and the commodities they produce. I therefore center my definition of the factory on what I take to be the constitutive elements of its production model: capital, labor, and control. I argue that the factory's particularity inheres in its historically stable ability to *place the labor process under capital's control* through an integrated apparatus of *discipline*, *supervision*, and *fragmentation* that has been a persistent feature of consolidated production since the early modern period, from workhouses (Pinheiro 2022) and manufactories (Berg 1994) to dockyards (Cooper 1984) and plantations (Mintz 1985). Indeed, from the perspective of capital and control, "the fully developed factory was really not different from the 'protofactory,' except for the intensification of [its] crucial elements" (Freudenberger and Redlich 1964, 382). And while factories vary significantly across periods, regions, cultures, industries, and states of technological development, the factory model's distinctive contribution to the organization of capitalist production has been, and remains, to control the labor process through what I call "protocols of production": formal and objective directives for standardized procedures and behaviors that are mediated and enacted by a combination of diverse spatial arrangements, technologies, and management regimes in order to discipline workers, fragment tasks, and supervise the labor process. As much in physical as in digital form, the factory is a workplace in which workers are directly organized by a superior authority to perform tasks that generate value for their employer, whether the end product is a material good, a digital commodity, or a logistical task. Situated at the bottom of the factory's hierarchal chain of command, workers are required to follow a script and obey the rules laid out by management: time and productivity are assiduously tracked, quantified, and monetized; physical movements and cognitive operations are determined and bound by discrete, fragmented tasks; compliance to protocols is ordained by regimes of discipline and supervision; and production is technically standardized. The particular organization of the labor process in a factory is a means to the end of capital accumulation, which presses the factory to constantly adapt its form by applying technological innovations, scientific improvements, and more efficient spatial configurations to production while constantly prying open new sources of exploitable, precarious labor. But whatever the factory produces, however it produces it, its model of extracting and generating value has historically entailed capital's consolidated control of labor through techniques of discipline, supervision, and fragmentation that reproduce alienation and precarity as concrete social qualities of its labor process.

Borrowing the concept of "protocol" from networked computing, I use the term "protocols of production" to theorize the ways in which the factory model purveys capital's control over labor. According to media theorist Alexander Galloway (2004), a computer protocol is a "distributed management system that allows control to exist within a heterogeneous material milieu" (8). Based on a given set of rules that "outline specific technical standards" (6), protocols "govern the set of possible behavior patterns" and "enact an agreed-upon standard of action" (7). Protocols therefore manage, regulate, and control; they encode information, execute standardized operations, and "create the core set of rules from which all other decisions descend" (245). In the context of a factory, protocols are implemented to order production—space, people, and things—through a synthesis of variegated technological systems, spatial arrangements, and management regimes specifically combined to administer control over the labor process. And if protocols "always operate at the level of coding"

[5] Altenried's (2022) thoroughgoing and insightful study of the digital factory reflects this view by attributing the particularity of the factory system to the employment of large-scale machinery as a means of structuring and dominating production (181n5).

(8), then they are, as Eugene Thacker remarks of all computer codes, "always enacted" (xii). The factory's protocols of production also operate at the level of coding insofar as its own codes define "a set of procedures, actions, and practices designed in particular ways to achieve particular ends in particular contexts" (xii). "In the factory code," as Marx wrote in *Capital* ([1867] 1990), "the capitalist formulates his autocratic power over his workers like a private legislator," as a "factory Lycurgus" whose factory code is a pure "emanation of his own will" (549–50). "This code," Marx continues, "is merely the capitalist caricature of the social regulation of the labour process which becomes necessary in co-operation on a large scale and in the employment in common of instruments of labour, and especially of machinery" (550). Like a computer code, the factory code is a performative text that commands, authorizes, and restrains; it imposes demands on the reader to perform precise, formal, and standardized courses of action in pursuit of a specified goal: the accumulation of capital through the extraction of value. As a technique of controlling production by discipline, supervision, and fragmentation, the factory code is the essence of the factory's protocols. Marx's allegorical rendering of the capitalist as a "factory Lycurgus"—the Spartan lawgiver—captures capital's autocratic authority over production embodied in the factory's protocols, the enactment of which is mediated by technology, enforced by management, and finally performed by workers.

Despite the overwhelming association of factories with assembly lines and heavy machinery, technology is an ancillary instrument of the factory's protocols and therefore insufficient to delineate its distinctive mark. Rather than displacing or radically altering the factory model's means and goals, automated technologies—from mechanical machines to algorithmic infrastructures—only amplified its tendency to integrate previously distinct nodes in the supply chain while perfecting and rationalizing its propensity to subsume the labor process under its control. The historical triumph of the factory over competing organizations of production was therefore not primarily a product of its competence in increasing efficiency by dint of technological innovation (Marglin 1974, 62, 84), but of its efficacy in commanding the labor process through discipline, fragmentation, and supervision. Even Andrew Ure (1835), one the most ardent advocates of the factory's claim to technological progress, conceded that the invention responsible for inaugurating the modern factory system was not Richard Arkwright's pioneering self-acting spinning frame, but his "code of factory discipline," which succeeded in solving the "main difficulty" of factory production: "training human beings to renounce their desultory habits of work, and to identify themselves with the unvarying regularity of the complex automaton" (15). Arkwright's groundbreaking contribution to the factory system, then, lay in devising protocols of production that rendered his technological invention useful in subduing "the refractory tempers of work-people accustomed to irregular paroxysms of diligence" (16). Capital's control over labor in the factory was therefore, as Ure concluded, not the result of technology but of "obedience to Arkwright's polity." Only under the command of protocols that discipline, supervise, and fragment production would further technological innovations be useful in perfecting capital's control over the labor process. By using automatic machinery as a medium for its protocols, the industrial factory was able to rule out human judgment from production and consequently deskill, standardize, and devalue labor by supplanting the worker's allegedly irregular hand and intractable will with a machine "so self-regulating, that a child may superintend it" (19). Indeed, deskilling through the decomposition of tasks and the annihilation of human judgment was the lauded effect of automated technologies that, "in embodying handicraft dexterity and intelligence in a machine" succeeded in "substituting cheap and docile labour for what is dear, and sometimes refractory" (150). What Ure deemed the progress of the factory system (x), then, was owed not to self-acting machines alone, but to their application of the factory's protocols of production.

Similarly, the emblematic contributions to the modern factory system by Samuel Bentham's panopticon in the late eighteenth century and Frederick Taylor's system of scientific management in the early twentieth century were based less on technological innovations than on a rational reorganization of the protocols of production. That is, both Bentham and Taylor applied existing technologies to amplify capital's control over the labor process. While the novelty of Bentham's panopticon inhered in a more efficient spatial arrangement for supervision (Ashworth 1998), Taylor's improvement consisted in a forensic approach to task management that dressed labor discipline and fragmentation in the garbs of scientific reason (1911b, 139–40). Indeed, Taylor's theory of scientific management, in particular, enunciated the basic feature of the factory's protocols—control—by systematizing and quantifying production into fragmented, simplified, and regular tasks (69–73, 96–7, 121, 146, 181) while also eliminating human judgment from task-work (Taylor 1911a, 28, 72–9, 102–4, 125–33). Combined, these strategies resulted in the heightened alienation of workers from their work while reproducing the social elements of precarity in the workforce upon which Taylor's system depended (Aitken 1960, 12). Historically, the social effects of scientific management were palpably evident in Ford's auto plants, where protocols of production were mediated by a series of technological innovations, from the assembly line at Highland Park in 1910 to the automatic engine at the Cleveland Foundry in the 1950s—where the term "automation" was coined by the Company's Vice President of Manufacturing (Diebold 1952, ix). Indeed, Ford's strides in automated manufacturing were technical applications of protocols that exacted absolute conformity and obedience from line workers, consequently uprooting their sphere of autonomy in production by circumscribing the requirement for tasks to the most basic human capacities and movements (Biggs 1996, 130–4). Socially, Taylor's and Ford's contributions to the factory model produced familiar results: an expansive precarious workforce, high turnover rates, the active recruitment of untrained immigrants, and a constant pool of surplus workers standing by at the gates (Biggs 1996, 134; Meyer 1981, 67–94). From Arkwright and Bentham to Taylor and Ford, all the way up to Google and Amazon, the discipline, supervision, and fragmentation provided by the technological, spatial, and administrative implementation of the protocols of production have allowed the factory to fulfill its social function of capital accumulation by placing the labor process under its hierarchical control while reproducing a precarious workforce that becomes increasingly alienated from the materials, activities, and content of their work to the extent that the labor process becomes more fragmented, supervised, and disciplined. As we come to grips with the social relations of production inside data centers and microwork platforms, we will find ourselves in the midst of a digital labor process at once thoroughly anchored in and utterly dependent upon the factory model's protocols of production.

ABSENT FACTORIES: INSIDE THE HUMAN ABODE OF AUTOMATION

As one of Silicon Valley's largest employers, Google hosts a substantial segment of its workforce across three million square feet of office space at the company's global headquarters. Commonly referred to as a "knowledge campus," the Googleplex comprises an opulent recreational and technological infrastructure that epitomizes digital capitalism's knowledge-based mode of production and a postindustrial work ethic centered on personal fulfillment, cooperation, flexibility, and amusement. According to some critics, the company couches extraction in the language of play through a horizontal organizational structure and a consent-based management regime rooted in its "don't-be-evil" ideology and fulfilled materially by its leisurely amenities (Levy 2011, 121–66; Vaidhyanathan 2012, 1–12). On this account, Google appears to confirm the progressive, postindustrial trend in management discourse characteristic of capitalism's "new spirit" (Boltanski and Chiapello [1999] 2005). And although such renderings of Google as a quintessential expression of postindustrial regimes of control do well to describe its means to organize and discipline skilled knowledge workers (Fuchs 2014, 223–30), they tend to miss the crucial fact that, throughout the early 2000s, the company deployed management practices characteristic of the factory model to preside over workers who "flipped pages in time to a rhythm-regulated soundtrack" in a hidden data factory in the outskirts of the Googleplex (Irani 2015b).

In 2007, Andrew Norman Wilson (2016), then a part-time employee at Google, recalls this very cohort of data workers—predominantly people of color—leaving a secluded building as though "a factory bell had just gone off." Identifiable by distinctive yellow badges, most of these subcontracted workers—known by the codename "ScanOps"—were hired to scan printed matter for Google Books, page by page, from 4:00 a.m. to 2:00 p.m. Google's color-coordinated badges—green, white, red, and yellow—are a visual representation of the company's employment hierarchy; they determine the places, services, and facilities employees may and may not access across the Googleplex. Unlike yellow-badge workers, "Googlers" wearing red, white, and green badges make up the company's knowledge-based workforce and have access to most spaces and amenities across the headquarters. "Purposefully kept separate," yellow-badge workers were by contrast "not allowed [to] set foot anywhere else on campus, except for the building they worked in" (Norman Wilson 2011; Ptak and Norman Wilson 2013, 126). Management enforced the secrecy and confinement of this workforce through a rigid apparatus of discipline and surveillance that included punitive measures to restrain data workers from disclosing any detail about their work and workplace (Norman Wilson 2011). Their yellow badges signified "getting paid $10 an hour, going to the bathroom only when a bell indicated it was permissible to do so, and being subject to a behavioral point system that could lead to immediate termination" (Norman Wilson 2016). Not only was the regime of discipline and supervision that Google deployed toward its data workers decidedly at odds with its organization of skilled labor at the knowledge campus, but the working conditions of yellow-badge workers were distinctly precarious: high turnover rates, long shifts, low wages, lack of security and benefits, and a taxing—mostly manual—fragmented work routine. Despite Google's relentless efforts to stylize digital production as horizontal, skilled, creative, and edifying, its data factory disclosed instead a labor process strictly organized by protocols of discipline, supervision, and fragmentation. Inert and quiet at their scanning stations in a room without windows, data workers obeyed three directives that structured their 10-hour shifts: "press button, turn page, repeat" (Ptak and Norman Wilson 2013, 129).

Google's data factory reflects broader industrial patterns in digital production. It followed an earlier digitization initiative, the Million Book Project, which consisted of a massive human workforce and a vast logistical infrastructure, from scanning centers in India and China rendering thirty-four million pages a day to transcontinental container ships ferrying hard-drives and printed materials halfway across the world, which laid bare—if nothing else—the indispensable industrial fabric of the global knowledge economy (St. Clair 2005, 1196–7). Ironically, this digitization process is exceedingly more labor-intensive, fragmented, and manual than the production of physical books (Roth 2001). While industrial printing has been at the forefront of automation since the nineteenth century (Fyfe 2012, 55–64), the current process of digitizing books relies on an assembly-line production method long since abandoned by commercial publishers, thus marking the emergence of "digitization on an industrial scale" (Milne 2008, 5). In principle, then, Google Books encapsulates digital culture, immaterial labor, and the knowledge economy at their most advanced state; in practice, it illustrates the extent to which the factory model—with all its manual drudgery, discipline, surveillance, alienation, and precarity—remains a fundamental element of digital capitalism. Indeed, Google's application of the factory model in its covert data center registers a pervasive trend in data-driven sectors of the global economy, from "gaming factories" that combined employ over four hundred thousand gamers worldwide, predominantly in China (Dibbell 2016; Heeks 2010), to the field of supply chain management where companies like Walmart and Amazon have adapted the factory model to the organization of logistical work. Like Google's data center, Amazon warehouses are highly technological workplaces where scanners are not only ubiquitous productivity tools that augment the capacity of workers to identify items across cavernous warehouses, but also instruments of control through which supervisors direct, evaluate, track, and discipline workers, tethering them to the factory's protocols as the omnipresent "eyes" of management (Lecavalier 2016, 156–62). And like Google's ScanOps workers, packers at Amazon are required to stand still at automated workstations and engage in highly repetitive tasks in routine shifts of 10 hours (Struna and Reese 2020, 91–6). Within the sprawling network of global supply chains, each distribution center employee becomes a data point that must be "managed, hoarded, and deployed" as—in the words of one Amazon manager—"a robot, but in human form" (Lecavalier 2016, 156, 158). These aspects of the factory model's digital immersion are just as prevalent in the "virtual" world of the internet.

While one of the most anticipated developments of automation since the 1940s has been its prospect to end the scourge of human drudgery on the assembly line, the postindustrial society slated to fulfill this promise never arrived (Frey and Osborne 2017). To compensate for the shortcomings of automation, technological companies masquerade a vast supply of human workers as a new "technology" called upon to perform repetitive digital tasks that require little technical skills and training (Irani 2015a, 225). Insofar as it allows companies to hire someone for a few minutes, "pay them a tiny amount of money, and then get rid of them" (Prassl 2018, 4), MTurk's algorithmic infrastructure has lent form to the most efficient configuration of the factory model to date, one that would be unthinkable in physical space. Indeed, the networked systems of algorithmic management deployed by MTurk to track productivity, monitor and assess workers, measure work rates, standardize production, fragment tasks, and steer workflow mark not only the factory model's adaptation to the online workplace, but its unprecedented amplification and intensification in terms of the precision of work metrics, the scope of surveillance, and the consolidation of capital's control over the labor process (Altenried 2020, 149–50; 2022, 93–106, 120). MTurk's infrastructure organizes production through a software architecture that connects microworkers ("Turkers") to employers ("Requesters") who are given the technical means to evaluate output, monitor performance, and adjudicate how much—if anything—to pay Turkers based on fulfillment rates, accuracy standards, delivery targets, and output quality (Altenried 2022, 104; Gray and Suri 2019, 13, 70–81, 124–30; Irani 2013, 725–7). MTurk's infrastructure illustrates the factory model's adaptability to multiple formats regardless of the technology it employs and the commodities it produces. Although a distributed human–computer network powers MTurk's infrastructure, the specific ways in which Amazon disciplines, supervises, and fragments the labor process is a social, political, and juridical organization of labor irreducible to this technology. By combining the legal categories of independent subcontractors and the piece-rate wage form with its algorithmic infrastructure, MTurk is able to create both a precarious workforce and the technical means to control it (Altenried 2022, 107, 120).

MTurk's digital embodiment of the factory model is nowhere more evident than in its patent, which describes the platform's infrastructure as a "hybrid machine/human computing arrangement" composed of "a *central* coordinating server and a number of human operated nodes" (Harinarayan, Rajaraman, and Ranganathan 2007, 2; emphasis mine). This description evokes the conventional definition of factories as units of production in which human labor is regulated by "a *central*, typically inanimate source of power" (Landes 1998, 186; emphasis mine). If in the nineteenth century, the common shorthand for the factory was a self-acting "automaton" (Marx [1867] 1990, 502; Ure 1835, 13) and, in the early twentieth century, industrial engineers designated the factory as "the master machine" (Biggs 1996, 49, 53), MTurk's inventors refer to their architecture of production, synoptically, as "a computer" or "computer system" that "decomposes a task […] into subtasks for human performance" (Harinarayan, Rajaraman, and Ranganathan 2007, 2). In describing MTurk's computing arrangement as a technology that assembles "humans to *assist* a computer system to solve particular tasks" thereby "allowing the computer system to solve the tasks more efficiently," the inventors categorically place the agency of production on the computer while understating its human component. This is, again, a digital redeployment of the conceit used by industrial engineers to depict factory workers as attendants to the machine or, in the words of an efficiency engineer in 1912, to "ignore the human element entirely" and "describe the people handling the operations as […] animate machines" (Biggs 1996, 51). At the level of our screens, then, microwork platforms are virtual workspaces powered by algorithms and automated technologies; beyond our screens, however, they are central nodes of data production within a prodigious, global network of physical infrastructures—data centers, server farms, gaming factories, and distributions warehouses—whose predominantly contingent and precarious workforce is tasked with fulfilling the internet's incessant logistical and productive demands (Ensmenger 2021; Irani 2013).

FACTORY DOMINATION: ALIENATION AND PRECARITY

If factories are "sensuous embodiments" of capital's productive power (Rofel 1992, 103), then the differences in design and applications of technology at Google and MTurk illustrate the ways in which the factory's embodiment of productive power can take shape through a plurality of forms. Historically, the particular spatial configurations of a factory have promoted correspondingly specific practices of control, exploitation, and commodification. Whereas in nineteenth-century British factories, work began the moment workers entered the factory and continued until they left, in German factories of the same period, work began not when workers entered the factory but only once they were engaged in production (Biernacki 1996, 93–144). On the surface, these are two disparate modes of delimiting work. In the first template, the boundary of employment is marked by the *position of labor in space*, while in the second, work is determined by the *use of labor in production* (125–6, 141–2). But a more meaningful difference is at stake here: each approach to ascertaining *where* or *when* work begins and ends also betrays a complementary approach to domination based on capital's control of space and time. While in nineteenth-century British factories subordination turned on the "momentary regulation of workers' bodies as workers stepped over the factory threshold," German employers "used workers' bodies as a marker of the continuous alienation of the labor power lodged in the person of the worker" (127). This distinction does well to illustrate the different means of control and exploitation at Google and MTurk.

While physical space delineates the threshold of employment and exploitation at Google's data center, MTurk's digital factory extends the frontier of work and subordination beyond fixed space. In other words, the limits of domination at Google are bound by the data center as a circumscribed and supervised workplace; Google begins to discipline, supervise, and regulate workers as soon as they step into the factory's premises. By contrast, the boundaries of the factory at MTurk are digital and thus ubiquitous with regard to physical space; the platform's threshold of subordination clings to the labor time of workers wherever they may be. MTurk's approach to delimiting domination is therefore to do away with the physical space of the factory altogether; it effectively retains practices of disciplining labor at a distance by blurring the divide between the spatial-temporal spheres of work and nonwork. In releasing supervision and discipline from the limitations imposed by physical space, MTurk's extraction of value from labor unfolds through a remote regime of discipline, surveillance, and fragmentation; the "space" upon which capital appropriates value from labor is thus vested in the worker's body-at-work. The contrasting layouts and uses of technology in these data factories are a testament not only to the myriad forms through which factories can embody productive power, but just as much to the assorted techniques of control, exploitation, and commodification to which these unique designs and technologies can lend form.

Above all, the factory's technical makeup, its social organization of labor, and the protocols that call its production process to action transmit and enforce a script of alienated work to workers who in turn live out that text in their capacity as producers. Indeed, the technical conditions of the factory's architecture, be it a physical building or an online platform, are reifications of a script that yields analogous results in terms of alienation; buildings and technology are merely the perceptible shapes of a work process that ultimately produces labor as a commodity (Biernacki 1996, 141). As factories, Google and MTurk are concrete sites of alienation whose designs, technologies, and protocols are means to the factory's social function and most basic end of capital accumulation. Like Arkwright's mill and Ford's auto plant, Google and Amazon perform this function by controlling the labor process. Yet, what is distinctive about MTurk's platform is that it hones the exercise of control to an unrivaled pitch of perfection. With unprecedented expediency, accuracy, and frugality, MTurk brings workers to work, fragments their labor, assigns them their work, rewards or punishes them for their performance, and disciplines them through an online rating system that lifts surveillance and control from its spatial limitations. The governing conceit behind Jeremy Bentham's inspection principle—of "seeing without being seen" (1791, 21)—is nowhere as close to his ideal than in MTurk's "algocratic" panopticon where software code becomes "the key to governing globally dispersed labor" (Aneesh 2009, 347).

Another key distinction between both data factories is that, at MTurk, alienation is not only a consequence of how the platform controls production, but also of the uniquely abstract commodity it produces. In a brutally literal expression of the commodification of labor, the metadata of data work—the information about how workers work, how they behave, how frequently they log in, and how fast and accurately they complete tasks—is itself packaged as a commodity. The immense value of this metadata for Amazon Web Services inheres in the company's applicability of this information as a means of tightening control, surveillance, and discipline over labor not only at MTurk but across all branches of the business (Jones 2021, 74–5). One result of this tautological work of producing data about data production is a twofold erasure of the worker. On the one hand, the human elements of thought and judgment in the worker's operations are erased by the technical demands of a task so minutely fragmented that its content is exceedingly abstract and void of any intelligible human meaning while its final product is utterly opaque to the worker. This alienation is not merely incidental to this type of work; it is rather shored up by the technical aspects of the platform that reinforce the alienated nature of microwork, including the impersonal quality of domination by anonymous Requesters and algorithms, the abstract nature of meticulously fractured tasks, the imposed isolation of workers, and the engineered opacity of the most basic aspects of production, from how and on what grounds algorithms make the decisions that govern the quantity, speed, and frequency of work, to the obscure purpose of their tasks (Jones 2021, 65, 69–70). Insofar as it "deprives the work itself of all content" and "confiscates every atom of freedom, both in bodily and in intellectual activity" (Marx [1867] 1990, 548), MTurk carries forth the alienated labor process of mechanization in the industrial factory. On the other hand, microwork performs a second, more literal erasure of the worker, one that ensues from what is, in the long run, the most valuable use of microworkers from the perspective of capital: training the artificial intelligence poised to replace them (Tubaro, Casilli, and Coville 2020).

Although the technical demands of most microwork tasks such as transcribing texts or rating search engine results tend to be minimal, many assignments also call on workers to exercise cultural fluencies and emotional sensibilities such as those required to, say, interpret and categorize "the sentiment expressed in a comment" (Irani 2015a, 228; Kost, Fieseler, and Wong 2018, 101). MTurk's patent recognizes this by stipulating a division of labor between algorithms and workers based on the general human aptitude to parse cultural objects (Harinarayan, Rajaraman, and Ranganathan 2007, 1). As a result, algorithms are assigned the role of fragmenting tasks, delegating them to human workers, and collecting the finished output. This scenario points to a dialectal tension within microwork platforms: in their role as mediators of cultural production they depend on the very sensibilities and aptitudes of human workers that their infrastructures undermine. MTurk's protocols of production reduce the potential linguistic, technical, intellectual, and aesthetic qualities of digital labor to an atomized, repetitive form of mindless "ghost-work" while allowing the creative substance of the finished commodity to be appropriated by the skilled "innovators" who own the rights of all content produced on the platform (Altenried 2022, 104; Gray and Suri 2019). Microworkers are therefore rendered "menial" laborers by the protocols and infrastructure that structure their relations with employers and the cultural content of the objects that, despite helping to produce, they encounter as abstract and alien things (Irani 2013, 728–34). So, even if microworkers produce immaterial goods replete with knowledge and cultural information, MTurk precludes them from accessing the intellectual and aesthetic qualities of the materials they work on, which are torn asunder into meaningless data fragments by a digital assembly line. As a result, the platform's protocols divest microwork from the potentially transformative types of subjective, affective, and creative investments generally attributed to cultural, artistic, and intellectual labor by theorists of postindustrial capitalism.

Finally, while the data center is immediately recognizable as a traditional factory where production is organized and controlled within a confined space, MTurk's ploy to keep workers at work outside the factory's premises is just as conventional. This too was a standard practice in nineteenth-century factories, many of which were composed of various departments within and beyond their physical premises. One of these departments is what Marx ([1867] 1990) calls "the modern domestic industry," which takes the form of an "external department of the factory, the manufacturing work-shop, or the warehouse" where the factory's division of labor and production process are reproduced and continued "on a very large scale" beyond its walls (590–1, 600). As a result, the factory system commands not only the workers "it concentrates in large masses at one spot," but also "the outworkers in the domestic industries" (591). Like MTurk, these "outside departments" of the factory are characterized by high levels of precarity for labor and accumulation for capital (608). As one of the branches of large-scale industry, the "extended factory" is not antithetical to the factory but an intrinsic and essential part of its production model (590–1). In short, the factory system has been and continues to be able to exploit a vast contingent of precarious workers by extending its operations beyond its physical premises in order to capture a larger, cheaper, and ever more precarious workforce.[6]

Today, microwork platforms have intensified the magnitude and broadened the scope of this model through an algorithmic infrastructure that allows capital to capture a mass of precarious workers on a global scale and avail itself of a diverse spectrum of distinctions—in terms of race, gender, ethnicity, nationality, citizenship, language, immigration status, and criminal record—that intersect with class to form its ideally precarious workforce. In transgressing barriers imposed by geography, work visas, and time zones, microwork platforms are uniquely apt to amplify the factory's ongoing production of precarity by simultaneously employing an ample, heterogeneous, and contingent workforce the world over. This deliberate and systematic production of precarity is also a byproduct of the factory model's protocols. For Marx ([1867] 1990), this was plainly clear in the factory's creation of a relative surplus population by, on the one hand, "placing at the capitalists' disposal new strata of the working class previously inaccessible to him" and, on the other, "setting free the workers it supplants" (531–2, 792–3, 798). Today, data workers are part of a fragmented, global class structure characterized by flexibility, insecurity, instability, hardship, isolation, and constant displacement (Apostolidis 2019, 3–24; Standing 2011, 5–13).[7] As a central node in a global network of precarious labor, data processing reproduces these conditions on a prodigious scale, spawning a reserve army of digital workers who have been structurally barred from stable employment, including migrants, refugees, and formerly or currently incarcerated workers—disproportionately people of color and women—predominantly in the Global South, from the slums of Kolkata and Caracas to refugee camps in Kenya and Palestine (Altenried 2022, 94; Jones 2021, 11–8; Munn 2022, 32, 42, 93–8). These patterns are far from incidental. In the same way that the industrial

[6] On the factory's reproduction of precarity through an active and reserve industrial army of workers, see Marx ([1867] 1990, 517, 527, 545, 577, 582–3, 590, 615).

[7] Likewise, the industrial factory system depended upon the "variation of labour, fluidity of functions, and mobility of the worker in all directions" and the suppression of "all repose, all fixity and all security" (Marx [1867] 1990, 617–8).

factory system forged its own precarious workforce, the infrastructure of microwork platforms, based on its expedient model of connecting employers to a massive supply of on-demand labor, is systematically deployed to prey on existing structures of precarity among contingent workers, be it by targeting members of the Uyghur ethnic minority in China's Xinjiang province to work for cotton producers, or actively recruiting refugees in India and Uganda to work for MTurk (Jones 2021, 12; Munn 2022, 74–8). These are illustrations of a coherent and methodical regime of precaritization that propagates the socioeconomic circumstances for global capital's optimal workforce by, as Paul Apostolidis notes, designating "specific groups of people for uncommonly deplorable treatment" and making "work-related experiences isomorphic for populations throughout class, racial, and gender hierarchies" (Apostolidis 2019, 3).

Google's data factory illustrates a similar pattern. While standard accounts of Silicon Valley portray the region as a metonym for postindustrial society (Piscione 2013), throughout most of the twentieth century this bucolic crest of Santa Clara County was distinguished less for its startup offices than for its orchards, groves, and meadows, which belied the toil of migrant workers of color across farm fields and inside canneries (Pellow and Park 2002, 46–58; Pitti 2003, 1–77). Today, representations of the region as a mecca of innovation and wealth obscure the labor of Mexican and Latinx janitors and data workers who commute in and out of tech companies every day from the barrios of East San Jose (Zlolniski 2006). Google's "data janitors," then, are a material ramification and outgrowth of the racialized hierarchies of labor and spatial segregation that have historically sustained Silicon Valley's economy through a vast pool of precarious, casual, and informal labor. As was the case with agriculture and microchip manufacturing, the integration of migrant workers of color into the local high-tech sector has been distinguished by precarious working and lived conditions. Not only does the material reality of unskilled data work refute the alleged tendency of the general intellect to abolish "the division of labour into specialized hierarchical tasks" and eradicate the "separation between the workers and their reified work" (Gorz [2003] 2018, 14), but it also reveals the extent to which digital capitalism depends on hierarchies of knowledge and skill that are intimately enmeshed in racially marked patterns of economic inequality and spatial segregation (McPherson 2012, 149–51; Mezzadra and Neilson 2013, 131–66). This disparity, however, is less a factor of unequal access to technology than of unequal access to the linguistic, technical, intellectual, affective, and cultural competencies that this technology can yield—the very competencies that postindustrial thinkers construe as the meaningful and transformative character of immaterial labor. As much in the Global South as in Silicon Valley, then, data work conveys the crucial ways in which digital capitalism is shored up by structural patterns of precarity that attest to the dominant and reinforcing expressions of digital capital's real subsumption of the labor process today: "the redundancy of labour and its expulsion from the value circuit" (Best 2024, 46).

CONCLUSION

Google's data center, MTurk's platform, and the people who work in and through them illustrate the extent to which the factory model has become a dominant process of production in digital capitalism. Contrary to theories about the organization of work in postindustrial capitalism, Google and Amazon bring the digital labor process under their direct command through protocols aimed at disciplining workers, fragmenting tasks, and supervising production. These workplaces reveal that the factory model's protocols of production are as useful and applicable to data production as they are to industrial manufacturing. Although the postindustrial paradigm construed immaterial production as the basis for new technical skills, new forms of knowledge, and the erosion of capital's regimes of direct control, the absent factories offer an alternative account of the character and organization of digital work. Inside and through these data factories, capital extracts value by directly disciplining workers, fragmenting operations, and monitoring the labor process; workers obey a script, meet quotas, and are constantly helmed from the inside by managers and algorithms. At both factories, protocols of production actively thwart autonomous cooperation by undermining labor's political agency through technologies that foster isolation, alienation, and anonymity while meticulously dividing the labor process into minute, atomized tasks.

Additionally, the absent factories press us to reconsider the postindustrial construction of work as informational, interpersonal, and communicative (Bell [1973] 1999, 162–3), which some thinkers further construe as a source of virtuous potentialities (Virno 1996), "cultural capacities such as aesthetic and conceptual production," and the cognitive abilities to "create, employ, and manipulate languages, code, symbolic systems, [and] algorithms" (Hardt and Negri 2017, 232). Here again, the reality of work inside the absent factories runs counter to postindustrial theory, revealing instead that the more fragmented digital labor becomes, the more its interpersonal and transformative qualities are subsumed. The protocols of production at these data factories have kept the potentially liberating qualities of knowledge work almost entirely separate from the manual labor of data processing. Rather than interacting with the ennobling and edifying attributes of immaterial labor, yellow-badge workers and Turkers mediate the mass dissemination of digital objects; instead of sharing in the cultural and intellectual byproducts that their services yield, data workers are estranged from the subject matter of their work and the commodities they produce. In moderating, digitizing, and classifying information, their labor is explicitly engineered to enable their employers to "meaningfully" and "creatively" interface with the substance of digital knowledge and culture. In short, the promising cognitive, linguistic, affective, technical, and cultural capacities of postindustrial work—however, diffuse and collective the internet has made them—do not trickle down the digital supply chain to data workers. Together, these complementary articulations of the factory confirm that automation, algorithms, and the internet have not foiled but promoted the development of the factory system, its control over production, and the boundaries it has cultivated between creative work and manual labor since its inception.

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CONFLICT OF INTEREST

The author declares no ethical issues or conflicts of interest in this research.

ETHICAL STANDARDS

The author affirms this research did not involve human participants.

REFERENCES

Aitken, Hugh G. J. 1960. *Taylorism at Watertown Arsenal: Scientific Management in Action, 1908–1915*. Cambridge, MA: Harvard University Press.

Allison, Juliann Emmons, and Ellen Reese. 2023. *Unsustainable: Amazon, Warehousing, and the Politics of Exploitation*. Oakland: University of California Press.

Altenried, Moritz. 2020. "The Platform as Factory: Crowdwork and the Hidden Labour Behind Artificial Intelligence." *Capital and Class* 44 (2): 145–58.

Altenried, Moritz. 2022. *The Digital Factory: The Human Labor of Automation*. Chicago, IL: University of Chicago Press.

Andersson, Jenny. 2021. "Planning the American Future: Daniel Bell, Future Research, and the Commission on the Year 2000." *Journal of the History of Ideas* 82 (4): 661–82.

Aneesh, Aneesh. 2009. "Global Labour: Algocratic Modes of Organisation." *Sociological Theory* 27 (4): 347–70.

Apostolidis, Paul. 2019. *The Fight for Time: Migrant Day Laborers and the Politics of Precarity*. New York: Oxford University Press.

Ashworth, William J. 1998. "'System of Terror': Samuel Bentham, Accountability and Dockyard Reform During the Napoleonic Wars." *Social History* 23 (1): 63–79.

Bell, Daniel. [1973] 1999. *The Coming of the Post-Industrial Society: A Venture in Social Forecasting*. New York: Basic Books.

Bentham, Jeremy. 1791. *Panopticon: Or, the Inspection-House*. Dublin, Ireland: Thomas Byrne.

Berardi, Franco "Bifo". 2009. *The Soul at Work: From Alienation to Autonomy*. Translated by Francesca Cadel and Giuseppina Mecchia. South Pasadena, CA: Semiotext(e).

Berg, Maxine. 1994. *The Age of Manufactures, 1700–1820: Industry, Innovation and Work in Britain*, 2nd edition. London: Routledge.

Best, Beverley. 2024. *The Automatic Fetish: The Law of Value in Marx's Capital*. London: Verso.

Betancourt, Michael. 2016. *The Critique of Digital Capitalism: An Analysis of the Political Economy of Digital Culture and Technology*. Brooklyn, NY: Punctum Books.

Biernacki, Richard. 1996. *The Fabrication of Labor: Germany and Britain, 1640–1914*. Berkeley: University of California Press.

Biggs, Lindy. 1996. *The Rational Factory: Architecture, Technology and Work in America's Age of Mass Production*. Baltimore, MD: Johns Hopkins University Press.

Boltanski, Luc, and Ève Chiapello. [1999] 2005. *The New Spirit of Capitalism*. Translated by Gregory Elliott. London: Verso.

Brick, Howard. 1992. "Optimism of the Mind: Imagining Postindustrial Society in the 1960s and 1970s." *American Quarterly* 44 (3): 348–80.

Brick, Howard. 2006. *Transcending Capitalism: Visions of a New Society in Modern American Thought*. Ithaca, NY: Cornell University Press.

Brown, Philip, Hugh Lauder, and David Ashton. 2011. *The Global Auction: The Broken Promises of Education, Jobs and Incomes*. Athens: Ohio University Press.

Brzezinski, Zbigniew. 1970. *Between Two Ages: America's Role in the Technetronic Era*. New York: Viking Press.

Caffentzis, Constantine George. 2013. *In Letters of Blood and Fire: Work, Machines, and the Crisis of Capitalism*. Oakland, CA: PM Press.

Campbell, Stephen. 2018. "Anthropology and the Social Factory." *Dialectical Anthropology* 42 (3): 227–39.

Castells, Manuel. 1989. *The Informational City: Information Technology, Economic Restructuring, and the Urban-Regional Process*. Oxford: Blackwell.

Castells, Manuel. 2010. *The Rise of the Network Society*, 2nd edition. Oxford: Wiley-Blackwell.

Christiaens, Tim. 2022. *Digital Working Lives: Worker Autonomy and the Gig Economy*. Lanham, MD: Rowman & Littlefield.

Cohen, Daniel. [2006] 2009. *Three Lectures on Post-Industrial Society*. Translated by William McCuaig. Cambridge, MA: MIT Press.

Cooper, Carolyn C. 1984. "The Portsmouth System of Manufacture." *Technology and Culture* 25 (2): 182–225.

Crowley, Martha, Daniel Tope, Lindsey Joyce Chamberlain, and Randy Hodson. 2010. "Neo-Taylorism at Work: Occupational Change in the Post-Fordist Era." *Social Problems* 57 (3): 421–47.

Dahrendorf, Ralf. 1959. *Class and Class Conflict in an Industrial Society*. Stanford, CA: Stanford University Press.

Dalle, Jean-Michel, Matthijs den Besten, Catalina Martínez, and Stéphane Maraut. 2017. "Microwork Platforms as Enablers to New Ecosystems and Business Models: The Challenge of Managing Difficult Tasks." *International Journal of Technology Management* 75 (1–4): 55–72.

Deleuze, Gilles. 1992. "Postscript on the Societies of Control." *October* 59: 3–7.

Dibbell, Julian. 2016. "Invisible Labor, Invisible Play: Online Gold Farming and the Boundary between Jobs and Games." *Vanderbilt Journal of Entertainment & Technology Law* 18 (3): 419–65.

Diebold, John. 1952. *Automation: The Advent of the Automatic Factory*. New York: D. Van Nostrand Company.

Drai, David. 2018. "Avoiding the Perils of 'Dirty' Data." *Information Management*, September 4, 2018.

Drucker, Peter. 1969. *The Age of Discontinuity: Guidelines for Our Changing Society*. New York: Harper & Row.

Ensmenger, Nathan. 2021. "The Cloud Is a Factory." In *Your Computer Is on Fire*, eds. Thomas S. Mullaney, Benjamin Peters, Mar Hicks, and Kavita Philip, 29–49. Cambridge, MA: MIT Press.

Freeman, Joshua B. 2018. *Behemoth: A History of the Factory and the Making of the Modern World*. New York: W. W. Norton.

Freudenberger, Herman, and Fritz Redlich. 1964. "The Industrial Development of Europe: Reality, Symbols, Images." *Kyklos* 17 (3): 372–400.
Frey, Carl Benedikt, and Michael A. Osborne. 2017. "The Future of Employment: How Susceptible Are Jobs to Computerisation?" *Technological Forecasting & Social Change* 114: 254–80.
Fuchs, Christian. 2014. *Digital Labour and Karl Marx*. London: Routledge.
Fyfe, Aileen. 2012. *Steam-Powered Knowledge: William Chambers and the Business of Publishing, 1820–1860*. Chicago, IL: University of Chicago Press.
Galbraith, John Kenneth. 1958. *The Affluent Society*. Boston, MA: Houghton Mifflin.
Galloway, Alexander R. 2004. *Protocol: How Control Exists after Decentralization*. Cambridge, MA: MIT Press.
Gillespie, Tarleton. 2018. *Custodians of the Internet: Platforms, Content Moderation, and the Hidden Decisions that Shape Social Media*. New Haven, CT: Yale University Press.
Gorz, André. [1980] 1982. *Farewell to the Working Class: An Essay on Post-Industrial Socialism*. Translated by Michael Sonenscher. London: Pluto Press.
Gorz, André. [2003] 2018. *The Immaterial: Knowledge, Value and Capital*. Translated by Chris Turner. London: Seagull.
Gray, Mary L., and Siddharth Suri. 2019. *Ghost Work: How to Stop Silicon Valley from Building a New Global Underclass*. Boston, MA: Houghton Mifflin Harcourt.
Hardt, Michael. 2006. "Immaterial Labor and Artistic Production." *Rethinking Marxism: A Journal of Economics, Culture & Society* 17 (2): 175–7.
Hardt, Michael, and Antonio Negri. 2009. *Commonwealth*. Cambridge, MA: Belknap Press.
Hardt, Michael, and Antonio Negri. 2017. *Assembly*. Oxford: Oxford University Press.
Harinarayan, Venky, Anand Rajaraman, and Anand Ranganathan. 2007. "Hybrid Machine/Human Computing Arrangement." United States Patent 7,197,459 B1, filed October 12, 2001, and issued March 27, 2007.
Heeks, Richard. 2010. "Understanding 'Gold Farming' and Real Money Trading as the Intersection of Real and Virtual Economies." *Journal of Virtual Worlds Research* 2 (4): 3–27.
Irani, Lilly. 2013. "The Cultural Work of Microwork." *New Media and Society* 17 (5): 720–39.
Irani, Lilly. 2015a. "Difference and Dependence among Digital Workers: The Case of Amazon Mechanical Turk." *The South Atlantic Quarterly* 114 (1): 225–34.
Irani, Lilly. 2015b. "Justice for 'Data Janitors.'" *Public Books*, January 15. http://www.publicbooks.org/nonfiction/justice-for-data-janitors.
Jones, Barry. 1982. *Sleepers, Wake! Technology and the Future of Work*. Melbourne: Oxford University Press.
Jones, Philip. 2021. *Work Without the Worker: Labour in the Age of Platform Capitalism*. London: Verso.
Kelly, Kevin. 1999. *New Rules for the New Economy: 10 Radical Strategies for a Connected World*. New York: Penguin Books.
Kost, Dominique, Christian Fieseler, and Sut I Wong. 2018. "Finding Meaning in a Hopeless Place? The Construction of Meaning in Digital Microwork." *Computers in Human Behavior* 82: 101–10.
Kumar, Krishan. [1995] 2005. *From Post-Industrial to Post-Modern Society: New Theories of the Contemporary World*, 2nd edition. Oxford: Blackwell Publishing.
Landes, David S. 1986. "What Do Bosses Really Do?" *The Journal of Economic History* 46 (3): 585–623.
Landes, David S. 1998. *The Wealth and Poverty of Nations: Why Some are so Rich and Some so Poor*. New York: W. W. Norton.
Lazzarato, Maurizio. 1996. "Immaterial Labor." In *Radical Thought in Italy: A Potential Politics*, eds. Paolo Virno and Michael Hardt, translated by Paul Colilli and Ed Emery, 133–47. Minneapolis: University of Minnesota Press.
Leaver, Eric W., and John J. Brown. 1946. "Machines Without Men." *Fortune*, November.
Lecavalier, Jesse. 2016. *The Rule of Logistics: Walmart and the Architecture of Fulfillment*. Minneapolis: University of Minnesota Press.
Levy, Steven. 2011. *In the Plex: How Google Thinks, Works, and Shapes Our Lives*. New York: Simon & Schuster.
Lohr, Steve. 2014. "For Big-Data Scientists, 'Janitor Work' is Key Hurdle to Insights." *The New York Times*, August 17. http://www.nytimes.com/2014/08/18/technology/for-big-data-scientists-hurdle-to-insights-is-janitor-work.html?_r=0.
Mallet, Serge. [1963] 1975. *The New Working Class*. Translated by Andrée Shepherd and Bob Shepherd. Nottingham, UK: Spokesman Books.
Marcuse, Herbert. [1964] 1991. *One-Dimensional Man: Studies in the Ideology of Advanced Industrial Society*. Boston, MA: Beacon Press.
Marcuse, Herbert. 2001. "Letter to Raya Dunayevskaya (August 24, 1960)." In *Collected Papers of Herbert Marcuse: Towards a Critical Theory of Society*, ed. Douglas Kellner, 2: 226. London: Routledge.
Marglin, Stephen A. 1974. "What Do Bosses Do? The Origins and Functions of Hierarchy in Capitalist Production." *Review of Radical Political Economics* 6 (2): 60–112.
Marx, Karl. [1867] 1990. *Capital: A Critique of Political Economy*. Translated by Ben Fowkes. Vol. 1. London: Penguin Books.
McPherson, Tara. 2012. "Why are the Digital Humanities so White?" In *Debates in the Digital Humanities*, ed. Matthew K. Gold, 139–60. Minneapolis: University of Minnesota Press.
Meyer, Stephen. 1981. *The Five Dollar Day: Labor Management and Social Control in the Ford Motor Company, 1908–1921*. Albany: State University of New York Press.
Mezzadra, Sandro, and Brett Neilson. 2013. *Border as Method: Or, the Multiplication of Labor*. Durham, NC: Duke University Press.
Miceli, Milagros, and Julian Posada. 2022. "The Data-Production Dispositif." *Proceedings of the ACM on Human-Computer Interaction* 6 (CSCW2): 1–37.
Mills, C. Wright. 1963. "Culture and Politics (1959)." In *Power, Politics and People: The Collected Essays of C. Wright Mills*, ed. Irving Louis Horowitz, 236–46. New York: Oxford University Press.
Mills, C. Wright. [1959] 1963. "The Cultural Apparatus (1959)." In *Power, Politics and People: The Collected Essays of C. Wright Mills*, ed. Irving Louis Horowitz, 405–22. New York: Oxford University Press.
Mills, C. Wright. [1958] 1963. "The Structure of Power in American Society (1958)." In *Power, Politics and People: The Collected Essays of C. Wright Mills*, ed. Irving Louis Horowitz, 23–38. New York: Oxford University Press.
Mills, C. Wright. [1959] 2000. *The Sociological Imagination*. Oxford: Oxford University Press.
Milne, Ronald. 2008. "From 'Boutique' to Mass Digitization: The Google Library Project at Oxford." In *Digital Convergence—Libraries of the Future*, eds. Rae Earnshaw and John Vince, 3–9. London: Springer.
Mintz, Sidney. 1985. *Sweetness and Power: The Place of Sugar in Modern History*. New York: Penguin Books.
Muldoon, James, Callum Cant, Boxi Wu, and Mark Graham. 2024. "A Typology of Artificial Intelligence Data Work." *Big Data & Society* 11 (1): 1–13.
Munn, Luke. 2022. *Automation is a Myth*. Stanford, CA: Stanford University Press.
Myrdal, Gunnar. [1963] 1965. *Challenge to Affluence*. Expanded and Revised. New York: Vintage Books.
Negri, Antonio. 1988. "Crisis of the Planner-State: Communism and Revolutionary Organisation (1971)." In *Revolution Retrieved: Writings on Marx, Keynes, Capitalist Crisis and New Social Subjects (1967–83)*, ed. Antonio Negri, 91–148. London: Red Notes.
Negri, Antonio. 1989. *The Politics of Subversion: A Manifesto for the Twenty-First Century*. Translated by James Newell. Cambridge: Polity.
Norman Wilson, Andrew. 2011. "Workers Leaving the Googleplex." HD Video. http://www.andrewnormanwilson.com/WorkersGoogleplex.html.
Norman Wilson, Andrew. 2016. "The Artist Leaving the Googleplex." *E-Flux* 74. https://www.e-flux.com/journal/74/59791/the-artist-leaving-the-googleplex/.
Peacock, David. 2006. "Dyeing Winchcombe Kersies and Other Kersey Cloth in Sixteenth-Century Newbury." *Textile History* 37 (2): 187–202.
Pellow, David Naguib, and Lisa Sun-Hee Park. 2002. *The Silicon Valley of Dreams: Environmental Injustice, Immigrant Workers,*

and the High-Tech Global Economy. New York: New York University Press.
Pinheiro, Lucas G. 2022. "A Factory Afield: Capitalism and Empire in John Locke's Political Economy." *Modern Intellectual History* 19 (1): 1–28.
Piscione, Deborah Perry. 2013. *Secrets of Silicon Valley: What Everyone else can Learn from the Innovation Capital of the World*. New York: Palgrave MacMillan.
Pitti, Stephen J. 2003. *The Devil in Silicon Valley: Northern California, Race, and Mexican Americans*. Princeton, NJ: Princeton University Press.
Prassl, Jeremias. 2018. *Humans as a Service: The Promise and Perils of Work in the Gig Economy*. Oxford: Oxford University Press.
Ptak, Laurel, and Andrew Norman Wilson. 2013. "Andrew Norman Wilson: ScanOps; Conversation with Laurel Ptak." *Aperture* 210: 128–33.
Riesman, David. 1958. "Leisure and Work in Post-Industrial Society." In *Mass Leisure*, eds. Eric Larrabee and Rolf Meyersohn, 363–85. Glencoe, IL: The Free Press.
Roberts, Sarah T. 2019. *Behind the Screen: Content Moderation in the Shadows of Social Media*. New Haven, CT: Yale University Press.
Rofel, Lisa. 1992. "Rethinking Modernity: Space and Factory Discipline in China." *Cultural Anthropology* 7 (1): 93–114.
Rose, Margaret A. 1991. *The Post-Modern and the Post-Industrial: A Critical Analysis*. Cambridge: Cambridge University Press.
Roth, Jill. 2001. "Direct Imaging: The Future of the Printing Press." *American Printer* 227 (2): 70–1.
Safley, Thomas Max, and Leonard N. Rosenband, eds. 1993. *The Workplace before the Factory: Artisans and Proletarians, 1500–1800*. Ithaca, NY: Cornell University Press.
Schwab, Klaus. 2017. *The Fourth Industrial Revolution*. New York: Crown.
Simbirski, Brian. 2016. "Cybernetic Muse: Hannah Arendt on Automation, 1951–1958." *Journal of the History of Ideas* 77 (4): 589–613.
Spence, Crawford, and David Carter. 2011. "Accounting for the General Intellect: Immaterial Labour and the Social Factory." *Critical Perspectives on Accounting* 22 (3): 304–15.
St. Clair, Gloriana. 2005. "Million Book Project vs Google Print." *Journal of Zhejiang University* 6A (11): 1195–200.
Standing, Guy. 2011. *The Precariat: The New Dangerous Class*. London: Bloomsbury Academic.
Struna, Jason, and Ellen Reese. 2020. "Automation and Surveillance-Driven Warehouse in Inland California." In *The Cost of Free Shipping: Amazon in the Global Economy*, eds. Jake Alimahomed-Wilson and Ellen Reese, 85–101. London: Pluto Press.
Taylor, Frederick Winslow. 1911a. *Shop Management*. New York: Harper & Brothers.
Taylor, Frederick Winslow. 1911b. *The Principles of Scientific Management*. New York: Harper & Brothers.
Toffler, Alvin. 1970. *Future Shock*. New York: Random House.
Touraine, Alan. [1969] 1971. *The Post-Industrial Society: Tomorrow's Social History: Classes, Conflicts and Culture in the Programmed Society*. Translated by Leonard F. X. Mayhew. New York: Random House.
Tubaro, Paola, Antonio A. Casilli, and Marion Coville. 2020. "The Trainer, the Verifier, the Imitator: Three Ways in Which Human Platform Workers Support Artificial Intelligence." *Big Data & Society* 7 (1): 1–12.
Ure, Andrew. 1835. *The Philosophy of Manufactures: Or, An Exposition of the Scientific, Moral, and Commercial Economy of the Factory System of Great Britain*. London: Charles Knight.
Vaidhyanathan, Siva. 2012. *The Googlization of Everything (And Why We Should Worry)*. Berkeley: University of California Press.
Vercellone, Carlo. 2007. "From Formal Subsumption to General Intellect: Elements for a Marxist Reading of the Thesis of Cognitive Capitalism." *Historical Materialism* 15 (1): 13–36.
Virno, Paolo. 1996. "Virtuosity and Revolution: The Political Theory of Exodus." In *Radical Thought in Italy: A Potential Politic*, eds. Paolo Virno and Michael Hardt, transl. Ed Emory, 189–210. Minneapolis: University of Minnesota Press.
Virno, Paolo. 2007. "General Intellect." *Historical Materialism* 15 (3): 3–8.
Virno, Paolo, and Michael Hardt, eds. 1996. *Radical Thought in Italy: A Potential Politics*. Minneapolis: University of Minnesota Press.
Wiener, Norbert. [1948] 1961. *Cybernetics: Or Control and Communication in the Animal and the Machine*, 2nd edition. Cambridge, MA: MIT Press.
Woodcock, Jamie. 2019. *Marx at the Arcade: Consoles, Controllers, and Class Struggle*. Chicago, IL: Haymarket.
Wright, Steve. [2002] 2017. *Storming Heaven: Class Composition and Struggle in Italian Autonomist Marxism*, 2nd edition. London: Pluto Press.
Zlolniski, Christian. 2006. *Janitors, Street Vendors, and Activists: The Lives of Mexican Immigrants in Silicon Valley*. Berkeley: University of California Press.