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Labor

When I enter Amazon's vast fulfillment center in Robbinsville, New Jersey, the first thing I see is a large sign that reads "Time Clock." It juts out from one of the bright yellow concrete pylons spanning across the vast factory space of 1.2 million square feet. This is a major distribution warehouse for smaller objects—a central distribution node for the Northeastern United States. It presents a dizzying spectacle of contemporary logistics and standardization, designed to accelerate the delivery of packages. Dozens of time-clock signs appear at regular intervals along the entryway. Every second of work is being monitored and tallied. Workers—known as "associates"—must scan themselves in as soon as they arrive. The sparse, fluorescent-lit break rooms also feature time clocks—with more signs to underscore that all scans in and out of the rooms are tracked. Just as packages are scanned in the warehouse, so too are workers monitored for the greatest possible efficiency: they can only be off-task for fifteen minutes per shift, with an unpaid thirty-minute meal break. Shifts are ten hours long.

This is one of the newer fulfillment centers that feature

robots to move the heavy shelving units laden with products in trays. The bright orange Kiva robots glide smoothly across the concrete floors like vivid water bugs, following a programmed logic that causes them to spin in lazy circles and then lock onto a path toward the next worker awaiting the trays. Then they move forward, carrying on their backs a tower of purchases that can weigh up to three thousand pounds. This shuffling army of ground-hugging robots presents a kind of effortless efficiency: they carry, they rotate, they advance, they repeat. They make a low, whirring hum, but it is almost entirely drowned out by the deafening sound of fast-moving conveyor belts that act as the factory's arteries. There are fourteen miles of conveyor belts moving without pause in this space. The result is a constant roar.

While the robots perform their coordinated algorithmic ballet behind bare chain-link fences, the workers in the factory are far less serene. The anxiety of making the "picking rate"—the number of items they must select and pack within the allocated time—is clearly taking a toll. Many of the workers I encounter on my visits are wearing some kind of support bandage. I see knee braces, elbow bandages, wrist guards. When I observe that many people seem to have injuries, the Amazon worker guiding me through the factory points to the vending machines spaced at regular intervals that are "stocked with over-the-counter painkillers for anyone who needs them."

Robotics has become a key part of Amazon's logistical armory, and while the machinery seems well tended, the corresponding human bodies seem like an afterthought. They are there to complete the specific, fiddly tasks that robots cannot: picking up and visually confirming all of the oddly shaped objects that people want delivered to their homes, from phone cases to dishwashing detergent, within the shortest amount of time. Humans are the necessary connective tissue to get

Workers and time clocks at the Amazon fulfillment center in Robbinsville Township, New Jersey. AP Photo/Julio Cortez

ordered items into containers and trucks and delivered to consumers. But they aren't the most valuable or trusted component of Amazon's machine. At the end of the day, all associates must exit through a row of metal detectors. This is an effective antitheft measure, I am told.

Within the layers of the internet, one of the most common units of measurement is the network packet—a basic unit of data to be sent from one destination and delivered to another. At Amazon, the basic unit of measurement is the brown cardboard box, that familiar domestic cargo vessel emblazoned with a curved arrow simulating a human smile. Network packets each have a timestamp known as a *time to live.* Data has to reach its destination before the time to live expires. At Amazon, the cardboard box also has a *time to live* driven

by the customer's shipping demands. If the box is late, this affects Amazon's brand and ultimately its profits. So enormous attention has been devoted to the machine learning algorithm that is tuned to the data regarding the best size, weight, and strength of corrugated boxes and paper mailers. Apparently without irony, the algorithm is called "the matrix."[1] Whenever a person reports a broken item, it becomes a data point about what sort of box should be used in the future. The next time that product is mailed, it will automatically be assigned a new type of box by the matrix, without human input. This prevents breakages, which saves time, which increases profits. Workers, however, are forced continually to adapt, which makes it harder to put their knowledge into action or habituate to the job.

The control over time is a consistent theme in the Amazon logistical empire, and the bodies of workers are run according to the cadences of computational logics. Amazon is America's second-largest private employer, and many companies strive to emulate its approach. Many large corporations are heavily investing in automated systems in the attempt to extract ever-larger volumes of labor from fewer workers. Logics of efficiency, surveillance, and automation are all converging in the current turn to computational approaches to managing labor. The hybrid human-robotic distribution warehouses of Amazon are a key site to understand the trade-offs being made in this commitment to automated efficiency. From there, we can begin to consider the question of how labor, capital, and time are entwined in AI systems.

Rather than debating whether humans will be replaced by robots, in this chapter I focus on how the experience of work is shifting in relation to increased surveillance, algorithmic assessment, and the modulation of time. Put another way, instead of asking whether robots will replace humans, I'm interested in how humans are increasingly treated like robots

and what this means for the role of labor. Many forms of work are shrouded in the term "artificial intelligence," hiding the fact that people are often performing rote tasks to shore up the impression that machines can do the work. But large-scale computation is deeply rooted in and running on the exploitation of human bodies.

If we want to understand the future of work in the context of artificial intelligence, we need to begin by understanding the past and present experience of workers. Approaches to maximizing the extraction of value from workers vary from reworkings of the classical techniques used in Henry Ford's factories to a range of machine learning–assisted tools designed to increase the granularity of tracking, nudging, and assessment. This chapter maps geographies of labor past and present, from Samuel Bentham's inspection houses to Charles Babbage's theories of time management and to Frederick Winslow Taylor's micromanagement of human bodies. Along the way, we will see how AI is built on the very human efforts of (among other things) crowdwork, the privatization of time, and the seemingly never-ending reaching, lifting, and toiling of putting boxes into order. From the lineage of the mechanized factory, a model emerges that values increased conformity, standardization, and interoperability—for products, processes, and humans alike.

Prehistories of Workplace AI

Workplace automation, though often told as a story of the future, is already a long-established experience of contemporary work. The manufacturing assembly line, with its emphasis on consistent and standardized units of production, has analogues in the service industries, from retail to restaurants. Secretarial labor has been increasingly automated since the 1980s

and now is emulated by highly feminized AI assistants such as Siri, Cortana, and Alexa.[2] So-called knowledge workers, those white-collar employees assumed to be less threatened by the forces driving automation, find themselves increasingly subjected to workplace surveillance, process automation, and collapse between the distinction of work and leisure time (although women have rarely experienced such clear distinctions, as feminist theorists of work like Silvia Federici and Melissa Gregg have shown).[3] Work of all stripes has had to significantly adapt itself in order to be interpretable and understood by software-based systems.[4]

The common refrain for the expansion of AI systems and process automation is that we are living in a time of beneficial human-AI collaboration. But this collaboration is not fairly negotiated. The terms are based on a significant power asymmetry—is there ever a choice *not* to collaborate with algorithmic systems? When a company introduces a new AI platform, workers are rarely allowed to opt out. This is less of a collaboration than a forced engagement, where workers are expected to re-skill, keep up, and unquestioningly accept each new technical development.

Rather than representing a radical shift from established forms of work, the encroachment of AI into the workplace should properly be understood as a return to older practices of industrial labor exploitation that were well established in the 1890s and the early twentieth century. That was a time when factory labor was already seen in relation to machines and work tasks were increasingly subdivided into smaller actions requiring minimal skill but maximum exertion. Indeed, the current expansion of labor automation continues the broader historical dynamics inherent in industrial capitalism. Since the appearance of the earliest factories, workers have encountered ever more powerful tools, machines, and electronic systems

that play a role in changing how labor is managed while transferring more value to their employers. We are witnessing new refrains on an old theme. The crucial difference is that employers now observe, assess, and modulate intimate parts of the work cycle and bodily data—down to the last micromovement—that were previously off-limits to them.

There are many prehistories of workplace AI; one is the Industrial Revolution's widespread automation of common productive activities. In his *Wealth of Nations,* the eighteenth-century political economist Adam Smith first pointed to the division and subdivision of manufacturing tasks as the basis of both improved productivity and increasing mechanization.[5] He observed that by identifying and analyzing the various steps involved in manufacturing any given item, it was possible to divide them into ever-smaller steps, so that a product once made entirely by expert craftspeople could now be built by a team of lower-skill workers equipped with tools purpose-built for a particular task. Thus, a factory's output could be scaled up significantly without an equivalent increase in labor cost.

Developments in mechanization were important, but it was only when combined with a growing abundance of energy derived from fossil fuels that they could drive a massive increase in the productive capacities of industrial societies. This increase in production occurred in tandem with a major transformation of the role of labor vis-à-vis machinery in the workplace. Initially conceived as labor-saving devices, factory machines were meant to assist workers with their daily activities but quickly became the center of productive activity, shaping the speed and character of work. Steam engines powered by coal and oil could drive continuous mechanical actions that influenced the pace of work in the factory. Work ceased to be primarily a product of human labor and took on an increasingly machinelike character, with workers adapting to the needs of

the machine and its particular rhythms and cadences. Building on Smith, Karl Marx noted as early as 1848 that automation abstracts labor from the production of finished objects and turns a worker into "an appendage of the machine."[6]

The integration of workers' bodies with machines was sufficiently thorough that early industrialists could view their employees as a raw material to be managed and controlled like any other resource. Factory owners, using both their local political clout and paid muscle, sought to direct and restrict how their workers moved around within factory towns, sometimes even preventing workers from emigrating to less mechanized regions of the world.[7]

This also meant increasing control over time. The historian E. P. Thompson's formative essay explores how the Industrial Revolution demanded greater synchronization of work and stricter time disciplines.[8] The transition to industrial capitalism came with new divisions of labor, oversight, clocks, fines, and time sheets—technologies that also influenced the way people experienced time. Culture was also a powerful tool. During the eighteenth and nineteenth centuries, the propaganda about hard work came in the forms of pamphlets and essays on the importance of discipline and sermons on the virtues of early rising and working diligently for as long as possible.[9] The use of time came to be seen in both moral and economic terms: understood as a currency, time could be well spent or squandered away. But as more rigid time disciplines were imposed in workshops and factories, the more workers began to push back—campaigning over time itself. By the 1800s, labor movements were strongly advocating for reducing the working day, which could run as long as sixteen hours. Time itself became a key site for struggle.

Maintaining an efficient and disciplined workforce in the early factory necessitated new systems of surveillance and

control. One such invention from the early years of industrial manufacturing was the inspection house, a circular arrangement that placed all of a factory's workers within sight of their supervisors, who worked from an office placed on a raised platform at the center of the building. Developed in the 1780s in Russia by the English naval engineer Samuel Bentham while under the employ of Prince Potemkin, this arrangement allowed expert supervisors to keep an eye on their untrained subordinates—mostly Russian peasants loaned to Bentham by Potemkin—for signs of poor working habits. It also allowed Bentham himself to keep an eye on the supervisors for signs of ill-discipline. The supervisors, mostly master shipbuilders recruited from England, caused Bentham great annoyance due to their tendency to drink and get into petty disagreements with one another. "Morning after morning I am taken up chiefly with disputes amongst my Officers," Bentham complained.[10] As his frustrations grew, he embarked on a redesign that would maximize his ability to keep a watchful eye on them, and on the system as a whole. With a visit from his elder brother, the utilitarian philosopher Jeremy Bentham, Samuel's inspection house became the inspiration for the famous panopticon, a design for a model prison featuring a central watchtower from which guards could supervise the prisoners in their cells.[11]

Since Michel Foucault's *Discipline and Punish,* it has become commonplace to consider the prison as the origin point of today's surveillance society, with the elder Bentham as its ideological progenitor. In fact, the panoptic prison owes its origins to the work of the younger Bentham in the context of the early manufacturing facility.[12] The panopticon began as a workplace mechanism well before it was conceptualized for prisons.

While Samuel Bentham's work on the inspection house has largely faded from our collective memory, the story behind

it remains part of our shared lexicon. The inspection house was part of a strategy coordinated by Bentham's employer, Prince Potemkin, who wished to gain favor in Catherine the Great's court by demonstrating the potential for modernizing rural Russia and transforming the peasantry into a modern manufacturing workforce. The inspection house was built to serve as a spectacle for visiting dignitaries and financiers, much like the so-called Potemkin villages, which were little more than decorated facades designed to distract observers from the impoverished rural village landscapes discreetly obscured from view.

And this is just one genealogy. Many other histories of labor shaped these practices of observation and control. The plantation colonies of the Americas used forced labor to maintain cash crops like sugar, and slave owners depended on systems of constant surveillance. As Nicholas Mirzoeff describes in *The Right to Look*, a central role in the plantation economy was the overseer, who watched over the flow of production on the colonial slave plantation, and their oversight meant ordering the work of the slaves within a system of extreme violence.[13] As one planter described in 1814, the role of the overseer was "to never leave the slave for an instant in inaction; he keeps the fabrication of sugar under surveillance, never leaving the sugar-mill for an instant."[14] This regime of oversight also relied on bribing some slaves with food and clothing to enlist them as an expanded surveillance network and to maintain discipline and speed of work when the overseer was occupied.[15]

Now the role of oversight in the modern workplace is primarily deputized to surveillance technologies. The managerial class employs a wide range of technologies to surveil employees, including tracking their movements with apps, analyzing their social media feeds, comparing the patterns of replying to emails and booking meetings, and nudging them with suggestions to make them work faster and more efficiently. Employee

data is used to make predictions about who is most likely to succeed (according to narrow, quantifiable parameters), who might be diverging from company goals, and who might be organizing other workers. Some use the techniques of machine learning, and others are more simplistic algorithmic systems. As workplace AI becomes more prevalent, many of the more basic monitoring and tracking systems are being expanded with new predictive capacities to become increasingly invasive mechanisms of worker management, asset control, and value extraction.

Potemkin AI and the Mechanical Turks

One of the less recognized facts of artificial intelligence is how many underpaid workers are required to help build, maintain, and test AI systems. This unseen labor takes many forms—supply-chain work, on-demand crowdwork, and traditional service-industry jobs. Exploitative forms of work exist at all stages of the AI pipeline, from the mining sector, where resources are extracted and transported to create the core infrastructure of AI systems, to the software side, where distributed workforces are paid pennies per microtask. Mary Gray and Sid Suri refer to such hidden labor as "ghost work."[16] Lilly Irani calls it "human-fueled automation."[17] These scholars have drawn attention to the experiences of crowdworkers or microworkers who perform the repetitive digital tasks that underlie AI systems, such as labeling thousands of hours of training data and reviewing suspicious or harmful content. Workers do the repetitive tasks that backstop claims of AI magic—but they rarely receive credit for making the systems function.[18]

Although this labor is essential to sustaining AI systems, it is usually very poorly compensated. A study from the United Nations International Labour Organization surveyed

3,500 crowdworkers from seventy-five countries who routinely offered their labor on popular task platforms like Amazon Mechanical Turk, Figure Eight, Microworkers, and Clickworker. The report found that a substantial number of people earned below their local minimum wage even though the majority of respondents were highly educated, often with specializations in science and technology.[19] Likewise, those who do content moderation work—assessing violent videos, hate speech, and forms of online cruelty for deletion—are also paid poorly. As media scholars such as Sarah Roberts and Tarleton Gillespie have shown, this kind of work can leave lasting forms of psychological trauma.[20]

But without this kind of work, AI systems won't function. The technical AI research community relies on cheap, crowd-sourced labor for many tasks that can't be done by machines. Between 2008 and 2016, the term *"crowdsourcing"* went from appearing in fewer than a thousand scientific articles to more than twenty thousand—which makes sense, given that Mechanical Turk launched in 2005. But during the same time frame, there was far too little debate about what ethical questions might be posed by relying on a workforce that is commonly paid far below the minimum wage.[21]

Of course, there are strong incentives to ignore the dependency on underpaid labor from around the world. All the work they do—from tagging images for computer-vision systems to testing whether an algorithm is producing the right results—refines AI systems much more quickly and cheaply, particularly when compared to paying students to do these tasks (as was the earlier tradition). So the issue has generally been ignored, and as one crowdwork research team observed, clients using these platforms "expect cheap, 'frictionless' completion of work without oversight, as if the platform were not

an interface to human workers but a vast computer without living expenses."[22] In other words, clients treat human employees as little more than machines, because to recognize their work and compensate it fairly would make AI more expensive and less "efficient."

Sometimes workers are directly asked to pretend to be an AI system. The digital personal assistant start-up x.ai claimed that its AI agent, called Amy, could "magically schedule meetings" and handle many mundane daily tasks. But a detailed Bloomberg investigation by journalist Ellen Huet revealed that it wasn't artificial intelligence at all. "Amy" was carefully being checked and rewritten by a team of contract workers pulling long shifts. Similarly, Facebook's personal assistant, M, was relying on regular human intervention by a group of workers paid to review and edit every message.[23]

Faking AI is an exhausting job. The workers at x.ai were sometimes putting in fourteen-hour shifts of annotating emails in order to sustain the illusion that the service was automated and functioning 24/7. They couldn't leave at the end of the night until the queues of emails were finished. "I left feeling totally numb and absent of any sort of emotion," one employee told Huet.[24]

We could think of this as a kind of Potemkin AI—little more than facades, designed to demonstrate to investors and a credulous media what an automated system would look like while actually relying on human labor in the background.[25] In a charitable reading, these facades are an illustration of what the system might be capable of when fully realized, or a "minimum viable product" designed to demonstrate a concept. In a less charitable reading, Potemkin AI systems are a form of deception perpetrated by technology vendors eager to stake a claim in the lucrative tech space. But until there is another way

to create large-scale AI that doesn't use extensive behind-the-curtain work by humans, this is a core logic of how AI works.

The writer Astra Taylor has described the kind of overselling of high-tech systems that aren't actually automated as "fauxtomation."[26] Automated systems appear to do work previously performed by humans, but in fact the system merely coordinates human work in the background. Taylor cites the examples of self-service kiosks in fast-food restaurants and self-checkout systems in supermarkets as places where an employee's labor appears to have been replaced by an automated system but where in fact the data-entry labor has simply been relocated from a paid employee to the customer. Meanwhile, many online systems that provide seemingly automated decisions, such as removing duplicated entries or deleting offensive content, are actually powered by humans working from home on endless queues of mundane tasks.[27] Much like Potemkin's decorated villages and model workshops, many valuable automated systems feature a combination of underpaid digital pieceworkers and consumers taking on unpaid tasks to make systems function. Meanwhile, companies seek to convince investors and the general public that intelligent machines are doing the work.

What is at stake in this artifice? The true labor costs of AI are being consistently downplayed and glossed over, but the forces driving this performance run deeper than merely marketing trickery. It is part of a tradition of exploitation and deskilling, where people must do more tedious and repetitive work to back-fill for automated systems, for a result that may be less effective or reliable than what it replaced. But this approach can *scale*—producing cost reductions and profit increases while obscuring how much it depends on remote workers being paid subsistence wages and off-loading additional tasks of maintenance or error-checking to consumers.

Fauxtomation does not directly replace human labor; rather, it relocates and disperses it in space and time. In so doing it increases the disconnection between labor and value and thereby performs an ideological function. Workers, having been alienated from the results of their work as well as disconnected from other workers doing the same job, are liable to be more easily exploited by their employers. This is evident from the extremely low rates of compensation crowdworkers receive around the world.[28] They and other kinds of fauxtomation laborers face the very real fact that their labor is interchangeable with any of the thousands of other workers who compete with them for work on platforms. At any point they could be replaced by another crowdworker, or possibly by a more automated system.

In 1770, Hungarian inventor Wolfgang von Kempelen constructed an elaborate mechanical chess player. He built a cabinet of wood and clockwork, behind which was seated a life-size mechanical man who could play chess against human opponents and win. This extraordinary contraption was first shown in the court of Empress Maria Theresa of Austria, then to visiting dignitaries and government ministers, all of whom were utterly convinced that this was an intelligent automaton. The lifelike machine was dressed in a turban, wide-legged pants, and a fur-trimmed robe to give the impression of an "oriental sorcerer."[29] This racialized appearance signaled exotic otherness, at a time when the elites of Vienna would drink Turkish coffee and dress their servants in Turkish costumes.[30] It came to be known as the Mechanical Turk. But the chess-playing automaton was an elaborate illusion: it had a human chess master hiding inside an internal chamber, operating the machine from within and completely out of sight.

Some 250 years later, the hoax lives on. Amazon chose to name its micropayment-based crowdsourcing platform "Ama-

zon Mechanical Turk," despite the association with racism and trickery. On Amazon's platform, real workers remain out of sight in service of an illusion that AI systems are autonomous and magically intelligent.[31] Amazon's initial motivation to build Mechanical Turk emerged from the failures of its own artificial intelligence systems that could not adequately detect duplicate product pages on its retail site. After a series of futile and expensive attempts to solve the problem, the project engineers enlisted humans to fill the gaps in its streamlined systems.[32] Now Mechanical Turk connects businesses with an unseen and anonymous mass of workers who bid against one another for the opportunity to work on a series of microtasks. Mechanical Turk is a massively distributed workshop where humans emulate and improve on AI systems by checking and correcting algorithmic processes. This is what Amazon chief executive Jeff Bezos brazenly calls "*artificial* artificial intelligence."[33]

These examples of Potemkin AI are all around. Some are directly visible: when we see one of the current crop of self-driving cars on the streets, we also see a human operator in the driver's seat, ready to take control of the vehicle at the first sign of trouble. Others are less visible, as when we interact with a web-based chat interface. We engage only with the facades that obscure their inner workings, designed to hide the various combinations of machine and human labor in each interaction. We aren't informed whether we are receiving a response from the system itself or from a human operator paid to respond on its behalf.

If there is growing uncertainty about whether we are engaging with an AI system or not, the feeling is mutual. In a paradox that many of us have experienced, and ostensibly in order to prove true human identity when reading a website, we are required to convince Google's reCAPTCHA of our

humanity. So we dutifully select multiple boxes containing street numbers, or cars, or houses. We are training Google's image recognition algorithms for free. Again, the myth of AI as affordable and efficient depends on layers of exploitation, including the extraction of mass unpaid labor to fine-tune the AI systems of the richest companies on earth.

Contemporary forms of artificial intelligence are neither artificial nor intelligent. We can—and should—speak instead of the hard physical labor of mine workers, the repetitive factory labor on the assembly line, the cybernetic labor in the cognitive sweatshops of outsourced programmers, the poorly paid crowdsourced labor of Mechanical Turk workers, and the unpaid immaterial work of everyday users. These are the places where we can see how planetary computation depends on the exploitation of human labor, all along all the supply chain of extraction.

Visions of Disassembly and Workplace Automation: Babbage, Ford, and Taylor

Charles Babbage is well known as the inventor of the first mechanical computer. In the 1820s, he developed the idea for the *Difference Engine*, a mechanical calculating machine designed to generate mathematical and astronomical tables in a fraction of the time required to calculate them by hand. By the 1830s, he had a viable conceptual design for the *Analytical Engine*, a programmable general-purpose mechanical computer, complete with a system of punch cards for providing it with instructions.[34]

Babbage also had a strong interest in liberal social theory and wrote extensively on the nature of labor—the combination of his interests in computation and worker automation. Following Adam Smith, he noted the division of labor as a means

of streamlining factory work and generating efficiencies. He went further, however, arguing that the industrial corporation could be understood as an analogue to a computational system. Just like a computer, it included multiple specialized units performing particular tasks, all coordinated to produce a given body of work, but with the labor content of the finished product rendered largely invisible by the process as a whole.

In Babbage's more speculative writing, he imagined perfect flows of work through the system that could be visualized as data tables and monitored by pedometers and repeating clocks.[35] Through a combination of computation, surveillance, and labor discipline, he argued, it would be possible to enforce ever-higher degrees of efficiency and quality control.[36] It was a strangely prophetic vision. Only in very recent years, with the adoption of artificial intelligence in the workplace, has Babbage's unusual twin goals of computation and worker automation become possible at scale.

Babbage's economic thought extended outward from Smith's but diverged in one important way. For Smith, the economic value of an object was understood in relation to the cost of the labor required to produce it. In Babbage's rendering, however, value in a factory was derived from investment in the design of the manufacturing process rather than from the labor force of its employees. The real innovation was the logistical process, while workers simply enacted the tasks defined for them and operated the machines as instructed.

For Babbage, labor's role in the value production chain was largely negative: workers might fail to perform their tasks in the timely manner prescribed by the precision machines they operated, whether through poor discipline, injury, absenteeism, or acts of resistance. As noted by historian Simon Schaffer, "Under Babbage's gaze, factories looked like per-

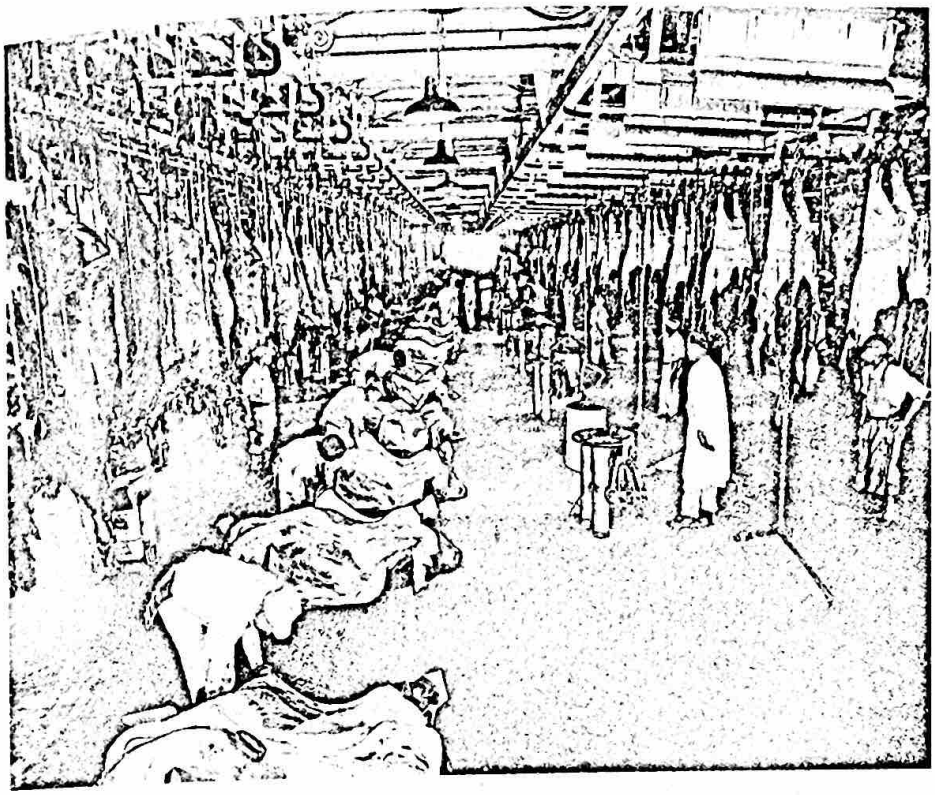
fect engines and calculating machines like perfect computers. The workforce might be a source of trouble—it could make tables err or factories fail—but it could not be seen as a source of value."[37] The factory is conceived as a rational calculating machine with only one weakness: its frail and untrustworthy human labor force.

Babbage's theory was, of course, heavily inflected with a kind of financial liberalism, causing him to view labor as a problem that needed to be contained by automation. There was little consideration of the human costs of this automation or of how automation might be put to use to improve the working lives of factory employees. Instead, Babbage's idealized machinery aimed primarily to maximize financial returns to the plant owners and their investors. In a similar vein, today's proponents of workplace AI present a vision of production that prioritizes efficiency, cost-cutting, and higher profits instead of, say, assisting their employees by replacing repetitive drudge work. As Astra Taylor argues, "The kind of efficiency to which techno-evangelists aspire emphasizes standardization, simplification, and speed, not diversity, complexity, and interdependence."[38] This should not surprise us: it is a necessary outcome of the standard business model of for-profit companies where the highest responsibility is to shareholder value. We are living the result of a system in which companies must extract as much value as possible. Meanwhile, 94 percent of all new American jobs created between 2005 and 2015 were for "alternative work"—jobs that fall outside of full-time, salaried employment.[39] As companies reap the benefits of increasing automation, people are, on average, working longer hours, in more jobs, for less pay, in insecure positions.

The Meat Market

Among the first industries to implement the type of mechanized production line Babbage envisioned was the Chicago meat-packing industry in the 1870s. Trains brought livestock to the stockyard gates; the animals were funneled toward their slaughter in adjacent plants; and the carcasses were transported to various butchering and processing stations by means of a mechanized overhead trolley system, forming what came to be known as the *disassembly line.* The finished products could be shipped to faraway markets in specially designed refrigerated rail cars.[40] Labor historian Harry Braverman noted that the Chicago stockyards realized Babbage's vision of automation and division of labor so completely that the human techniques required at any point on the disassembly line could be performed by just about anyone.[41] Low-skill laborers could be paid the bare minimum and replaced at the first sign of trouble, themselves becoming as thoroughly commoditized as the packaged meats they produced.

When Upton Sinclair wrote *The Jungle,* his harrowing novel about working-class poverty, he set it in the meat-packing plants of Chicago. Although his intended point was to highlight the hardships of working immigrants in support of a socialist political vision, the book had an entirely different effect. The depictions of diseased and rotting meat prompted a public outcry over food safety and resulted in the passing of the Meat Inspection Act in 1906. But the focus on workers was lost. Powerful institutions from the meat-packing industry to Congress were prepared to intervene to improve the methods of production, but addressing the more fundamental exploitative labor dynamics that propped up the entire system was off limits. The persistence of this pattern underscores how power responds to critique: whether the product is cow carcasses or



Armour Beef dressing floor, 1952.
Courtesy Chicago Historical Society

facial recognition, the response is to accept regulation at the margins but to leave untouched the underlying logics of production.

Two other figures loom large in the history of workplace automation: Henry Ford, whose moving assembly line from the early twentieth century was inspired by Chicago's disassembly lines, and Frederick Winslow Taylor, the founder of scientific management. Taylor forged his career in the latter years of the nineteenth century developing a systematic approach to workplace management, one that focused on the minute movements of workers' bodies. Whereas Smith's and Babbage's notion of the division of labor was intended to provide a way to distribute work between people and tools, Taylor

narrowed his focus to include microscopic subdivisions in the actions of each worker.

As the latest technology for precisely tracking time, the stopwatch was to become a key instrument of workplace surveillance for shop-floor supervisors and production engineers alike. Taylor used stopwatches to perform studies of workers that included detailed breakdowns of the time taken to perform the discrete physical motions involved in any given task. His *Principles of Scientific Management* established a system to quantify the movements of workers' bodies, with a view to deriving an optimally efficient layout of tools and working processes. The aim was maximum output at minimal cost.[42] It exemplified Marx's description of the domination of clock time, "Time is everything, man is nothing; he is, at most, time's carcass."[43]

Foxconn, the largest electronics manufacturing company in the world, which makes Apple iPhones and iPads, is a vivid example of how workers are reduced to animal bodies performing tightly controlled tasks. Foxconn became notorious for its rigid and militaristic management protocols after a spate of suicides in 2010.[44] Just two years later, the company's chairman, Terry Gou, described his more than one million employees this way: "As human beings are also animals, to manage one million animals gives me a headache."[45]

Controlling time becomes another way to manage bodies. In service and fast-food industries, time is measured down to the second. Assembly line workers cooking burgers at McDonald's are assessed for meeting such targets as five seconds to process screen-based orders, twenty-two seconds to assemble a sandwich, and fourteen seconds to wrap the food.[46] Strict adherence to the clock removes margin for error from the system. The slightest delay (a customer taking too long to order, a coffee machine failing, an employee calling in sick)

can result in a cascading ripple of delays, warning sounds, and management notifications.

Even before McDonald's workers join the assembly line, their time is being managed and tracked. An algorithmic scheduling system incorporating historical data analysis and demand-prediction models determines workers' shift allocations, resulting in work schedules that can vary from week to week and even day to day. A 2014 class action lawsuit against McDonald's restaurants in California noted that franchisees are led by software that gives algorithmic predictions regarding employee-to-sales ratios and instructs managers to reduce staff quickly when demand drops.[47] Employees reported being told to delay clocking in to their shifts and instead to hang around nearby, ready to return to work if the restaurant started getting busy again. Because employees are paid only for time clocked in, the suit alleged that this amounted to significant wage theft on the part of the company and its franchisees.[48]

Algorithmically determined time allocations will vary from extremely short shifts of an hour or less to very long ones during busy times—whatever is most profitable. The algorithm doesn't factor in the human costs of waiting or getting to work only to be sent home or being unable to predict one's schedule and plan one's life. This time theft helps the efficiency of the company, but it comes at the direct cost of the employees.

Managing Time, Privatizing Time

Fast-food entrepreneur Ray Kroc, who helped turn McDonald's into a global franchise, joined the lineage of Smith, Babbage, Taylor, and Ford when he designed the standard sandwich assembly line and made his employees follow it unthinkingly. Surveillance, standardization, and the reduction of individual craft were central to Kroc's method. As labor re-

searchers Clare Mayhew and Michael Quinlan argue with regard to the McDonald's standardized process, "The Fordist management system documented work and production tasks in minuscule detail. It required on-going documented participation and entailed detailed control of each individual's work process. There was an almost total removal of all conceptual work from execution of tasks."[49]

Minimizing the time spent at each station, or cycle time, became an object of intense scrutiny within the Fordist factory, with engineers dividing work tasks into ever-smaller pieces so they could be optimized and automated, and with supervisors disciplining workers whenever they fell behind. Supervisors, even Henry Ford himself, could often be seen walking the length of the factory, stopwatch in hand, recording cycle times and noting any discrepancies in a station's productivity.[50]

Now employers can passively surveil their workforce without walking out onto the factory floor. Instead, workers clock in to their shifts by swiping access badges or by presenting their fingerprints to readers attached to electronic time clocks. They work in front of timing devices that indicate the minutes or seconds left to perform the current task before a manager is notified. They sit at workstations fitted with sensors that continuously report on their body temperature, their physical distance from colleagues, the amount of time they spend browsing websites instead of performing assigned tasks, and so on. WeWork, the coworking behemoth that burned itself out over the course of 2019, quietly fitted its work spaces with surveillance devices in an effort to create new forms of data monetization. Its 2019 acquisition of the spatial analytics startup Euclid raised concerns, with the suggestion that it planned to track its paying members as they moved through their facilities.[51] Domino's Pizza has added to its kitchens machine-vision systems that inspect a finished pizza to ensure the staff made it

according to prescribed standards.[52] Surveillance apparatuses are justified for producing inputs for algorithmic scheduling systems that further modulate work time, or to glean behavioral signals that may correlate with signs of high or low performance, or merely sold to data brokers as a form of insight.

In her essay "How Silicon Valley Sets Time," sociology professor Judy Wajcman argues that the aims of time-tracking tools and the demographic makeup of Silicon Valley are no coincidence.[53] Silicon Valley's elite workforce "is even younger, more masculine and more fully committed to working all hours," while also creating productivity tools that are premised on a kind of ruthless, winner-takes-all race to maximal efficiency.[54] This means that young, mostly male engineers, often unencumbered by time-consuming familial or community responsibilities, are building the tools that will police very different workplaces, quantifying the productivity and desirability of employees. The workaholism and round-the-clock hours often glorified by tech start-ups become an implicit benchmark against which other workers are measured, producing a vision of a standard worker that is masculinized, narrow, and reliant on the unpaid or underpaid care work of others.

Private Time

The coordination of time has become ever more granular in the technological forms of workplace management. For example, General Motors' Manufacturing Automation Protocol (MAP) was an early attempt to provide standard solutions to common manufacturing robot coordination problems, including clock synchronization.[55] In due course, other, more generic time synchronization protocols that could be delivered over ethernet and TCP/IP networks emerged, including the Network Time Protocol (NTP), and, later, the Precision Time

Protocol (PTP), each of which spawned a variety of competing implementations across various operating systems. Both NTP and PTP function by establishing a hierarchy of clocks across a network, with a "master" clock driving the "slave" clocks.

The master-slave metaphor is riddled throughout engineering and computation. One of the earliest uses of this racist metaphor dates back to 1904 describing astronomical clocks in a Cape Town observatory.[56] But it wasn't until 1960s that the master-slave terminology spread, particularly after it was used in computing, starting with the Dartmouth timesharing system. Mathematicians John Kemeny and Thomas Kurtz developed a time-sharing program for access to computing resources after a suggestion by one of the early founders of AI, John McCarthy. As they wrote in *Science* in 1968, "First, all computing for users takes place in the slave computer, while the executive program (the 'brains' of the system) resides in the master computer. It is thus impossible for an erroneous or runaway user program in the slave computer to 'damage' the executive program and thereby bring the whole system to a halt."[57] The problematic implication that control is equivalent to intelligence would continue to shape the AI field for decades. And as Ron Eglash has argued, the phrasing has a strong echo of the pre–Civil War discourse on runaway slaves.[58]

The master-slave terminology has been seen as offensive by many and has been removed from Python, a coding language common in machine learning, and Github, a software development platform. But it persists in one of the most expansive computational infrastructures in the world. Google's Spanner—named as such because it spans the entire planet—is a massive, globally distributed, synchronously replicated database. It is the infrastructure that supports Gmail, Google search, advertising, and all of Google's distributed services.

At this scale, functioning across the globe, Spanner syn-

chronizes time across millions of servers in hundreds of data centers. Every data center has a "time master" unit that is always receiving GPS time. But because servers were polling a variety of master clocks, there was slight network latency and clock drift. How to resolve this uncertainty? The answer was to create a new distributed time protocol—a proprietary form of time—so that all servers could be in sync regardless of where they were across the planet. Google called this new protocol, without irony, TrueTime.

Google's TrueTime is a distributed time protocol that functions by establishing trust relationships between the local clocks of data centers so they can decide which peers to synchronize with. Benefiting from a sufficiently large number of reliable clocks, including GPS receivers and atomic clocks that provide an extremely high degree of precision, and from sufficiently low levels of network latency, TrueTime allows a distributed set of servers to guarantee that events can occur in a determinate sequence across a wide area network.[59]

What's most remarkable in this system of privatized Google time is how TrueTime manages uncertainty when there is clock drift on individual servers. "If the uncertainty is large, Spanner slows down to wait out that uncertainty," Google researchers explain.[60] This embodies the fantasy of slowing down time, of moving it at will, and of bringing the planet under a single proprietary time code. If we think of the human experience of time as something shifting and subjective, moving faster or slower depending on where we are and whom we are with, then this is a social experience of time. TrueTime is the ability to create a shifting timescale under the control of a centralized master clock. Just as Isaac Newton imagined an absolute form of time that exists independently of any perceiver, Google has invented its own form of universal time.

Proprietary forms of time have long been used to make machines run smoothly. Railroad magnates in the nineteenth century had their own forms of time. In New England in 1849, for example, all trains were to adopt "true time at Boston as given by William Bond & Son, No. 26 Congress Street."[61] As Peter Galison has documented, railroad executives weren't fond of having to switch to other times depending on which state their trains traveled to, and the general manager of the New York & New England Railroad Company called switching to other times "a nuisance and great inconvenience and no use to anybody I can see."[62] But after a head-on train collision killed fourteen people in 1853, there was immense pressure to coordinate all of the clocks using the new technology of the telegraph.

Like artificial intelligence, the telegraph was hailed as a unifying technology that would expand the capabilities of human beings. In 1889 Lord Salisbury boasted that the telegraph had "assembled all mankind upon one great plane."[63] Businesses, governments, and the military used the telegraph to compile time into a coherent grid, erasing more local forms of timekeeping. And the telegraph was dominated by one of the first great industrial monopolies, Western Union. In addition to altering the temporal and spatial boundaries of human interaction, communications theorist James Carey argues that the telegraph also enabled a new form of monopoly capitalism: "a new body of law, economic theory, political arrangements, management techniques, organizational structures, and scientific rationales with which to justify and make effective the development of a privately owned and controlled monopolistic corporation."[64] While this interpretation implies a kind of technological determinism in what was a complex series of developments, it is fair to say that the telegraph—paired with

the transatlantic cable—enabled imperial powers to maintain more centralized control over their colonies.

The telegraph made time a central focus for commerce. Rather than traders exploiting the difference in prices between regions by buying low and selling high in varying locations, now they traded between time zones: in Carey's terms, a shift from space to time, from arbitrage to futures.[65] The privatized time zones of data centers are just the latest example. The infrastructural ordering of time acts as a kind of "macrophysics of power," determining new logics of information at a planetary level.[66] Such power is necessarily centralizing, creating orders of meaning that are extremely difficult to see, let alone disrupt.

Defiance of centralized time is a vital part of this history. In the 1930s, when Ford wanted more control over his global supply chain, he set up a rubber plantation and processing facility deep in the Brazilian rain forest, in a town he named Fordlandia. He employed local workers to process rubber for shipping back to Detroit, but his attempts to impose his tightly controlled manufacturing process on the local population backfired. Rioting workers tore apart the factory's time clocks, smashing the devices used to track the entry and exit of each worker in the plant.

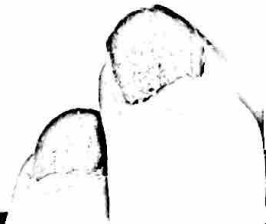
Other forms of insurgence have centered on adding friction to the work process. The French anarchist Émile Pouget used the term "sabotage" to mean the equivalent of a "go slow" on the factory floor, when workers intentionally reduce their pace of work.[67] The objective was to withdraw efficiency, to reduce the value of time as a currency. Although there will always be ways to resist the imposed temporality of work, with forms of algorithmic and video monitoring, this becomes much harder—as the relation between work and time is observed at ever closer range.

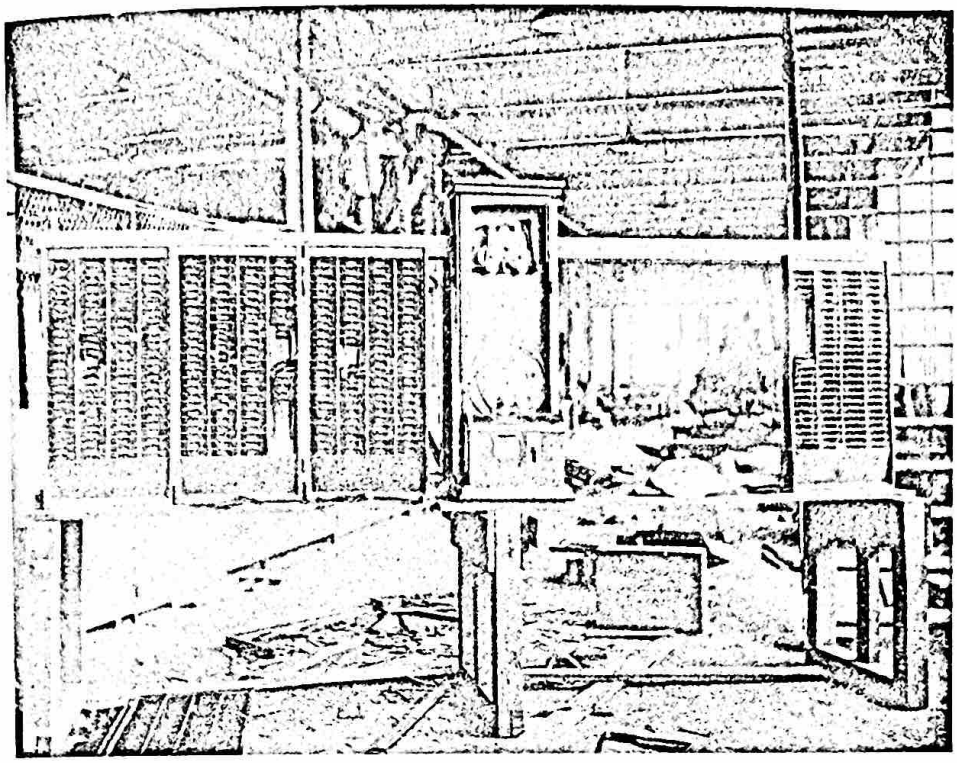
From the fine modulations of time within factories to the big modulations of time at the scale of planetary computation networks, defining time is an established strategy for centralizing power. Artificial intelligence systems have allowed for greater exploitation of distributed labor around the world to take advantage of uneven economic topologies. Simultaneously, the tech sector is creating for itself a smooth global terrain of time to strengthen and speed its business objectives. Controlling time—whether via the clocks for churches, trains, or data centers—has always been a function of controlling the political order. But this battle for control has never been smooth, and it is a far-reaching conflict. Workers have found ways to intervene and resist, even when technological developments were forced on them or presented as desirable improvements, particularly if the only refinements were to increase surveillance and company control.

Setting the Rate

Amazon goes to great lengths to control what members of the public can see when they enter a fulfillment center. We are told about the fifteen-dollar-an-hour minimum wage and the perks for employees who can last longer than a year, and we are shown brightly lit break rooms that have Orwellian corporate slogans painted on the walls: "Frugality," "Earn trust of others," and "Bias for action." The official Amazon guide cheerily explains what is happening at predetermined stops with rehearsed vignettes. Any questions about labor conditions are carefully answered to paint the most positive picture. But there are signs of unhappiness and dysfunction that are much harder to manage.

Out on the picking floor, where associates must pick up gray containers (known as "totes") full of purchases to ship,





Fordlandia Time Clock, destroyed in the riot of December 1930. From the Collections of The Henry Ford

whiteboards bear the marks of recent meetings. One had multiple complaints that the totes were stacked too high and that constantly reaching up to grab them was causing considerable pain and injuries. When asked about this, the Amazon guide quickly responded that this concern was being addressed by lowering the height of the conveyor belt in key sections. This was seen as a success: a complaint had been registered and action would be taken. The guide took this opportunity to explain for the second time that this was why unions were unnecessary here, because "associates have many opportunities to interface with their managers," and unionization only interferes with communication.[68]

But on the way out of the facility, I walked past a live feed of messages from workers on a large flat screen, with a sign

above it that read, "The Voice of the Associates." This was far less varnished. Messages scrolled rapidly past with complaints about arbitrary scheduling changes, the inability to book vacation time near holidays, and missing family occasions and birthdays. Pat responses from management seemed to be multiple variations on the theme of "We value your feedback."

"Enough is enough. Amazon, we want you to treat us like humans, and not like robots."[69] These are the words of Abdi Muse, executive director of the Awood Center in Minneapolis, a community organization that advocates for the working conditions of Minnesota's East African populations. Muse is a soft-spoken defender of Amazon warehouse workers who are pushing for better working conditions. Many workers in his Minnesota community have been hired by Amazon, which actively recruited them and added sweeteners to the deal, such as free busing to work.

What Amazon didn't advertise was "the rate"—the worker productivity metric driving the fulfillment centers that quickly became unsustainable and, according to Muse, inhumane. Workers began suffering high stress, injuries, and illness. Muse explained that if their rate went down three times they would be fired, no matter how long they had worked at the warehouse. Workers talked about having to skip bathroom breaks for fear that they would underperform.

But the day we met, Muse was optimistic. Even though Amazon explicitly discourages unions, informal groups of workers were springing up across the United States and staging protests. He smiled widely as he reported that the organizing was starting to have an impact. "Something incredible is happening," he told me. "Tomorrow a group of Amazon workers will be walking off the job. It's such a courageous group of women, and they are the real heroes."[70] Indeed, that night, approximately sixty warehouse workers walked out of a deliv-

ery center in Eagan, Minnesota, wearing their mandated yellow vests. They were mostly women of Somali descent, and they held up signs in the rain, demanding such improvements as increased wages for night shifts and weight restrictions on boxes.[71] Only a few days earlier, Amazon workers in Sacramento, California, had protested the firing of an employee who had gone one hour over her bereavement leave after a family member died. Two weeks before that, more than a thousand Amazon workers staged the first ever white-collar walkout in the company's history over its massive carbon footprint.

Eventually, Amazon's representatives in Minnesota came to the table. They were happy to discuss many issues but never "the rate." "They said forget about 'the rate,'" recounted Muse. "We can talk about other issues, but the rate is our business model. We cannot change that."[72] The workers threatened to walk away from the table, and still Amazon would not budge. For both sides, "the rate" was the core issue, but it was also the hardest to alter. Unlike other local labor disputes where the on-the-ground supervisors might have been able to make concessions, the rate was set based on what the executives and tech workers in Seattle—far removed from the warehouse floor—had decided and had programmed Amazon's computational distribution infrastructure to optimize for. If the local warehouses were out of sync, Amazon's ordering of time was threatened. Workers and organizers started to see this as the real issue. They are shifting their focus accordingly toward building a movement across different factories and sectors of Amazon's workforce to address the core issues of power and centralization represented by the relentless rhythm of "the rate" itself.

These fights for time sovereignty, as we've seen, have a history. AI and algorithmic monitoring are simply the latest technologies in the long historical development of factories, timepieces, and surveillance architectures. Now many more

sectors—from Uber drivers to Amazon warehouse workers to highly paid Google engineers—perceive themselves in this shared fight. This was strongly articulated by the executive director of the New York Taxi Workers Alliance, Bhairavi Desai, who put it this way: "Workers always know. They are out there building solidarity with each other, at red lights or in restaurants or in hotel queues, because they know that in order to prosper they have to band together."[73] Technologically driven forms of worker exploitation are a widespread problem in many industries. Workers are fighting against the logics of production and the order of time they must work within. The structures of time are never completely inhumane, but they are maintained right at the outer limit of what most people can tolerate.

Cross-sector solidarity in labor organizing is nothing new. Many movements, such as those led by traditional labor unions, have connected workers in different industries to win the victories of paid overtime, workplace safety, parental leave, and weekends. But as powerful business lobbies and neoliberal governments have chipped away at labor rights and protections over the past several decades and limited the avenues for worker organizing and communications, cross-sector support has become more difficult.[74] Now AI-driven systems of extraction and surveillance have become a shared locus for labor organizers to fight as a unified front.[75]

"We are all tech workers" has become a common sign at tech-related protests, carried by programmers, janitors, cafeteria workers, and engineers alike.[76] It can be read in multiple ways: it demands that the tech sector recognize the wide labor force it draws on to make its products, infrastructures, and workplaces function. It also reminds us that so many workers use laptops and mobile devices for work, engage on platforms like Facebook or Slack, and are subject to forms of workplace

AI systems for standardization, tracking, and assessment. This has set the stage for a form of solidarity built around tech work. But there are risks in centering tech workers and technology in what are more generalized and long-standing labor struggles. All kinds of workers are subject to the extractive technical infrastructures that seek to control and analyze time to its finest grain—many of whom have no identification with the technology sector or tech work at all. The histories of labor and automation remind us that what is at stake is producing more just conditions for every worker, and this broader goal should not depend on expanding the definition of tech work in order to gain legitimacy. We all have a collective stake in what the future of work looks like.