The Tools of Management: Adapting Historical Union Tactics to Platform-Mediated Labor

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At the same time that workers' rights are generally declining in the United States (US), workplace computing systems gather more data about workers and their activities than ever before. The rise of large scale labor analytics raises questions about how and whether workers could use such data to advocate for their own goals. Here, we analyze the historical development of workplace technology design methods in CSCW to show how mid-20th century labor responses to scientific management can inform directions in contemporary digital labor advocacy. First, we demonstrate how specific methodological tendencies from industrial scientific management were adapted to work in CSCW, and then subsequently altered in crowd work and social computing research to more closely resemble industrial approaches. Next, we show how three tactics used by labor unions to strategically engage with industrial scientific management in the mid-20th century can inform data-driven worker advocacy in platform-mediated work. Finally, we discuss how this history shapes our understanding of worker participation and the implications of using worker data for contemporary advocacy goals.

CCS Concepts: • **Human-centered computing** → *Computer supported cooperative work*;

Additional Key Words and Phrases: workplace technology, worker advocacy, labor history, industrial engineering, crowdwork

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1 INTRODUCTION

This paper draws on US labor history to understand the opportunities and challenges of using workplace data collection to support worker advocacy. Algorithmic systems in the workplace now use and generate massive amounts of data to mediate peoples' work experiences. Workers may have access to or even self-track some of this data. Workplace data gathering and aggregation provides opportunities for worker advocacy by helping workers understand and advocate for better working conditions. For example, social sharing of wages can help provide evidence for pay discrepancies such as rate cuts[158], and wage theft [160]. The challenge with collecting and aggregating worker

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data, even for advocacy purposes, is that disclosure of worker data may have unintended privacy consequences and may further surveil marginalized workers [46].

Even when operating outside of an explicitly worker-centered design framing, the CSCW community has long grappled with the unanticipated consequences of representing fine-grained data about individual behavior in technology designed for coordinated work. From a management and design perspective, granular data about workers' behaviors (*e.g.*, location, movement, computer activity) can be used to design workplace systems that facilitate more efficient and effective work coordination (for example, systems for routing, delegating, and tracking work). However, from a worker perspective, the same data gathering could decrease worker autonomy by impeding individual workers' ability to assess their local context and connect to other workers. This tension lies at the heart of CSCW research that analyzes the intellectual problem of articulating work practices [3, 12, 17]. CSCW researchers have developed formal modeling and ethnographic approaches to address the challenges of articulating complex, distributed, and cognitive work. Participatory and ethnographic methods have also been used to push back against proposed technological change that threatened worker autonomy, though the efficacy of these interventions has been questioned from different perspectives, including practical limitations of technology refusal and the limits of participation given workplace power dynamics.

This paper examines how responses to scientific management in the past could inform new worker advocacy tactics in data-driven, platform-mediated workplaces. We draw on the history of workplace design methods for industrial work (factory work, *e.g.* garment manufacturing), office work (clerical work, *e.g.* word processing), and platform-mediated work (*e.g.* crowd work, ride-share, and food delivery work), along with the history of industrial labor tactics for managing the impacts of scientific management. First, we describe how methods from industrial scientific management were altered in CSCW to address the practical challenges of designing for the office work context, and then demonstrate how contemporary research in platform-mediated labor (specifically in the case of crowd work) has begun to undo some of these earlier alterations. We describe how the use of new workplace design techniques limits the discretion of both platform workers and technology designers, and by drawing parallels to the transformation of industrial work, we show how labor questions emerging in crowd work research echo earlier questions about the impact of scientific management on industrial work. Next, we explore how industrial labor perspectives on scientific management can inform worker advocacy strategy. We present and analyze three worker data tactics from industrial labor union manuals published in the 1940's to 1960's to understand how industrial labor advocates mitigated and selectively took on the techniques of scientific management. We then discuss how these strategies of *data transparency*, *wage contestation*, and *strategic participation* could be used to guide the design of data-driven worker advocacy in contemporary, platform-mediated work contexts.

2 WORKER ADVOCACY IN PLATFORM-MEDIATED LABOR

In May of 2019, Uber and Lyft drivers in the US and around the world organized a strike action, calling drivers and riders to boycott ride-sharing applications and participate in local picket-lines [26, 62]. Earlier actions had been organized by Uber drivers in response to fare-cuts in 2018 [149], and 2016 [102], but the May 2019 action specifically captured the popular media attention as both a "test" of gig-worker leverage [26] and as an explicit demand for data transparency [142]. Data, wage, and algorithmic transparency have also been central demands for delivery platform workers (*e.g.* Postmates [126] and Instacart [160]). In absence of formal transparency mechanisms, platform workers share their individual data (for example, trip rates per mile and per minute) in rider groups and forums like UberPeople, and through advocacy tools like "Check Your Checks," which calculates wage breakdowns using weekly pay data [159]. Platform workers also take their compensation

data to social media, where "viral" posts detailing wage breakdowns for Instacart work showed tips being used toward order minimums [106, 132] which has since been corroborated by aggregate findings from advocacy groups[159]. Self-reported worker data has been part of public awareness campaigns [102, 160] that have pushed for changes in platform work conditions (including payment structure changes [105]). The impact of transparency on the ground is supported by preliminary empirical research in online labor markets that shows how employer reputation transparency can "discipline" platforms into worker-friendly outcomes [16].

Though platform workers are not considered employees under United States labor law, and thus cannot legally be represented by labor unions, some of these actions were organized with support from unions such as Service Employees International Union (SEIU)[77]. Platform workers have also organized through local coalitions and online forums, and with support from national labor advocacy organizations (*e.g.* Gig Workers Rising). Other online Labor advocacy organizations such Coworker.org [40, 121] and Organization United for Respect (OUR) [154] provide online resources and strategic support for advocacy initiatives. These organizations coordinate advocacy efforts including public awareness campaigns and online petitions for decentralized workers who have limited institutional resources and legal protections.

Supporting worker advocacy in platform-mediated labor is also an active research area within CSCW. Prior interventions by CSCW researchers engaged crowd workers, through the Amazon Mechanical Turk (AMT) platform, in writing a "Bill of Rights" [85] for Amazon Turk Workers. Drawing on the responses about what a "better" world of crowd work could look like, the authors designed a system called Turkopticon, which allowed workers to rate task requesters. This system corrects an asymmetry in the Amazon Mechanical Turk platform, which only supports the rating of workers by requesters. In subsequent work [86], the system's creators have drawn attention to the limited recognition given to crowd workers for building and sustaining an ecology of mutual aid infrastructures including forums like Turknation [114]. We Are Dynamo complements Turkopticon by centering Turker expertise in designing interventions, which led to a campaign of worker letters called "Dear Jeff Bezos" asking Amazon founder Jeff Bezos to recognize and acknowledge the human identity of crowd work [137].

Worker-centered research on crowd work in CSCW has also yielded criteria for fair work [144], requirements for worker-centric crowd work systems [6], and mechanisms to mitigate work rejection and support collective dispute resolution [119]. CSCW researchers have also worked with the German Metalworkers' Union, IG Metall, to translate lessons learned from Turktopicon to redesign a system for rating working conditions on digital labor platforms [73]. Other qualitative and ethnographic work in the field has drawn attention to the emotional and administrative work that falls outside of platform work's formal task models [69, 128], applied Marxist theory to identify typologies of worker relations in crowd work [72], and explored the labor perspectives of workers outside the traditional workplace [56, 138]. This paper informs ongoing discussions about advocacy tactics for platform-mediated work with a historical perspective. We compare the techniques for designing the platform workplace with earlier transformations of industrial and office work to explore how, and to what degree, data-driven worker advocacy strategies used by labor unions in the past might apply to current advocacy efforts in platform-mediated work.

3 TRACING METHODOLOGICAL CONTINUITY

In order to make an argument for the contemporary relevance of older advocacy tactics, we first analyze workplace design methods to identify continuities and differences in designing for industrial, office, and platform mediated work. Previous CSCW and Science and Technology studies scholarship has accounted for the impact of technological change in the workplace, analyzing how making certain work information visible or enforceable impacts organizational relationships [23, 117, 127,

146]. Critical scholarship argues that in measuring worker performance and exerting control over the work process, technology systems have a tendency to promote managerial interests [49, 57]. This perspective is strongly articulated in *Work-Oriented Design of Computer Artifacts,* where Pelle Ehn explicitly traces the connection from modern computer based planning to managerial "prerogatives" [49, p 250] motivating the separation of planning and execution found in Fredrick Winslow Taylor's system of Scientific Management. An alternative narrative has emerged within CSCW research that acknowledges the impact of scientific management on early CSCW methods, but asserts that these methods have been largely superseded by other techniques that center the contextual experiences of technology use. This shift away from scientific management has been interpreted both as a reflection of interdisciplinary commitments, and as a way to deal with practical constraints posed by complex, coordinated, cognitive work (*e.g* [11, 42, 70, 113]).

In this section, we draw on both of these arguments to analyze how technology design methods reproduce management goals, and evaluate the extent to which CSCW design methods depart from, and continue to draw on, scientific management strategies. We organize the discussion around three core strategies: *decomposition*, or the process by which work is observed and then formalized into elemental components; *delegation*, or when work is redesigned so that its elements are potentially divided among different workers; and *centralized oversight*, or the process of consolidating information about work to inform its centralized evaluation and planning. We explore how these components were adapted to meet the concerns and practical constraints presented by the CSCW context, and how emerging methods in crowd work research have subsequently begun to challenge and undo these disciplinary adaptations. We locate these methodological differences in workplace technology design within crowd work and social computing but, as we argue in the next section, these developments have implications for platform-mediated labor more generally.

3.1 Decomposition: Formalizing task breakdown

In the *Principles of Shop Management*, Fredrick Taylor writes that the foundation of scientific management rests on "an accurate study of unit times" for worker operations [151, p65]. Under Taylorism (the dominant mode of scientific management from 1900-20 [98, 108]), the "time study" method measured elapsed time for each component operation of a work process. However, this method had two limitations: first, it had to be studied in practice, using crude measurement tools (*e.g.* the stopwatch) and second, the insights from the method could not generalize beyond the specific operation being measured [24, pp 120-122]. Taylor's successors, Frank and Lillian Gilbreth, addressed these problems by adding "motion study" to the method. This method involved identifying and measuring the elemental "therbligs" or motions of the body that comprise all work movement, and creating charts of standard data for how long the motions ought to take under different conditions [61]. These therblig charts were expanded and refined to include measurements for more precise conditions, measured in time measurement units (TMU) of one hundred-thousandths of an hour [123]. This standard data was published, along with formulas and instructions, in industrial engineering manuals [54] and handbooks [115] throughout the 20th century.

This decomposition work was drawn on and adapted in early CSCW. Scientific management had charted the course for decomposing physical work into measurable and reproducible elements, but did not give guidance for decomposing mental work. As a result, when formalizing the Keystroke-Level Model (KLM) to predict task times using physical and mental operators, Card, Newell and Moran were able to use standard [48] MTM industrial engineering measurements for physical operators (*e.g.* press, point, home, draw) but the mental operator, "mental preparation", had to be calculated experimentally [28]. KLM was found to be effective for predicting the time to execute routine, low-level tasks [89] but in order to predict behavior in complex tasks in office work (*e.g.* to account for learning and parallel activities) CSCW researchers needed more robust techniques to

account more carefully for mental tasks. Several other Goal Operator Model Selection rule (GOMS) techniques emerged, each with different approaches to calculating mental effort. Because different methods led to different measurement outcomes, and because each method required extensive work, GOMS literature emphasizes the importance of training [89, 90] and analyst discretion in applying the techniques:

> "[A]n analyst will decide that certain user activities do not need to be 'unpacked' into any more detail... [t]hus, any particular GOMS analysis assumes a certain grain of analysis, a 'stopping point' in the level of detail, chosen to suit the needs of the analysis" [89].

While different GOMS methods varied widely in their assumptions about mental time, they treat complex cognition as a black box—an "unobservable operator" [88]. However, crowd-work research has since demonstrated the potential to subdivide cognition into more specific mental operators. In one project, the cognitive work required to generate taxonomies is classified into "human intelligence task primitives" (Generate, SelectBest, Categorize) [36]. Another project, Soylent, decomposes text editing into Find, Fix, and Verify tasks [19]. A more general framework draws on prior crowd work research to describe cognitive tasks on Mechanical Turk in terms of 10 primitives: Binary Choice, Likert Scale, Categorize, Tag, Describe, Math, Transcribe, Find, Fix, and Search) [34] which can be used to decompose task design, estimate completion time and anticipated effort, and price cognitive work. Developing reliable time estimates for the sub-components of work is a distinct methodological continuity in the representation of work from scientific management to contemporary practice, but crowd work research demonstrates that previously incalculable mental operators can now be usefully approximated to design crowd-work tasks.

3.2 Delegation: Shifting the locus of coordination

In Taylor's view, the difference between scientific management and "ordinary" management was that while the latter leaves the details of work implementation up to the worker, the former places "a great part of it upon the management" [151, p 64]. Scientific management required the work of every worker to be carefully planned out by management with instructions describing in detail the task which s/he is to accomplish [150]. Taking up the task of planning allowed management to optimize work not only by removing unnecessary or inefficient processes in an individual's work, but also by dividing complex tasks into sub-tasks that could then be delegated to different workers. Industrial engineers planned and delegated work for complex industrial production by combining their specialized engineering education with standard data and on-the-job observation of industrial workers.

Delegation methods from industrial engineering also required adaptation to work in a CSCW context. Even in office work tasks with clearly defined goals (*e.g.* editing text), while it was theoretically possible to break the task down into subroutines and use formal modeling techniques like GOMS to propose efficiency improvements for an individual user, it was not possible to use these formal models to meaningfully sub-divide and delegate the task to groups of workers. This was held to be true because the subroutines could not be understood "without the frame of reference created by the corresponding task, *i.e.* actions derive their meaning from the task" [155]. In order to delegate office work, Group Task Analysis relied on Activity Theory [125], which emphasized the indeterminacy of actions outside of their context and the role of ethnographic observation in understanding group phenomena. From a GOMS perspective, text editing was simply held to be a "passive-system task" where delegation was constrained by the computer having to wait for input from the user, to contrast with "active-system tasks" where the system dynamically generates events outside the user's control and the user must be prepared to react to them (*e.g.* a telephone

operator). It was theorized that artificial intelligence could shift the "locus of control" from passive systems to active ones.

However, crowd-work research on text editing shows that it is possible to delegate sub-tasks that can be dynamically assigned to crowd workers [19]. Furthermore, while systems like Soylent rely on pre-established task decomposition (such as Find-Fix-Verify), subsequent research in crowd work has demonstrated how task decomposition can be delegated to crowd workers themselves, who can propose how requests on the platform ought to be decomposed and delegated without specialized training in task analysis [100]. Where older approaches to CSCW and scientific management emphasize the role of analyst expertise in the redesign of workplace task delegation, crowd work has shown that it is practically possible to divide and execute complex tasks with just-in-time planning that can be done by non-experts.

3.3 Oversight: Centralizing task flows

In Taylor's mind, "the task idea" was the "most prominent single element in modern scientific management" [150, p 39]. Work that had previously been imagined only in the minds of skilled workers could now be decomposed into sub-routines, which could then be delegated to workers as a series of instructions, which, Taylor specified, should be given to workers as written instruction cards. By the middle of the 20th century, it was acknowledged that the production of such cards for individual workers was impractical, but standard documentation continued to play an essential role in industrial manufacturing [115, p 2-17]. In order to plan and maintain the operation of the industrial shop, engineers created and relied on process charts. These charts gave industrial engineers overview access to data ranging from worker micro-motion to shop-wide operations, which reduced worker training overhead and facilitated operations planning and cost estimation [115, 116].

When CSCW researchers began to map behavior in office work places, the industrial engineering techniques for task planning and representation did not work in the same way. In industrial work, the shop floor was separated between planner-engineers and workers who executed the plans, but in the office work, CSCW researchers found that planning was organizationally decentralized. Occurring in different teams, planning lacked an "omnipotent and omniscient center" that observed work delegation [113]. Hierarchical Task Analysis (HTA) [8] was an early method for adapting industrial engineering approaches to decentralized planning contexts. HTA works by decomposing goals into sub-tasks and operations, which are graphically represented in a organizational structure chart. The method could be applied toward indefinitely "unraveling" complex behavior [141], but like GOMS, this method includes "stop-rules" negotiated with different stakeholders [7] to cease decomposition when all useful information has been collected. For example, when a version of HTA was used in a study of air traffic control, analysis stopped when it reached tasks that controllers judged as being demanding or satisfying [41]. To deal with modeling group environments with different team cultures, tools were also developed to help designers keep track of ontologies for tasks in their different representations across contexts [156], but even task analysis proponents recognized that using these methods required substantial training and time to process vast quantities of data [1, 7].

By the 1990's, serious philosophical contention was levied against the usefulness of modeling tasks a priori due to the "improvisations of people and the local culture of groups" which, as the argument went [30], would be better captured using ethnographic methods toward the more descriptive goal of understanding usability, which led to the decreased, explicit use of task analysis [45]. But the linking of understanding usability with the need for ethnographic methods (*e.g.* as seen in contextual design [78, 145]) was in turn challenged by influential research in crowd work that showed that user studies could be structured and sourced remotely through Amazon's

Mechanical Turk platform [95]. Crowd-work platforms have the ability to gather vast amounts of granular computer activity [60, 109, 136, 161] and use behavioral traces to represent complex behavior, which can be used for usability testing [99] and studying group work [130]. Extensive process visualizations exist in crowd research software to provide dynamic representations of task processes so that task designers with little previous experience can access an omniscient view of the work being done and intervene to optimize the process [97, 135]. In this way, crowd work research demonstrates the potential for complex cognitive work to be centrally managed using representations based on modeling techniques that were once considered "moribund"[30], and while it is acknowledged in the community that the representations are imperfect [129], they are practically implementable and accessible by non-expert analysts.

4 LEARNING FROM LABOR HISTORY

Viewed across the previously described strategies of decomposition, delegation, and oversight, the history of CSCW reveals a clear pattern. Scientific management, as it was used in industrial settings, was not immediately applicable to office settings involving complex, coordinated, context-dependent cognitive work. CSCW research therefore retooled these methods to rely to a greater degree on worker and analyst discretion. However, research in crowd work has since demonstrated that aspects of complex, context-dependent work can be modeled—or practically approximated–using granular data collection in platform-mediated work contexts. As a result, methods for designing for data-driven contexts are in more direct continuity with earlier scientific management techniques than previous generations of CSCW.

This shift over time to a greater reliance on scientific-management-like strategies suggests that contemporary CSCW researchers interested in supporting worker advocacy in data-driven work may be able to learn useful lessons from understanding the labor movement's tactics for dealing with scientific management in the past. In this section, we describe how historical labor issues from scientific management are becoming salient in contemporary CSCW. First, we compare the impact scientific management had on deskilling industrial work with the impact of CSCW design methods. Second, we argue that the new affordances of granular data gathering pose substantial challenges to applying existing humanistic and participatory methods for worker advocacy by undermining aspects of both worker and analyst discretion. Third, we show how crowd work research already challenges CSCW to engage with labor issues and draw comparisons between proposed solutions to improve crowd work with work improvement techniques that have been proposed in industrial contexts in the past.

4.1 Worker Discretion

In CSCW, the work that early Taylorists intervened in has been characterized as "simple" [5] (or the workers as "unskilled workers" [42]), implying that Taylorist tendencies are less likely to be a concern in relation to the kinds of complex, coordinated, context-dependent cognitive work often addressed in CSCW. But industrial work, like sewing garments and smelting iron—when done outside of rationalized industrial production—requires exacting, complex craft knowledge acquired through training. Another way to understand the influence of Taylorism was not that it was intended to be used in low-skill contexts, but that the methods directly led to the simplification of high-skill tasks and the subsequent deskilling of once high-skill work.

The instructive difference between industrial craft work and digitally mediated knowledge work is not that one is simple and the other is cognitively complex, but rather that different information needs to be gathered about the worker's local context in order to decompose, delegate, and oversee the work using formal models. Though craft work in industrial contexts also involves judgment, cognition, and coordination, enough of this work is externally measurable that engineers were able

to build a corpus of standard data to predict time and effort needed to do tasks. Engineers were able to use this data to re-design work, separating its conception from execution. The presumed distinction between CSCW methods and the techniques of scientific management relies on the belief that the separation of work planning from work execution though technical system design is practically infeasible for certain kinds of work. This was because analysts have believed that the sub-elements were not meaningfully measurable or separable from their immediate context. Contemporary crowd work research suggests that this distinction may no longer hold.

The most empirically visible difference between crowd work research and earlier work in CSCW is a shift in what is practical to measure, model, and evaluate in complex, coordinated, context-dependent cognitive work. This new accounting of modern work is made possible by robust, granular data-gathering apparatuses. These apparatuses do not need to make ground-truth calculations about the precise local context of the worker, as long as they provide a 'good enough' account, which can be used to evaluate, model, and intervene in work processes. The resulting impact on workers is that they are no longer understood as stakeholders with unique, privileged knowledge of their local work context. We have analyzed this effect in crowd work, but similar surveillant task delegation exists in ride share, housekeeping and other platform-mediated work (*e.g.* [103, 111, 133]).

This loss of privileging of workers' unique knowledge about their work context has consequences for how we think about worker advocacy. When it was considered impossible to sufficiently model local context in CSCW, this methodological limitation opened up the space for worker advocacy in two ways: first, workers, who held in their hands the unique knowledge of what was actually happening at work, were in a position to leverage that knowledge in participatory design. Workers not only now have less discretion about how to execute their work, but in participatory design contexts, they hold less power because management already has a "good enough" model of what's going on. Without this unique, organizationally-valuable asset, the power dynamics of participatory design stack further against the worker. In addition, as we explain in the next section, the ease of representing local context also diminishes the leverage of technology researchers.

4.2 Analyst Discretion

When automation took place in the factory, engineers became invaluable stakeholders in the design process. This was because the labor of planning operations that had previously been done by individual workers had not been automated *away* under scientific management[24]. Rather, it was transferred from individual workers to the process charts of industrial engineers, who, using their consolidated view of the factory, now had the unique knowledge and the technical expertise to make improvements and maintain production. Since the redesigned work no longer relied on the expert judgment of individual workers, by design, manufacturing processes now required the discretion of industrial engineers. Early in the history of CSCW, the complexity of the methods of analysis meant that technology researchers, like industrial engineers before them, were uniquely able to understand how technology would impact work contexts. Because they were charged with assessing when worker knowledge could be relocated to software and when it could not, researchers were key stakeholders in mediating the needs of workers and management. Formal methods may not be remembered for their emphasis on analyst intervention, but our analysis of prior work shows explicit allowances in methods like GOMS and Hierarchical Task Analysis for the analyst to use their judgment about when to stop modeling task decomposition, delegation, and oversight.

The role of analyst discretion is more visible in the uptake of ethnographic methods. Ethnographers in CSCW were able to intervene in technology uptake by surfacing detailed understanding of what was already happening in the workplace, which they could use to warn technologists against the disruptiveness of a proposed change [71]. There are numerous examples of research

that refuses degrees of automation in workplaces such as law firms [148], flight control [80], and architecture offices [74][71]. Lucy Suchman and her research group at Xerox PARC presented an influential argument against models of the workplace as reducing workers' ability to "play the cooperation-conflict-negotiation game" [113], advocating instead for a design philosophy centered on supporting workers' tacit knowledge and skills [21, 118]. This research represents a strategic linking between worker advocacy and practical feasibility, which was reinforced by the high stakes of technology development [39] and the expertise of technology researchers themselves.

The diminished opportunity for technology researchers to intervene in workplace design has already been documented by socio-technical systems researchers as a result of lean software production methods [15] and in participatory design due to the decline of bespoke software design [22]. The potential for de-skilling CSCW methods has also already existed, as Hierarchical Task Analysis, Cognitive Task Analysis, GOMS, and usability methods all have heuristics that 'satisfice' given limited expertise and time [91, 120, 134]. But what the crowd-work platform, and the casualized labor situation that makes it possible [32, 44], has done is drastically lower the stakes of development for technology implementation so the need for researcher discretion and expertise has further decreased. What this means is that compared to their historic counterparts, contemporary CSCW researchers may have less leverage to advocate for workers in the technology design context. This poses a real challenge to strategies that rely on technology researchers to achieve humanistic outcomes.

4.3 Crowd Work's Labor Question

The impacts on worker discretion in crowd work are consistent with what has been observed in changing organizational contexts of office work [63, 92, 139, 140, 147, 162]. But because crowd work is mediated outside of traditional work structures, crowd work researchers in CSCW have also engaged more directly with elements of the employment relation that extend beyond technology use. Research in crowd work has explored mechanisms for worker recruiting and retention [18, 20, 37], maintenance of shared worker memory [101], and worker evaluation [75]. Crowd work research has also reflected on the potential impact of crowd work on different labor markets and employment relationships in the future [79, 96, 130]. Surveying prior research in crowd work, it is also evident that the research community has already begun to propose ways to improve the platform mediated work experience. In this section, we describe some of these proposals and draw connections to 20th century discourse on the "labor question" or how to solve the problems of the worker in an industrial society [104].

Proposals to improve crowd work have ranged from immediately actionable improvements to address the monotony of work through gamification [55] and micro-diversions [43], to incorporating elements of worker autonomy in task selection [33, 131], and self-evaluation [47], to substantial restructuring of crowd work to support worker involvement in task design[59] and peer evaluation[157]. Some proposals aim to address the problems of crowd work by mirroring aspects of the traditional office workplace: for example, by supporting mentoring relationships [35] and implementing hierarchical decision making, skill development, and career ladders [96]. Many of these proposals parallel earlier transitions from Taylorism to "more enlightened job design" [96] previously seen in industrial production [5]. Once industrial knowledge had been centralized, the systems of control could be replaced by more advanced management techniques, namely ones that incorporate limited elements of "job enrichment" [76, 122] or "job enlargement" (*i.e.* the opposite of job decomposition). Job enlargement included job rotation, the removal of assembly line techniques and clocks, replacing piecework incentives with group tasks and group incentives, allowing for the operator to have degrees of flexibility in methods, and incorporating limited elements of worker participation in work design [24, 68, 110].

Drawing on prior research that has applied a historical lens to the piece-work configurations in crowd work [5], we believe that a historical lens can also be applied to these proposals for work improvement. Since labor history offers the opportunity to see the worker advocacy perspective on these decisions in the past, it may be helpful to use labor strategy to inform our judgment about what is worth pursuing for worker advocacy in the future. Because many of the work-measurement configurations of crowd work are not unique to systems like Amazon Mechanical Turk, we believe that these perspectives can inform worker advocacy not only for crowd work but in platform-mediated work more generally.

5 CASE STUDY: HISTORICAL DATA TACTICS

In this section, we describe historical strategies used by unions in the United States to advocate for workers in the context of scientific management. We draw our insights about labor strategy in the past from an analysis of six union manuals published in the years 1942-1967: [10, 81–83, 153] and [84] (reproduced in [67]). We chose this time period as it offers a reasonably consistent labor perspective on how to accomplish worker advocacy goals given the use of scientific management in the industrial workplace. The following criteria was used to guide the selection of these manuals: first, they are written for a union audience; second, they explain scientific management techniques and give guidance for how to best mitigate their impact in the workplace (as opposed to agitating for the abolishment of scientific management); and third, they are published materials with copies available in circulating collections and online repositories. Though additional research in archival material informs our analysis of union strategy, the latter criteria was included so that other researchers would have easy access to the documents to gain more context about how unions responded to scientific management techniques. We analyzed these manuals for common themes, general sensibilities, and concrete strategies, which we describe in this section and connect to present-day labor advocacy in data-driven workplaces.

5.1 Background

When Taylor and his associates first introduced the techniques of scientific management, workers immediately saw the threat posed to craft knowledge and worker power [24, 58]. The methods also drew ire from unionists, as early proponents of scientific management hoped to use the techniques as "objective methods" for determining wages, thus eliminating the need for collective bargaining (negotiation between employers and a group of employees over work conditions) outright [66]. Due to militant worker and union resistance to scientific management, Taylor's successors were compelled to make meaningful concessions in order to bring their techniques into the mainstream [124]. These concessions included cooperation with labor unions and the establishment of joint processes to determine how scientific management techniques would be used in the workplace. A warming toward "new" Taylorism, and its compatibility with collective bargaining, led members of the labor movement to weaken their resolve against the techniques of scientific management.

After a series of short-lived experiments in cooperative rate-setting, unions realized that a strategy of fully joint participation in scientific management was as unsustainable as unilateral resistance. This was because unions quickly found themselves unmatched by management in the use of industrial engineering techniques [93]. Instead, unions relied on their ability to selectively contest management decisions using bureaucratic mechanisms like collective bargaining, which were reinforced by organized workers' ability to withhold labor if no agreement could be reached. The relationship between trade unions and industrial engineering in the mid-20th century was also shaped by legal protections such as the Wagner Act, the unique constraints of wartime production, and the organizing effects of worker militancy in the early 20th century [93, 124]. Here, we describe three key strategies unions used to address scientific management: data transparency,

wage contestation, and selective participation. We describe each strategy and considerations for its use. In the next section, we describe how these strategies could be adapted for use in present-day, data-driven workplaces given the constraints of platform work.

5.2 Data Transparency

One strategy that unions pursued was to secure oversight into the use of scientific management methods, including access to both the results of the analysis and the original data gathered. Characterized by one labor engineering expert [67, p. 1138] as the "coy" or "show me" approach, this strategy was seen as a middle-ground between refusal and acquiescence of time study methods:

> "As with time studies, the [Electrical, Radio, and Machine Workers of America] let the company use whatever method it pleases but under close union surveillance. If the result is satisfactory, well and good. If it is not, the company will hear from us."[153, pp. 77-80]

In addition to seeking employer data on wage rates and processes, the union claimed to possess "the most complete and authentic collection of rates which exists in our industry" which they used to assist union members in the event of wage disputes [153, p. 82]. Unions made efforts to secure full access to employer wage data and original time study data (with provisions that the techniques be explained in layman's terms [82]. In situations when workers could not rely on legally sanctioned access to complete information about wages and wage calculation methods, union tactics included circulating wage surveys (*e.g.* to measure highest, lowest, and average rates)[153, p 127] which they shared with union engineers who attempted to reverse engineer the incentive structure.

5.3 Wage Contestation

Once labor advocates had work data and understood how it was used to calculate wages, they considered possible avenues for wage contestation. To facilitate the process of contesting wages on the grounds of how they were being determined, union manuals contain extensive checklists for assessing the 'validity' of management-conducted time and motion studies studies. A United Autoworkers (UAW) Manual offered guidance on how to "subject the time study to thorough and searching examination" [84] in the following ways (also reproduced in [67, p 1167], and paraphrased in [82, p. 84]):

- Evaluating the reproducibility of the time study (*e.g.* are the conditions of the study sufficiently documented so that the study could be recreated?)
- Reading over the work elements to make sure the steps follow sequentially and are carefully defined.
- Looking for gaps in the timing to make sure no work has been left out.
- Checking for clear justification for excluded time measurements.
- Querying whether excluded "abnormal" values did not include those that would normally recur on the job (*e.g.* "fumbling or dropping are not valid reasons")
- Making sure that appropriate allowances were included for personal time and fatigue.

If possible, the union strategy was to first demonstrate errors in employer time studies. For example, because work rates were calculated based on the average of measured times, management had incentives to omit motions immediately before or after the element being studied, and "strike out" [82, p 85] time readings where they felt the element took uncharacteristically long. In response, union tactics emphasize checking for sequential elements and accounting for discarded measurement times. When it was not possible to demonstrate errors without providing data for comparison, unions would conduct their own studies to contest management. The manuals note, however, that union representatives have found it "unwise" to take time studies themselves, except

as a matter of last resort [82, p 85]. One of the reasons why unions avoided conducting their own studies was because it was tedious, expensive, and required technical expertise, to which few unions had regular access. Even when stewards were trained in time study, they were outnumbered by management's industrial engineers who considered the former to be "unschooled" [83, p 2].

Union manuals also warn local unions not to agree to any proposals to send members to learn time study methods at management's expense, as they felt that such training would only offer the "management perspective" and not give the union representative "an honest understanding of the unavoidable errors and arbitrary personal judgments with which the time study is filled"[84]. Instead, unions offered training on the use and limits of time study through their own education and research departments. Industrial union researchers also published some of the most technically rigorous critiques of the objectivity of the time-study [2, 13, 65, 107]. Since the time study method was a "crooked yardstick," unions did not necessarily believe that their own use of it would lead to any better measurements than management [84]. Thus, whenever a union conducted a time study, it was done very cautiously,

> "with the full knowledge of the weakness of their results, and only when they are convinced that this is an unavoidable step in the direction of resolving the dispute in the workers' best interests. When a UAW-CIO engineer makes a time study, he does it as a frank and open compromise with the principle dictated by the urgencies of a practical situation" [67, p 1166].

5.4 Selective Participation

Beyond any particular data practice, these manuals offer a sensibility toward participation that differs from how participation is typically imagined in CSCW. Unions were ultimately selective about whether to participate in management methods because, while there was benefit in reinforcing arguments with empirical evidence or providing concrete alternatives to management practice, there was also risk that too much "participation" would undermine the union's ability to advocate effectively for its members:

> "Any local union which makes the mistake of taking over functions which belong to the management will get nothing but headaches for its trouble. Let a shop steward picture the difference between telling a union member the following... No.1. '*We* talked your case over, Joe, and *we* decided that *we* can't give you more job evaluation points to get you upgraded.' No.2. '*I* tried to get you a higher rating, Joe, but *they* turned you down'"[153, p 99].

The manual cautions that scenario No.1 is likely to result in a union member blaming the union for abandoning their rightful function of protecting the worker by participating in management's function. Several manuals draw the connection between the use of management methods and the potential for tension between union leadership and rank-and-file members [10, 81, 82], so the decision of whether or not to participate involved assessing relationships with both workers and management.

Union participation in workplace decision making was also, in some cases, an explicit management goal. This may seem counter-intuitive, especially given the history of labor's relationship to industrial engineering, where efficiency experts testified that workers were fundamentally unfit to conduct time studies or participate in planning functions [24, 151]. However, worker participation had been advocated for by management [31], at times to a much fuller extent than unions were willing to do [93, p 154]. Union participation in management function was sought by employers in order to enlist workers into adopting management perspectives and redirect future worker dissatisfaction to the union. As job enrichment and job enlargement techniques rose in popularity,

unions were also confronted by management-initiated calls for workers to directly take part in management decision-making. Unions were suspicious that in doing so, employers sought to establish an "apparatus" for making use of workers' "special knowledge" [153]. Echoing concerns raised by HCI and CSCW scholarship years later [9, 112], unions also found the nature of this 'participation' to be under-defined and continued to advocate for "the real thing"—the ability to negotiate rates and incentives—over the "some fancy facsimile" [110, p 12].

6 IMPLICATIONS FOR WORKER ADVOCACY

Our analysis in this paper has focused on the US labor context, in contrast with the Scandinavian context which animates much of the writing in participatory design. It has been argued that the work process focus of Scandinavian Participatory Design maps poorly onto the US labor context because it is "poorly organized and concerned chiefly with employment security and wage rates" [29]. Our case study draws from a historical moment where labor was well organized, but had the same strong concerns about wages and employment stability. We argue that this emphasis underscores an instructive alternative avenue for worker advocacy. A focus on wages, working conditions, and employment stability aligns well with contemporary work contexts and concerns and may be more strategic for worker advocates given the diminished levels of worker and analyst discretion in platform mediated work contexts. In this section, we discuss how data transparency, wage contestation, and selective participation tactics could inform worker advocacy strategy in platform-mediated work.

The task of securing wage transparency in digitally mediated labor is an active channel of contemporary labor advocacy discourse [4, 27, 52, 53, 121], which has been heightened through the recent realization that the lack of wage transparency in gig work has become an avenue for digitally-mediated wage theft [152, 159]. However, given that many of the algorithms that mediate labor are considered intellectual property by the employing platforms [87] labor advocates will likely need to gather and aggregate data about workers themselves. One way to do this is to circulate self-report questionnaires about wages and other work conditions, as unions did, and worker advocates continue to do [73]. The advantage of self-report is that it is an active way to solicit user involvement, gauge interest, and build communication [25], with a clear mechanism to communicate what data is being gathered. The disadvantage is that self-report data about digitally mediated work may not be granular enough to reverse-engineer anything meaningful about the underlying algorithms. Alternatively, workers could agree to share automatically gathered data. This would improve data gathering, but would also introduce concerns about data privacy, consent, and sustained interest as the transfer of work data would be less actively mediated by the worker.

Union manuals also offer nuanced and practical insight on the risks and benefits of using their own measurements to contest management decisions. In digitally-mediated labor situations when the algorithm is not fully available to workers [51], it could be possible to build tools to compare aggregate data with whatever information employers do make available to identify 'contestable' situations while protecting individual data. Contemporary worker advocacy campaigns have been able to hold employers accountable through public awareness campaigns ("the digital equivalent of the picket line"[143]). However, as we discuss in the next section, advocacy coalitions will need to be careful about applying contestation strategies that were developed for unionized workers.

Finally, labor perspectives on the risks of worker participation in management decision-making offer insights for contemporary labor advocacy. while it has already been acknowledged within CSCW literature that direct worker participation in work design can be used to circumvent union negotiation [112], a renewed sensitivity to the risks of participation is in order for the following reasons. First, as our analysis of worker implications of new workplace methods has shown, digital workers have a decreased amount of knowledge about their work context that management cannot

usefully approximate in their models, which diminishes their leverage in participatory design situations. Technology researchers also have less leverage to mediate these interactions since they no longer possess unique expertise in designing workplace systems. Finally, historical perspectives suggest that participation in management function limits the ability for advocacy coalitions to sustain an adversarial stance toward management. As we see more initiatives by platform employers to enlist worker participation (*e.g.* [77, 94]), applying the sensibility of selective participation to contemporary worker advocacy requires a move away from seeing worker participation in workplace design process as an end in itself, and instead as a potentially risky decision with long-term consequences for worker advocacy.

7 DISCUSSION AND FUTURE WORK

While methods for designing platform work resonate with historical transformations of industrial work, industrial and contemporary crowd work have substantially different labor contexts. Even under prior conditions, unions faced challenges in appropriating managerial strategies to advocate for their members. The title of this paper, "the tools of management" [64, p.65] draws on a derisive characterization of scientific management by Sol Barkin, who, in his position as Director of Research at the Textile Workers Union, wrote extensively about the struggles unions faced in using scientific management techniques during collective bargaining [14, 64]. In this section we revisit the historical context that facilitated the use of these strategies in the past and discuss how CSCW researchers can anticipate challenges, both old and new, in the design of data-driven advocacy tools in the present.

The context of industrial production itself was central to understanding industrial union strategy. Because workers were already assembled in factories, organizing was facilitated by shared work experiences and geographic co-location. In addition, industrial work stoppages had the capacity to create bottle-necks in industrial manufacturing, allowing spontaneous strikes to disrupt production even when a minority of workers participated. At this point in the history of industrial unionism, effective militant organizing leading up to WWII had resulted in key legal protections for unions, giving way to a period of institutionalized labor relations. These new protections included not only collective bargaining, but also mandatory membership and dues payment for all workers represented by the union. These protections could be interpreted as mechanisms to subdue rank-and-file militancy (which was especially important for maintaining production efficiency during the war) but they also provided unions with stable, large memberships and treasuries, which supported more bureaucratic and expertise-driven tactics for labor advocacy.

Even under these historical conditions, the use of centralized data analysis tools had the risk of creating tension between union leadership and rank-and-file members. This tendency was also observed in early participatory design, where "data shop stewards" who were interested in the technical aspects of workplace design needed "support" or pressure from other parts of the union in order to not be assimilated into management-oriented system design [50]. The use of data-driven tactics requires building and maintaining both technical and institutional structures to sustain democratic processes in order to avoid falling into top-down, managerial tendencies. At the same time, CSCW researchers should expect democratic decision-making about how to use workplace data to be constrained by the technical complexity of data work (which tends to attract people with technical expertise or pre-existing interest in technical system design) and its tendency to reproduce the elements of decomposition and centralized oversight we describe in the paper.

In order to make use of historical insights without falling into the trap of "too much analogizing to unions" [38], it is also important to account for important ways that worker advocacy in platform work differs from industrial union strategy. Since platform workers are not considered employees under US labor law, they cannot form legally recognized unions to collectively bargain work

conditions, which is where engineering-management style contestation typically took place. In addition to being excluded from legal union organizing, platform workers are geographically dispersed and their work is loosely coupled, which means that partial strikes are unlikely to disrupt non-participating workers. Without legal protections, stable membership and dues, or easy avenues for labor disruption, it is not realistic (or safe) for platform worker advocates to simply mirror the bureaucratic strategies of industrial labor unions in the past. Instead, in times of labor quiescence, democratic data tools could potentially bring workers together over shared work concerns through democratic data work. In times of worker mobilization, data tools could be used to increase public visibility of working conditions. Looking to previous work on applying historical insights to present-day organizing [38], CSCW researchers should design these systems to aggregate worker data anticipating that they will be used by non-experts, sometimes in rapidly organized and temporary coalitions.

Assessing the feasibility of adapting historic perspectives and strategies to the present will require not only technical design experimentation but also deep engagement with worker advocacy experts. Translating older strategies involves understanding existing data practices in contemporary advocacy work. It will also be important to work with worker advocacy coalitions outside of traditional labor organizing, particularly those who have expertise with the demands and constraints of organizing in platform-mediated forms of work. Future research on the practices of unions in the mid-century should also look beyond the limited body of text we explore here (*e.g.* published union manuals that are held in circulating collections). These manuals represent the "ceremonial pronouncements" of union leadership in their published materials [67] rather than their actual practices. Further research into the long-term impact of these union strategies will also require additional research using archival and secondary sources.

8 CONCLUSION

In this paper we have looked at workplace technology design methods for work decomposition, delegation, and centralized oversight as they were translated from industrial work contexts into CSCW, and then subsequently re-tooled in crowd work and social computing research. Our central argument is that new data gathering affordances allow technology designers to transform the experience of complex, coordinated, cognitive work using methods that more closely resemble scientific management approaches in the past. These techniques limit both worker and analyst discretion, which in turn limits the efficacy of participatory approaches to workplace design and decreases technology researchers' abilities to intervene on workplace transformation.

We show that organized labor approaches in the US, which have previously been dismissed as incompatible with Participatory Design, can provide instructive alternatives for worker advocacy and for conceptualizing participation itself. We have described three strategies used by industrial unions to mitigate and selectively take on scientific management and trace implications for contemporary data-driven worker advocacy. Finally, we have argued that while these strategies can inform design, data-driven advocacy systems should account for the ways that worker advocacy in platform work differs from the industrial labor context. Without access to the same legal protections, resources, and avenues for labor disruption, advocates cannot expect to use data-driven strategy toward bureaucratic negotiations with platform employers. Instead, we suggest that the strategies could be used toward bringing workers together over shared concerns and drawing visibility to work conditions. This work demonstrates the potential of drawing on the history of pre-digital labor advocacy in future research addressing the challenges posed by contemporary workplace automation.

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