THE TOOLS OF MANAGEMENT: DATA PRACTICES FOR WORKER ADVOCACY

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This dissertation explores the impact of data-driven approaches to worker advocacy. I combine historical and design research, organized around a case study of management-engineering projects conducted by the International Ladies Garment Workers Union (ILGWU). I survey how workplace data been used to advocate for US workers in the past, how the decisions and challenges of using data to represent worker perspectives map onto analogous methodological challenges that impact the design of workplace measurement analytics today, and how these design techniques and insights from the past can be be applied in present-day workplace advocacy for workers in data-driven workplaces. I conclude with key trade-offs in relying on worker data and data expertise for worker advocacy.

BIOGRAPHICAL SKETCH

Vera Khovanskaya studies the impact of data collection in the workplace and the role of data-intensive methods in worker advocacy. Her other research areas include critical data studies and speculative design. Before starting graduate school, she was a visiting researcher at the University of California, Irvine, and interned at Intel Labs and Yahoo Research. In 2013, Vera graduated *summa cum laude* with a Bachelor of Arts in Information Science from Cornell University. She was born in Moscow, Russia and graduated from high school in Potomac, Maryland.

To Vasya

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CHAPTER 1

INTRODUCTION

In December 2019, the Philadelphia Inquirer named Google's collaborative, online spreadsheet program, Google Sheets, as the most powerful tool for labor in 2019 [257]. Over the past few months, workers in Philadelphia coffee shops and museums used the google sheet to collect data about worker salaries. These "viral" Google Sheets circulated across the United States, sharing data about compensation in various sectors of work including the nonprofit sector, academia, the tech sector, publishing, advertising, museum work, media work, restaurant and cafe work, paralegal work, and more [305]. Making salary information visible to people across a given industry is powerful because it allows workers assess to their own compensation against industry norms. In situations where workers are being underpaid, aggregated data allows individuals to begin advocating for fair compensation for their own work as individuals.

Beyond individual action in the workplace, the spreadsheet works to support collective identity and collective action in the workplace. When a spreadsheet circulates, workers are presented with an opportunity to discuss what is often taboo. Sharing salary information normalizes discussions about pay and other workplace-wide and industry-wide work conditions (for example, workers' compensation, medical leave, and benefits). The circulation of a spreadsheet presents an opportunity for workers to identify shared workplace concerns. The power of the Google Sheet – in its ability to both aggregate and share data – is that it works against the individualization of work. The individualization of work and the individualized identity of a worker is bolstered not only by workplace norms against discussing salary but also by individual contracts,

which work to prevent workers from seeing themselves as "collective workers" or group of people with common workplace conditions [291, p 277]. If a shared concern is identified, workers – sometimes with the assistance of various advocacy organizations, sometimes not – can use the data as part of a campaign to draw public visibility to the workplace issue, galvanizing support for change within the workplace and outside of it. For example, after gathering and aggregating compensation breakdown of wages, Instacart workers were able to draw public outrage to documented cases of wage theft within the Instacart platform, ultimately pressuring the company to change their compensation algorithm [208].

Technologies that gather data about the workplace for workers correct for what researchers and worker advocates call "data asymmetry" [262, 20, 60, 297, 304, 232, 103], or an imbalance between data that employers and workers respectively have about the workplace [231, 252, 314]. Extending beyond salary data, employers typically have access to granular data about workers' behaviors (*e.g.*, location, movement, computer activity) which can be used to design workplace systems that facilitate more efficient and effective work coordination (for example, systems for routing, delegating, and tracking work). Asymmetrical access to this data makes it more difficult for workers to voice concerns about or perspectives on workplace decisions. When workers do not have access to the information being gathered and used to shape their work experiences, they face barriers in contesting and advocating for changes to their work conditions. Management, labor, and policy experts have made the case for combating asymmetrical data relationships by increasing transparency around workplace data [219, 303, 59, 231], arguing that transparency will lead to more ethical decisions by employers, improve cross-organizational support for workplace analytics

programs, and empower workers to use workplace data for mediation [273]. Toward this end, multiple workplace transparency laws have been proposed within congress [91, 315, 250, 286, 234] with an emphasis on wage-incentive transparency on pay-stubs (*e.g.* tips and hourly wages, overtime etc.).

Yet it takes more than a transparent pay-stub or a google spreadsheet to effectively advocate for change in the workplace. Granular data is difficult to gather consistently, and poses privacy concerns when it contains personal and sensitive information. When data is gathered for advocacy purposes, who decides what data to gather, and what to do with it? Though employers are typically reluctant to 'open the books' to share the data that informs their decision-making, the tactic of making some information visible, for example on worker compensation, on its own, can be used by management to create competition between workers in the same job, or sow division between different groups of workers in the same workplace [204]. The efficacy of a data-driven and worker centered advocacy strategy depends heavily on the context in which it is used: what data is gathered, by whom, and for what purpose.

This dissertation looks to the history of data-driven advocacy in the labor movement to show how it is possible for worker advocates to use data-driven methods to accomplish their goals. Though many of the data-driven technologies being introduced in the workplace rely on new technologies, there have been moments in the past where worker advocates – industrial labor unions – were able to improve workplace conditions by collecting worker data. More generally, the unions engaged, selectively, with the tools of management in order to push for improved working conditions for their members. The central argument of this dissertation is that the appropriation of data-driven, managerial

tactics can be effective, but it requires not only the collection and aggregation of workplace data, but access to technical, organizational, and legal resources. The dissertation makes a historical argument about how the use of data-driven tactics has lead to tangible improvements to work conditions, though these effects have been somewhat limited. More generally, I show how applying technological solutions and the rhetorical use of data into the struggle for fair work is tempting, useful, and risky.

This dissertation builds on a growing interest in worker advocacy and labor issues within the Human-Computer Interaction (HCI) and Computer-Supported Collaborative Work (CSCW) community. Throughout the history of both of these fields, researchers have been concerned with the implications of making data about work visible through data tools. More recently, there have been two growing sub-fields of research that this work hopes to contribute to: the first is explicitly worker-centered and activist technology design, and the second is work where, through their work in crowd sourcing and social computing technology, researchers directly encounter how employment relationships are mediated by data-driven systems.

Two key challenges face researchers aiming to assess how data driven technologies of these systems impact worker advocacy efforts: (1) the unpredictability of long-term impacts given complex organizational dynamics and the short-term cycle of standard technology design evaluation; (2) the lack of access to information about and data from proprietary systems currently being deployed in the workplace. This project addresses these methodological challenges by analyzing earlier forms of work measurement that form the precedent for systems used today–and by showing how worker advocates made use of these systems

to fight for improved work conditions. By comparing the present to the past, we can trace the continuity of management practices from the beginning of the data-driven workplace to the present. Labor history offers the opportunity to see how worker advocates resisted and appropriated managerial tactics over time. Surveying the impact of data-driven advocacy practices over time can help us understand what is worth doing–and the opportunities and challenges of using worker data to drive workplace advocacy efforts.

The central case study of this dissertation is work of the Management Engineering Department of the International Ladies Garment Workers Union (ILGWU). Created in 1941, the department was officially tasked with improving manufacturing techniques and operating methods, as well as providing information on "fair rate pieces," monitoring manufacturing techniques, and providing training to workers on efficient operations [6]. Techniques and methods improvements were made by first observing the womens' garments manufacturing operations, and then recommending process efficiencies [132]. The department evaluated and conducted time studies, conducted surveys of industry practices, and used both to negotiate piece rates [318, 323, 33, 275, 296] and develop worker training [102, 290, 168, 167].

This case study has new relevance to the contemporary work context because what was possible to gather in the past under the controlled environment of the industrial time-motion study, resembles the data that we can now collect automatically using data from workplace sensors and communication technologies (e.g cell phones and computer applications). In fact, through manual coding of workers' movements from video footage of controlled time-study environments allowed engineers to manually approximate and analyze levels

of data granularity that are currently being gathered using sensing technology. As a result, many of the same concerns about the negative impacts of workplace data collection were appearing in the garment industry as early as 1915, when engineers where first employed by the union to work with employers associations to generate "scientific" piece-rates and prototypes of the scientifically managed shop [247, 174, 242].

By employing their own engineers, unions began to use data to negotiate relationships – between the union and employers and within the union itself. While unions and employers had quite different goals, garment unions faced a complex bind: on one hand, they needed to advocate for improved conditions for their members, but on the other, to ensure the existence of jobs for their members, they needed to preserve a flighty industry. Garment work ran on thin margins and was always imminently at risk of being outsourced elsewhere (either through subcontracting of the work or geographically, to some place with cheaper labor and less union presence). As a result, the union often sought to apply industrial engineering techniques to simultaneously improve efficiency (from the perspective of the employer) and work conditions (from the perspective of the worker) at the same time[36, 324, 137].

In some situations, the engineers were able to simultaneously lift performance and advocate for workers, but in situations where different stakeholder interests had to be balanced, the Management Engineering department faced a double bind. Since the methods they used for worker advocacy necessarily required the gathering and analysis of worker data, their work was at risk for being re-absorbed by the employer for uses other than what the union intended. For example, the department itself was in part founded in response to unan-

ticipated and "seldom recognizable" employer appropriation of the previously mentioned cooperative engineering work that sought to stabilize the garment industry through rate-setting standardization [135].

The Management Engineering department also faced the bind that their rhetorical appeal required them to appear more reasonable through their crafting of alternatives to existing practices. Not only could this put the union in an awkward situation with the workers, but they also had to make sure that employers did not abuse the engineering efforts of the department by relying on union resources to optimize their workplace (a situation that one could compare to Amazon's embrace of the Turkopticon system – a system for crowd workers to rate the people who upload tasks – instead of using their own resources to build out their own feature [173]).

Again similar to what the designers of Turkopticon observed with mainstream narratives about their intervention, the expert personnel in the department are credited with diagnosing and resolving labor-management disputes using data-driven methods, yet the archival record details how their work was critically informed by collaboration with workers and local unionists on the ground (*e.g.* [165]) who pointed the engineers to the areas of concern and negotiated the relationship between the engineering department and the shop floor. [1]. Secondary sources also reveal conflicting sentiments toward this department which suggest that the engineers were not unilaterally trusted to represent the interests of workers [320, 3].

The record of the Management Engineering department contains rich and

[1]The role of the garment worker participants is difficult to tease out of the archival record that focused on the engineering department itself. A point that I will return to in the future work section is about how data-intenisve methods impact participation in data processes overall

unique data about the conditions and strategies, at a time when manufacturer business records were difficult to maintain due to industry volatility. Data from this department was used for surveys of the garment industry [96, 39, 36] and cutting edge academic work in industrial engineering and scientific management [211, 323, 13, 14, 210]. The forms of data archived include: time sheets, micro-motion logs and simultaneous motion charts, video footage used for motion analysis, layout and process charts, incentive rates calculations, and summaries of interviews with workers and management. Project folders also contain reports that were shared differentially with workers and employers. The archive of the Management Engineering department also includes reports to the general board, correspondence within the ILGWU (*e.g.* with union locals), and correspondence with academic researchers, publishers, and professional and academic societies [164].

The case is useful for understanding the future of the data-driven workplace for two reasons. The first is because of the many analogies between the struggles faced by worker advocates in the past and those in the present. The second reason is that the methods we currently use to design workplace data tools are rooted in the very same methods that were being developed and contested by management and labor in this case study. Prior work connects HCI's research domain with scientific management and the history of industrial engineering, both as methodological inspiration for HCI design and evaluation techniques [63, 104, 48, 176, 94, 126, 302, 8], and as a critical framework for understanding technological change in the workplace [190, 30, 31, 150, 144]. Thus understanding how those methods were being approached and reframed by stakeholders interested in leveling the playing field between management and workers, and how effective those approaches eventually turned out to be, has the potential to

give new insight into how such methods could be effectively deployed today.

Such history can be particularly important in bringing worker perspectives more centrally into the design of data-driven systems. The techniques of scientific management are today typically understood as being management-centered [105, 180, 293, 44, 240, 239]. Yet prior historical research shows that groups who centered the workers perspective also participated in and shaped the trajectory for scientific management [237, 242]. By the 1930s, what had started as a full-scale rejection of time study by worker advocates had given way to an uneasy co-operation. Many employee groups, guilds, and labor unions had adopted a stance of "qualified acceptance" toward industrial engineering and scientific management techniques [214, 237, 14].

As argued by many labor experts and engineers at the time, despite its objective appearance, scientific management was imperfect, subjective, and needed to have participation from both management and worker stakeholders to actually achieve Taylor's ideal of a "fair day's pay for a fair day's work" [93, 274, 28, 308, 57, 100, 130]. As worker advocacy coalitions began to negotiate the terms of their participation in industrial engineering to meet the needs of its members, they faced challenges with responsible data stewardship, management-appropriation of their work, and understanding the role of technical expertise in sustaining long-term advocacy coalitions. My argument is that understanding how worker advocates used these techniques in the past and the issues they faced in doing so, can help us identify the limits of and alternatives to current practices in the design of data tools to support worker advocacy. In sum, my goal is to draw on historical insights in order to (1) identify lessons for the design of workplace data tools by assessing the consequences of design de-

cisions from the past and (2) find opportunities to rework current methods for designing workplace data tools by reconstructing how scientific management techniques were used to center worker perspectives in the past.

This research is guided by three specific research questions: (1) how and under what conditions has workplace data been used to advocate for workers in the past?; (2) how do the decisions and challenges of using data to represent worker perspectives map onto analogous methodological challenges that impact the design of workplace measurement tools today?; and (3) how can these design techniques and insights from the past be used in present day workplace to sustain collaborative advocacy in the future?

To answer these questions, I begin analysis at start of the turn of the 20th century, to understand the development of data-driven work practices *i.e.* the history of Taylorism and scientific management leading up to their adoption within the labor movement. Then I survey the impact of labor's use of data-driven methods both concretely within the ILGWU, and outside of it, on the labor movement and on the fields of management and engineering. Since my goal is to understand how these practices could translate into the present, the second half of the dissertation unpacks how data-driven work practices–and the conditions of worker advocacy–both break from and have continuity with the past. From this, I then describe tactics and sensibilities for approaching data-driven worker advocacy moving forward. The summary of chapters is as follows:

Chapter 2 describes the research objectives, case study and methods used. Chapter 3 explores the context that supported the creation and functioning of the Management Engineering department at the ILGWU. More generally, this

chapter describes the historical conditions that supported organized labor's relationship to Scientific Management in the mid-20th century. This is divided into 3 histories: 1) history of Taylorism such that labor had a place at the table to weigh in on scientific management; 2) the history of the professional engineer, its commitments to management (vs. labor) and efforts to contest this commitment; and 3) the history of American industrial labor relations - what made it possible for labor to contest work conditions rates within the industrial labor relations framework. I show how the development of Scientific Management as a sociotechnical practice responded to the pressures of engineering, management, and labor. This framing emphasizes the role of organized labor–and engineers working under the bannner of labor–in shaping how Taylorism unfolded. Drawing on arguments from David Noble and Edward Layton, I position the professional engineer of the early 20th century as simultaneously complicit in furthering managerial prerogatives and–at the same time, positioned to contest management and advocate for ethical reforms of the profession from within [201, 241]. Finally in this chapter, I assess the intersections of technical practices, worker advocacy, and industrial labor relations policy to argue that the use of data-driven tactics was, initially, made practically possible through specific policies that allowed organized labor to formally contend the conditions of work under wartime production.

In the next chapter, I analyze the data artifacts and academic writings of the Management Engineering department of the International Ladies Garment Workers Union from its beginning in 1941 through the early 80s. I start by describing the specific projects that the department took on, and describe how the department took action within the the union and within the labor movement as a whole. I examine how–and what kinds–of data the department used,

and explore how data rhetoric worked within a mutual-gains model of workplace participation in the mid-20th centry. Moving forward in time, I follow the professional activities of the department's first director, William Gomberg. There I show how Gomberg influenced the fields of engineering and management studies. I demonstrate how his own views about data-driven advocacy tactics were shaped by his experience in the department and afterward. From the projects of the Management Engineering department, I develop the concept of "data rhetoric" in worker advocacy contexts. Next, I survey how the practices of the department changed from the 40s through the 70s, and compare the works of Gomberg with the works and writings of the department's second director, Mitchell Lokiec. My analysis of the department over time focuses on how the department identified and responded to the changing nature of data-driven advocacy within the labor movement. In the conclusion of this chapter, I assess the long-term impact of data-driven advocacy tactics and identify the double-binds and challenges that organized labor navigated while using worker data to accomplish advocacy goals.

In chapter five, I analyze the trajectory of workplace technology design methods since the development of Scientific Management. I trace how methods from Scientific Management and Industrial Engineering were taken up in Computer Supported Collaborative work in order to show how mid-20th century labor responses to scientific management can inform directions in contemporary digital labor advocacy. First, I 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. In order to draw connections between the contemporary data-driven workplace and the history of Scientific

Management and Industrial Engineering in the beginning of the 20th century, I draw on Harry Braverman's theory of automation, which connects the technical and managerial practices of automating work to the deskilling of work and the degradation of labor power [54]. Braverman helps us understand what is the same, from the earliest stages to industrial automation to the present age of the surveillance capitalism (etc.) and what is a unique effect of computerization and the changing approaches to management.

In chapter six, I 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. I discus how this history shapes our understanding of worker participation and the implications of using worker data for contemporary advocacy goals. I conclude the dissertation by examining what it means to "participate" in setting the terms of work, given that any participation constitutes a risk–that labor's use of management's tools is always limited by the underlying power differential in labor's relationship to management.

This dissertation addresses the necessary conditions for democracy in the modern workplace. What are the tools, tactics, and expertise that are needed for workers and management to negotiate fair work? Underlying this question is a strong assumption that work – modern work, work under capitalism, in the age of smart surveillance machines [333] – can, or could be (more) fair, even when so much of modern business practice depends on the effective exploitation of the worker. The belief that fair work is possible connects this project to a longer history of worker struggle. Here, we look at what happens when workers contest management decision-making using tactics appropriated from

management. Our goal is to understand how such approaches have worked in the past, to show what has and has not been effective, and under what conditions it was effective, and how those things translate to the present.

CHAPTER 2

RESEARCH METHODS

2.1 Introduction

This thesis uses historical and design research methods to understand the impact of data on the workplace. As discussed in the introduction, these methods allow us to use our understanding of the past to help navigate the challenges of studying workplace data systems and data-driven advocacy tactics in the present. The dissertation is based on evidence acquired through a combination of archival methods, analysis of primary and secondary sources (academic and professional texts), and design research techniques. I have surveyed texts on Industrial Engineering and Scientific Management in the first half of the 20th century, conducted archival research at the Kheel Center for Labor-Management Documentation and Archives at Cornell University and the University of Pennsylvania Archives and Records. I digitized and visualized worker data from the Management-Engineering department of the International Ladies Garment Workers Union (ILGWU) using contemporary task analysis techniques, and I have surveyed workplace data representation techniques in Computer Supported Collaborative work (CSCW) from the 1980s to present. Finally, I use speculative scenarios to map insights about worker-centered data tactics to contemporary advocacy contexts. This chapter provides an overview of the research objectives, further explains the research methods used, and motivates and describes the chosen case study.

2.2 Research objectives

My research approach is guided by three specific research questions: (1) How has workplace data been used to advocate for workers in the past? What was effective and what kinds of double-binds emerged as a result? (2) How do the decisions and challenges of using data to represent worker perspectives map onto analogous methodological challenges that impact the design of workplace measurement analytics today? (3) How can these design techniques and insights from the past be used in present day workplace analytics and to sustain collaborative advocacy in the future?

In order to answer these orienting research questions, I conduct two mutually informing strands of research. An *empirical* strand involves close analysis of projects conducted by the management-engineering department of the ILGWU and archival analysis to identify long-term impacts of management-engineering decisions. The *design* strand of my research uses data-driven visualization methods to reconstruct and disseminate historic user-study data, evaluation methods, and advocacy tactics; analyzing methods used in the design and evaluation of for workplace data systems to identify disciplinary trajectories and persistent challenges; and using research through design techniques to connect insights from the past to contemporary problems. Below, I describe each method in detail.

2.3 Research Methods

In this project, I use historical analysis to better understand the causes and consequences of past sociotechnological changes and thereby inform future design. This approach combines historical methods with techniques from design research, design speculation, digital humanities, and science, media, and technology studies.

2.3.1 Archival Methods

In HCI and CSCW, histories have been deployed in several ways. First, internal histories of the field are used to reflect on where we came from and could go [37, 146, 147, 183, 298]. History of technology has been used as an immediate resource for design, as when Wyche *et al* [327] and Blythe et al [51] elicited personal histories of domestic technologies as inspiration for new products. In this thesis, I build on HCI work using histories of technology to rethink how the field approaches contemporary objects of study. This has been used to defamiliarize contemporary trends in domestic product design [41] and to problematize contemporary crowdwork through historical scholarship on piecework [17].

I apply the method of *documentary history* to understand the long-term impacts of past data design decisions. Using this method, one constructs empirical arguments based in texts and archival materials whose content other scholars can verify. For this reason, the methods used by this project rely on close engagement with several archives for primary sources (data and texts by direct observers) and large-scale literature surveys for secondary sources (texts by his-

torians or other analysts based on primary documents). In documentary history, historical arguments are built on this raw material by developing a new, empirically defensible interpretation of this evidence.

My historical analysis draws on a combination of primary and secondary sources. The majority of my archival research was conducted at the Kheel Center for Labor-Management Documentation and Archives at Cornell University. There I began with the Management-Engineering department files, and used the finding guide to look for engineering materials in other collections from the ILGWU (including other departments and archives from different regional offices). I also worked with the William Gomberg papers, which are located at the University of Pennsylvania Archives and Records. In addition to these two collections, I followed references and out-links to other files at the Kheel center, with a focus on union manuals and other non-circulating publications that focused on industrial engineering.

At several points in this project, I have come up against what is *not* in the archive. Archives preserve an institutional record, which excludes (sometimes deliberately) the perspectives of all actors in the case study [328]. Specifically in the cases of official union and university records, it has been more difficult to construct empirical arguments about the impact of different engineering techniques on people who are not recognized as experts in these contexts. To address this methodological challenge, I have highlighted where I believe there are gaps in the record, whose perspectives are missing, and draw on secondary sources to make arguments for how these gaps and omissions in the archival record can also inform our understanding of history.

2.3.2 Design Methods Analysis

In addition to the archival research, this project is informed by an analysis of workplace design methods over time. This type of design methods analysis happens in two places in the dissertation: the early development of Scientific Management methods, and the eventual migration and adaptation of scientific management techniques in the white-collar workplace.

In chapter 2, I survey early texts in Scientific Management to assess what is consistent about its application in the workplace, versus the features of the method that were different depending on the proponent of the methods. In order to select texts for this methods analysis, I looked for references to industrial engineering texts in the archival sources, as well as in relevant secondary literature, both contemporary and retrospectively.

In chapter five, I use a design methods analysis to show that present-day workplace design methods are grounded directly in industrial engineering techniques like those used in my case study. I show how the methods were initially transformed when they entered into Computer Supported Collaborative Work (CSCW) contexts due to limits in work measurement for cognitive, complex, and collaborative tasks. Drawing on these methods texts, I show how these early adaptations made room for technology designers and analysts to exercise discretion. Finally, I survey contemporary design methods in crowdwork and other platform mediated work to show how the initial limits in work measurement have been addressed by new measurement techniques. In order to do this methods analysis, I started with early, highly-cited methods papers in CSCW and connected the references from these texts to industrial engineering literature. Then I used keyword searches and citations analysis to trace the trajectory

of workplace design methods and identify relevant texts throughout the time periods being studied.

2.3.3 Data Reconstruction and Design Research

In addition to documentary history, I apply reconstructive techniques to represent historical data using present-day data visualization techniques. This method takes inspiration from replication studies [71] and replication of user-studies more specifically [322]. Its goal is not to reenact history, but to leverage modern data tools to "enliven" [98, p. 163] traces of "past reality" [270, 271] and demonstrate the relevance of historical techniques that may be occluded from contemporary technology design practices. In addition to reconstructing artifacts from the past, this approach also applies design research [331, 292, 198] and research through design [121, 332, 52, 330] techniques to explore how historical insights could be translated into contemporary matters of concern. Using design research techniques to represent archival data offers ways to imagine new processes of technology making [264].

2.4 Case study

The proposed work posits that historical precedent will help us to address the challenges of evaluating the potential impact of design choices in workplace data systems and of using data methods to better balance management and worker perspectives on data. To do so requires a historical case which (1) involves similar pressures and opportunities as the present moment, (2) involves

data-intensive methods for work, (3) involves historical actors who were navigating issues around data symmetry; (4) is far enough in the past to let us evaluate long-term consequences, and (5) for which, unlike present-day proprietary systems, there is extensive available historical and quantitative data. In the next section, I will describe the case study around which the thesis is organized, explain why this case is particularly illuminating for the contemporary design of data-driven workplaces in HCI, and how the historical methods we are using fit within HCI design strategies and precedent.

Created in 1941, the Management Engineering Department of the International Ladies Garment Workers Union (ILGWU) was charged with improving manufacturing techniques and operating methods, as well as providing information on "fair rate pieces," monitoring manufacturing techniques, and providing trainings to workers on efficient operations [6]. Techniques and methods improvements were made by first observing the womens' garments manufacturing operations, and then recommending process efficiencies [132]. The department evaluated and conducted time studies, conducted surveys of industry practices, and used both to negotiate piece rates [318, 323, 33, 275, 296] and develop worker training [102, 290, 168, 167].

The record of the management-engineering department contains rich and unique data about the conditions and strategies, at a time when manufacturer business records were difficult to maintain due to industry volatility. Data from this department was used for surveys of the garment industry [96, 39, 36] and cutting edge academic work in industrial engineering and scientific management [211, 323, 13, 14, 210]. The forms of data archived include: time sheets, micro-motion logs and simultaneous motion charts, video footage used for mo-

tion analysis, layout and process charts, incentive rates calculations, and summaries of interviews with workers and management. Project folders also contain reports that were shared differentially with workers and employers. The archive of the management-engineering department also includes reports to the general board, correspondence within the ILGWU (*e.g.* with union locals), and correspondence with academic researchers, publishers, and professional and academic societies [164]. For the thesis, I focus on the Management-Engineering Department as the central case study for the impact of data-driven methods on worker advocacy. In the next chapter, I begin by describing the historical context that gave rise to the Management-Engineering department and what formed the precedent for the department's methods.

2.5 Note on Research Process

In the previous section, I have provided an argument for why studying the ILGWU Management-Engineering Department is useful for understanding the impacts of data and data-driven advocacy in the contemporary workplace. In this section I reflect briefly on how I personally came upon this case study in my research.

My initial goal in my research was to explore how data collection and the use of data in work evaluation shaped the experience of work in different workplaces including academic work and entrepreneurial work. To understand the role of data collection in the transformation of work, I began to study the history of Scientific Management. I ran into Gomberg's writing on the scientific merits of the time study when I was collecting books in the Catherwood Library (the

Industrial Labor Relations library) at Cornell University. I was surprised, at the time, that the IGWU had put out such an empirically grounded text questioning the objectivity of Scientific Management, and was compelled by the style of arguments that provided a parallel to similar arguments about the social construction of science.

Before arriving at this case study, I had not planned on using historical methods for my dissertation. I was in the process of securing researcher access to a site, but found it difficult to negotiate a research relationship with a contemporary workplace data system without being constrained about what I would be able to write about. I am very lucky to have pulled at this particular research thread at this particular institution, as Cornell's circulating collections are impressively mirrored by its unique labor and industrial relations archive. Following the trail of William Gomberg, I found the Management-Engineering Department and its out-links to other collections in the archive. As I moved from ethnographic methods to a historical dissertation project, I developed on-the-job expertise in conducting archival research and contextualizing archival insights within broader historical understanding.

My other research goal was to understand the impact of workplace data systems by working with the data directly. This idea came on the heels of my prior research on critical design and personal informatics, where I had argued that working with the data allowed the analyst to arrive at unique experiential insights by enlivening a computational system. The data archive of the ILGWU Management-Engineering department therefore appealed to me because it presented an opportunity to work closely with detailed workplace data without violating proprietary algorithms or engaging in inappropriate or dangerous lev-

els of worker surveillance. I open chapter four of the thesis with a vignette that illustrates both the granularity of the data from the Management-Engineering department's projects and the perspective that working with the data affords – one that knows exactly what each hand of the garment worker is doing and how long it takes.

CHAPTER 3

HISTORICAL CONTEXT AND BACKGROUND

3.1 Introduction

For technology designers in Human Computer Interaction (HCI) and Computer Supported Collaborative Work (CSCW) the earlier fields of Taylorism, Scientific Management, and Industrial Engineering are sometimes acknowledged as early predecessors to contemporary workplace technology design methods in Human Factors engineering [145, 94, 149]. As we look to this intellectual legacy, it has also been assert that these work measurement and rationalization methods have been largely superseded by other techniques that center the contextual experiences of technology use [145]. Though HCI and CSCW may claim to be the present-day inheriters of Taylorism, however reformed, it has been argued elsewhere that Taylorism is not is a method for technology design method at all [54, p.59]. Drawing on Peter Drucker, Harry Braverman has argued that Taylorism is not a technology design method but rather a method of managing labor ("belongs to the chain of development of management methods and the organization of labor, and not to the development of technology, in which its role was minor"). Braverman argues that Taylor largely took the design of technology and the techniques of work as given and instead optimized the management of workers.

Within the study of management practices, a similar narrative exists about Taylorism as it does in the fields of HCI and CSCW: internal narratives of management science position Taylorism as an influential technique in the first half of the 20th century that has since given way to more advanced and humanistic

management techniques, with more emphasis on "the human element", and human relations more generally, as well as worker cooperation and participation in the work design and evaluation process. In this history, Taylorism is seen as a needlessly harsh and ultimately limited approach to management that is unsuitable for the modern workplace. Undergirding both narratives in technology design and management is the same premise: Taylor's methods and Scientific Management were once operationalized, have since become outmoded, and ultimately replaced with more humanistic techniques.

It is not surprising that this parallel narrative occurs in both fields in part because technology design very much reflects and is embedded with management philosophies [115]. It is clear that the disciplines intersect, but it is harder to asses the degree to which Taylorism and Scientific Management have actually been outmoded. This, I argue, is because the practice of Scientific Management is not self-consistent, and its early practitioners approached their methods with varied intentions. This chapter dissects the early history of the Scientific Management movement in order to reveal some of the same "humanistic" tendencies which have later been claimed as innovations to Scientific Management from the fields of technology design and management. In this framing, the concern for the "human element" in Scientific Management can be traced back to the early 20th century, as a fraught response to push-back from labor. This early transformation of Scientific Management was not only supported but also actively initiated by "reformers" – engineers who worked from within the Scientific Management movement to reform it from within.

3.2 History of Taylorism

In this section I explain how techniques of Scientific Management were first combined into Taylorism. I describe the variation in approaches to managerial cooperation and control that existed within the movement from the beginning. Then I describe how the Taylor Society experienced a shift toward worker cooperation, and how this shift impacted the practice of scientific management. The higher-level argument I make is that Taylorism has always been malleable in some (mostly superficial) ways that can be interpreted as humanistic and leveraged for creative appropriation by labor, while retaining the core principles of knowledge transfer, centralized control, and labor degradation.

Several histories of Scientific Management trace its origins to the post-Civil War era. [237, p.1] [1] The techniques arose to address the problem of accounting for increasingly complex, industrial production that was no longer easily understood by the people who owned and managed industrial operations. The engineer was tasked with implementing these techniques and reporting the results to the employer. The entry of industrial engineers into the study of work was necessary for separating the "optimization" of work from the people who actually performed that work from day to day [2].

One of the early influential arguments in favor of professional engineers entering into the realm of management appears in 1886, in a paper titled "The Engineer as an Economist" originally presented to the American Society of Me-

[1] There is also a growing body of scholarship emerging from the New History of Capitalism that associates the practices of Scientific Management with what was previously considered to be pre-capitalist accounting practices to monitor the labor of the enslaved in the United States and the Caribbean [263, 259].

[2] The stopwatch, one of the more visible elements of Taylorism, had been in use in the workplace by the workers themselves, who had timed their own operations to arrive at the most optimal methods long before the entry of Scientific Management into the workplace

chanical Engineers (A.S.M.E). In this paper the author, Henry Towne, calls for the systematization of "workshop management" practices, with an explicit emphasis on economic efficiency:

> The primary object to which all of these contribute is the systematic recording of the operations of the different departments of the works, and the computation therefrom of such statistical information as is essential to the efficient management of the business, and especially to increased economy of production. [306].

Towne, then president of the Yale and Towne Manufacturing Company, was emphasizing to the engineering audience present the "economic" value of their work [245, p 428]. In 1889, Towne proposed his own method of workshop management, which he called "gains-sharing". Under gains-sharing, the savings in the cost of product, labor, and supplies was to be shared between the workers, operators, and the company. In order for an employer to implement gains-sharing, a technically trained overseer had to account for the costs of production. This in turn placed the techniques of production, as well as the techniques of wage payment, into the domain of the engineer.

What followed Towne's proposal in the 1886 ASME proceedings was a series of wage payment plans, one of which was Fredrick Winslow Taylor's. The different wage payment plans developed at the same time as Taylor's original techniques capture different attitudes to labor-management cooperation and worker control. The two fundamental methods components to wage payment are "day pay" and "piece rate" [125, p. 125]. Day pay refers to payment for hours worked (regardless of output) and piece rate refers to getting paid for the amount of work done (regardless of time it takes to do it). Both methods are

effective for extracting surplus value from the worker ; from the perspective of management, however, neither approach on its own was seen as sufficient for industrial work [221]. The problem with day pay was that it failed to encourage workers to increase their production. On the other hand, piece-rate was difficult because, as the worker becomes financially motivated to produce at a faster rate, the employer becomes tempted to cut rates (a practice referred to as "rate-cutting"), which in turn motivates workers to restrict their production. "Advanced" wage incentive plans (e.g. the premium plan,bonus system, efficiency system and differential piece rate, which I discuss below) attempted to combine elements of day pay and piece rate to achieve more desirable outcomes for management.

Frederick A. Halsey's wage incentive plan, called the Halsey premium plan, was designed as an improvement on the straight piece-rate system that reduces wage rate cutting by management. Halsey's premium plan works by paying workers a day rate for completing the anticipated amount of work (which was calculated from "previous experience" [237, p. 3]) and then rewarding workers with an extra payment, a premium, typically calculated as one third of the hourly rate. Under this plan, the employee receives one third of the gains accrued per hour saved, but the total labor costs are still lowered because the plan encourages absolute increase in output for a fractional increase in wages (i.e. a worker's total pages rise but the cost per piece declines).

Like Halsey's premium plan, Taylor's differential piece rates plan relies on prior analysis of the elements of a given job to determine how long it ought to take [125, p. 134] and then applies two different piece rates based on whether the worker meets the standard time. If a worker completes the given assign-

ment in the time allotted, they are paid the higher piece-rate, and if they do not, they are paid the lower piece-rate ("scarcely a day's pay"[237, p 4]) forcing the worker to either increase their production or to quit. What is important to note about Taylor's wage payment plan is that it included features that went beyond payment. First, the plan explicitly stipulated the creation of a department that conducted research (i.e. time studies) to determine how long work operations ought to take. In addition to determining the rates, Taylor's "elementary rate-fixing department" [237, p. 4] was charged with determining the best way to do the work instead of relying on the worker for "originating betterments in practice":

> Under the Taylor system, it was not intended to leave within the workman's power much more than this co-operation. That is, it is not intended to rely upon the workman to originate betterments in practice, at least until he has accepted all the betterments contemplated by the investigators and instructors. This is a sharp distinction from the Halsey system... [which] relies almost entirely on the workman's knowledge of his job... Taylor, by a minute time study and a carefully elaborated scheme of operations, manipulations, and methods, purposes to supersede the workman's knowledge—to cancel, as it were, the workman's personal equation. In principle, there is no objection to the workman turning out as large an access over the standard output as he can. In practice it is not intended to leave him any large margin of capacity for doing better than the standard [125, p. 135]

Within Taylor's prerogative, worker co-operation is narrowly limited to co-

operating with the instructions of the rate-setting (later termed "planning") department. However, adhering to this scientific determination of rates would, as Taylor argued, eliminate the temptation for employers to succumb to rate-cutting (lowering piece rates in response to increased production) and the higher wages alone would ensure worker cooperation.

Next, Henry L. Gantt, one of Taylor's closest assistants, developed a wage system that accepted many–but not all–of the features of Scientific Management as it was imagined by Taylor. Gantt's system, like Taylor's, calls for conducting research on work methods to arrive at standard rates. Unlike Taylor however, the plan begins with day-rate, which the worker receives regardless of how much he works. Then, if a task is done within the standard rate, then the worker is paid extra compensation. The philosophical difference [211], as outlined by Robert Hoxie [160, pp. 12-13], is that Gantt puts less faith in the "democracy" of scientific management, or the methods' abilities to discover scientific laws undergirding the actions of management and workers.

Like Gantt, Harrington Emerson was another one of Taylor's associates who designed his efficiency system with a lack of commitment to "fundamental principles" (e.g. that scientific management techniques can be used to discern the natural laws of industrial production, or that the implication of those techniques necessarily created the conditions of workplace democracy). Like Halsey and Gantt, Emerson's system begins with a daily-wage. Like Gantt, it offers a large bonus for meeting the standard of production (calculated through prior research) and, like Halsey, it reaches up to that bonus in an incremental way (but these increments are nonlinear). By putting the minimum day rate, and calibrating the system of rewards for exceeding the standard, Emerson and Gantt (and

arguably Halsey) give workers an insurance in case it is not feasible to meet the ideal, as calculated by the techniques of scientific management. In conversation with Robert Hoxie, Emerson "takes it for granted that 'the ideal is never attained"' [160].

One difference between Halsey's plan and the subsequent plans proposed by Taylor, Gantt, and Emerson is the in application of scientific management techniques. Halsey's plan stipulated that the rates would be established based on "prior research" but scientific management went beyond that to include procedure and personnel for the detailed analysis and planning of work. For Taylor, duties of scientific management entailed first breaking the work down into elements, which were then optimized (replacing previous methods for doing the work) and timed; second, training men to do work in the redesigned way; third, making sure that workers comply with the redesigned methods; and fourth, that management engineers take on the tasks of planning work. The overall goal is to replace the judgement of individual workers with the "establishment of rules, laws, and formulae" which are systematically recorded and indexed in the "planning room" [300, pp 37-3]. Putting these things together -— combining the wage incentives with the research, done by external engineers, with the goal of lowering workers' discretion in doing the job—is what made the "system" of scientific management.

Though these wage plans differ in the degree to which they believe in the possibility of a "scientifically determined" wage, each plan is still practically implementable. More concretely, Gantt and Emerson implemented their alternatives to Taylorism because while they agreed with Taylor's approach for addressing the "physical problems" of work management, they disagreed that the

system of scientific management "provides justice to the worker according to natural laws and scientific facts" [211].

The mounting critiques of the scientific nature of Taylorism culminated in his famous appearance before the 1911 Congress. Here Taylor was questioned on whether it was scientifically possible to calculate a fair day's work using a stopwatch over a brief period of time because the method failed to consider fatigue and mental operators. Following the congressional hearing, professor Robert Robert F. Hoxie was tasked with conducting a survey of scientific management, interviewing stakeholders from within the scientific management movement and the labor movement, tabulating lists of claims and objections from both sides. Members of the labor movement felt that scientific management was threatening collective bargaining. They were right to think so, since at the time many proponents of scientific management, including Taylor, felt that the scientific method would replace the need for employers and unions to negotiate the terms of work.

After they conducted their interviews, Hoxie and his selected committee of examiners (with members representing both the scientific management and labor movements) surveyed plants where scientific management techniques were in use. Unsurprisingly, they did not find much consistency in the way that the techniques were applied on the ground. In the report published in 1915, Hoxie concludes that the time study, far from being objective, requires a lot of judgement and is "subject to all the possibilities of diversity, inaccuracy, and injunctive that arise from human ignorance and prejudice" [160]. More concretely, the areas of possible subjectivity, as identified by Hoxie, lay in the realms of:

1. The degree to which the job to be timed has been standardized in advance

2. The mode of selection of the workers to be timed and their speed and skill relative to other members of the group
3. The conditions under which the study is made and the judgment used in reducing these matters to ”normal”
4. The judgment of the time study man with respect to ”abnormally” high or low readings
5. The statistical measure used to summarize the readings
6. The method of estimating human and machine allowances.

Hoxie’s report has been multiply cited for its condemnation of scientific management on scientific grounds, however, his perspective on the techniques’ ultimate effects on labor was starkly negative for reasons separate from their supposedly scientific nature. Hoxie concludes that scientific management has a deleterious effect on labor solidarity because the techniques support the break-down of craft knowledge and classification:

> “Time and motion study, the chief cornerstone of all systems of scientific management, tends inherently to the narrowing of the job or task itself.... this inherent tendency to specialize is buttressed, broadened in its scope, and perpetuated by the progressive gathering up and systematizing, in the hands of the employers, of all the traditional craft knowledge in the possession of the workers.[161, pp 321-322]”

Hoxie was concerned that because Scientific Management supports the “gathering up” and systematization of craft knowledge, and, in taking away

craft knowledge and parceling it out when required, employers could individualize workers and reclassify them as needed. This, in turn, affected workers' ability to organize (and maintain organizing relationships) and also had the potential to make collective bargaining difficult (due to endless permutations of worker classifications) [160, pp 129-131] [237, pp 92-92]. Though Taylor himself was particularly adamant that Scientific Management was scientific, the variations by Gantt and Emerson illustrate that it was perfectly possible to transform the workplace and deal identical blows to worker knowledge without believing that the techniques delivered any sort of "exact justice" to the worker according to natural laws and scientific facts.

Several events occurred in 1915 that shaped the trajectory of the Scientific Management movement: Fredrick Winslow Taylor died, opening up the possibility for new ideas in the Scientific Management movement; further hearings before Congress lead to legislation banning the use of stopwatches in government sponsored projects; and Robert Valentine presented a paper titled "The Progressive Relation Between Efficiency and Consent" to the Taylor Society, signaling a new potential direction for the society's relationship to organized labor.

Valentine's position draws on his own experience working with industrial labor unions, notably, the International Ladies Garment Workers Union (ILGWU). Following a strike in the New York garment industry, the "Protocols of Peace" – later amended – included a provision to examine existing standards and operating practices. This new direction, centered on the vital word "consent" would be built around the acceptance of worker participation, especially union participation, in management decision-making around the conditions of work [237, p 98].

In contrast to Taylor, who believed that democracy would automatically be achieved in the workplace as soon as the "natural laws" were discovered, Valentine believed that workplace democracy required the "active and willing participation of the workers in the determination of the conditions of work" [237, p 98]. And that it was only under these conditions that the methods of scientific management could be most effectively realized. This paper suggested that organized labor could play an important role in increasing industrial efficiency through the use of scientific management techniques. Though Valentine's actual effect on the society at the time was limited (due to both a breakdown in the protocols of peace and his own untimely demise) – his paper and his work with the ILGWU made it clear that scientific management was not incompatible with labor (as Taylor had previously suggested), that its methods were malleable enough to enlist labor's participation without threatening the most important component, the "gathering up and systematization of craft knowledge" (and in fact that the cooperation of labor was needed to achieve this more fully).

3.3 The Professional Engineer

Fredrick Taylor dies in 1915 and his death throws the Tayorist society and the Scientific Management movement into a state of flux. In his life, Taylor argued that in order for Scientific Management to thrive, a "mental revolution" was needed on the sides of both workers and management. In this section, I address a (third) mental revolution that occurred not among workers or employers, but rather on the part of professional engineers within the Taylorist society. After Taylor's death, the society leadership first adhered closely to Taylor's beliefs about the time study. This meant that the dominant value within the society

was that the engineer was the arbiter and discoverer of "natural laws" about the universe, leaving no place for negotiation with workers (neither groups of workers nor organized labor unions) about what constituted a fair day's work and how it ought to be compensated. For Taylor, adherence to this perspective was essential, as without it, he argued that scientific management was just another kind of management technique [201, pp 139-141]. But underneath this layer of ideological cohesion, there was a struggle within the profession about the true role of the engineer in the workplace.

Within Taylor's framework, the engineer was, in theory, a neutral party between workers and management. In practice, however, the engineer was almost exclusively employed by management in order to improve efficiency (i.e. save money). As a result, the engineer's decision-making tended to be partial to the employer. This is consistent with what Towne had previously described:

> The monogram of our national initials, which is the symbol for our monetary unit, the dollar, is almost as frequently conjoined to the figures of an engineer's calculations as are the symbols indicating feet, minutes, pounds, or gallons. The final issue of his work, in probably a majority of cases, resolves itself into a question of dollars and cents, of relative or absolute values. This statement, while true in regard to the work of all engineers, applies particularly to that of the mechanical engineer... There are many good mechanical engineers; — there are also many good "business men;"— but the two are rarely combined in one person. But this combination of qualities, together with at least some skill as an accountant, either in one person or more, is essential to the successful management of industrial works, and has

> its highest effectiveness if united in one person, who is thus qualified to supervise, either personally or through assistants, the operations of all departments of a business, and to subordinate each to the harmonious development of the whole. [306]

So the conflict these group of professionals faced was that on one hand, they were the diviners of natural laws, and on the other, they were the right-hand man of management (and so partial to making decisions that furthered management prerogatives and improved financial efficiency). The trouble was that the engineers needed to appeal and lay claims to scientific truth-telling to have traditional management functions ceded to them, but in order to maintain control over those functions, they also needed to appeal to the financial bottom line.

In the early 20th century, economist and sociologist Thorstein Veblen theorized that the tension between natural laws and the accounting ledger ought to throw the engineer into the forefront of social change [201, 313, p 1]. His hope was for the engineers to embrace their social responsibility role and become involved in government decision making. To a degree, this did occur with early practitioners of Scientific Management participating in wartime planning during WWI, and through a short-lived "technocracy" movement in the 1930s that aspired to solve the great depression through autocratic government by engineers. (Arguably the driving principle behind the organization of the engineering profession, however, was less the struggle for social justice than the drive for autonomy, ultimately achieved through technical esotericism[201, p 4].)

The designing of the professional engineer was a complex phenomenon of the early 20th century. Universities and corporations alike moved to create the engineering pedagogy. Corporate leaders hoped that the correct educational

system would ensure that engineers would enter into the workplace thoroughly inoculated with "corporate imperatives" [241, p 189] [3].

In the late 1800s, the technically trained engineers could reasonably expect to eventually command their own industrial operations. As more engineers (including graduates of corporate and state-run engineering schools) proliferated, drawing from lower levels of social stratification (in contrast to the older generations of engineers, who tended to come from upper-class backgrounds), the engineering position was no longer automatically "[standing] next to the Proprietor in the chain of command" [334, p 6]. This put engineers in a kind of tension with management, as they reported to and were dependent on their employers materially, but were under new pressure to justify and secure themselves professionally. As engineers struggled to maintain dominance in industrial and scientific contexts, part of the willingness to work with unions came from an identification of a potential common enemy, the inefficiencies of traditional management approaches.

3.3.1 The Mental Revolution

Since Taylor's commitment to the scientific determination of the natural laws dictating efficient work uniquely elevated the practice of the engineer in setting rates, Taylor's methods had immediate purchase within the engineering profession because they positioned the engineer as uniquely competent to implement them. However, when Taylor began to take on leadership roles within the

[3] In *America By Design*, David Noble describes how the development of corporate engineering schools was driven by a desire to train people with technical expertise outside of the trade schools and trades unions, which were imagined to be breeding grounds for socialism and undue sympathy for the workers [241, 180-182]

ASME – and especially when he attempted to apply efficiency principles to the society's internal practices [201, pp 154-155], tensions quickly emerged between the Taylor and the older, established "oligarchy" of engineering professionals (these older members felt that Taylor was threatening their status quo methods for professional practices). As Taylor's associates took on projects in government works, railroads, and public utilities, they continually came against the backdrop of status quo practices within engineering to represent progressive and reformist causes. Counter-intuitively, at the time, the Taylorists comprised a younger generation of "reformers" within the engineering profession, who attempted to break from the prior commercial and business orientation in the field to bring the professional engineer to bear on issues of inefficiency, corruption, and human relations.

A major figure in the Taylorist embrace of progressive reform was Morris Cooke. Cooke was one of Taylor's closest associates; he was originally hired by Taylor to help with the reorganization of ASME publication and operation costs—of ASME in 1903 [237, p 16]. He had taken on several projects with the city of Philadelphia to reduce operating costs in their public utilities] [237, p 69]. Cooke identified corruption and racketeering practices in his work with the public utilities and wrote of the tension, for the engineer, between public interest and business interest [201, p 159]. By drawing attention to the inefficiencies resulting from corruption in public utilities, Cooke tied the concerns of Scientific Management with the national progressive movement. Cooke's own reformist alignments started even before that when he worked for the Ordnance department during the first world war [237, p 105]. In this work, Cooke and other Taylorists found themselves working in government services where collective bargaining rights were protected. There, he began to articulate his stance on

collective bargaining and improved relations between workers and employers as not a threat but instead an asset to efficient production.

By 1920, Cooke had risen in leadership within scientific management and courted the collaboration of labor leader Samuel Gompers. Cooke attended labor conferences and published in the *American Federationist*, Gompers jointly edited an issue of the Annals of the American Academy of Political and Social Science, which has been cited by many labor scholars as a pivotal moment in the establishment of (peak) cooperative relations between labor and management in the 1920s [237, 289, 174, 242, 243]. Cooke invoked the influence of Robert Valentine and this work with the unions as an early force pushing Taylorists towards cooperation with labor[237, p 116].

The spirit of reform within the engineering profession also came with a renewed concern for the human element of labor. This, too, was not entirely new to the society. Henry Gantt, who had found Taylor's differential piece rate system to be too harsh on the worker, sought to both humanize management and give science priority over profit [310, 241]. But, after the first World War, after the experience of working with labor leaders and under the influence of ideas from Thorstein Veblen about the role of the engineer in maintaining a healthy society, Gantt and several other Taylorists came together to form a group called The New Machine, which aimed to expose the incompetence of dominant practices in business management and change the managerial prerogative from profit to service to society. Some engineers, for example Robert Wolf, called to "abolish the more visible pieces of [scientific management], piecework, bonuses rates to promote cooperation" [237, p 129][4].

[4]Wolf's stance is potentially exaggerated, see [237] but it again demonstrates that the visible pieces are not necessary in order for the scientific management techniques to happen.

Outside of the New Machine, members of the Taylor Society began proposing a degree of engagement with the labor unions that would have been considered highly unorthodox in Taylor's time. For example, in 1929, Godfrey Brown wrote an article for the Taylor Society arguing that "the only way that organized labor can meet management effectively is on a scientific basis" – proposing that unions ought to employ time study engineers and participate in incentive wage and standard determination [185, p 157]. This is very different from the society's prior dismissal of Valentine's paper on consent. This period of "cooperation fever" illustrated how leaders within the scientific management movement took on revisionist perspectives on Taylor's original stance on unions. A report on Industrial Waste from a "Committee on Industrial Waste" published by Taylorites including Sanford Thompson and Cooke concludes: "...over 50% of the responsibility for these wastes can be placed at the door of management and less than 25% at the door of labor, while the amount chargeable to outside contacts is least of all" [237, p 120]. This report was "hailed with delight" by leaders of organized labor, who saw their own role in shaping the attitudes of the Taylorists and hoped that efforts to eliminate waste and develop efficient workplace methods would result in higher wages [5].

The "mental revolution" on the part of these engineers was a realization that their professional fate could be hitched to organized labor in identifying the failures of traditional management approaches. This can be seen through a series of co-operative experiments in joint rate-setting between management and engineers in the first part of the 20th century. The common goal of the experiments was "harmonization of union and Taylorist leadership" [237, p 126].

[5]This report was also cited positively within the engineering community, for example when it was reviewed by Dwight T. Farnham for the Journal of the American Ceramic Society, the report was hailed as "a wonderful piece of work.... you want to go home and take some black coffee and put some ice on your head and get down to business"[112].

In the next section, I briefly survey two experiments: in the garment and textile industries industry, in the Cleveland Women's Garment Industry and the Naumkaeg Steam Cotton Company – to understand what kinds of problems and precedents these experiences posed for future union engagement in scientific management techniques.

3.3.2 Early Co-operative experiments

In this section we cover cooperative programs in the garment and textile trades that evidence the good will between labor movement and scientific management in the heyday of "cooperation fever". Both of these experiments were ultimately curtailed by the economic devastation of the great depression but we can see (before their eventual demise) some of the benefits of and challenges to labor's engagement in scientific management tactics that form the precedent for later experiments. The empirical details for these experiments come from the 1941 edition of *Union Policies and Industrial Management* by Industrial Relations Scholar Sumner H. Slichter [6].

Cleveland Garment Industry

When the post-WWI boom ended in 1920, garment and textile industries came under pressure from a growing number of non-unionized garment shops, which generally paid lower wages [296, p 393]. In an effort to keep wages stable at the unionized garment shops, the Cleveland garment union found itself under pres-

[6] These cases are largely omitted from the subsequent 1961 version of the work, "The Impact of Collective Bargaining on Management" – which we discuss in Chapter 3.

sure to make concessions in the conditions of work. Chief among these concessions was the issue of piecework. The textile trades had, for many years faced efforts to substitute timework (i.e. hourly wages) for piecework (i.e. payment for units of completed work). A system for jointly (employer and union) negotiated standards for piecework rate determination was something the union had been working on since the Cleveland garment industry was first organized in 1919

There was opposition to piecework from within the union (described in the footnotes [296, p 395]) but ultimately joint standards came to be seen as a compromise, for unions to be able to intervene in and avoid the transition to piecework and for employers to avoid paying for timework. Union leaders were also conscious of the vulnerable position of the Cleveland garment industry (e.g. compared to established garment production centers like New York City) and hoped to prevent movement to non-union shops, as well as movement to outside shops (outside does not mean non-union, it means outside of the manufacturer who owns and designs the line, i.e. subcontracting). The latter was to be avoided because the unions felt that it would be harder to enforce union standards in these outside shops because there the sub-contracted workers were being paid per piece (and therefore incentivized to work faster) and because it would be harder to collect time data from the subcontracted shops.

The goal of the Cleveland cooperative experiment was to set standard times for each job on the basis of the time study and pay hourly rates on the basis of the time value of each job. To achieve this compromise between timework and piecework, the union and management established a joint Bureau of Standards [296, p 398]. This bureau first trained time-study men in needle trades and then

aimed to install standards across the Cleveland garment industry, starting in the pressing department (which was chosen as a good starting point due to the relative standardization of pressing work). Slichter notes that one of the challenges faced by these engineers, almost immediately, was that the engineers felt a conflict of partiality between the joint board and to their employer (the manufacturer) who was paying them.

Joint rates were established using an extensive system of "element times" [296, p 401] – which were measurable parts of work that were consistent (or varied according to known values) between operations, as determined by industrial engineers [296, p 343]. The standards were to be calculated based on the rate of the average worker, using the methods of the average worker pre-standards [296, pp 402-403]. Notably the workers did not all do the work the same way. The argument for the absence of a single best way for doing the work was that there was no expectation that workers could be trained to do the work in the same way, and furthermore that the best way was considered to be the intellectual property of the employee [296, p 403]

The Cleveland Garment Industry took on one of the most extensive joint-standards experiments of its time. This task was made more complicated not only by the problem of partial engineers, but also problems due to the partiality of workers, who hoped to raise the calculated time value of piece rates in order to offset time waiting for work. Even with some incorporation of "idle time" into the standards, the rates were lower than what workers had become used to. The elemental times also failed to account for rates and quality differences on expensive vs. cheap production garments. More importantly, the project of establishing standards continued to strain the relationship between workers

and management, catching the union leadership awkwardly in the middle. Implementing the elemental system created more work for management [296, p 408], and there was widespread distrust of the time-study engineer, who workers felt was barely trained on understanding garment work. Workers and employers alike found the engineers irritatingly methodological in their approach for studying all the components of the garment process. Even though the engineers reported to the joint board, workers unsurprisingly saw the engineers as "hirelings for management" [296, p 413]

According to Slichter's assessment of the Cleveland joint-rate setting experiment, there was no point in which the union, the time-study men, and the manufacturers were able to agree on an agreement on the standard data [296, p 414]. No committee was able to empirically criticize the data either, but the widespread dissatisfaction led to suspicion about the efficacy of element times. The experiment illustrated how much, especially under rapid implementation, the introduction of standards relied on the judgement of the engineers [296, p 415] and–as mentioned above, drew attention to the need for an impartial engineer. The experiment also showed how standards functioned as a strategy for union to exert control over a region's garment production.

By the 1930s, joint standards had gaven way to piece rates again [296, p 431]. What is interesting to note is that during the Depression, the joint standards did protect the workers' wages against fluctuations in the union's bargaining power. But, the standards also impaired the manufacturers' ability to navigate competition in the Depression and in that way, the standards continually threw the workers into a different kind of precarity. Slichter's survey of the implementation of the standards also sheds light on the the difficulty in maintaining

standards and the bureaucratic delays of joint-rate setting (which were sometimes "good" for the union and sometimes resulted in some broken practices like getting approval after a week of running on a certain rate because the bureau knew that no one would agree on the rates before they were implemented -ref??). Slichter's conclusion was that maybe a more truly neutral, third party rate-setting structure could be more efficient, as the calculations by partisan people seemed to contribute to bureaucratic stalemates [296, p 435]. Ultimately this early and long-term experiment illustrates the weaknesses and challenges for joint rate-setting as a sustained strategy for unions.

The Naumkaeg Company

Another extensive "experiment" – described by Milton Nadworny as "the most ambitious of all the cooperation schemes" [237, p 136] – took place in the Naumkaeg Steam Cotton Company in Salem, Massachusetts in cooperation with the United Textile Workers of America. The Naumkaeg Company manufactured "Pequot" sheets and pillowcases. Under decreased revenue conditions, the company looked to reduce costs by increasing the number of looms assigned to each operator from thirteen to twenty-four. This process is known as a "stretch-out"–a tactic that had been widely pursued in the 1920's as a way to reduce labor costs by increasing the output of each worker, or decreasing the work force, or both. Unsurprisingly, when the stretch-out plan was proposed, there was strong resistance from union membership. There was also a concern that the new plan would result in labor dilution–that experienced weavers would be demoted to "helpers" which the union sought to prevent if possible [296, p 533]

Union leadership sensed that a stretch-out was inevitable and sought guidance from Morris Cooke, who recommended hiring Francis Goodell to study the conditions at the plant and make recommendations for more efficient operating procedures. Goodell was hired by both management and the union to conduct "joint research" [237, 137]. Goodell reported to a Waste Elimination Committee with representatives from both sides [296, p 536]. Though he was paid by the company, he was – like the engineers in Cleveland – expected to be neutral and "equally responsible" to both sides. He trained two union representatives and two company representatives to assist him with the time studies, and was to submit all of his findings to the Waste Elimination Committee. The aspiration of this arrangement was to make opportunities for collective bargaining based on empirical "facts" (with the understanding that facts would be a matter of judgement but bounded by scientific determination).

As the observations went underway, the union, the employers, and the workers were all taken aback by the extent to which the engineers recommended to standardize methods. Deemed ridiculous [296, p 539], like the methods pursued by the engineers in Cleveland, the research conducted at Naumkaeg was more thorough than workers felt comfortable with, and proposed doing more than management wanted to do in terms of standard process protocols. The workers also deemed that the research was "too theoretical" about the standards (e.g. for cleaning looms). Ultimately, as it was in the Cleveland experiment, it was difficult to arrive at joint determination of new job assignments. The delays in decision-making contributed to a sense of unrest in the plant. Eventually the union agreed to a stretch-out, but not, as Schlicter notes, though "fact finding" but by negotiation. The union knew, through the joint research, that it was possible for a single operator to easily manage 20-loom

assignments and suspected that methods could be introduced making 24-loom assignments practical [296, p 542].

The benefit that the union was able to find via joint determination was access to information about what was "scientifically practical", which they used to negotiate something ahead of that reality. The point here is that the union had insight into what was practically possible, e.g. how few weavers were really necessary according to fact, and was able to negotiate something that kept more weavers employed. The eventual demise of the program was triggered too by the Great Depression. Newly demoted workers were upset and directed their frustration at joint research [296, p 545]. The union proposed abandoning joint research, which in turn discredited the experiment among the rank and file union membership, who was already unhappy about being observed and researched by the engineers. The union took a vote which determined that membership was willing to abandon joint research in favor of taking a wage cut. When research was reinstated by the employer, the workers organized an unsanctioned strike [296, pp 549-551] this leads to a strike by the workers (which was unsanctioned by the union). As a result, the joint research techniques that the union invited in an effort to preserve the company and the jobs of its members, and the use of "experts declared to be reasonable", led to a loss of confidence in the union and eventually the opposition, by the workers affected by the stretch-out, to the United Textile Union [296, pp 552-553].

In his analysis, Slichter wonders whether it would be more useful for the union to use the outcomes of the research to criticize employer practices more than to jointly propose improvements [296, pp 559]. Looking at this case study, other scholars reach a similar conclusion. The reasoning here is that taking co-

operation to this level is "very apt to take a union outside its province" – that sharing responsibility for rates and standards exposes union leadership to "almost inevitable suspicion" from membership. On the other hand, when viewed as not a means to itself but as a means to accomplish other purposes, joint participation emerges not as a long-term goal, but as a strategy that a union can participate in selectively [185, p 151] for example, in an attempt to stave off the worst of labor reductions (for as long as possible).

In conclusion, both of these early experiments in joint rate setting illustrate that participation in scientific management with management is a double-edged sword. In the Cleveland experiment, we see that setting standards gives you power to affect change across the industry, but the process is not only cumbersome, but the effort involved in maintaining the set standards weighs down efforts to move forward. In Naumkaeg, we see that having union agents involved in conducting the time study gives union leadership a more accurate picture of what the potential situation is, but putting oneself in this overseer role is risky for the union and (not easily countered by member education). Ultimately this involvement can seeds substantial division between union leadership and rank and file.

In a 1945 survey of union policy and incentive wage methods, Van Dusen Kennedy echoes the concern about "ideological incompatibility" between unionism and "modern management" (e.g. incentive wage methods). He also notes that in rare cases where joint determination "genuinely" occurs, there is potential for workers' production and effort to increase at a rate that would have been intolerable "in other auspices" [185, p 151]. Kennedy raises argument that the "sense of participation itself" (a "less obvious product of worker

participation") is desirable no matter the outcome because it satisfies a desire in workers for "self-expression" and for social function that has no outlet in the modern industrial job. This idea was echoed by management engineer Phil Carroll, who pushed for workers' training and direct participation in rate setting. Kennedy doubts how much meaningful self-expression and sustained participation is possible in joint-rate setting experiments. This is later echoed by engineer and unionist Willam Gomberg, who questioned the emotional benefits to participation. The "sense of participation itself" as a cure for alienation in industrial work, while improving production, was something that organized labor rightfully approached with caution as it was often used to subvert union structures. But, as a short term strategy to ensure fairness or just to contest a specific management practice, it is very tempting.

3.4 Government Policy and Labor-Management Cooperation

Generally the Great Depression signaled the conclusion to the age of "cooperation fever" [237, p 152]. Most unions became uninterested in pursuing fully cooperative, joint rate-setting endeavors. However, key legislative developments during the New Deal, WWII, and the post-war period shaped industrial labor relations and specifically unions' attitudes toward industrial engineering [132, p 11]. In this section, I discuss the relationship between government policy and what seemed possible or desirable to do, from unions' perspective, with engineering methods.

The first time that Scientific Management appears in United States law, it is in legislation at is (initially) detrimental to to its implementation in the work-

place. In 1911, the Molders Union and the International Association of Machinists at Rock Island arsenal sent a committee to Washington, DC to protest the US Ordnance Department's plan to extend the use of scientific management [237, p 55]. The union aimed to curtail the use of scientific management government shops out of fear that their use would eventually spread into private practice throughout the industry. Government shops were seen as a valuable point of access for Scientific Management to gain public support since the government was considered a "good employer" [237, p 56]. After a series of union actions at Mare Island Navy Yard and Watertown Arsenal, the US House of Representatives organized a series of congressional hearings on the Taylor System of Shop Management [237, p 57]. After these hearings, the United States Commission on Industrial relations appointed Robert. F. Hoxie to investigate scientific management. After this, they adopted the "Deitrick bill" as an amendment to the Army and Navy Appropriation bills banning the use of premium bonus and stop-watch legislation.

This first legislative move was seen as a victory for labor but it was a limited one. Though the bill posed an obstacle for the Taylorist society from a legal standpoint, many of the same Taylorists were able to work around this legislation in their own projects for the US government during the first World War. Even the same arsenals were able to continue their use of premiums if they were funded by sources other than the Army Bill. One other notable characteristic of this legislation in practice was that while some unions objected to the recording of workers' production rates in principle [237, p 55], other unions targeted the "humiliting" and "un-American" [237, p 59] use of the stop-watch in particular. Some unions objected to the stopwatch exclusively, and were amenable to the same techniques if times were measured through some other method (e.g.

by punching a timecard). In the words of one of the workers at the Watertown arsenal, "I don't object to their finding out how long it takes but I do object to their standing over me with a stop watch as if I was a race horse or automobile." By targeting the more visible trappings of Taylorism (the premiums, the stopwatch) the bill was not enough to stop the "essential elements" of scientific management [237, p 84],

This earlier legislation reflects organized labor's suspicion toward the methods (without fully capturing the long-term threat to workers autonomy). Globally, the fear was that the scientific determination of rates would eliminate collective bargaining. What came next was key legislation that protected collective bargaining: the Wagner Act. The Wagner Act (also called the National Relations Act) states that the employer cannot interfere with organizing employees, interfere with the formation of a union, or discriminate against employee members of the union. The Act also prescribes that management must engage in collective bargaining with respect to rates of pay, wages, hours of employment, or other conditions of employment. What was 'fair game' for these other conditions of employment was debated extensively, but the Act dictated that the employer and the union need to negotiate in good faith to reach agreement over the conditions [69, p 173]. Good faith bargaining requires an earnest effort at compromise (e.g. union offer met with counter offer). This opened up some ambiguity about the proper subject of collective bargaining, for example, did it include the techniques management used to determine rates, or other management practices like designing work flows, assigning tasks, pricing merchandise, and marketing it.

During World War Two, there was a War Labor Board that was influential

in negotiating relationship between workers, unions, and employers. During World War One, an earlier War Labor Board established "the worth of workers to organize in trade unions and bargain collectively through chosen representatives" [69, p 160]. However, since the Wagner Act had been passed during the interwar period which protected the collective bargaining rights, the War Labor board was able to focus more on contract disputes between labor and management [69, p 162]. For unions who – having achieved the "mature stage" of collective bargaining – felt like they could participate in or make use of scientific management, the war labor board was a boon to union research because it "could demand and secure elaborate data, which of course became available to the labor members" [69, p 126].

The conditions of the war themselves also affected union actions. Before WWII, organized restriction of output by workers was a prevalent tactic that employers struggled to eradicate with wage guarantees and other incentive systems [185, p 122]. One could ask whether the war provided the patriotic impetus to challenge these practices. On one hand, there were efforts by labor and the government to boost production. Labor unions - like the United Electrical and Machine Workers Union, pushed for a 15 percent output increase. In effect, they were offering to create a patriotic, self-imposed speedup. On the other hand, the union's offer had some hedges: for example, that all new rates would be set according to pre-war (pre Pearl Harbor) standards [185, p 125], to protect workers from rate-cutting by their employers. The National War Board worked to 1) approve incentive plans in which employers (and employers and unions) wanted to install where hourly rates had existed previously 2) pass adjustments and address controversies in plans with established incentive plans [185, p 131].

In 1943, the board adopted 2 resolutions that pushed employers to cooperate with unions using joint-research techniques. First, they would only consider voluntary proposals where there was a recognized bargaining representative (e.g. a union) at the plant and would not order adoption of incentive plans in dispute cases. Instead, they would and only address whether the proposal was approvable or not (and not deal with implementation details). Second, the board resolved that they would "require periodic review of the plans as a precaution against violation of stabilization principles" – this review process required data to be gathered in a way that was accessible to both the government and to the engineering-management and research departments within organized labor [185, p 132]. The rules for what plans were to be accepted (written by George W. Taylor, vice chairman of the national war labor board) stress "the necessity not only of having union approval of a plan but of labor-management cooperation in developing it and of allowing free play to collective bargaining in connection with changes in rates and tankards under a plan" [185, p 134]. In practice, wartime incentive plans were "distorted and demoralized" by disruptions in products, production difficulties, production standards manipulated to give hidden wage increases, slowdowns and wildcat strikes to force concessions, and shortage of time study engineers [296, p 494].

Though the actual implementation of what was proposed and approved by the War Board was likely nebulous and maybe inconsistent [207], and the actions of the War Board didn't move labor relations any closer to understanding what was and was not under the scope of negotiability under the Wagner Act, the implication of these War Board resolutions is that they stressed the importance of cooperation with the labor unions, and pushed the employers and union management to work together.

In conclusion, the combination of the methodological flexibility of Scientific Management, combined with the discursive tension within the engineer profession in the early 1900s, and the affordances of industrial labor relations legislation created an opening for unions to participate in and experiment with using the techniques of scientific management to accomplish their goals. This window of opportunity allowed organized labor to have formative experiences that would shape their relationship with data-driven techniques later in the 20th century, but there is a sense of foreboding in these early cooperative experiments.

In the next chapter, I will show how absences within the union prerogative, namely a lack of interest by industrial labor unions in protecting workers from workplace redesign and against the loss of craft production, throws union strategy into a double bind. Data collection, in unions, like in the workplace, had a tendency to consolidate and centralize knowledge within the ranks of the unions data-gathering departments (e.g. research, engineering departments). This meant that as the union gathered more data about its workers, the union bureaucracy would become more powerful in ability to capture a more holistic understanding of the shop floor than any regular, rank-and-file member.

In navigating the tension between, for example, the idea that the "one best way" to do something was the intellectual property of individual union members and the idea that the union needed know and have something to counter the calculations of management, the unions consistently favored the latter. The consequence of prioritizing union data-gathering over preserving craft knowledge is not only that unions are not able to intervene in the broader process of automation (it is debatable whether unions wanted to, or could even intervene in this in a big way since they were invested in stabilizing their respective in-

dustries), but also that the data-gathering missions throw the unions into a particular vision for a workplace democracy that required a centralized and professionalized union to challenge management decision-making in the workplace. "Workplace democracy" then had to do with two competing actors, management and the professional labor union.

CHAPTER 4

HOW THE ILGWU MANAGEMENT-ENGINEERING DEPARTMENT USED DATA

On October 28th, 1941, the clock reads 744. Ruby Forman takes the gusset into her left hand and places it in front of the machine. This operation takes 40 thousandths of minute. The clock reads 744. Meanwhile in her right hand, she grasps the cloth, holding it for placing for 51 thousandths of a minute. The clock reads 784, and in her left hand, she carries the gusset, placing it under the foot of the machine. Now the clock reads 795, her right hand holds and moves the cloth while the machine stitches, as her left hand guides the garment. At 840, her left hand guides the garment. At 860, her right hand assists the turn to the front of the sewing machine as her left hand turns the garment. At 885, her right hand lifts the garment and her right hand holds and grasps the lower portion of it. At 896, her left hand turns the cloth to the right. Her right hand holds, moves back, and turns the cloth.... by 969, her right hand lifts and breaks work. At 981, her left hand pushes the cloth to the machine to bundle. Meanwhile the clock resets to 0. At 71, her left hand picks up one edge, lifting by the edge, to the front of the table, as the right hand grasps, lifts, and carries to table.

....

William Gomberg positions the clock, a micronometer, so that it is in view of the camera. He records the operation which he titles "overlock gusset and front seam" by operator Ruby Forman onto film rolls No. 20, 21, 22, and 23. Later, he and his team of engineers will examine the film frame by frame, noting the micromotions that the operators perform with each hand. Therbligs will accompany timestamps and written shorthand descriptions of the operations of each hand. Ruby Foreman's movements will also be transcribed into a "Simo Chart" ("Simultaneous MOtion" chart). Ruby Forman

is observed on the overlock gusset and front seam along with her colleagues, Sophie Rabnold and Vivian Cox. Ruby Forman was selected by her employer as an example of a "minimum operator"[1]: the operation takes her 1161 thousandths of a minute (where Vivian Cox took 1120 and Sophie Rabnold took 860). Analysis of the frames reveals that all three operators approach the task in different ways. This is important for the report that the engineers will write about the Belle Knitting Corporation.

Figure 4.1: "Two women sewing machine operators being filmed for a time-motion study" 35mm negatives of photographs. Kheel Center for Labor-Management Documentation and Archives 5780 Box 84 Folder 5; Box 85 Folder 1

[1] A minimally efficient operator.

Figure 4.2: "Women sewing machine operators being filmed by two men for a time-motion study" 35mm negatives of photographs. Kheel Center for Labor-Management Documentation and Archives 5780 Box 84 Folder 5; Box 85 Folder 1

4.1 Introduction

To gain historical insight into the role of technical expertise in enacting change in the workplace, this chapter analyzes the data-driven practices of mid-century American labor unionists who strategically appropriated the techniques of scientific management to advocate for garment workers. Through my survey of the projects, data artifacts, and academic writings of the Management Engineer-

ing department of the International Ladies Garment Workers Union, I describe the rhetorical use of data-intensive methods within a mutual gains-model of worker participation. I then follow the writing of the department's first director, William Gomberg, during and after his time at the ILGWU. I also survey publications from the Management Engineering department after Gomberg's time as the director. This allows us to better understand the long-term implications of data-driven approaches to worker advocacy in the garment industry context. My goal is to understand both the risks and opportunities of employing a data-driven approach at the ILGWU, and what can be drawn from this case moving forward.

4.2 Management Engineering at the ILGWU

The ILGWU established a Management Engineering Department in 1941. The department was charged with developing the union's rate-setting policy. The office was located in the flatiron district of New York City and consisted of a team of 5-6 engineers and was directed by William ("Bill") Gomberg. Officially, as presented in an Order to the Executive Board of the ILGWU in 1941, [138, p 11 n2], the objectives of the department were:

1. To assist in improving the manufacturing techniques and operating methods of all branches of the industry with which our workers earnings are intimately bound. This will be done through plant inspections by department representatives, followed by specific recommendations.
2. To serve as a central information agency:

- To determine the level of 'fair piece rates'
- To record the production system and manufacturing techniques under which these rates are paid
- To assist in training shop members and committees in distinguishing bad time study practices and good time study practices in the determination of rates.

In a more elaborate description of the department's function published to the American Society of Mechanical Engineers (ASME), the department was founded to "continue the tradition of labor-management co-operation fostered by the Union's pioneers" [96, p 190]. In order to fulfill these objectives, the department created a "time-study laboratory" with various kinds of time study equipment ("motion-picture cameras, projectors, wink counters, stop watches, and the like") [96, p 191]. In Gomberg's narration, the department's work was divided into two categories: short and long-term. The long-term goal was to build up a library of standard data for work across the garment industry. The ambitiously stated "hope" of the department was "to develop standard formulas from these data which will give an ideal time for every type of manual operation in the industry" [96, p 191].

The more short-term goal of the department was to provide "immediate field service in specific situations where the local union officials felt that the department could assist in overcoming stumbling blocks in negotiations and price-rate settlements". Basically, the goal was for the department to trouble-shoot union negotiations in situations where the presence of engineering knowledge could be useful. In doing so, the department struggled to "steer a middle course" – providing enough expertise to stave off an employer who thought that an en-

gineer could be hired to completely transform plant operations over two weeks (e.g. by demonstrating the resources required to do it right) while not falling into the hands of an employer who recognized that the use of industrial methods for work redesign was an expensive, long-term project but hoped to use the union as a means for actually implementing the plan. [137]

4.2.1 Background

In order to understand the impact of the ILGWU engineers, it makes sense to unpack the context in which they appeared in the union. Going beyond the formal charter of the department, a sequence of historical events motivated the ILGWU to invest in their own in-house technical expertise. To capture the motivations behind the Management Engineering department, I describe the legacy of management engineering work within the ILGWU and the union's changing relationship to engineering practices. I explain the political challenges for the union in promoting industrial engineering techniques, and describe how the department emerged in response to specific events within the New York dress industry:

Gomberg's Management Engineering department was a continuation of prior Scientific Management experiments by the garment unions, notably Robert Valentine's "test shop" [96, p 189]. Valentine, in 1916, had written the paper on the importance of unions' consenting participation in the application of Scientific Management and had had the opportunity to put his ideas into practice at the invitation of supreme court justice Louis Brandeis and Morris Hillquit as part of the Protocols of Peace. Valentine was hired by the joint board to de-

velop a set of standard data about efficient operations in the waist and blouse industry for the development of a rational "price fixing" system for the scientific management of the garment trade [237, p 99][96, 189]. This extension set the basis for a "new attitude" toward the techniques of industrial engineering within the garment trades. Valentine collaborated with Ordway Tead, Sanford Thompson, and William Lichtner to establish the test shop but then died before he was able to produce useable results. The Protocols of Peace broke down soon after Valentine's death, but the effect they had on the union was of introducing the concept of "convert[ing] motion and time study from a substitute for collective bargaining into a tool of collective bargaining" [137]. The next foray within the ILGWU is the unit system in Cleaveland (described in the last chapter), the failures of which Gomberg wholeheartedly ascribed to the Great Depression [132, p 21]. Nonetheless, the union continues to build a body of experience with industrial techniques through these earlier experiments.

After the Great Depression, the ILGWU drew on this prior expertise to renegotiate their relationship with Scientific Management. When Gomberg describes this negotiation, he refers to J. T. McKelvey's periodization of the historical relationship between organized labor and scientific management, in which there are three periods: a period of "unmitigated hostility from 1911 to 1915; a period of transition from 1915 to 1917; and a period of cooperation between 1917 and the Great Depression [228] (this is also mostly Nadworny's account in [237]). To this history, Gomberg adds a fourth period, which he calls " the emergence of positive trade union philosophy of industrial engineering following the great organization rives and the passage of the New Deal legislation" [132, p 11].

Gomberg's stance echoed the perspectives of other union leaders within the ILGWU: in the foreword to both the 1948 and 1955 editions of Gomberg's book on the validity of the time study, ILGWU president and (former secretary) David Dubinsky editorializes the early history of labor that has "looked askance" at time study techniques. He characterizes these earlier unionists as "prone to regard... studies and techniques as management tools for labor speed-ups and for dilution of skills in industries where skills are valued... that management in the past sought to exclude labor from taking part or exercising any control over time studies served to strengthen this prejudice" [132, p vii]. For Dubinsky, in addition to the legal securities of collective bargaining, a "revision of this viewpoint" began when in the early 1930s when "the sweep of collective bargaining compelled the adoption of new approaches to piece-rate price settlement in one of our largest markets, the New York dress industry". Dubinsky describes the adoption of a "unit system" for the determination of garment work prices, which coincided with the time manufacturers started to employ industrial engineers tasked with installing "scientific" piece rates. But this coinciding – of the unit system with the time that manufacturers started to employ their own engineers – connects to the political history of the union and motivates the founding of the department. The union was interested in using their collective bargaining powers to develop the "unit system" in the New York dress industry out of concern for the "welfare of the industry... something on which their very bread and butter depends" [156].

4.2.2 ILGWU, Section Work, and the Unit System

The garment industry, in these mid-century narrations by academics and members of the ILGWU alike, is described as a particularly volatile industry. Success in the garment trades hinges on successful and rapid implementation of clothing designs, which leaves the industry vulnerable to the whims of fashion (and women's fashion in particular, in which trends and garment styles develop faster than in men's and children's garment industries). The unionized garment industry was also vulnerable to competition from non-union shops, which had the advantage of charging lower wages. Since labor costs comprise a greater percentage of total costs in garment trades compared to other forms manufacturing [324, p 34], unionized shops that were trying to raise wages had taken some interest in production and management problems to combat non-union competition. Typically one thinks of the ways that unions limit "innovation and technological development" to protect an industry [36, p 23], but during this time, the union was demanding greater industrial efficiency from their employers in an effort to preserve their conditions of work [39, p 195].

In the 1935, the ILGWU took on an aggressive program of "industrial self-regulation" in New York City [324]. The garment industry in NYC was considered "insecure" and there was thought to be a substantial risk that business would be driven not only out of union shops, but out of the city entirely. There were two main incentives for employers to look elsewhere: lower labor costs, and less union interference. In order to maintain the New York dress industry, the union felt compelled to call for improved efficiency. To accomplish this, a Labor Bureau was set up by collective agreement, financed by the joint board of the ILGWU and the employers' associations. The bureau facilitated joint promo-

tion of sales, setting up a Dress Institute that promoted and stimulated desire for New York craft. Additionally, the agreement had stipulations to improve production (cost accounting, budgetary control, and improved factory management) and standardize prices for garments [156].

Dress prices were determined on the basis of time required for each operation in making them [36, p 25]. The logic was that though styles changed rapidly, there were certain components of "fundamental parts" that comprise women's dresswear. In 1936, a group of industrial engineers studied these fundamental parts and established the standard time required for the necessary operations. When a style change occurs, one could (theoretically) use the unit system to determine the time required to make the garment – these calculations comprised the "unit system" the motivated the management-engineering efforts of the ILGWU. Once the time to make the garment was calculated, the union would bargain over the minimum hourly rate and then the time units would translate into hourly earnings, and then piece rate for each garment would be set in accordance with this hourly wage [39]. The following images depict the unit system at work for determining dress prices – these ones are from 1938 for cotton dresses produced by union shops in Philadelphia.

Similar to what the ILGWU set out to do in the Cleveland garment industry (described in the last chapter), the unit system was a way to balance between hourly wages and piece rates to meet the needs of its members and employers. In New York, the unit system was also a tool to deal with the transition between whole-garment production versus section work. Whole garment production is when one garment worker makes the entire article of clothing, for example, a dress, from start to finish. Section work is when the operations required to

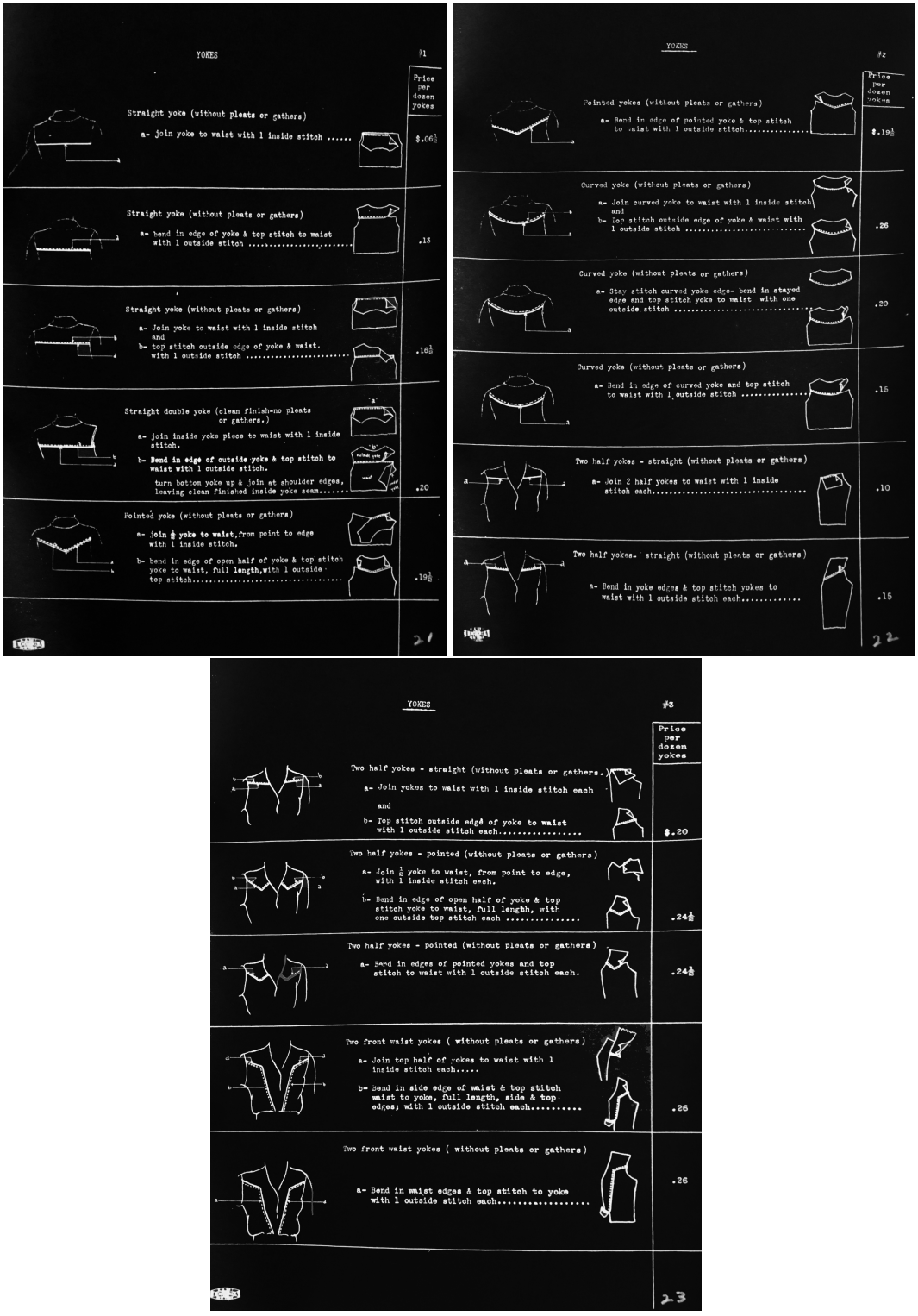


Figure 4.3: Unit prices for the yokes of cotton dresses, 1938, Kheel Center 5780/047, box 32, folder 13, pp 21-23.

make the dress are systematically broken down into smaller sub-routines. Individual workers are then trained to execute the sub-routines, performing the same operation on a ”bundle” of half-finished garments, which are routed from worker to worker through the shop floor. For the employers, the advantage to section work was that they could train workers faster and hire less skilled labor (ultimately resulting in lower wages). The disadvantage was that installing and maintaining a system of section work raised the managerial and engineering burden [39, p 195]. Employers who were less familiar with the logistical demands of implementing section work were, in the union's experience, reluctant (or unable) to hire necessary technical personnel to redesign the shop (there was less demand on the managerial abilities of the employer under the whole garment system because “they could simply turn over the sewing of the garment to one individual worker”[39, p 195]. During this time, some employers adopted section work in hopes that it was a panacea solution for lowering labor costs but, upon discovering the redesign itself required an investment in human resources, and that the results of poorly implemented section work were less efficient, employers, especially of smaller shops, would return to whole garment production because of the large amount of supervision that section work required.

For the ILGWU, in section work and in piece work, the added administrative burden of negotiating piece rates posed challenges for locals officials (gomberg 1955 book, 27). Here it is important to note that piece rates and section work had a tendency to go together, as they both require the work to be split into sub-routines, but the former describes how work is organized and the latter describes how work is compensated; one could, in principle, pay piece rates for both section work and whole garment production, just like one could pay

hourly wages for both whole garment and section work. If there was disagreement between the workers and management in the negotiation of rates for a new garment style, officers from the ILGWU local would typically be called in as 'business agents' to help the union settle the dispute. In the cases where the business agent had previously worked as a sewing machine operator or a presser, they were able to apply their prior knowledge to help settle disputes. But, as Gomberg points out, this process was not systematic and relied on prerequisite knowledge of garment trades by the union officer.

The unit system was an attempt to decouple prior craft knowledge from the settling of rate negotiation conflicts [132, p 28]. Unsurprisingly, older generations of union officers "derived a sense of relief and impish satisfaction" when the unit system didn't work and expressed their distrust for the system ("so you expect a lot of youngsters with slide rules to set rates, huh? Did they ever sew a seam?") [132, p 29]. Overall, however, the unit system worked as a "loose guide that set up more rational limits within which haggling continued to take place" [132, p 29]. At the same time that union officers struggled to work within the loose parameters of the unit system, industrial engineers (mostly operating outside of New York City, Gomberg points out) hailed the same system "in glowing terms." Unlike the ILGWU officers, Gomberg writes, the engineers sought to apply the techniques in order to set work rates "scientifically" and without negotiation (that is without negotiation over any aspect of work except the hourly wage, so the union and the employer could engage in collective bargaining over the wage, but how long operations should take would be 'objectively' determined using the unit system) [132]. This appearance of industrial engineers applying the unit system into the rate setting functions with unrecognizable "rigidity of the technique as they thought it was practiced" directly

motivated the union to employ their own, in-house engineers who could help union locals counter these techniques.

Another important political aspect of introducing section work to the garment industry was that the union needed to negotiate with the identity of the workers and the degree of industrialization they were willing to tolerate. In the early 20th century, the garment workers of New York City and Philadephia were largely immigrants – a large majority were Jewish and Eastern European, some were Italian [137]. These workers, who dominated the New York dress, coat, and suit industries were seen as "skilled continental immigrant workers" and they were "protective of their craft and wary of replacement" [96, p 189]. Within New York City, among these older workers in these industries, there was a lot of opposition to section work because the workers (correctly) recognized that section work posed a threat to their craft knowledge and the 'skilledness' of their work. This is because it was much easier to train a worker to implement a fraction of garment construction, compared to the training required to finish one garment from start to finish [137][39, p 193]. As this tension persisted in the dress, coat, and suit industries, the New York blouse, underwear, and children's dress manufacturing, along with shops outside of New York, faced less resistance. This is because they had begun to recruit their workers from "semi- or unskilled sources" and trained them on sectionalized production from the beginning of their employment [39, p 189](189). Section work posed no "psychological" barriers to this second group because they knew no alternative [39, p 193].

In New York City, the ILGWU struggled to support their older membership (which, being comprised of older, Jewish and Eastern European immigrants,

had a lot in common with union leadership, which had also tended to be older, and Jewish and Eastern European [275]. On the other hand, the union weighed a growing concern that if they didn't allow section work at all, then the garment manufacturers would have a lot more incentive to set up outside of NYC. In order to balance between practical concerns (representing the needs of its members while preserving the industry on which their employment depends) the union avoided taking an "official position" [323] on section work. It could be, and has been, argued that the union was potentially playing a waiting game, anticipating that its older members would eventually leave and be replaced by workers who did not share the older generation's craft knowledge or expectations:

> "As the older members leave, the union may not have any internal political reason for opposing the spread of section work. Furthermore, as the older workers disappear, the supply of highly skilled operators will rapidly diminish. The industry will find itself with workers of limited skill who can only be employed in section work shops" [39, p 193].

Another thing to be noted about the "supply" of skilled continental workers to the American garment industry is that when the waves of immigration that brought the skilled garment workers from Eastern Europe were curtailed by 1920s immigration laws [137], the children of these immigrant garment workers did not follow in their parents footsteps. This "shortage" of skilled workers was apparently addressed by the appearance of "new disadvantaged groups that seep in at the bottom of the pyramid. The immigrant Jews and Italians in areas like New York and Philadelphia are more and more replaced by Puerto

Ricans and Southern Negroes" [137].

So what was happening within the union was that work was being being simultaneously re-designed in a way that deprioritized craft knowledge, and that older generations of "skilled" immigrant workers was being replaced with newer workers, who were seen as "unskilled" – and those "unskilled" workers belonged to social groups that were different from union leadership. Since there was seemingly no obligation to build up craft knowledge in this new generation of garment workers, section work seemed like a logical 'solution' to the shortage of skilled workers ("the industry feels that section work will obviate the need for the development of highly skilled workers and the lengthy training periods involved") [39, p 190].

It is impossible to know how much of this perceived shortage logic was reinforced by a continued difference between the union leadership and the union membership, but during this transitional time, the leadership of the union continued to draw from the older, male, and Jewish immigrants. The lack of craft knowledge not only limited the employment of the new workers within the industry to sectionalized jobs, but it simultaneously limited their ability to move up through union leadership, as the lower levels of skill attained by the newer members "do not tend to offer many candidates for leadership posts" [275]. In conclusion, as the garment industry was making itself amenable to the use of scientific management techniques, there was a shift within the membership of the union (and the contrast between the membership and the leadership of the union) which made the transition to the rationalized workplace seem more acceptable and inevitable than it would have, if the composition of the labor force had stayed the same. This tendency for the union to more readily accept

work re-design for some of its workers was reinforced by a persistent economic unease and fear that the work opportunities would be lost to more rationalized garment centers outside of New York City, but it is possible that the union would have been less aggressive in its embrace of rationalization if its membership continued to be who it was at the beginning of the century.

4.3 Management Engineering Projects 1941-1942

In this section I describe several projects of the Management Engineering department of the ILGWU, drawing on archival and secondary sources to show how data practices and technical expertise worked within the union's vision of workplace democracy. These projects will comprise case studies from which I will generalize strategies for advocating with worker data, which I will revisit again in chapter 5 (using materials from other industrial labor unions in addition to the materials from the ILGWU).

4.3.1 Belle Knitting Mills

In the summer of 1941, the workers of the Belle Knitting Mills had gone on strike at multiple locations to secure collective bargaining rights[2, 1]. In October of 1941, the Management Engineering department of the ILGWU began investigating the machine loads at the Belle Knitting Corporation in Sayre Pennsylvania. They conducted this investigation as part of the sought-after collective agreement between Belle Knitting and the ILGWU, which had stated that:

"The parties agree that within a reasonable time after the signing of this

agreement, a committee consisting of representatives of the Employer and a shop committee of the workers will study the problem of the machine load with a view to provide for a machine load which will be fair and reasonable to the Employer and the workers." [2].

This first study, of two that would eventually take place, focuses on the Thompson knitting room, which had been identified as the problematic area in the shop by the union workers, who had complained of excessive work loads. Leading up to the investigation, the department gathered data by observing the knitting room operations first-hand and by interviewing different people: the workers and the Production Foreman of the knitting room. The wartime conditions ("the national defense situation") compelled Belle Knitting to use a lower quality of yarn. The defects of the lower quality yarn ("slugs") resulted in an increase in knitting machine breakdowns. The questions posed by the department were 1) whether the knitters ought to maintain the same number of machines as before the war if they are expected to have the same productivity yield; 2) assuming that workload has increased, what remedies could be implemented to equalize workers' machine load without interfering with basic shop standards; and 3) how can productivity of the machines be increased.

To address these questions, the engineers used various industrial engineering techniques to survey the operations of the Thompson knitters. They classified their jobs, examined what was causing machine stoppages, and classified and coded those reasons. A "man-machine chart" was devised to simultaneously record machine breakdowns, their causes, and the work of the knitter. Then the engineers observed different knitters on different shifts. The engineer recorded what the knitter was doing and the assistant observed and recorded

[2]Kheel Center 5780/118 box 2, folder 14

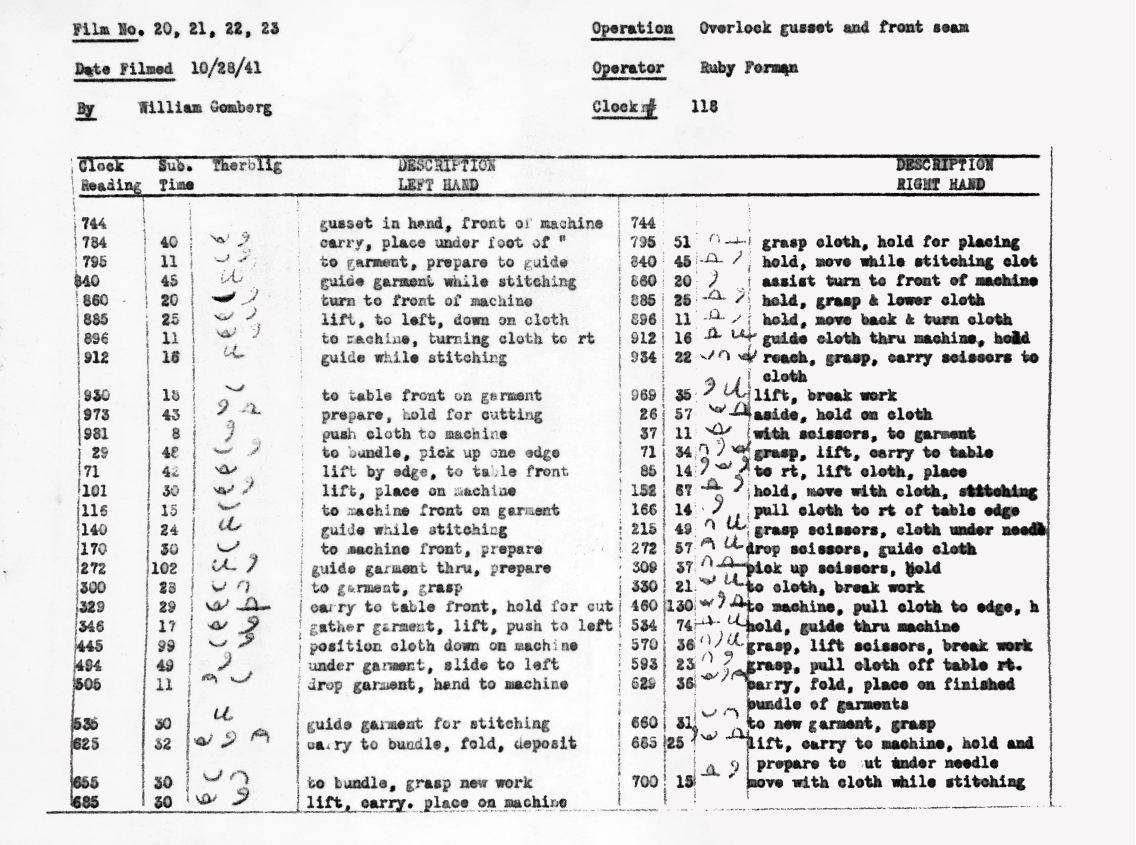
machine breakdowns (times, causes, and when the machine resumed operation). They found that, on average, 34.8 percent of the machines were idle at any one time (*i.e.* the factory is operating on an average of 65.2 percent productivity), while the workers averaged 2 percent idle time. The authors of the report note that is possible the workers took less than the ordinary time to be idle because they were being observed, but took this fact to strengthen their argument, that despite a small amount of worker idle time, there was a high percentage of machine idle time (e.g. that "more work idle time would mean even more idle machine time"). They also looked into how much help was being given to each knitter. They found that it was not efficient at addressing idle time.

The recommendations made by the engineers where to either 1) decrease the machine load per knitter, or 2) analyze the jobs performed by the knitter and see whether some of the work could be assigned to less skilled operators. The author of the report favored the second recommendation, apparently because it was "more flexible" and would result to an easier return to normal. The engineers then rate operations in terms of the amount of skill required. They argue that because stitching on requires the most skill, it should be taken away from regular knitters and assigned to a small number of highly skilled floor workers who would move from machine to machine to stitch on and perform inspections at the desired rate. Or, alternatively, the knitters could perform four of the more demanding jobs and leave the rest to the auxiliary (less skilled) floor workers. Here, the author of the report note that potential future complaints about floor workers doing their jobs sloppily (since they themselves did not need to "stitch on" the knitting that was made more difficult by defects in their work) could be addressed by having some of the floor workers be responsible for a smaller number of machines. In essence, they hoped to enlist the cooperation of

the future unskilled category of workers they were proposing by giving them responsibility over a small fraction of the skilled work. The engineers also calculate how much of the disturbances are directly caused by poor quality yarn. They then make some recommendations about placement of machines and necessary supplies. The conclusions of the Management Engineering department are that: 1) the plant is only running at 65 percent capacity; 2) the knitters are "saddled with unjustifiable heavy work load"; 3) the load is traceable to the decreased quality of the yarn; 4) the knitters should be relieved of stitching on by highly skilled operators, or more of the menial tasks should be taken by less skilled operators.

The Management Engineering department returned to Belle Knitting in December, this time tasked with examining the basis for variations in productivity between different workers performing the same tasks and evaluating the firm's exiting time study practice (this is described in the vignette at the beginning of the chapter). After interviewing members of management and union members, the engineers conducted time and motion studies. They filmed working operators with a specifically designed microchronometer (a clock indicating very small fractions of time). The filmed material was analyzed frame by frame, the operator's motions were broken down into motions called Therbligs, which are shown in the Figure 4.5 below. Formalized by Frank and Lilian Gilbreth [236], Therbligs ("gilbreth" backwards) comprise the 17 elementary motions common to all human activity. The Therbligs were timed and individual worker processes were documented in Simo (Simultaneous Motion) charts, also shown below in Figure 4.5.

The findings of the Belle Knitting report explain that large variations in op-



Film No. 20, 21, 22, 23 — Operation: Overlock gusset and front seam

Date Filmed 10/28/41 — Operator: Ruby Forman

By: William Gomberg — Clock #: 118

Clock Reading	Sub. Time	Therblig	DESCRIPTION LEFT HAND	Clock Reading	Sub. Time	Therblig	DESCRIPTION RIGHT HAND
744			gusset in hand, front of machine	744			
784	40		carry, place under foot of "	795	51		grasp cloth, hold for placing
795	11		to garment, prepare to guide	840	45		hold, move while stitching clot
840	45		guide garment while stitching	860	20		assist turn to front of machine
860	20		turn to front of machine	885	25		hold, grasp & lower cloth
885	25		lift, to left, down on cloth	896	11		hold, move back & turn cloth
896	11		to machine, turning cloth to rt	912	16		guide cloth thru machine, hold
912	16		guide while stitching	934	22		reach, grasp, carry scissors to cloth
930	18		to table front on garment	969	35		lift, break work
973	43		prepare, hold for cutting	26	57		aside, hold on cloth
981	8		push cloth to machine	37	11		with scissors, to garment
29	48		to bundle, pick up one edge	71	34		grasp, lift, carry to table
71	42		lift by edge, to table front	85	14		to rt, lift cloth, place
101	30		lift, place on machine	152	67		hold, move with cloth, stitching
116	15		to machine front on garment	166	14		pull cloth to rt of table edge
140	24		guide while stitching	215	49		grasp scissors, cloth under needle
170	30		to machine front, prepare	272	57		drop scissors, guide cloth
272	102		guide garment thru, prepare	309	37		pick up scissors, hold
300	28		to garment, grasp	330	21		to cloth, break work
329	29		carry to table front, hold for cut	460	130		to machine, pull cloth to edge, h
346	17		gather garment, lift, push to left	534	74		hold, guide thru machine
445	99		position cloth down on machine	570	36		grasp, lift scissors, break work
494	49		under garment, slide to left	593	23		grasp, pull cloth off table rt.
506	11		drop garment, hand to machine	629	36		carry, fold, place on finished bundle of garments
536	30		guide garment for stitching	660	31		to new garment, grasp
625	32		carry to bundle, fold, deposit	665	25		lift, carry to machine, hold and prepare to cut under needle
655	30		to bundle, grasp new work	700	15		move with cloth while stitching
685	30		lift, carry. place on machine				

Figure 4.4: micromotion transfer sheet from Belle Knitting, Belle knitting mills report: Management Engineering department. Kheel Center for Labor-Management Documentation and Archives KCL05780-118, box 2, folder 5.

erator times were due to the vastly different methods being used by different operators. The report argues that since the method of micromotion techniques rests on the assumption that there is a single 'one best way' of performing a particular task, then time studies cannot be properly conducted if workers are unaware of this method (or seldom use it). Additionally, the union writes that when they compare their time study to the one supplied by management, they find that the management time study was not compliant to professional standards in establishing allowances for work that falls outside of the repetitive cy-

CODE	SYMBOL	DESCRIPTION
Sh		SEARCH
F		FIND
St		SELECT
G		GRASP
TL		TRANSPORT LOADED
P		POSITION
A		ASSEMBLE
U		USE
DA		DISASSEMBLE
I		INSPECT
PP		PRE-POSITION
RL		RELEASE LOAD
TE		TRANSPORT EMPTY
R		REST FOR FATIGUE
UD		UNAVOIDABLE DELAY
AD		AVOIDABLE DELAY
Pn		PLAN
H		HOLD

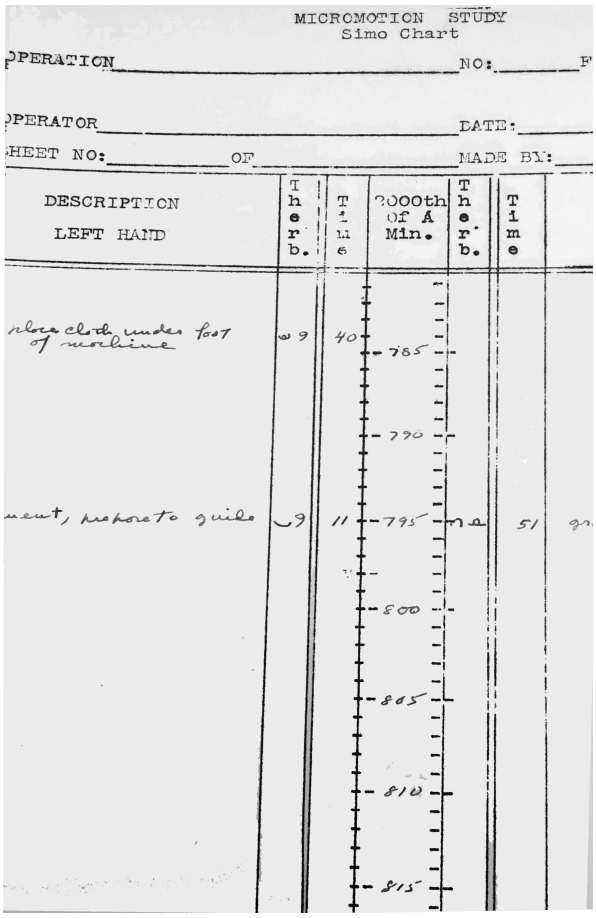


Figure 4.5: Left: Therblig chart, adapted from [236], Right: SIMO (Simultaneous motion) chart from Belle Knitting, Belle knitting mills report: Management Engineering department. Kheel Center for Labor-Management Documentation and Archives KCL05780-118, box 2, folder 5.

cle (including fatigue and personal needs). By doing the time study themselves, the union engineers were able to use the techniques to contest management decisions.

4.3.2 Dutchess Manufacturing

The second case I will survey is the Management Engineering's analysis of production at the Dutchess Manufacturing Company [3]. This Dutchess plant, located in Old Forge Pennsylvania (with headquarters in Brooklyn) made underwear, and during the war, they made underwear for different branches of the military. What concerned the ILGWU and the Dutchess Manufacturing Company was: 1) how could the company increase production without increasing unit costs; 2) how could the union secure wage increases and simultaneously keep the company's cost within competitive levels; and 3) what changes in production methods could be introduced with minimum cost to accomplish these goals.

Like at Belle Knitting, the study began with firsthand observation, followed by interviews with members of the shop committee and Mr. Cregan, the factory supervisor. The engineers took time studies to measure productivity and "degree of standardization" within the plant (presumably how much people were doing the same things consistently) [4]. When taking the time studies, the engineers timed the "basic repetitive cycle" along with all work done outside of this repetitive cycle. The engineers attempted to arrive at a measurement for the time that work ought to take outside of the repetitive cycle (e.g. how much time can we set aside for operations that are unique to a particular instance of a routine operation, accounting for things like breakage, adjustments, idle time, etc.). Of the 42 studies taken, 20 were of work outside of the repetitive cycle and 22 were on the repetitive cycle. Work outside of the repetitive cycle included

[3] This company had previously experimented with "shop committee" business systems in 1918 [191]

[4] Kheel Center 5780/118 box 2, folder 7

operations like:

- Fixing broken elastic, thread, piping.
- Preparing bundle before and after operation
- Changing bobbin, thread, piping, or elastic
- Machine adjustment and repair
- Interruption by Supervisor, Floorworkers
- Trimming seams, lace, uneven edges of garment
- Going for work, equipent or some other person
- Waiting for work
- And other miscellaneous pause not of personal nature

The report explains that an engineer attempted to secure a list of existing operating standards from the sewing room foreman but was unable to do so, as the foreman had felt that the standards were confidential to the firm, and should be shared with neither the union engineer nor the worker. The method that the employer used for arriving at the standards was similarly deemed confidential. Thus,

> "[Y]our engineer soon discovered that a *secret* incentive plan, at the basis of which a *secret* standard, *secretly* stimulated workers who never knew exactly what they were supposed to do and hence the following picture of what is happening in the plant" (emphasis added)[5].

[5]Kheel Center 5780/118 box 2, folder 7, p.2

The wide variation of operations and downtime are explained, in the report, by the lack of standard practices within the sewing room. The author writes that the operators at the Dutchess plant were not being shown the best method, and instead were driven by a balance of avoiding discipline from the supervisor and doing "the minimum of what she believes she can get away with under Union protection" [6] - the report compares two workers on their speed in the repetitive cycles and the downtime outside of the repetitive cycle to show how more efficient operators are having their time wasted by avoidable delays. The author of the report argues that if all workers were instead trained on the more efficient methods, then all workers production would increase.

The union engineers recommend steps to provide "some incentive for the workers to attain a higher rate of production" - maintaining all existing time rates plus whatever the new collective agreement may demand, and then proceeding as follows: 1) Determine the average hourly wage rate for the sewing room 2) Take steps to standardize all operations in accordance with best practice available 3) Take open and objective time studies of these operations with the best operators and determine the unit labor rate 4) Inform the people they are on time work, but that their production will be measured against these standards which are no longer secret, but are posted on the bulletin board and that anyone exceeding these standards will be paid on the basis of the unity rate posted on the bulletin board. They note that the installation of these rates should not be hurried nor should rates be set until operations are standardized because otherwise the situation of varied productivity will only be further aggravated. The engineers remind the management that it is their responsibility to standardize routing, scheduling, and dispatching so that idle time is minimized. Controver-

[6]Kheel Center 5780/118 box 2, folder 7, p.3

sially (i.e. from a union perspective, which is typically seen as being in favor of preserving employment, for instance through "make work"), the report also recommends eliminating one of the three positions in finishing operations.

4.3.3 "Section-Work" System Development at the K.U. Dress Company and Lillian Dress Company in N.Y.

In this project, the Management Engineering Department surveys the installation of section work in two New York City dress manufacturing shops. These are two shops that were in the process of changing from a "complete-garment" system of production to the "section-work" system. The investigation was done at the request of the Joint Dress Board on April 10, 1942. The department was tasked with surveying the relative earnings of the workers under section work vs. the older system, the "smoothness with which the system was working" within the respective factories, and the sources of any frictions that may have emerged [7].

In order to accomplish the first part of their investigation, the department needed access to data about the workers' earnings. This was difficult to determine from the financial records. Instead, the estimated earnings had to be reverse-engineered by comparing samples of the garments against the unit system from which rates were allocated. It was possible to do this for the K.U factory, but the Lillian Dress Company's records of hours worked made it impossible to calculate average earnings. To fill the gaps in the data, the department interviewed the managers of the companies, the manager of the Dress

[7] 5780/118 box 2, folder 9, p.1

Joint Board, and "chairladies" and workers of the two factories.

At the K. U. factory, the department concludes that the shift to section work resulted in average hourly earnings increases of 11.3 percent (9.4 cents, from 83.2 cents to 92.6 cents). According to the employers, section work led to an increased quality of merchandise and, from conversations with the manager of the joint board and the workers, the union also concluded that workers were "completely satisfied" with the system. The engineers note that the distribution of price among different sections of the work could be done more accurately, but find this to be under the responsibility of the joint board (and that further development of the experiment would justify re-analysis of the unit system leading to a more accurate unit system) [8].

At the Lilian factory, however, the report indicates that the introduction of section work happened very differently. No quantitative comparisons could be made between the earnings, as mentioned, and due to the lack of advance planning in the allocation of sections, bottlenecks were appearing in the production, leading the workers to "pay" for the omissions and inefficiencies of management. The workers resented this, and in return, management deployed two strategies: "1) reducing the number of sections into which the garment was divided until the workers were virtually working on a complete garment at a reduced price; 2) they permitted themselves to be drawn into a regular program of mutual recrimination" (e.g. a mutual exchange of accusations between workers and management) [9].

From these two surveys, the department concludes that section work *can* be introduced into the New York market, and that it is *possible* to retain work-

[8] 5780/118 box 2, folder 9, p.2
[9] 5780/118 box 2, folder 9, p.3

ers who were accustomed to complete-garment systems under section work. However, in order to do this, the management needed to fulfill certain obligations: the installation of a "rational method of production control permitting the scheduling of operations to secure machine balance" (and to control their temperament, "to focus on management function rather than the search for political recriminations against its labor force") [10]. This emphasis on increased managerial burden in the installation of section work connects back to the department's foundational logic: moving from whole garment production to section work allows one to hire cheaper labor, but it creates more work for management to install the plan effectively, and in turn, it creates more work for the union to combat the practices of management. In order for the operation to be effective, management would need to find ways to reap the benefits of automation while minimizing its burdens. It is clear from this report that some shops were more effective at doing this than others.

4.3.4 Real Silk Hosiery

In September of 1942, the Management Engineering Department conducts a survey of Real Silk Hosiery Mills, in Indianapolis, Indiana. In a joint report to the general manager of Real Silk and A. Plotkin, the regional director of the Midwestern Office of the ILGWU in Chicago, the Management Engineering department evaluates the existing time practices in the underwear department of Real Silk and, based on their evaluation, makes recommendations for how to improve the time study methodology [11]. Unlike the projects which address or dispute the study of specific manufacturing operations, the department takes

[10] 5780/118 box 2, folder 9, p.4
[11] 5780/118 box 2, folder 19

the time study samples submitted by the manager as "an indication of the general time study practice" at Real Silk and focuses on time study practice itself [12]. The section of the report outlays the criteria by which time study practices can be evaluated. The department breaks this down into what is done before the studies are taken, and then the analysis of the time studies themselves. The goal was to evaluate the time studies and identify deficiencies in management's approach.

For the first part, the time before the time study, the department identifies three criteria: 1) the work in advance to develop standard methods of performance for operations; 2) the instruction available to workers to insure performance by "the determined standard best method" [13]; and 3) the duration of supervised practice which workers have had on an operation. The report argues that the application of time study techniques is useless without standardization of the garment production method method, and adequate training on the standardized method. If the time study is done before the standardization and the training, the engineers argue that it "does not fulfill the requirements of systematized time study" and therefore, "haggling between the price committee of the union and the company's time study engineer is inevitable" [14].

The analysis of the time study is itself broken into three categories as well: the analysis of the readings or the "raw data", the analyses of the allowances "added to the derived statistic", and the method used to "level" the time study – or to adjust the data to the operating level of a "normal" (i.e. average) worker.

The analysis of the raw data can be evaluated in terms of the consistency of

[12] 5780/118 box 2, folder 19, p.1
[13] 5780/118 box 2, folder 19, p.1
[14] 5780/118 box 2, folder 19, p.2

the readings, the sample size of readings, and the "statistic derived from the raw data" [15]. The report cites industrial engineer Dwight Merritt, who recommends rejecting any reading which is anomalously high or low compared to the other readings. Then the engineers point out that at Real Silk, the time study of style #722 shows that

> "for the first element, "Join Bandeau", a maximum of .84 is recorded for the element, 'position', and a minimum of .43. That is a variation of 100 percent. Yet an attempt is made to derive a selected time of .56 minutes from this array of data. The data itself should have been a signal to the time study engineer that the operation was completely un-standardized and not ready for time study." [16]

The engineers go on to point out that .56 is derived from 12 readings, but "the statistical theory upon which time study is based would require at least 30, and even then, the method for arriving at .56 is a "complete mystery to your engineer and, as he later discovered, the the time study engineer of the firm, also". Next, the report casts doubt on how the allowances were added for various operations. Since they are based on past practices for which no records exist, the department concludes that it is impossible to evaluate them. Finally, with regards to leveling, the report suggests that this is the one field of the time study where "judgement may be used and then care and skill must be exercised". Here the engineers express skepticism that the company's time study engineer would be able to "assign individual performance ratings to individual elements of an operation" (As opposed to leveling based on workers, e.g. fast

[15] 5780/118 box 2, folder 19, p.3
[16] 5780/118 box 2, folder 19, p.2

worker, average worker etc.)[17].

The department recommends that a "joint conference" organized between the management, the representatives of the ILGWU, and the representatives of the shop committee of the union in order to formulate a manual of standard time study practices for the company (including analysis, how to do affordances, etc.) with the expectation that workers would participate in evaluation and leveling in the future. The reason for this undertaking is that it would "repay itself many times over" with hours spared of management from "haggling" and in "the creation of an atmosphere of mutual trust and respect". The report concludes that until the (ambitious) plan is undertaken, the employer has no choice but to continue to deal with the union in the way that it had been doing before:

> "[U]ntil such time as such an program is undertaken, the firm should reconcile itself to the haggling which must go in the disputes over its use of time study techniques." [18]

4.4 Data Rhetoric

In this section I draw on the case studies above to illustrate the ILGWU Management Engineering department's varied, rhetorical use of data-driven arguments (what I term *data rhetoric*). The union aimed to enlist management cooperation by offering practical solutions to improve efficiency while using the formal tenents – the so-called "scientific" standards – of Scientific Management to advance the union's interests. I break down some of the specific strategies that the

[17] 5780/118 box 2, folder 19, p.3
[18] 5780/118 box 2, folder 19, p.4

Management Engineering department used and analyze the general stance of the department as it related to the representatives of labor and management.

Demanding transparency: the most immediate thing that the department did was try to secure as much information about time studies and incentive rates as possible. It argued that you simply could not perform meaningful assessment or validation of the time study without access to the time study. For example, as we saw in the Dutchess case, the Management Engineering department argued that it was unable to evaluate operating standards without data. One of the differences between the "successful" section-work redesign and the less successful one, was also the availability of data to the union. The department also argued that the success of the plans depended on having access to information about work standards being given to the workers. The deriding of the "secret" standard that "secretly" stimulated the workers who never knew what was expected of them, again, at Dutchess, leveraging productivity desired by the employer in exchange for the transparency desired by the union. Access to the data being used to determine rates and wages was of course necessary in order for the union to begin to evaluate the legitimacy of the methods used to arrive at them. It is also reasonable to suggest that access to the data was important for the union engineers because it meant that they could analyze and evaluate the employer's practices without conducting their own time studies, which was a substantial undertaking in terms of resources and a strategic risk for the union in terms of its relationship to its members (as we saw earlier with Cleveland).

Leveraging credentials: the Management Engineering department emphasized the identity of its personnel as practicing, professional engineers in order

to justify its ability to critique and participate in management practices at union shops. Some ways that the department accomplished this in the reports is by lengthily explaining the fundamental tenents of Taylorism to the readers of the memo (both the union officers and the employer). For example, in the Belle Knitting project, the report describes the micromotion techniques ("there are 17 therblings which encompass every motion that as been observed by trained investigators"), and in the Real Silk case, they (extensively) formalize the different stages and criteria for time study analysis. Other forms of credential-waving involve alluding to industrial engineering unit standards (e.g. for light), referencing academic authors and engineering texts for the employer to consult (Belle knitting, Real Silk), or explaining other professionalized practices like statistical methods (taking the average, Real silk). This strategy is highly reliant on the first strategy (transparent access to data), because once access to the data is obtained, it is possible to use that data as an empirical basis for a kind of 'proof by intimidation.' Extending beyond the reports, the department maintained and built on its credentialed expertise by compiling industry data, contributing to academic discussions, running classes, hosting industry conferences, and consulting with other unions and mediating labor disputes. As I explain later in the section, the department establishing themselves as experts in the field of industrial engineering is a key step for being able to intervene effectively on the ground.

Doing the Manager's Job: in a counter-intuitive manner for a union in general (though less so for the ILGWU, given its explicit role in reforming and stabilizing the garment industry) the Management Engineering Department appealed to management by suggesting practices that would raise productivity in the garment shop. Sometimes these practices have immediate, negative implications

for the workers – for example, at the first Belle Knitting project, the department recommended to consolidate the skilled tasks and assign them to a smaller number of operators, leaving a larger set of workers who do not have the opportunity to develop their skills to the same degree. Similarly, at Dutchess, they recommended eliminating one of the finishing positions. Sometimes the department was agnostic in a way that favored the worker, for example in another project they proposed to eliminate a poorly defined distinction between "special" and regular operators at a dress manufacturing plant, thereby allowing all operators to learn both special and regular jobs (in the report about manufacturing at Mary Muffet Inc.[19]). Sometimes the managerial recommendations had less to do with the worker (their employment and training) and more with keeping up appearances, as a source of counsel that was concerned with raising production. For example, in the Mode O' Day corporation (the first project done by the department) the Management Engineering department's first recommendation was to play music in the shop, "a device that many progressive forms have found useful to eliminate gossip during work hours") [20]).

The range of possible impacts on the worker suggests that the union was sometimes willing to make real concessions to managerial prerogatives as part of its rhetorical strategy. There are several possible explanations for this. First, it is possible that the union felt it could afford to pursue less combative strategies (like assisting management) because as an organization, the union did not need to rally support for its continued existence (the union was "here to stay" [156], protected by the collective bargaining agreements). However, it is hard to say whether the union could afford to take on this stance. In the event that the workers were (likely would be) deskilled, the union felt that their protections

[19] 5780/118 box 2, folder 10
[20] 5780/118 box 2, folder 18, p.18

were enshrined institutionally. Even if the workers became more replaceable, the union would still have power to represent their interests. Of maybe it was that the union could not afford not to take up scientific management, because protecting the health of the (unionized) garment industry was crucial for staving off subcontracting and other forms of outsourcing. It is difficult to imagine what the department would do if its goal was to stop deskilling and industrialization. This connects to earlier discussions about the union's relationship to the state of the garment industry overall: one way for labor to have a finger in the pot of industrialization is to weigh in on how it can be done effectively, as sort of compromise; however, it is important to note that in many cases, the union explicitly refused to do the manager's job, which forms the basis for the next strategy.

Identifying deficiency: in this strategy, the department identifies the deficiencies of extant management practices – but instead of filling in what has not been done, the department leverages this lapse in practice as an opportunity for the union to engage in bargaining. Part of this strategy is very simply not wanting to be abused as a technical resource for the employer (e.g. so that the employer doesn't think they can get away with using the union's resources for infinite technical support). The other part, more rhetorical, is that by identifying the deficiencies of what is already in place, the union can cast doubt on the legitimacy of current work practices. For example, in Belle Knitting, the department emphasizes the role of managements' responsibility in properly instituted Scientific Management:

"The entire method is based on the assumption that there is one best method of performing a particular operation... and that one of the primary duties of

management is to make this method available to the employees before any time standards are taken" (Belle Knitting, page 2).

Since the operators at that plant were all doing the operations in different ways, then management had failed to hold up their end of the bargain. This is also very evident in the KU and Lillan dress case, where the Lilian factory is sharply chastised in the Management Engineering report for failing to provide data, failing to standardize operations, and leaving the operators (the garment workers) to "pay for the omissions and inefficiencies of management" [21] In other cases where the management was found to be deficient, the remedy was to conduct further studies, and ultimately to consult the workers themselves, after they were trained in basic time study principles, as was the case in the Mode O' Day Corporation [22].

The overall argument that the Management Engineering department makes is that while there is some 'platonic ideal' of Scientific Management that could be implemented in theory, the employer cannot realistically attain it in practice. Since it is not feasible to do it in practice, especially not in the garment industry with its fast runs and low investment requirements, then the best the employer can do is treat the time study as a crude tool that sets the bounds for haggling (as seen in the K.U and Lillian dress case). In this way, the department uses professionalized nitpicking in order to steer employers toward working with the union and engaging in collective bargaining. I argue that this is a wager – a gamble – because it assumes that full implementation of Taylor's methods is prohibitive, and suggests that the union is only necessary because the calculation is incomplete. It is strategic to assume this position if the union wants

[21] 5780/118 box 2, folder 9, p.3
[22] 5780/118 box 2, folder 18

management to believe that they are actually "for" efficiency (and for not needing to reveal their opposition to rationalization of the workplace) but it is also a risky wager because if the employer is somehow able to fulfill the conditions of the wager, so to speak, by implementing the method at least up to the level of nitpicking raised by the critique, then the union no longer has a place in the negotiation of fair rates (which is ultimately what Taylor believed would be true if his methods were used.

So far, this section has drawn on the archival records of the Management Engineering department – its project reports for the employer and union locals, and its summary reports to the union's executive board, along with records of its correspondences with ILGWU locals in Chicago and New York. These records miss directly capturing the relationship between the engineers and the workers/rank and file union members they observed. Outside of the one stamp of "confidential copy" that appears on a report in the Chicago garment industry Kheel Center 5780/044 box 22, folder 8, p.2, which suggests that there could have been something to keep a confidential between the engineers and the union officials, we do not know what normal workers thought about the department. By Gomberg's own admission, the reports were incomplete: "it should be remembered that the Union has undertaken a huge educational task in convincing employers that scientific management techniques are applicable to the ladies' garment industry. Thus, reports very often may be incomplete. This is done purposefully lest the recommendation of too many changes frighten employers and evoke resistances from rank-and-file employees" [23] Based on earlier experiences like the ones in Cleveland and Naumkaeg, we can speculate that the department likely also occupied an uneasy role between the interests of

[23]Kheel Center 5780/118 box 2 folder 25, p.8

labor and management.

Harold Wilensky, in his 1956 survey of "intellectual" personnel in American labor unions, classifies professional engineers employed by various unions (including the ILGWU) as "facts and figures men": facts and figures men function, according to Wilensky, as people to "persuade and impress quasi-judicial boards... and promote a reorientation of the negotiators toward data" [319, p 44]. Wilensky notes that even engineers with a"cynical" perspective on the value of data were simultaneously concerned with the "assembly of impressive arguments, trend exhibits, mountains of data." In his interviews, he recounts a conversation with one "facts and figures man" who had compiled 150 pages of data and at the same time wondered aloud how anyone could be bothered to read it all. When questioned "why bother?" the engineer retorted that it was impossible to negotiate without statistics [319, p 45].

Outside of their function in arbitration and before the boards, Wilensky describes how the facts and figures man functioned in relationship to the employer, and to the union membership. The engineer appears more "responsible" and more willing to pay attention to the "facts" — but in doing so (talking about the facts), is sometimes in a position to criticize the practices of workers too, not just employers [319, p 51]. This sort of agnosticism could lead to contempt from the rank-and-file (regular union members), a contempt on top of the suspicion that comes from being observed at work (even if it is by someone from the union). Additionally, if management perceives the facts and figures man as impartial and having integrity (as they did, and needed to, for some of the strategies to work), then workers could suspect the engineer to be incapable of fully representing worker interests [319, p 51], sowing more seeds of discon-

tent between union-appointed experts, union leadership, and the rank-and-file membership.

On the other hand, the engineer could also strengthen the morale of the union and the relationship between unions and members. They could do this in two ways: first, they "take the heat" by taking over functions from the local leadership (so if negotiations with arbitrators fail, the local leadership can save face); second, if the company hires an engineer – "some hotshot in to give us some double-talk" – then it is reasonable that the rank-and-file would want the union to also "hire some guy to out-talk the sunnuvabitch" [319, p 47]. So the union relied on the facts and figures man to match the employer, which strengthened the morale of the union committee and the workers faith in the union. And so, as Wilensky describes, the engineer is left suspended between the "possible dysfunctional consequences" of his simultaneous role as both "impartial mediator" and combative union advocate [319, p 52]).

4.4.1 Changing the course of Scientific Management

Following from these case studies conducted in 1941-1942, the Management Engineering department charted forward. It continued to take on projects at specific shops, trying to advocate for workers through individual projects "with a high degree of technical complexity (or at least conceptual elaboration)" [319, p 50]. Working "within the system" of established Scientific Management practices , but in 1943, William Gomberg decided to propose a pivot in the Management Engineering department's strategy:

"Up to a short time ago, the union's practice in coping with factories

> using advanced management techniques was to secure improved earnings by stretching the existing time-study standards, largely by challenging the firm's time study accuracy. We were able to do this because of a lack of universally accepted time study method. Thus, although we were in a position to ably represent the union's interests, it was always on the basis of the firm's existing time-study methods and existing wage-incentive plan design. For some time, your director has felt the shortcomings of this policy and the need for a method of time-study analysis which could becomes the union's official plan under such circumstances. Naturally, such a plan would have to withstand professional challenge more easily than the plans which are extant at the present time" [24],

The limitations that Gomberg identified in extant industrial engineering practice where that there was little to no standardization of the methods, and insufficient education on how to do them correctly. He requests permission from Dubinsky, then the president of the ILGWU, to do research at New York and Columbia Universities. He cites his early progress: a published paper in the ASME journal, which I discuss in the next section. The paper is "highly technical in nature and formulates in a fool-proof manner our challenge of existing techniques and by publication now attains top professional standing" Kheel Center 5780/005 box 16, folder 3, p.5. He also cites two other forms of evidence that the department is already making an impact on scientific management in academic and professional spheres. First, he notes that the department had attained enough professional status that it was called upon repeatedly by other unions (the UAW and "even" the United Electrical and Radio Workers) for con-

[24]Correspondence from Gomberg to Dubinsky, Kheel Center 5780/005 box 16, folder 3, p.3

sultation work. Second, the engineers from the department were being invited by universities (and specifically, Gomberg notes, not just in sociology and labor departments, but by engineering departments) to share their practices and methods. This report of the departments activities depicts (aspiration ally) both the department's work so far and its trajectory into the future. If the earlier experiments at union shops are an effort to work within the given system framework to accomplish their goals, the move toward bolstering the department's (and Gomberg's) credentials further through more fundamental research into the scientific aspects of industrial engineering represents a desire to accomplish their goals by changing the landscape of scientific management.

4.5 William Gomberg

In this section, I explore how the first director of the Management Engineering department, William Gomberg, formalized the ILGWU's challenge to the objective nature of scientific management and charted out a version of combining data practices with industrial democracy. I will analyze his first writing on the relationship between unions and engineers published to ASME, his dissertation research, and his later research. I look at Gomberg's theory of how democracy ought to happen in the workplace, and the role of the data practices and the role of the union in this theory, and how that theory changes over time as he exits from union leadership and moves into academic work.

4.5.1 Poking holes in the logic of Taylorism

On January 14, 1943, William Gomberg presents a paper titled "The Relationship between the Unions and Engineers" to the Management Division of the Metropolitan Section of the American Society of Mechanical Engineers (ASME). The paper [25] spells out organized labor's stake in the practice of industrial engineering. The paper opens with the necessary caveats that the labor movement as a whole is not a homogeneous entity, and that a single union itself "possesses an institutional existence of its own which permits a much wider view of industry and its interests than would be afforded by one single member" (meaning that the union's own institutional history possesses it to take stances that do not represent the opinions of any of its individual members - which Gomberg frames as a good thing - but speaks to the tensions within the organization)[26].

Then Gomberg presents a brief institutional history of the ILGWU, as a laboratory for collective-bargaining techniques, paving the way for them to be adopted in other unions. Gomberg describes the pioneering efforts at the ILGWU to engage with scientific management when it was "at complete loggerheads" with the labor movement. He cites Louis Brandeis and Morris Hillquit, and their invitation of Robert Valentine (who Gomberg described as "a founder of Scientific Management", as opposed to a heretical character who pushed for consent way before the rest of the movement caught on, as he has been characterized by others within the scientific movement (e.g. in [237])). Gomberg's summary walks through Valentine's untimely death and the experiments in Cleveland, and how his department continues that earlier tradition into the present. He describes the functions of the department and its operating pro-

[25] whose reprint is located in Kheel Center 5780/118 box 2 folder 24
[26] Kheel Center 5780/118 box 2 folder 24, p.425

cedures, citing again the conflict between demonstrating the improvements of adopting their recommendations and being saddled with the full task of reorganizing a shop [27].

Gomberg asserts that the relationship between labor's engineers and management's engineers "leave[s] something to be desired" [28]- he describes how work simplification manuals make the argument for the adoption of work redesign techniques by saying that increased production is necessary for increased wages. Unions do not share this belief, and this drives the wedge between unions and industrial engineers. Further barriers are posed by "technical barriers" — which are defined as the shortcomings of the time study and the limits of its accuracy (note, not unions' misunderstanding of the techniques) and the engineering profession's "failure to police itself" with regard to the method. Gomberg complains that the profession is "content to denounce malpractice in general. It has not, to my knowledge, denounced any malpractitioners" [29]. Even, Gomberg continues, if the "conscious malpractitioners" are removed, we are still left with the fundamental variability of the time study, to which he refers to Hoxie's examination of how personal judgement affects the outcomes of what is measured. Surveying the progress since Hoxie's investigation, Gomberg asserts that the time study has made little progress towards becoming more accurate.

Gomberg takes two issues with the accuracy of the time study. The first is the use of "selected minimums" in the calculation of average times, and the

[27]Here there is an aspect of the authenticity of data collection: that the data becomes "unassailable" when it is collected with representatives from management and labor, and shared exclusively with plant manager and local union manager, exclusively to prevent misuse. I will return to the strategy of limited access to gathered workplace data again in the conclusion of the thesis.

[28]Kheel Center 5780/118 box 2 folder 24, p.426

[29]Kheel Center 5780/118 box 2 folder 24, p 426

Table 4.1: Over-all Timing Method

	Observations														
Complete Cycle	1	2	3	4	5	6	7	8	9	10	Average	Minimum	Selected Minimum	Leveling Factor	Adjusted TST
All elements	72	70	70	73	72	70	71	70	72	70	.71	.70	.705	.70	.494

Table 4.2: Elemental Timing Method

	Observations														
	1	2	3	4	5	6	7	8	9	10	Average	Minimum	Selected Minimum	Leveling Factor	Adjusted TST
Element A	4	6	8	4	10	5	8	14	5	6	.07	.04	.055	..	...
Element B	40	20	18	20	30	18	37	19	37	31	.27	.18	.225	..	...
Element C	12	8	6	10	14	6	8	7	13	6	.09	.06	.075	..	...
Element D	10	28	24	22	10	26	10	16	10	14	.17	.10	.135	..	...
Element E	5	8	14	17	8	15	8	14	7	13	.11	.06	.085	..	...
						TOTALS					.71	.44	.575	.70	.403

second is the timing of specific elements versus timing of the entire operation. These two issues interlock, as Gomberg describes. In order to raise his issues with the application of time study techniques, Gomberg reproduces time study data from an unnamed "leading consulting firm operating within our industry"which I have also reproduced below in tables 4.1 and 4.2 [30]:

Gomberg's first issue with time study practice arises from the calculations in Table 1, the Over-All Timing, where he notes that the "Selected Mean" is constructed by averaging the arithmetic mean of the observed times with the minimum time observed (71 and 70 respectively). On the basis of which statistical sampling theory, Gomberg asks, is this selected mean calculated? Gomberg is incredulous that this "selected minimum" can be more descriptive of expected

[30]C.J. Anson's 1953 survey of the time study credits D. V. Merrick [229] with invention of "selected minimums" [24, p 20]. The note on the two tables: "Reviewing these tabulations, it is observed that if only total cycle times had been recorded, a minimum of .70 min would have resulted, which is 82 per cent higher than the minimum time of .44 min recorded for the cycle under the second method. While the selected minimum time for the synthetic cycle of elements was .575 min, the selected minimum obtained by the over-all timing method would be over 22 per cent higher at .705 min. *From this it may be seen that the fundamental principle of time-study work, namely, the timing of the small elements of the cycle separately and then constructing a new synthetic cycle on the basis of selected minimum times, must never be departed from...*(Italics, [Gomberg's])

performance than the straight average. To bolster this skepticism, Gomberg furnishes another equation, describing the "law of large numbers"[31]:

$$P[(M - Exc)\frac{\sigma^2}{na^2} \tag{4.1}$$

Where P = probability, M = mean, Exc = a priori expectation, σ^2 = variance, n = any number of readings, a = any preassigned number. This equation exists to demonstrate that as the number of observations increase, the expected value will come closer to the mean.

The second issue, apart from the selected minimum, lies in the practitioner's insistence on elemental times (vs. overall time) for an operation. Taking the sum of the average (selected minimums) of each of the parts results in a much smaller total – which is explicitly hailed by the practitioner as the reason for doing the calculation by the elements. Gomberg derides this "chiseling" and speculates that, since there is so much variation in the elementary readings, there could be either a lack of standardization of the operation (ergo the job is not ready for time study) or a lack of accuracy in the observation of start and stop times during the time study. Gomberg cites NYU engineering professor Morrow's studies into stopwatch measurement [32] to point out how much deviation there has been in stopwatch observation and speculates that some of the variation could be the result of the observer, rather than the observed.

What is the "union engineer" like himself to do[33], Gomberg asks, when he is

[31]This equation appears in many of Gomberg's publications including [127, 132]

[32]not cited in the text but discussed here [233]

[33]It is interesting to contemplate how much of Gomberg's attitude toward industrial engineering is shaped by his own unique personal identity in the union engineering context. In the words of Dubinsky, up until this point "[Gomberg's] entire adult life, since graduation from college, has been identified with union service in various capacities" [127, p viii] so rather than

confronted with professional standards that guarantee an implausible amount of accuracy in the time study calculations gathered? Gomberg writes that he believes that the barriers could be lowered by "joint study and research" - pushing the ASME to partner with a university to set up "joint research programs" (joint between universities and ASME, it seems, but also that it would be wise to "secure participation from engineers working both in management and with labor so that the points of view might be compared and differences resolved.") Gomberg argues that since it took Scientific Management practitioners twenty years "to find out what the best feeds and speeds are for operating machine tools" then it is just a shortcoming of measurement to try to analyze a human being in less time. Furthermore, there remain so many outstanding questions about the nature of human work and human fatigue (and even defining human fatigue) that it is impossible to believe there could exist, at the point in 1943, an accurate method for computing rates for human work:

> Further study will perhaps eventually solve the problem, but it is a bit presumptuous for us to pretend in 1943 that we have an "accurate, scientific method of computing allowances." The truth of the matter is the we are working under severe limitations of knowledge. Hence, we cannot eliminate bargaining in the determination of rates, we can but reduce the range within rational limits [34]

This argument follows a familiar contour to the rhetoric employed by the Management Engineering department in 1941 and 1942: because adequate ex-

being an academic or a professional who was pressed to union service, Gomberg was a unionist who first worked as a clerk for and then – with an engineering undergraduate degree – eventually made it back into engineering practice through the union and only later into higher education in Industrial Engineering

[34] Kheel Center 5780/118 box 2 folder 24, p 428

ecution is impractical, union intervention is necessary. In the future, Gomberg seems to think, the problem of limited knowledge could be solved with more research (more research with people representing union perspectives). The trouble with this argument is that the employer could infinitely approach more measuring accuracy (especially in the current moment – the imagined future of Gomberg's past – for some contemporary context about the effects of more accurate, present-day implementations of scientific management in the workplace, see a section in the appendix that describes the effect of working for Amazon A) but the increased accuracy of measurement, even by worker-aligned engineers, does not in itself do anything to strengthen the workers' bargaining position in the workplace. Gomberg and the union rest their whole argument on the assumption that the data would be both forever incalculable, and that the union would forever be an institutional presence to conduct negotiations in the absence of objective knowledge (even as workers' worker-power was depleted by the automation that the workplace data collection was ushering in). In short Gomberg chose not, or felt that he could not, make a moral argument about Scientific Management having a negative impact on workers' knowledge and power in the workplace. Instead, he makes an argument that the Scientific Management techniques are not empirically accurate, and so the union is a necessary corrective until more accuracy can be attained, begging the question of what would happen if that accuracy could be attained.

Later in the 1943 article, Gomberg begins to describe his vision of a functioning industrial democracy, and the ideal conditions under which it could take place. These conditions are important because they map out the lifeworld in which Gomberg was imagining implementing his strategic appropriation of Scientific Management techniques. Gomberg also writes that the real world most

closely approached these ideal environment conditions under wartime conditions. The conditions of the ideal environment are the following:

- The worker cannot be scared of long-term unemployment
- Any temporary threat posed by technological change is cushioned by advanced social security and job training
- The worker "must feel that they are citizens of an industrial community and are actually consulted in all matters affecting their welfare" [35]

For Gomberg, the union would need to move beyond being a "beneficent despot" (that workers would not like being "ruled" by a union "who is sincerely concerned for your interests but would permit you no voice in your government")[36].

Gomberg concedes that the war limited the realization of some of these possibilities, but holds up functional management-labor councils set up by the War Production Board as examples of functioning pluralistic management. These committees are most functional when management is willing to "show off its management techniques"(e.g. are transparent) and that, conversely, the employers who view joint committees as an invasion of management jurisdiction were doing so as a sort of smoke and mirror for managerial incompetence. Again, as echoed in the case studies, transparency was key to functioning industrial democracy.

In order to explain why those committees have ceased to function, Gomberg

[35]Kheel Center 5780/118 box 2 folder 24, p 428

[36]This is notable because later, Gomberg writes that industrial democracy would be achieved by two (despotic) heads vying for the favor of the worker, the union and management – to which the worker was loyal to neither

lays out what he calls the "social barriers" – which go along with the technical barriers to the implementation of scientific management. Gomberg's idea of what constituted "social barriers" went beyond the workplace. He was concerned with the idea that workers have less faith in the value of scientifically-determined wages because the *prices* for the goods they buy are not scientifically determined (i.e. that prices are set to optimize profit, not volume of production). Meanwhile in workplace, the workers find that if they increase their rate of production, this does not bear a necessarily direct relationship to more income.

Under the conditions of wartime production, Gomberg theorized that the worker was giving more of their productivity than they would under peacetime conditions ("when he figures that he is working solely for a private employer who will use every possible means to get the most possible work from him at the lowest market price") (430). After the war, however, Gomberg cites the work of researchers Roethlisberger and Mayo — and their analysis of their Hawthorne experiments — to suggest that production would fall drastically (this would be because the workers were nervous about their post-war prospects, and the mental state governs the rate of production above all the other working conditions such as lighting etc.). Gomberg, consistent with his views on the ideal conditions of industrial democracy, recommends bolstering the social safety net, but finds that management is mostly unreceptive to this (he accuses management experts of being calculatingly cynical in their belief that widening the social safety net would amount to "feeding the 'Hottentots'" [37].

Gomberg concludes the article by emphasizing the role of engineers involved in postwar planning, that they cannot be apolitical, and if the cynical phi-

[37] In this case, we can probably assume that Gomberg is accusing management experts of covert racism by operationalizing a racist term used to refer to Black people [162]

losophy dominates, then engineers will "of necessity be responsible to irresponsible employers" increasing the conflicts between unions and engineers. Here Gomberg marries empirical deficiencies of the method with social deficiencies of its implementation under the economic system, and in doing so pushes the engineer to consider their role not only in installing the plans but in pushing for external reforms outside of the workplace.

4.5.2 Gomberg's Dissertation Work

In 1943, after securing permission from ILGWU president Dubinsky, Gomberg begins his own analysis of Scientific Management. As indicated in his report, Gomberg's departments' prior work with the department trades carefully on management's own belief in the merits of time study methods (e.g. since the method is predicated on the existence of one best way, then it is management's responsibility to train workers on it). In his dissertation work, Gomberg more extensively critiques the validity of the time study as a source of scientific knowledge for discerning physical "laws" about the nature of human work [138, 132]. Our goal in looking through the work is to analyze the rhetorical qualities of the argument - how he puts together the "empirical" argument in order to signal authority as an academic engineer. We will see if Gomberg views the deficiencies of Taylorism as theoretically possible to overcome, or not, which has to do with how temporarily or not the role of the union is in the whole operation. Finally, I survey how the argument is put together, and whether it speaks to the more essential parts of scientific management, e.g. the transfer of unique knowledge from the worker to management or whether it only refers to the measurement parts (connecting back to the malleability of the method in the

first chapter).

Gomberg's Empirical Argument

In his dissertation project, Gomberg sets out to examine the "basic assumptions" and the "rational basis" behind the time study [127, p 3]. In the most general sense, the dissertation analyzes the time study practices and, in order to verify whether the practices are scientific, compares the techniques against the requirements of scientific method. What is at stake, Gomberg posits, is that "there is no doubt that the sound solution of the fundamental time study problem could lead to the development of standard labor units... that is, if the time study technique can stand the test of scientific validity" [127, pp 15-16]. The definition of scientific method and the "scientific ideal", and the theoretical requirements these pose for scientific management, comprise the first half of the book. This is interesting because it forms the basis of Gomberg's rhetorical appeal that is necessary for him to leverage technical and academic credibility, and what is the state of "the scientific" at the time that Gomberg publishes his dissertation.

Gomberg distinguishes between empiricism and rationalism, calling one "gathering facts" and the other "reasoning" [38]. He uses this distinction to critique the Scientific Management movement for having too much of the first and not enough of the second. Gomberg derides the typical rhetorical strategy, to "begin with the facts" [127, p 18], and quotes Morris Cohen:

> It is easy for those who have not reflected on actual scientific procedure to say: Begin with the facts.But an even more fundamental

[38]Gomberg's theoretical foundation draws on the writing of Morris Cohen [77, 79, 78] and George De Santillna and Edgar Zilsel [89]

> difficulty faces us. What *are* the facts? To determine them is the very object of the scientist's investigations, and if that were but the beginning or the first stage of science, the other stages might be dispensed with. To determine the facts scientifically, however, is a long and baffling enterprise, not only because the facts are so often inaccessible, but because what we ordinarily take for fact is so often full of illusion.[39]
>
> The positivists who boast that they are concerned with only what is, like the hard-hearted statesmen or businessmen who say they deal only with hard actualities, are deluding themselves with fantastical dogmas, hiding the crudity of their ideals with the pretense that they have none.[40][127, p 20]

Gomberg accuses practitioners of scientific management of "bedeviling" time study techniques with "artificial transplantations" [127, p 20] of scientific concepts from other fields, namely physics. Taylor, Gomberg argues, imports an assumption of a "purely mechanical view of nature" [127, p 21] and that an entirely 19th century view of physics was imbued into the time study techniques. The legitimacy of these techniques traded on a superficial similarity between the elementary particles of atoms and the elementary motions that comprise work. Meanwhile, a series of discoveries (Eisenstein, Planck, Heisenberg) collapsed the mechanical view of nature, and – Gomberg argues – should have resulted in those metaphors disappearing from the social sciences (e.g. economics).

The new post-mechanical view of nature, Gomberg writes, is now non-deterministic, grounded in statistical probability, meaning that you cannot give

[39] Quoted on p 20 of [127], from [80, pp. 77-78]
[40] Quoted on p 20 of [127], from [81, p 17]

any "quantitative information without accompanying estimates of the accuracy of the observations" [127, p 23] . Meanwhile, the mechanical view of nature remains a useful concept, still providing the foundations for mechanical and civil engineering applications. Gomberg feels that the metaphors have outstayed their usefulness in the scientific management community and that it is time for the field of time study to move on from a deterministic view of nature:

> "The behavior of little Heisenberg particles is completely indeterminate in their ultra-microscopic world. In huge collections, however, they show macroscopic properties which have been systematized by our laws of mechanics. However, let us assume that we are tiny people living in a Heisenberg particle world; the laws of mechanics would be of extremely limited usefulness in guiding our everyday behavior. The accuracy and usefulness of these laws start at zero at the ultimate particle level and increase as the collective of particles increases, leveling off at a very high constant long before they reach a size large enough for us to be aware of in our workaday world" [127, p 27] .

Here Gomberg develops a criteria for variation, represented in the diagram above:

Gomberg's critical investigation of the time study rests on applying probability reasoning to evaluate whether industrial time studies are taken within a system of variable chance, constant chance, or constant cause (which correspond to the three areas in Gomberg's diagram in Figure 4.6). Gomberg says that the "most important task confronting an investigator attempting to establish a time study system would be to determine into approximately what area

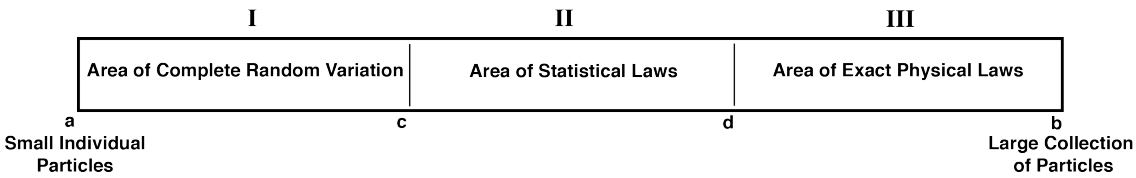


Figure 4.6: Diagram adapted from [127, p. 28]]: line ab represents the range in size of "a collective of Heisenberg particles"; Area I represents the area of variable chance; Area II represents the area of constant chance; and Area II represents the area of constant cause.

time study measurements are likely to fall" [127, p 29] . Here Gomberg appears to be arguing that one needs to understand what kind of variation one is dealing with before one can assess whether a model is "good enough" to be useful.

Gomberg's analysis is constrained to work on operations where the speed of the work is determined by the operator (this would exclude work done on a conveyor belt, and would include work done by the operator on a sewing machine). Drawing on Charles Myers's work, Gomberg divides variations into three classes: mechanical, physiological, and psychological. To these three, he also adds a fourth, more macroscopic class: the sociological. Under a mechanical view of nature, Gomberg argues, the time to perform an operation could be "solved" by setting up parametric functions (accounting for the interrelationships between these classes of phenomena)[41]:

$$X = f(L_1, L_2, L_3, l_4)$$

Where X = The time taken to perform an operation. L1 = The parametric function governing the mechanical sources of variation. L2 = The parametric

[41] these 'equations' can be found on pp 33-34 of Gomberg's thesis, published here [127]

function governing the physiological sources of variation. L3 = The parametric function governing the psychological sources of variation. L3 = The parametric function governing the sociological sources of variation. Then:

And each parametric function is dependent on sub-variables:

$$L_1 = (a_1, a_2, ..., a_n)$$

However, assessing all these sub-variables is difficult because they are mutually dependent. For example, a sociological force such as the relationship between workers and management could have psychological effects on individual workers. Because of this complexity with cross effects, Gomberg attests that mathematics "has not developed the power to treat phenomena as complex as we are handling, even assuming a mechanical view of its nature" [127, p 34]. He then substitutes the "mechanical view" with a "statistical view" in the following equation:

$$Y = \int_a^\beta f(X, L_1, L_2, L_3, L_4)dX$$

This equation represents the relative frequency that time taken, X, falls under the limits (a and β) "provided we are operating within an area of statistical control" [127, p 35]. Statistical control would allow one to make predictions about the behavior of the entire system without having to understand or account for the interrelationships needed to "solve" the mechanical equation. Gomberg's thesis then turns to the examination of this statisical control. Is it possible to stabilize the subvariables of mechanical, physiological, psychological, and sociological variables to establish a "constant chance cause system"? [42].

[42]Gomberg compares a constant chance cause system to drawing chips from a bowl[127, pp 35-36]

Gomberg's central thesis here is that one needs to demonstrate the existence of this state of statistical control in order to infer any "reasonably certain" result from the time study. To what degree, he asks, are we justified in assuming that physical causes in a normal industrial environment are stabilized where we can attribute variation to a constant chance cause system? To answer this, Gomberg assesses the sources of mechanical, physiological, psychological, and sociological variation. And he does this in the subsequent chapters of his dissertation.

Mechanical variation describes things such as the quality of tools used and the consistency of materials. Wartime conditions, the time that Gomberg conducted his thesis, highlighted the unpredictability of mechanical factors. What could once be fitted to a constant allowance was constantly in flux due to abilities of material (fabric, yarn - like in Belle Knitting, and steel for cutting tools). Gomberg also describes several more subtle mechanical factors that affect the physiology of the worker (rest periods, temperature and humidity) that are difficult to account for without a more detailed study of the worker.

Physiological variation (workers' nutritional habits, sleeping, muscular development) further pose measurement difficulties for the engineer because most industry standard measurements of workers fatigue are defined by reduced output which is tautological. Here Gomberg draws a comparison between human physiology and machine maintenance: you would not be able to rely on the speed of the machine until it breaks, you would conduct a metallurgic study of the parts. Otherwise you would wrongly conclude that everything is wrong until its not. But you cannot study a human being like this, except for some promising research (at the time) in measuring physiological stress by studying the excretion of hormones in the brain [127, p 170] . Fatigue opens up longer-

term questions about long-term effects, aging etc. for which there are also of course no production standards.

Psychological variation describes elements such as manual dexterity and reaction time. There is a fundamental tension here between measuring workers relatively to assess their differences and the drive towards the "one best way" standardized procedure of doing things. There is an observed effect of workers' emotional state on their production and Gomberg notes that it is difficult, in time study settings, to know if workers are working at the rate they are because their motivation is liberated by the incentive scheme or if they are withholding their labor for various reasons. This makes the time study of questionably useful accuracy. Social forces, the sources of sociological variation (e.g. effects of the relationship between workers and foremen) also determined to what extent the "motivating drive" could be liberated.

Assessing all sources of variation (mechanical, physiological, psychological, sociological) and using industry-standard statistical control techniques, Gomberg concludes that modern industrial time study techniques cannot make claims to scientific accuracy. The summary of his argument is that all of the variables cannot be stabilized, at this point in time, to the degree that the system can be seen as a constant chance system. Gomberg argues that the variations fail to fall within accepted standards of statistical control. Somehow the whole argument winds down to the fact that the margin of error on the tiny study was in excess of the 5 percent which they had set as "workable criterion" and – the actual margin of error was deemed "indeterminate because of the variability of the chance cause system" [127, p 187]. Gomberg yet again reaches the conclusion that modern industrial time study techniques, as they have been implemented

so far, cannot make claims to scientific accuracy: *they are at best empirical guides to setting up a range within which collecive bargaining over production rates can take place*.

How does Gomberg imagine the process using the time study as a tool for setting the range for collective bargaining? Rather than having rate setting as an inherently unilateral function of management, Gomberg argues that labor should play a role. However, this role should not be direct participation, as had been previously recommended, where a trained normal worker would perform the time study alongside management. Gomberg cautions against joint-rate setting by rank-and-file workers, unmediated by the union, because of his concern that time-study "trained" normal worker could become brainwashed by the managerial assumptions of the time study, resulting in them becoming "a hostage of the management" [127, p 173] . Another consideration Gomberg raises is of ensuring that the person doing the time study not be paid by the employer. He cites the Cleveland case for this, echoing Sumner Slichter's analysis that the time study men felt loyalty to the employer who paid them. Instead, the unions' time study technician should be paid by the union[43]. Next, Gomberg presents two options: joint rate setting, or the management sets the rates and the workers can reserve the right to complain through the union. Which strategy the union takes, based on Gomberg's experience, is dependent on the situation. It may be worth the resources to do joint rate setting when a lot of workers are affected, but for smaller union populations, the latter approach is more effective (e.g. whether the dues are enough to sustain the technical work). Gomberg also writes that, in his opinion, the role of self-expression though joint rate set-

[43] A cynical reading of this is that Gomberg was trying to secure a meaningful place for himself and his department within the union organizational structure, but both of his concerns also seem reasonable from the perspective of the union overall

ting and whether it makes the worker more harmonious is overemphasised by worker participation fanactics [127, p. 179]. Workers, Gomberg writes, can self-express through becoming a member of the union, a member of management, or just outside of work. This view of participation is something he will return to in his later writing (and I will return to it later in the chapter as well).

Though he believes that there are universally applicable rules for how the union ought to engage with the time study, Gomberg emphasizes that the union itself needs to needs to be secure. With regard to the future, Gomberg writes:

> Should future development of the time study technique indicate the possibility of a narrower band of accuracy for more systematic methods, at that time these approaches will be revised (180).

This was a strategic tabling of the question of what to do for later (though it is not clear that some of the things he claimed could be measured in theory could actually be measured in the present. e.g. the ketosteriods). Ultimately, the procedures described by Gomberg "constitute attempts to live together industrially" – they cannot yet be formalized. Ultimately this gives a wide berth for unions to try different tactics, at least for the moment that measurement techniques were lagging.

Gomberg's dissertation was reviewed by Paul Pigors in "Mechanical Engineering: the Journal of the American Society of Mechanical Engineers" [248]. The review surveys developments in labor-management cooperation and generally praises the work of labor "statesmen" like David Dubinsky and Walter Reuter, for concerning themselves with improving industry efficiency and developing co-operative relationships with management. Pigors describes

Gomberg's book as "challenging" and justifies its inclusion in the article for two reasons: the first is that Gomberg is a unionist and a director of Management Engineering at the ILGWU, and "the existence of this institution itself is convincing evidence of a progressive union's interest in scientific management"; and second, because of Gomberg's "dispassionate and scholarly" analysis of the time study:

> Heretofore, unions have ranted against [the time study] instead of studying it with scientific detachment.... Dr. Gomberg's book is of importance to the broader field of industrial relations. It suggests a method by which labor and management can get together. It provides management with a carefully documented and reasoned statement of a union's attitude toward time study. And by training and experience in setting production standards, Dr. Gomberg is well qualified to make such a study. It is immaterial whether or not management representatives accept all his conclusions. If management experts disagree they can effectively challenge his conclusions only with scientific statements. Whenever management and labor can meet on this objective plane, talking sense rather than sentiment, there is hope for genuine and lasting progress (534).

Gomberg forwarded this review to Dubinsky, along with the article that follows the review in "Mechanical Engineering: the Journal of the American Society of Mechanical Engineers" (ASME), on the merits of industrial decentralization as an important step in staving off the authoritarian doctrines of communism with the note that "I wanted you to know that the circulation of the magazine is confined to the most reactionary wing of our population. I don't

mean conservative, I mean reactionary" [44]. For Gomberg, for this review to be written and published in the ASME journal is a signal that his rhetorical tactics are working – his credentials cast the union in a legitimating light, his use of data-driven arguments makes him appear "dispassionate" – and maybe more surprisingly, Pigors believes that the book lays out a program for what is to be done to resolve conflict between labor and management. In Gomberg's own writing, however, the formal analysis that is used to diagnose the problem deliberately (strategically) does *not* extend to stipulating what unions ought to do, except for having a role in the use of Scientific Management Techniques. Yet, Pigors reads the writing as having a solution anyway, perhaps because a halo of scientific legitimacy extends from the manner in which Gomberg diagnoses the problem to his recommendation for how to solve it.

However, not all the reviews of Gomberg's dissertation book extend the same reading of his rhetorical tactics. Another review, written by Donald Schoeller and published in the Annals of the American Academy of Political and Social Science questions the goal and the intended audience for his work [272]. Schoeller cites Gomberg's expertise (both in practice and in terms of his academic participation) and positions him as presenting a "well-thought-out and seasoned slant" to the discussion of the time study (for which there exists "no sterner critic" than Gomberg). He writes that Gomberg puts forth an extremely meticulous effort into his data analysis ("over 350 sources of data are acknowledged" and "nearly every page contains a quote of some kind") but expresses frustration that Gomberg does not move beyond "destructive criticism" [272, p 159]. Schoeller also expresses uncertainty about the intended audience for the work, as the highly statistical approach is, by his assessment, incongru-

[44] Kheel Center 5780/002 116, folder 4

ous with the average rank and file union member as well as the average time study practitioner. Yet for a statistician or a psychologist, the book points out how the gaps in knowledge result in practical issues when implemented on the ground (e.g. neither are the gaps useful nor are they somewhere where people can intervene?). Schoeller's interpretation of Gomberg's conclusion is that he's attempting to inspire time study practitioners to "look over their techniques and make an honest attempt to develop better ones, or if that is not possible, to subject rates to collective bargaining" [272, p 160]. There collective bargaining really sounds like a fall-back option, presented because Gomberg has nothing better to offer. This illustrates a risk with Gomberg's wager, even as the new techniques are still to come, collective bargaining acts as an unsatisfying bandaid solution (as opposed to a moral or democratic right).

Gomberg's book is also reviewed by Ralph Presgrave, an author of several books on the time study [251]. His review falls somewhat between Pigors and Schoeller, he introduces Gomberg as having bias that cannot be doubted ("the title alone gives indication of that") but praises his work for being objective and dispassionate. The "restraint" of his tone allows Gomberg to reveal the "pretenses and errors of a system that has spread far and wide but is still suffering from growing pains" [251, p 439]. Presgrave, like Schoeller, complains that Gomberg quotes liberally and sometimes out of context, but unlike Schoeller, Presgrave finds Gomberg's "solution" to be clear: "if the margin of error in a time study is greater than the minimum wage change reached by negotiation, then it is not realistic to exclude rate setting from the bargaining procedure" (though he does lament that Gomberg does not go "as far as he is capable of going" in saying how the margin could be reduced). So in sum it appears that the rhetorical strategies we see in Gomberg's dissertation have mixed results. At

best received, they legitimate Gomberg's agenda with the union, but with some chance of being too heavy-handed or failing to provide satisfying alternatives (e.g. ones that match the rhetorical style of the problem diagnosis).

This is not the first time that Gomberg was unable to make good on legitimating his stance as a critical engineer. In September of 1941, before any of his academic work on the scientific merit of the time study was written, Gomberg submits his application to advance from junior to full member in ASME using reports from the projects undertaken by the Management Engineering department in 1941-42. In 1942, Gomberg visits the society headquarters and is examined as to whether he is actually engaged in "an engineering job or what [the examiner] considered a straight bargaining function" [45]. At the suggestion of the examiner (Dean Sackett), Gomberg submits a statement explaining the materials he had previously submitted in his application for advancement. From then, Gomberg engages in a several year long back-and-forth with the society. He is first rejected from full membership, appeals, and is unsatisfied with his subsequent advancement to associate member (an associate member "need not be an engineer but must have a record of recongized leadership in some profession, or branch of industry, or science related to engineering, and shall be qualified to cooperate with enginers in the practices of their prodession").

Gomberg resubmits copies of his application and correspondence with the society, and correspondences about his advancement case between the society and an engineering professor. Gomberg compares his record of work with the work done in the gament industry by other engineers (namely Morris Cooke) to argue that his impact has been on a much wider scale. Upon reviewing the list of advanced members, Gomberg also accuses the reviewing committee of har-

[45] Kheel Center 5780/118 box 2 folder 25

boring "economic prejudices" — in short, he feels that his engineering work has not been evaluated fairly, and rather that he is being held to distorted criteria.

"I am bringing these matters before you because upon them hinges to a large measure, the attitude of engineers engaged by labor toward the society. The society is not a private social club. It claims a quasi-public function. It wants its codes of practices recognized as authoritative whether promulgated in the fields of power engineering or industrial engineering. The success of the society in promulgating boiler codes has been based upon the participation of all interested parties in the field on an equal basis. The success of the society's promulgation of industrial engineering standards must likewise be based upon equal participation of all interested factors.... It has taken years, and we are not wholly successful yet, to get labor to accept the objectivity of industrial engineers. Such actions... overcome all our effectiveness in this field."

It was obviously important for Gomberg to advance within ASME, specifically to be seen as a professional engineer. The society, in refusing to validate his work on engineering merits, threatened the union's strategy of influencing the field of professional engineering. It is possible that this moment of tense conflict with the professional societ was also an instigation for Gomberg's decision to conduct additional research to write and publish his thesis, as an alternative mechanism for achieving legitimacy within engineering circles. In any case, it points to the ongoing difficulty that Gomberg and the ILGWU faced in maintaining the professional legitimacy of union-appointed technical expertise.

4.5.3 Bigger picture view of the Manager's tools at ILGWU in 1940s 1950s

Gomberg continues his work with the ILGWU Management Engineering department until 1956. In that time he publishes several papers on the relationship between unions and engineering techniques. "Union interest in Engineering Techniques" is published in 1946 to Harvard Business Review [135]. This paper critiques management approaches that exclude engineering techniques from the field of collective bargaining. Gomberg cites his own experiences and summarizes the technical weaknesses of the techniques. Towards the end of the paper, Gomberg makes an interesting argument for why unions ought to participate in the rate-setting process: he says, as Sumner Slichter had argued previously, that unions may think it is wiser to refrain from participating in rate-setting in order to "avoid any stigma that arises from the necessity, frequently enough, of telling a worker that his particular complaint is unjustified; non-participation in these techniques leaves the union representative in the luxurious light of always appearing to fight for more" [135, p 364]. Gomberg however argues that at some point, the union's arguments "will have to be related to some logical basis – and by means of an approach that will parallel management's efforts... it is just as well to tackle such matters at the level of participation from the outset and thus avoid a tremendous duplication of effort" [135, p 364]. Gomberg expresses his skepticism for the use of "non-financial" incentives, again arguing that management strategies that stress "self-expression" overemphasize its importance compared to financial incentives. He concludes that management function can only be improved if it has to interface and collaborate with unions on management functions.

In the same year, he publishes an article on Uunion participation in high productivity, which outlines the conditions where unions accept "high productivity techniques" – this article echoes earlier arguments about the conditions in which workers will participate in work redesign: a degree of acceptance of technological advance, an absence of short-term fear about being made obsolete, an industry (like the garment industry) where a worker can identify the importance of keeping the shop "competitive" etc. [136].

In 1949, he publishes an article on Job Evaluation and Wage Incentives to the Proceedings of New York University's first annual conference on labor: issues in collective bargaining and Taft-Hartley Act [129]. The conference agenda was guided by matters of "immediate and practical interest" arising from the Taft-Hartley Act, labor arbitration, and the problems arising from the establishment of health and welfare funds, job evaluation, incentive wages, and defining the proper areas of collective bargaining. Gomberg's paper addresses the challenges and pitfalls of job evaluation (when the industrial engineer evaluates the difficulty of the job in the "job hiearchy" to determine base rate, whereas time study determines the normal productivity rate) and wage incentives (the installation of "so-called premium pay"[129, p 40]). Gomberg gives a history of job evaluation where, like the time study, the technique was first positioned as firmly anti-union but more recently, its practitioners have become interested in working within the framework of collective bargaining.

The question he asks is whether trade unions could use more technically complex techniques as effectively as informal ones. Gomberg breaks down union sentiments on this question into three attitudes: complete rejection, "coyness" (an approach that emphasized the importance of transparency into man-

agement function), and full joint participation in the technique by the union and management. Though job evaluation should not be used on its own to determine rates, Gomberg points to transformations of work, such as section-work, as necessitating a method for establishing job rates. Under whole-garment production, all sewing could be paid the same rate, but under section-work, something needed to be done to understand the skill values of different sewing jobs.

Unsurprisingly, unions who opposed job evaluation felt that the adoption of job evaluation processes encourages the process of "job dilution" (when skilled jobs are broken down into smaller jobs for the purpose of hiring cheaper labor). Unions also felt, as Gomberg summarized, that the techniques were based on "unwarranted assumptions" and seemed to favor management instead of labor. The argument for union participation is that that it would help to formalize what is done unconsciously, and provide a counter-proposal to management plans. Advocates of joint participation, Gomberg writes, also believe job evaluation can resolve disputes within its own members, and that being "in on" the project put the union in a better position to argue for its position in terms of the job evaluation system. The conference paper also includes the subsequent question and answer period in which Gomberg directly evades answering whether he is in favor of job evaluation or not, but does affirm that unions should participate in setting standards for rates. Gomberg also explains that the main work on job evaluation that he's done has been while "on loan" to other unions, as the garment industry's work classifications have been small and simple enough that simple job evaluation plans (ranking and classification) had been sufficient.

Gomberg continues to write on the topic of Job Evaluation in the Journal of Applied Psychology [133]. For this audience, he is more adversarial in his

depiction of job evaluation and its potential as a tool for managerial control. He draws on this experience working on different job evaluation schemes to assert that the trade unionist "looks upon job evaluation as a subordinate tool in collective bargaining"; that it "determines a limited concept of job content"; that it is defective in measuring job content and that more abbreviated plans are the same level of deficiency but more practical to implement; and that the biggest merit to job evaluation is the research that it does to reveal and formalize the intuitions that had governed each party's concept of workplace equity in the past, making them more usefully available for collective bargaining [133, p 7]. It is interesting to note the contrast of the two tones and audiences in this writing. For an academic audience, Gomberg positions the labor movement as being uniformly and rightfully skeptical. To a labor audience, he is more nuanced about the shades of support for industrial techniques and in some ways more evasive about this own stance toward them. In addition to publishing in different academic venues, Gomberg continues to give lectures and workshops on the topic of industrial engineering and labor. In 1943, Gomberg writes to Dubinsky that he has provided the materials for "the first engineering conference held under union auspices"[46] - and to be invited to speak in universities, not at "trade union institutes and social science classes, which have customarily invited representatives of trade unions to present their sociological point of view" but at engineering schools, which are "actually interested in our technical procedures" [47]. Between 1941 and 1956, Gomberg gives several talks at universities including Northwestern and the Illinois Institute of Technology [9, 4]. In 1951 he presents about the New York Dress Industry on NBC radio [48], speaks

[46]Kheel Center 5780/005 box 16 folder 3

[47]Kheel Center 5780/005 box 16 folder 3

[48]Available for listening here: https://www.oldtimeradiodownloads.com/historical/the-people-act/a-cloth-of-many-colors-1951-02-03

at various ILGWU locals (e.g. twin cities), and presents at ASME as well as the Pacific Coast Management Conference [49]. In maintaining this public face to professional and academic societies, Gomberg boosts the credential of the ILGWU as a technically and academically relevant resource (though this is not without some friction within the professional engineering community, as I will discuss later). Speaking at union locals also affirms this expertise internally. It would not be unusual for the Management Engineering department to do work at a plant and also give a public seminar somewhere locally to discuss challenges in the industry [5].

In 1948, Peter Segel writes a masters thesis documenting the practices of the Management Engineering department at the ILGU in his survey of labor participation in time standard determination [274]. He draws heavily on Gomberg's early writing to explain unions' resistance to the techniques and the trouble with union stewards' participation in the plans [274, p 35] – the central question that Segel poses is whether unions ought to wait until time studies are completed to pass judgement on their adequacy, or whether they ought to "become involved in the regulation of the methods used in arriving at these standards" [274, p 92]. Segel characterizes the active participation in industrial techniques of Gomberg and the Management Engineering department of the ILGWU as "unique" (though "neither the product of naivete or false reasoning") [274, p 94]. But, by the time that Harold Wilensky writes his thesis (in 1955), on the Staff "Expert" intellectuals in labor unions, full-time professional engineers (self-categorized as "window dressing" (p51 in thesis version)) are retained by four national unions: ILGWU-AFL, USA-CIO, TWUA-CIO, and UAW-CIO [319, p 77]. In the second edition of Gomberg's trade union analysis of time study,

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Gomberg describes Management Engineering departments at the UAW and textile workers, along with other unions that retained engineering specialists. So basically over the time that Gomberg worked in the Management Engineering department, analogues of his role proliferated across other unions.

In addition, Wilensky writes "most" of the unions he surveyed have used outside consultants for engineering disputes. Gomberg documents his role as such a consultant for other unions. In his reports to Dubinsky, this is another form of a credential boost for ILGWU in the eyes of other unions. It is a signal that the department has attained "such professional status to be called upon repeatedly by the United Autoworkers and even the United Electrical and Radio workers" and a recognition of their ability to contend with "top flight consulting corporations"[50]. But in this consulting work, Gomberg was not above critiquing the practices of labor unions who were attempting to subvert or "throw out" a wage incentive plan, demonstrating that his loyalty to the unions was not indomitable in the face of bad industrial engineering practices [51].

It is not surprising to note that Gomberg's position on working with and reforming the job evaluation and time study techniques is not universally held within the labor movement itself. The "cooperation fever" of the interwar years (as described by Nadworthy [237]) had passed and organized labor, which was never homogeneous in its support of scientific management, was weighing the benefits of leveraging industrial engineering techniques. As Boris Shishkin, then economist for the AFL, writes, even unions did find themselves in positions where they could participate, for example, in job evaluation program, "they find themselves hopelessly out-flanked and out-maneuvered by the su-

[50] Kheel Center 5780/005 box 16 folder 3, p.4

[51] see more in trade union analysis of time study 1955 edition, p 261 [132].

pervisory management personnel on one side and job evaluation technicians on the other, all of them equipped with facts and technical ammunition to which the union has no ready access" [279]. Solomon ("Sol") Barkin, who worked as the director of research at the textile union, argued that the job evaluation methods reflected Management's prejudices, because of "the fact that few plans acknowledge the propriety of paying a higher rate for more productive equipment even if they job requirements do not change" [34]. Barkin felt that this ran counter to the largely palliative management assertions that the benefits of new technological improvements should be shared with the workers.

The final chapters of a union manual about job evaluation written by Gomberg are devoted to a reprint of a debate [140] between Gomberg and Solomon Barkin, the director of the research department at the Textile Workers Union of America. Barkin explains how rate setting techniques are biased toward management, and argues that adherence to the "management's tools" weakens the union's position in collective bargaining, as rigid formulas for calculating rates restricts the number of factors the union can raise for review [140, p.70]. Gomberg responds that the way forward is not to fight the tools, but to "reshape [them] into a more useful collective bargaining instrument" [140, p.73], calling on the labor movement to establish an industrial engineering research department to perform this work on behalf of unions. The debate captures a deeply variegated faith not in the validity of industrial engineering methods, but in the labor movement's ability to appropriate them for workers. Gomberg's stance comes across as painfully conflicted: he knows very well the methods are skewed towards the employer but still feels that he must advocate for union participation in them. How much is this (especially the emphasis on research) self-serving? On the other hand, if it was not self-serving, what must he have

seen as the alternative?

4.5.4 Scientific Management and Industrial Democracy

Several years later, Gomberg engages in another back-and-forth which is useful for understanding his position on unions, participation, and management. He publishes an article in Trans-action Magazine with a very acerbic critique of participatory management and of Kurt Lewin's famous experiments in participatory management at the Harwood factory [52]. The article [128], which is written in a somewhat colloquial and adversarial tone, compares the "value structure" of democratic management – specifically as proposed by Philip Slater and Warren Bennis – with the authoritarian tenents of Fredrick W. Taylor's methods and the lack of "checks" on the arbitrary judgement of management (i.e. saying that the new techniques of "democratic" and "participatory" management are no less authoritarian than Taylor's approach to management). Gomberg sees the "participatory" aspects of participatory management (e.g. without unions and economic participation) as "benevolent autocracies" that rely on the 'good will and good sense of the power wielder to show self restraint" [128, p. 31]. In contrast, he writes, a "true" democracy would require external checks on the autocrat "outside of his institutional boundary" – and here, unions (naturally) serve as an exemplary outside industrial organization that would "compete" with the employer for "superior status and superior knowledge" [128, p. 31].

Gomberg takes aim at efforts to decentralize management decision-making to the "grass roots" – one aspect of participatory management – by pointing out that so-called decentralized firms may decentralize marketing and production

[52] For more details about these experiments, see [92, 184]

but generally not finances. Then he goes after another tenent, of group dynamics based on the philosophy of Kurt Lewin. For Gomberg, the shortcomings of Lewin's approaches are that they avoid the power structures of industrial democracy and pose an implicit moral issue: "a second [shortcoming] lies in the implicit morality attending the use of quasi-psychotherapeutic techniques for industrial purposes" [128, p. 32]. His insinuation here is that the use of participatory management techniques constitutes deceitful psychological manipulation of the worker.

Gomberg brings up the Harwood experiments – a series of experiments in participatory management that took place in the Harwood Pajama Factory in Marion, Virginia – as an example of involuntary manipulation. Based on his personal knowledge of union organizing efforts that took place at the factory around the time of the experiments, Gomberg asserts that what management and behavioral scientists called "worker participation" was experienced by workers as manipulation. The general goal of the experiment was to show how worker participation in group decision-making would lead to increased productivity. In Gomberg's retelling of the Harwood experiments, is that the experiments proved that meetings of worker "representatives" with management purportedly raised productivity but also functioned as a managerial device to destroy the solidarity of the group.

Gomberg alludes to his own department's experience being directly touched by this experiment, as he writes that the president of the company, Marrow, went to meet an elected union shop steward with "a member of the union's engineering department". The summary that Gomberg gives at the end of his article is that since corporations are charged with the task of economic perfor-

mance, then a truly democratic corporation would checks and balances on the economic function of the company, and not the task of the "emotional rehabilitation" of its employees. He urges readers who are interested in democracy not to confuse "a benevolent paternal style of velvet-gloved autocracy" with the distribution of real (economic) power.

Warren Bennis writes an article in response to Gomberg, where he argues that his description of the experiment was a mischaracterization of what happened [42]. He writes that Gomberg had implied that the factory was unionized in record time in response to the experiments, when in reality they already had the ability to exercise due process through their union since they were already unionized. Gomberg responds to Bennis that the experiments were initially conducted in a non-union factory, and then the union was not made aware of subsequent experiments. Marrow also responds, mostly to deny that unionization occurred in response to the experiments and that the union contract had no provisions to protect workers against the alleged manipulation. Gomberg disputes the timeline and cites grievances filed to his office at the time of the later experiments as events in a sequence of rising tensions that culminated in a work stoppage, which necessitated the visit to the plant by the union engineer. Gomberg concludes his response with a statement that he had contended "from the begining" that management wasn't consciously and deliberately manipulative, but just unperceptive. This has been cited as Gomberg being beaten down into saying that the experiments "were not really democracy" and that the management and scientific were not being deliberately manipulative [184].

The precise details of this narrative are explained in more detail in Daniel Bell's writing [40] and re-explored more recently in Desmond and Wilson [92]

and Christopher Kelty's book on participation [184]. The stance that Gomberg maintains throughout the articles, when compared against his other writing, about participation and productivity illustrate the bind that he's in. It is clear that he is genuinely interested in raising productivity in the interests of stabilizing the industry. At the same time, he is also deeply offended by efforts to raise productivity that are not made explicitly and did not interface with the union. How much of the former (lack of transparency) really had to do with the latter (going through the union) has to do with Gomberg's concept of industrial democracy at work. He was (self-avowedly) not a Marxist[127][53], but even Marxist or Communist-led unions, to Gomberg, are led to serve the economic needs of the members:

> When a union is attempting to establish itself in its early developmental stages, it attracts a wide variety of people. The great majority are workers primarily interested in improving their working conditions. Some of these are dedicated idealists who look upon the trade union movement as a lever which will enable them to reconstruct society along models which they have developed out of either a Marxist or some other revolutionary philosophy.... Sooner or later a conflict develops between the elements in the union who are attempting to serve the economic needs of the workers and those people who are dedicated to the use of the organization to promote the needs of their new model society. Very often the very leadership who may have come to power because they were driven by the idealistic

[53]Gomberg had been an activist member of the Socialist Party, but like many members of the ILGWU, he later very personally and professionally kept his distance from left-wing organizations. The former is illustrated by his personal correspondences archived at UPenn and the latter is demonstrated in Gomberg's writing.

> vision of the new society they were going to create find that they are the victims of a new schizophrenia. They must choose between the immediate economic needs of their members and the long term requirements of their vision. The United States democratic atmosphere, which has always been pragmatically anti-ideological, leads them, if they are to remain as trade union leaders, to the satisfaction of short run economic ends [127, p. 8].

Instead he saw the union and the management as two somewhat paternalistic institutions that competed over doing the best management function, and the worker was only to have medium-levels of loyalty to either of them:

> Democracy is essentially a means of distributing power in society so that no single institution–political, social, or economic–is able to dominate the complete society. More often than not, these institutions, whether trade unions, business enterprises, or professional organizations, constitute oligarchies that receive and are only entitled to receive a partial commitment of their constituents' loyalty and interests. Those same people are committed to different organizations at different times depending upon which of their needs is being served. The same person is associated as an employee with a business enterprise, as a voter with a political party, as a professional with a professional society, etc. Democracy is served when all of these institutions strive to outdo each other in relative achievements, in an instutionalized climate, so that no single institution receives, or is entitled to receive, a full and absolute personal commitment from anybody [134, p. 30].

In order for this institutionalized workplace democracy to work as Gomberg imagined, the union had to be strongly institutionally established, it had to be able to access information about the workplace, and it had to be able to engage in both formal and informal processes to intervene in management function. This stance encapsulates how Gomberg understood his role within the ILGWU and what was required, institutionally, for the union to be able to wield the management's tools (e.g. working with and making recommendations using worker data).

4.5.5 Data Rhetoric and Mutual Gains participation

Within this framing of industrial democracy, the coexistence of formalized scientific language in the department's academic writing, along with the bottom-line oriented calculations of their daily work illustrates the department's varied, rhetorical use of data-driven arguments (what I have termed "data rhetoric"). The union aimed to enlist management cooperation by offering practical solutions to improve efficiency while using impressive tracts in the language of the hard sciences to bolster the legitimacy of organized labor's intervention on industrial engineering within academic and professional societies. Participating in these procedures not only gave the union rhetorical leverage to contest management decisions, but it also allowed them to work with management to accomplish shared goals. These goals were to use industrial engineering techniques to raise and stabilize wartime production across the garment industry [324]. The ILGWU's practice of 'in-house' engineering work, characterized as a mutual gains approach [242], illustrates an uneasy alliance between scientific management and organized labor, complicating the easy association of Tay-

lorism with management control and exclusion of employees from workplace decision-making.

Early Taylorist arguments for the separation of work's conception from its execution rested on lengthy justifications about how workers were incapable of, unable to afford, and could not be trusted to conduct the science of measuring and developing their own work methods (thus making necessary the role of management) [54, pp.79-81]. While the mutual gains approach could arguably be seen as a moment when unions gave in to managerial logic in order to secure short-term benefits, another interpretation is that organized labor's participation posed a challenge to scientific management's fundamental principle of the division of labor.

Organized labor taking on the mantle of industrial engineering offers a vision of workplace democracy centered on worker participation in management decisions. In theory, mutual-gains participation bears a strong resemblance to the ideals of participatory design (a design method that emphasises participation from all stakeholders in the design process, at all stages of the design process). However when held against the model of participatory technology design, the nature of worker participation practiced by the Management Engineering department was far from 'participatory'. The department was not seeking to achieve workers' participation in designing the optimal work processes but instead sought to use engineering methods to secure immediate material improvements for workers in rate setting and incentive structures. The execution of the time study also relied on the intellectual work of the "union expert" staff who represented the worker [174] but were not garment workers themselves (occupying different positions both professionally and socially).

4.5.6 Gomberg after the ILGWU

Gomberg had set out to reframe the landscape of industrial engineering techniques; however, it is more likely that in the long term, his own understanding of the role of unions in scientific management was reframed more than any techniques themselves. In his 1957 thesis, David Baker writes, on the influence of the unionists on the techniques of scientific management, that the methods were only modified situationally, in the process of negotiation between management and labor, and remained unchanged as techniques themselves:

"It is probable that neither the criticisms of time study, job evaluation, and wage incentives systems nor their incorporation into the realm of collective bargaining had any significant effect on these techniques. For the most part, these techniques were incorporated into industrial relations as modified and developed in the working relationships by negotiation" [27, p 184].

In 1968, Gomberg, now no longer the director of the Management Engineering department, writes a paper reflecting on the role of the ILGWU in stabilizing the New York garment industry [137]. In this paper he reflects on the impact of industrial engineering on the workers of the ILGWU. He begins with describing the impact of industrialization in the garment industry – in the domains of transport and communication – on the outsourcing of production from New York City to less organized manufacturing sites outside of the city and around the country [137, p. 72]. Here he writes very candidly about the impact of industrial engineering on the craft skill of the garment worker:

"Their monopoly of talent has been eroded by the industrial engineers, who have charted methods and instituted training programs that have transferred

from the workers to the management. The introduction of 'section-work' has deprived the old time operator of much of his or her craftsmanship" [137, p.72]

Gomberg explicitly describes the impact of automation (through section-work) on the gathering up of the unique knowledge of the worker and its consolidation under the purview of management ("transferred from the workers to the management") It shows that Gomberg understood that the bigger problem with the methods of industrial engineering was not that the methods were unscientific, it was that the process of automation that the methods supported ultimately decreased the power of the worker. Earlier in the chapter, I discussed how the identity of the garment worker changed from the Eastern European immigrant and the Italian to "the Puerto Ricans and the Southern Negroes." The question then was whether, with reduced unique knowledge, and with easier access to alternative production via outsourcing, the union would be able to continue to apply its professional expertise in order to protect the industry and secure short term gains for the worker. This eventually got much harder. [54]

This is not the first time that Gomberg was outspoken about the negative impacts of automation or the limits of automation thinking [131]. After exiting union service, Gomberg continued to write about the role of automation in industrial labor relations - concerned with "who ought to pay the burden of technological change" [316]. This writing centered on two concepts, featherbedding and work rules.

In his writing about work rules, Gomberg frames a worker's job as a "property right": he describes how a unionist seeks to protect workers' jobs using

[54]Gomberg's article on Union Policy Experimentation [137, pp. 80-81] discusses a concrete instance that occurred where the industrial engineers were employed to come up with a section rate plan that then became the basis for a contractual apparatus that frustrated local union decision-making and put tension between different different regional parts of the union.

health and safety type arguments to couch but "in the back of the mind of the trade unionist there is a property right he is trying to assert" [139]. The difference here, I would say, is how Gomberg would talk about the relationship between professional standards and workers jobs in his earlier writing – e.g. both in this writing, how an engineer must be prepared to tell the worker that they are being unreasonable, and more ideological than what they actually did in practice, which sometimes did involve calling for the elimination or reduction of some jobs). This, Gomberg says, the union used 'health and safety' as a workaround for not openly attacking that management implicitly assumes that it is entitled to workers' effort "just sort of his physiological and psychological limits" but by dealing with the job as a property right could allow explicit collective bargaining. The difference between this article and Gomberg's earlier rhetorical approaches is that here he links job retention (the property right) – what unions were fighting for implicitly – with financial costs to the employer, saying that it "would be silly and pointless to deny that work in many cases could be performed more cheaply if these property rights and the penalties for their violation did not exist" [139, p. 595]. Before, Gomberg wrote with confidence that benefits to working conditions could be married to industrial efficiency for the employer, now he does not engage with that argument. Where before, the goal was to link enforcing standardization of work processes like health and safety standards – with the implicit goal of protecting jobs, with improving efficiency, now the goal is to explicitly bargain for protecting jobs (e.g. wage cuts in exchange for work rules).

Gomberg also writes about how featherbedding is a term that management uses to refer to what they consider to be unearned work, make-work, useless work. Similar to work rules, Gomberg wanted the job to be explicitly consid-

ered a property right, and then arbitration could take place to figure out the appropriate compensation for the worker to relinquish their earning opportunity. A view of social efficiency that "would be free of the burden of obsolete performances insisted upon by the worker who must protect his earning capacity" - so there is a short term material gain, still, and an interest in industrial efficiency still, but Gomberg's interest is pointed not toward making efficiency arguments or arguments about standards, but toward paying the worker off for his job being made obsolete. The article contains lots of criticisms of the failures of several legal interventions (including United States v. Petrillo, Lea Act, Taft-Hartley, as interfering with good collective bargaining). Consistent attitude about the inefficiency of "unscientific" negotiation in a stretch out, but instead of trying to resolve it using sound methods, the call is to resolve it using explicit bargaining – like severance pay (e.g like severance pay built into contracts for executives) [142, p. 129]. The use of work rules and featherbedding were both Union responses to automation. Previously, in the garment work, it had been in response to work re-organization, which did not rely on a new technology but still had that effect of rendering workers craft skills and unique knowledge obsolete. The overall impression is that over time, Gomberg became less confident that one could stealthily protect workers jobs through arguments about efficiency. This shift could also reflect a diminished confidence that one could outwit the industrial engineers by pointing out the scientific deficiencies of their methods.

In the face of imminent job loss, some of Gomberg's earlier issues with the scientific merits of the time study seem almost quaint – and when the issue is explicitly preserving worker jobs at the cost of employer margins, Gomberg leans deeply into the formal functions of the union (collective bargaining). This

is different too from what he actually did in his Management Engineering cases in the 1940s, where he was able to leverage his technical expertise to "negotiate" and "consult" the then less-competent employer in how automation ought to take place in the workplace. In summary, when it appears that Gomberg's faith in data-rhetoric approaches has faded somewhat, he leans more explicitly into the collective bargaining functions of the union – more than he did in his own prior experience in the Management Engineering department.

4.6 ILGWU after Gomberg

Meanwhile the garment industry in the United States, and the unionized garment workers, felt substantially under threat by imported production. This is not surprising given that the garment industry is portable and, in a global version of the microcosm of outsourcing from New York City to the surrounding, less unionized areas of Pennsylvania, the south, and the midwest, garment business was driven out of the unionized strongholds to places with cheaper labor costs. And, similarly to how the New York garment industry looked to self-optimization in order to stay competitive (and doing so against the wishes of craft-laborer), the ILGWU felt pressure to push for more rapid technology to keep industry in, while still protecting the rights of workers and simultaneously dealing with workers' anxiety about being deskilled and replaced. The union continued to work with the unit system that had been first put into place in the 1930s and adjusted in the 1940s [253]. But at the time, garment labor leaders were outspoken in their support for increasing technical innovation and automation explicitly [21] as a way to stem the flow of manufacturing to countries like Japan, citing that these is a shortage of workers, less union membership,

bemoaning that we are "not getting native people into our industry. God help us if it wasn't for the Peurto Ricans and other Latin Americans coming into the union" [**?**]. Mitchell Lokiec – the then director of the Management Engineering department – writes, that "it is a tragedy of this industry that we have been relying on immigrant help. That is why we have never relied on technical innovation. You can't have high wages without high productivity. To get this, we have to adapt ourselves to change" [21].

Where before, and to Gomberg, the immigrant labor was a feature of the union - in assisting the upward mobility of new Americans - now the immigrant workforce was seen as a hindrance to the development of mechanised automation. The automation shift did happen at the same time as shift in immigrant labor, but it was not the "high tech" kind of innovation as much as a craft-busting work redesign innovation, which does not require technological change at all. Also the linking of high wages to high productivity, something that Gomberg framed as a challenge to why workers didn't believe in work redesign (e.g. a belief that the two were linked was something that engineers, management, and industry needed to work on overall in order to enlist the faith of the worker in industrialization) is instead seen as goal for the union to adapt to – which is the opposite of what the union would have argued during Gomberg's time.

At the same time, the union played an awkward role standing between the worker and the cutting edge of industrial techniques. In 1977 there is an exhibit of fancy new production tools but Lokiec, as the Management Engineering director, cautioned that it would be psychologically discouraging to look at them: "[s]tay away from the Bobbin Show. I can interpret new things better than you" [195]. Ultimately, with less bargaining power, it became a lot harder

for the union to rely on expertised labor to fulfill its goals, of stabilizing the industry and securing the short term gains. There was less demonstrable evidence that metrics could be used to rhetorical ends, or to compel management to take on pro-worker decisions. On the other hand, if we think that the union (as Gomberg said) should be disinclined to apply metrics in places where the union was not well established in fear that would-be members would not like being optimized by management, we can imagine why the union would have not used the strategy as membership was declining.

4.7 Engineering and Industrial democracy

Though he was critical of the ability of lawmakers to intervene effectively in industrial relations conflicts, Gomberg had much in common with an older school of industrial relationships scholars, like the John R. Commons (who Gomberg often cites). Commons was among the "Wisconsinite" school who believed that industrial cooperation *could* be achieved through cooperation between the state, national unions, and business associations [207, p. 91]. This "institutional" view of Industrial Democracy was challenged by right-wing organizational researchers like Elton Mayo who believed that industrial democracy could be achieved instead through small, spontaneously formed factory groups coordinated within industry [207, p. 91]. It is not surprising that Gomberg was so critical of the Harwood experiments along with Mayo's Hawethorne experiments (which measured what work conditions would improve industrial productivity). Both represented an effort to bypass unions and looked to achieve industrial democracy through spontaneously formed groups of (non-unionized) workers organized by industrial elites. For Mayo, it was the job of these indus-

trial elites to discern workers' needs and grievances before they manifested into formal protest and worker organization. For Gomberg, the role for the elite (the engineering elite) was to stand instead in the middle of workers and management. The expert, union or management, is meant to be just one voice and one was not supposed to "submit to their tyranny" [55].

After the Wisconsinites and Elton Mayo came a third wave of industrial thinkers who were neither pro-management nor pro-labor [207, p. pp. 101-106]. There was less of an explicit commitment to democracy and more one about maintaining peace. Unions were seen as a sort of peace-keeping device to persuade the workers that their conditions were generally fair, and to stave off workers demanding government interventions. There is a question whether Gomberg had anything really spectacularly different to offer compared to the third wave of industrial relations scholars – who also had the same conviction that "stable" negotiation would move industry from conflict to cooperation. Though Gomberg's rhetoric was ascerbic and aggressive on paper, in practice his strategies probably had a lot in common with the "accouterments of statesmanship" (multi-year contracts, wage forumulas based on productivity etc.)[207, p. 110]. But on the other hand, there was a contestational element of union strategy that Gomberg did not participate in himself as the director of the Management Engineering department but he also did not condemn those strategies being used alongside the more bureaucratic ones. Maybe Gomberg wouldn't disagree that all of this worked because the engineers constituted the "more reseasonable" part of an otherwise unpredictable and need-to-be-reeled in union (e.g. a strong one)? What would it mean – for it to "work" in a place with a less established union structure? I will address this question in chapter

[55]This sentiment is well expressed in a draft article to the AIIE, which can be found in the William Gomberg Papers archive at the University of Pennsylvania, Box 2, folder 28.

6.

For Slichter, the garment unions were, at least initially, the most promising institution for achieving the Wisconsinite vision of industrial democracy. Lichtenstein reflects on the decline of industrial democracy in America, narrates and intellectual legacy of a labor relations scholar that informed on a lot in earlier chapters. Slichter, a Wisconsinite, was not a fan of CIO (new industrial unions), instead his survey engaged with unions with a stable collective bargaining system: railroads, printing trades, construction, and big "above all" [207, p. 113] the garment and hosiery industries. As noted by Lichenstein, Slichter's tone was completely different between the 1941 and the revised 1965 version of his books, where he moves from a concept of "industrial jurisprudence" in which labor and management resolve conflict through a system of formally recognized practices to "industrial relations", a problem to be solved from a managerial perspective, without any mention of civil rights or constitutional governance [207, p. 114]. In the 1965 edition, the sections on Cleveland and Naumkaeg case studies are consolidated into one section with a bunch of other experiments sponsored by unions that emphasize employee participation (as opposed to outside or union experts - something Slichter would say unions would not like because it would cause workers to form affinity with management [284, p. 846] - the two editions reflect a shift from industrial rule-making and one toward maintaining industrial discipline.

So what happened? Legal scholar Katherine Stone [207, p. 116] argued that the premises of "industrial pluralism" (what Lichtenstein calls the ideology of self government, e.g. industrial democracy, probably what Gomberg thought, about unions and management feuding with the worker loyal to neither) did

not correspond to the reality in post-war America. Instead of collective bargaining relationships dawning the coming of genuinely pluralistic/democratic/self-governing relationships, it didn't. The whole vision of industrial democracy working in that way was predicated on that older version of the union in the 1930s – centered on these garment unions. Union stability was more threatened by nonunion shops than by the employer, employer recognized union strength and permanency, and then union, importantly, was committed to "industrial self-discipline" (117). This really fit with the "whiggery of the Anglo-American reform tradition"... ("made contact with social reality" in the "light manufacturing industries"[207, p. 117]). The self-discipline of the garment industry was really important in this. The challenge came of translating this sensibility from garment to other industries, first to steel and then to auto. The conditions of the auto industry, as Lichtenstein argues, really transformed and – challenged – the viability of the concept of industrial democracy. One version is that it just devolved into workplace contractualism brought on by union employees like Gomberg [55] - but it had to do with the conditions of the industry.

4.8 Summary

My analysis of the department over time focuses on how the department identified and responded to the changing nature of data-driven advocacy within the labor movement. In this section, I pull out the bigger picture of what insights we can draw from this case study, assessing both the benefits and the double-binds that a data-driven approach brings to worker advocacy.

The Management-Engineering department was founded at least partially in

response to employers' tactical appropriation of prior engineering efforts by the union to calculate prices for garment sections. By investing resources into the on-going maintenance of a dedicated engineering department, the union was able to take back some control over the use of industrial engineering methods in the union garment shops. The presence of data experts bolstered the legitimacy of the union to employers — and allowed the union to push back against management by creatively leveraging expertise in management's methods. Within the union, the presence of data experts also worked to bolster legitimacy and morale by reinforcing to its membership that the union had the ability to counter management's engineers with expertise of their own. Finally, through their published research works and speaking engagements at academic and professional conferences, the Management-Engineering Department was able to influence the broader industrial relations community.

However, all of these benefits, in the union's relationship to employers, its members, and the broader sphere of industrial relations came with their challenges that ultimately left the union in a double-bind in its use of engineering techniques. To engage with employers over what is rational and efficient is to tacitly uphold the idea that the processes of workplace automation – and the complementary processes of labor degradation – ought to continue. So the union was leveraging participation in a process that reduced the unique knowledge and skills of the workers, and ultimately its own bargaining strength, in exchange for what it saw as either survival in a particular region or as a means to secure short-term material gains. To engage with union members with professional experts also presented a risk of tamping rank and file organizing energy by relying on experts instead. Data-intensive methods also limited direct worker participation by requiring confidentiality (when working with sensitive

data) and also inherently, by requiring a degree of data expertise that the union was unable to feasibly provide for rank-and-file membership. The strategy of influencing industrial engineering in professional spheres too posed complications. As much as the department aimed to set the program for industrial engineering, the nature of their work meant that they were always positioned in reaction to employers and experts in management and engineering – who did not always acknowledge the union in return.

The union's ability to meet demands that the use of data methods imposed was contingent on its strength and the stability of the American labor movement as a whole. In the next chapters, I explore what it would mean to translate insights from this slice of industrial labor relations history to contemporary work conditions. I examine the development of "the manager's tools" to show how they have shifted (and remained the same) over time and from industrial contexts into other forms of work. Gomberg, in his time, was skeptical about how industrial engineering techniques could be applied to office work, or work without a lot of routines and repetitive function. In the next chapter, I think about how the legacy of industrial engineering, and the methods for pushing back against the negative effects of work redesign exist within the history of HCI and CSCW. In the subsequent chapter, I examine how the data-rhetoric tactics could be adapted to their benefits while anticipating an eye on the risks.

CHAPTER 5

HOW SCIENTIFIC MANAGEMENT BECAME COMPUTER-SUPPORTED COLLABORATIVE WORK

5.1 Introduction

This chapter draws implications from US labor history to our contemporary understanding of the workplace and the opportunities and challenges of using workplace data collection to support advocacy in the workplace [1]. What was painstakingly gathered frame-by-frame from film reels by William Gomberg and his engineers in the last chapter is now automatically gathered in aggregated by workplace data analytic systems, which use and generate massive amounts of data to mediate peoples' work experiences.

Contemporary workers may have access to or even self-track some of this data too. 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[321], and wage theft [326]. The challenge with collecting and aggregating worker data, even for advocacy purposes, is that without worker protections and strategic decision-making, the disclosure of worker data may have unintended privacy consequences and may further surveil marginalized workers [97].

[1]Chapters 5 and 6 are largely adapted from a previously published conference paper, "The Tools of Management: Adapting Historical Union Tactics to Platform-Mediated Labor" which was coauthored with Vera Khovanskaya, Lynn Dombrowski, Jeffrey Rzeszotarski, Phoebe Sengers and published to the Proceedings of the ACM on Human-Computer Interaction Volume 3, Issue CSCW [188]

This chapter connects between Industrial Labor Relations History and the discourse around workplace data collection within Computer Supported Collaborative work (CSCW). 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 [32, 15, 45]. 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 chapter examines how responses to scientific management in the past could inform new worker advocacy tactics in data-driven, platform-mediated workplaces.I 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, I 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. I 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, I show how labor questions emerging in crowd work research echo earlier questions about the impact of scientific management on industrial work. Next, I explore how industrial labor perspectives on scientific management can inform worker advocacy strategy.I 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. I 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.

5.2 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 [61, 123]. Earlier actions had been organized by Uber drivers in response to fare-cuts in 2018 [299], and 2016 [202], but the May 2019 action specifically captured popular media attention as

both a "test" of gig-worker leverage [61] and as an explicit demand for data transparency [280]. Data, wage, and algorithmic transparency have also been central demands for delivery platform workers (*e.g.* Postmates [244] and Instacart [326]). 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 [325]. 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 [209, 261] which has since been corroborated by aggregate findings from advocacy groups [325]. Self-reported worker data has been part of public awareness campaigns [202, 326] that have pushed for changes in platform work conditions (including payment structure changes [208]). 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 [43].

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)[157]. 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 [85, 231] and Organization United for Respect (OUR) [10] 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 lim-

ited 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" [173] 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 [172], 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 [220].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 [268].

Worker-centered research on crowd work in CSCW has also yielded criteria for fair work [282], requirements for worker-centric crowd work systems [19], and mechanisms to mitigate work rejection and support collective dispute resolution [227]. 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 [152]. 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 [143, 254], applied Marxist theory to identify typologies of worker

relations in crowd work [151], and explored the labor perspectives of workers outside the traditional workplace [114, 269]. This chapter informs ongoing discussions about advocacy tactics for platform-mediated work with a historical perspective. I 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.

5.3 Tracing Methodological Continuity

In order to make an argument for the contemporary relevance of older advocacy tactics, I 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 [288, 53, 249, 225]. Critical scholarship argues that in measuring worker performance and exerting control over the work process, technology systems have a tendency to promote managerial interests [116, 106]. 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" [106, 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* [218, 87, 29, 145]).

In this section, I 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. I 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. I 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.I locate these methodological differences in workplace technology design within crowd work and social computing but, as I argue in the next section, these developments have implications for platform-mediated labor more generally.

5.3.1 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 [301, p65]. Under Taylorism (the dominant mode of scientific man-

agement from 1900-20 [212, 196]), 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 [54, 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 [122]. 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 [236]. This standard data was published, along with formulas and instructions, in industrial engineering manuals [111] and handbooks [223] 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 [101] MTM industrial engineering measurements for physical operators (*e.g.* press, point, home, draw) but the mental operator, "mental preparation", had to be calculated experimentally [63]. KLM was found to be effective for predicting the time to execute routine, low-level tasks [176] 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 [176, 178] 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" [176].

While different GOMS methods varied widely in their assumptions about mental time, they treat complex cognition as a black box—an "unobservable operator" [177]. 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) [74]. Another project, Soylent, decomposes text editing into Find, Fix, and Verify tasks [47]. 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) [72] 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 incalcula-

ble mental operators can now be usefully approximated to design crowd-work tasks.

5.3.2 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" [301, 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 [300]. 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.* ac-

tions derive their meaning from the task" [311]. In order to delegate office work, Group Task Analysis relied on Activity Theory [238], 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 [47]. 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 [199]. 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.

5.3.3 Oversight: Centralizing task flows

In Taylor's mind, "the task idea" was the "most prominent single element in modern scientific management" [300, 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 [223, 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 [223, 224].

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 [218]. Hierarchical Task Analysis (HTA) [22] 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 [278], but like GOMS, this method includes "stop-rules" negotiated with different stakeholders [23] 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 [86]. 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 [312], but even task analysis proponents recognized that using these methods required substantial training and time to process vast quantities of data [23, 11].

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 [65], 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 [94]. But the linking of understanding usability with the need for ethnographic methods (*e.g.* as seen in contextual design [283, 158]) 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 [192]. Crowd-work platforms have the ability to gather vast amounts of granular computer activity [267, 119, 329, 213] and use behavioral traces to represent complex behavior, which can be used for usability testing [197] and studying group work [256]. 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 [194, 266]. 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"[65], and while it is acknowledged in the community that the representations are imperfect [255], they are practically implementable and accessible by non-expert analysts.

5.4 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, I describe how historical labor issues from scientific management are becoming salient in contemporary CSCW. First,

I compare the impact scientific management had on deskilling industrial work with the impact of CSCW design methods. Second, I 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, I 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.

5.4.1 Worker Discretion

In CSCW, the work that early Taylorists intervened in has been characterized as ”simple” [18] (or the workers as ”unskilled workers” [87]), 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 redesign 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. I have analyzed this effect in crowd work, but similar surveillant task delegation exists in ride share, housekeeping and other platform-mediated work (*e.g.* [203, 216, 262]).

This loss of privileging of workers' unique knowledge about their work con-

text has consequences for how I 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 I explain in the next section, the ease of representing local context also diminishes the leverage of technology researchers.

5.4.2 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 [54]. 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 [148]. There are numerous examples of research that refuses degrees of automation in workplaces such as law firms [295], flight control [163], and architecture offices [153][148]. 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" [218], advocating instead for a design philosophy centered on supporting workers' tacit knowledge and skills [226, 50]. This research represents a strategic linking between worker advocacy and practical feasibility, which was reinforced by the high stakes of technology development [84] 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 [38] and in participa-

tory design due to the decline of bespoke software design [58]. 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 [265, 230, 179]. But what the crowd-work platform, and the casualized labor situation that makes it possible [68, 90], 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.

5.4.3 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 [124, 333, 277, 276, 291, 182]. 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 [75, 46, 49], maintenance of shared worker memory [200], and worker evaluation [154]. Crowd work research has also reflected on the potential impact of crowd work on different labor markets and employment relationships in the future [159, 193, 256]. 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,I 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 [206].

Proposals to improve crowd work have ranged from immediately actionable improvements to address the monotony of work through gamification [113] and micro-diversions [88], to incorporating elements of worker autonomy in task selection [260, 70], and self-evaluation [99], to substantial restructuring of crowd work to support worker involvement in task design[118] and peer evaluation [317]. Some proposals aim to address the problems of crowd work by mirroring aspects of the traditional office workplace: for example, by supporting mentoring relationships [73] and implementing hierarchical decision making, skill development, and career ladders [193]. Many of these proposals parallel earlier transitions from Taylorism to ”more enlightened job design” [193] previously seen in industrial production [18]. 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” [235, 155] 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 [134, 215, 54].

Drawing on prior research that has applied a historical lens to the piecework configurations in crowd work [18],I 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, I believe that these perspectives can inform worker advocacy not only for crowd work but in platform-mediated work more generally. In the next chapter, I will revisit the ILGWU strategies for data rhetoric, and integrate them with sources from several other industrial labor unions, to generalize a set of strategies for thinking about the role of data and participation in data-logging for contemporary worker advocacy.

CHAPTER 6

DATA-DRIVEN TACTICS FOR WORKER ADVOCACY

6.1 Introduction

In this chapter, I summarize historical strategies used by ILGWU and other unions in the United States to advocate for workers in the context of scientific management. I combine my insights on the rhetorical use of data by the management engineering department with insights about labor strategy drawn from an analysis of six union manuals published in the years 1942-1967: [26, 309, 166, 169, 170] and [171] (reproduced in [132]). I 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 my analysis of union strategy (Chapter 4 of the dissertation), 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. I analyzed these manuals for common themes, general sensibilities, and concrete strategies, which I describe in this section and connect to present-day labor advocacy in data-driven workplaces.

6.1.1 Background

When Taylor and his associates first introduced the techniques of scientific management at the beginning of the 20th century, workers immediately saw the threat posed to craft knowledge and worker power [117, 54]. The methods also initially 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 [141]. 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 [237]. 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 (described at the end of chapter 3), 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 [186]. 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 [186, 237]. Here, I describe three key strategies unions used to address scientific management: data transparency, wage contestation, and selective participation. I describe each strategy and considerations for its use. In the next section, I describe how these strategies could be adapted for use in present-day, data-driven workplaces given the constraints of platform work.

6.1.2 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 [132, 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.”[309, 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 [309, 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 [169]. 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)[309, p 127] which they shared with union engineers who attempted to reverse engineer the incentive structure.

6.1.3 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" [171] in the following ways (also reproduced in [132, p 1167], and paraphrased in [169, 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" [169, 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 [169, 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" [170, 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"[171]. 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 [138, 211, 13, 34]. 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 [171]. 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" [132, p 1166].

6.1.4 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'"[309, 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 [26, 166, 169], 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 [301, 54]. However, worker participation had been advocated for by management [67], at times to a much fuller extent than unions were willing to do [186, 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” [309]. Echoing concerns raised by HCI and CSCW scholarship years later [217, 25], 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” [215, p 12].

6.2 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” [66]. Our case study draws from a historical moment where labor was well organized, but had the same strong concerns about wages and employment stability. I 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, I 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 [109, 110, 16, 231, 62],

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 [307, 325]. However, given that many of the algorithms that mediate labor are considered intellectual property by the employing platforms [175] 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 [152]. The advantage of self-report is that it is an active way to solicit user involvement, gauge interest, and build communication [56], 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 [108], 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"[281]). However, as I 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 [217], 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 I see more initiatives by platform employers to enlist worker participation (*e.g.* [187, 157]), 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.

6.3 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 chapter, ”the tools of management” [140, 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 [140, 35]. In this section I 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 [107]. 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 I describe in the chapter.

In order to make use of historical insights without falling into the trap of "too much analogizing to unions" [76], 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 [76], 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 I 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 [132] 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.

6.4 Conclusion

In this chapter I 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. My 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.

I 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. I 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, I 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, I 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.

CHAPTER 7

CONCLUSION

7.1 In Summary

This dissertation has drawn on the history of engineering methods in the labor movement to explore how data could be used as part of worker advocacy. First I examined how engineering methods made their way into the labor movement, and then I examined the effects of their use by the ILGWU. Then I surveyed the methodological continuities between industrial engineering and contemporary workplace design methods and synthesized strategies for how contemporary worker advocates should orient to worker data. My research surfaces three core insights on data-driven labor advocacy. First, worker-centered data tools are in opposition to how workplace technologies are typically designed. Second, even in situations where the modalities of data collection technologies are new, we can draw insights from cases where worker data was used for advocacy purposes in the past. Third, data collection in the workplace reshapes organizational relationships between workers and employers by centralizing both knowledge and procedural decision-making; therefore, efforts to appropriate data-collection techniques for worker-centered purposes must anticipate the risk of reproducing some of these effects within the worker advocacy organization. Below I will elaborate on these three insights and then describe three trade-offs that an organization seeking to use data-driven tactics ought to consider as part of their strategy.

The first insight, that worker-centered data tools are in opposition to how workplace technologies are typically designed, has to do with labor's funda-

mentally different relationship to workplace data tools compared to employers. Employers generally gather data about work (e.g. how to do a task, how long it takes to do it, how different workers' performance compares against each other) in order to consolidate workplace knowledge. This consolidation can then facilitate rationalization (e.g. re-design of work or compensation) but the goal is to get a "good enough" central representation of knowledge that had previously only existed in a decentralized way, within individual workers. This data collection has a tendency to empower the employer at the expense of the worker. In contrast, worker-centered data tools are designed to gain insight not into worker practices, at least primarily, but into management practices. Though unions including the ILGWU have also used their own data collection to make arguments about how to rationalize the workplace, the primary goal of the data collection has been to gain insight into management decision-making in order to better argue for improved work conditions.

If employers are to some extent transparent about some aspects of their data-collection, then the goal of worker-centered data tools is to gather data to contrast and contest what is gathered by management. Since the platonic ideal of transparency is impossible, if only because the data collection that one does in the name of transparency necessarily occludes other aspects that are not being measured [294], then worker-centered data tools can forever be in dialogue with employer-centered ones over what is worth capturing and how that data ought to inform work conditions. The difference between management-centered data tools and worker-centered ones is that the management-centered data tools work on their own, and worker-centered ones exist to be in dialogue with the ones used by management.

An interesting question that is outside of the scope of this dissertation is how worker-centered data tools could possibly look under a different system of economic and material relations. If automation was approached in the workplace not as a mechanism for consolidating worker knowledge in order to cheapen labor and increase managerial control, but as something done by workers to improve their own experience of work, or if workers themselves were collecting data in order to unify work processes [54, p. 320] then it is possible that the data tools could even be similar in appearance, but not have the same discursive role vis a vis management. However the appropriation of management tactics and the use of data rhetoric strategies described in this thesis is always in response to employers' use of data to reconfigure relations.

The second insight, that we can continue to draw lessons from older approaches to data-driven advocacy even when the surveillance technology has changed, has to do with the underlying methodological argument, which is that historical arguments can inform present actions regarding technology in the workplace. This argument connects to more general arguments about the value of history as a source of design inspiration and empirical insights about the long-term impacts of technology. There continues to be a body of scholarship in HCI and CSCW that explores how historical approaches can inform decisions about how to design technology [287, 95, 258, 327]. By studying how data-driven approaches impacted advocacy in the past, we have been able to anticipate some of the challenges of applying similar approaches in the present. However, there is also a strong temptation to take strategies from the golden years of industrial unionism and apply to them present-day worker advocacy contexts. In the previous chapter, I have argued that what worked for mid-century industrial labor unions is unlikely to work the same way for contempo-

rary workers, especially in more precarious and contingent work contexts (e.g. platform mediated labor, gig work). Contemporary approaches to data-driven worker advocacy must address new data gathering affordances as well as the current legal and political climate of worker advocacy.

However, though many of the conditions are different between the past and the present, the debates about the role of technical expertise and data driven methods in workplace advocacy that occurred in the context of the mid-century garment industry are relevant today because the current transformations of the data-driven workplace were largely prefigured by transformations in industrial manufacturing. The same processes that transformed garment work are being used to redesign office work over platforms like Mechanical Turk, or logistics work through Uber and Taskrabbit. What is in common between the move to section-work and the re-design of work through platforms like Mechanical Turk is not only the compensation (e.g. piecework pay) but the collection and aggregation of copious amounts of data.

Over the course of the management engineering department's history, the garment industry underwent rapid technological change, first moving from whole-garment production to section work, and then to using automated machines for cutting and steaming and specialized tools for pressing[285, 324, 39, 247]. Within the rationalizing factory floor, new ticketing tools where being used internally to track clothing bundles for quality control and to monitor individual work [120]. All of these operations relied on and generated vast quantities of workplace data. In order to analyze this data, engineers developed and refined methods of task analysis and work evaluation that were then used in other industries [130, 222]. Analyzing the archive of video footage, the time-sheet, and

motion charts generated by ILGWU management department, one could argue that under very controlled experimental conditions, using manual coding of workers' movements from video footage of time-study environments (like the footage from Belle Knitting in chapter 3) allowed engineers to manually approximate and analyze levels of data granularity that we are now able to gather automatically using cutting-edge sensing technology (for example by sensors like the ultrasonic bracelet [82] patented by Amazon for use in its warehouse).

As described in chapter 4, Industrial engineering directly informed early HCI methods (e.g. [223] qtd. in GOMS-KLM [64]), and while these techniques are seen as outmoded, task analysis experts have maintained that the underlying mechanisms of breaking work into smaller operations for analysis and delegation remain central to technology design in the present [12]. To visually demonstrate this methodological continuity, I digitized and translated the time and motion studies from Belle Knitting. The visualization in Figure 7.1 renders data about workers' micromotion from the past using the visual language of task analysis (echoing task fingerprinting in contemporary crowd work research [267]). Though the union was able to leverage the range in worker efficiency to critique management practices, this visualization captures how task analysis readily supports management goals by allowing the viewer to compare worker performance.

The third insight, that for worker advocates, gathering data affects relationships within an organization, draws on patterns of tension between data-gathering experts and the workers being observed from organized labor's first inquiries into Scientific Management through the 20th century. In the shops in the Cleveland Garment Industry and at Naumkaeg, union members expressed

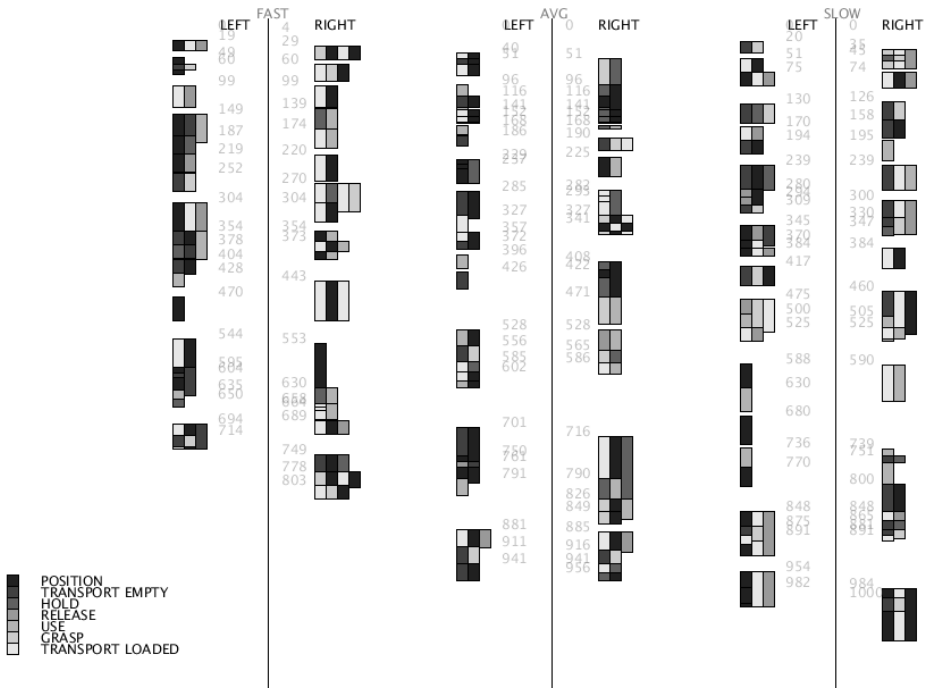

Figure 7.1: Time and motion study data from Belle Knitting [25]. Non-productive and less efficient therbligs, Position, Transport Empty, and Hold are rendered in dark values.

discomfort with being observed, even by representatives from their own union, for the explicit purpose of protecting their work conditions. At Naumkaeg, this very basic discomfort of being observed by the union was enough to drive a wedge between union leadership and rank-and-file union members that ultimately led to an unsanctioned strike. The gathering of workplace data further transforms the relationships within an advocacy organization by putting the "data-havers" into a position where they can, if desired, propose alternatives to management decision-making. Proposing alternatives can be helpful for making the organization seem "reasonable" but it also puts the organization into a position where they can make arguments for the redundancy of certain workers (as they did in Dutchess Manufacturing) – or bring to employers' attention various strategies used by workers to deal with their work that workers may have

not wanted to share.

Even when the union was successful in staving off the worst impacts of automation, doing the data-collection allowed some members of the union to gain managerial perspectives about what could be possible in terms of labor reduction or work speedups. From the case studies surveyed, it appears that this knowledge was not evenly distributed within the union. It seems more likely that both the intricacies and implications of the data being collected were shared beyond the Management Engineering department only to relevant union leaders and, when it was presented for maximum rhetorical appeal, to the employer. Furthermore, even if "regular" union members did have access to the data that was being collected about them, they likely lacked the technical expertise to make sense of what was being calculated, or participate in the process of data gathering and analysis. At some of the sites, the ILGWU did involve selected union members as interviewees, which may have informed the decision of what to study. In some of the manuals, it was also clear that the union had the intention of training regular union members in how to conduct time studies. However, it is reasonably clear from the archival records that actual projects from the Management Engineering Department were conducted by engineers and did not involve the substantive participation of rank-and-file union members. What this means is that as the union gathers more data, it also, like management, participates in the process of consolidating knowledge about work at higher levels of the organization, knowledge that used to reside within individual workers. (It was even the stated mission of the early garment "unit system" in the New York Garment industry to support the information gathering of union officials who lacked the craft knowledge of the old-hand union members; to that effect, the unit system manual depicted in Figure 4.3 (in chapter 4) reads "not for pub-

lication, confidential" across the top.)

The consequence of employing data-driven approaches, even when they are appropriated for worker-centered goals, is that they still risk reproducing the effects of disempowering the worker by leaving them with less uniquely-held knowledge about their work. It affects how worker advocates relate to the people they advocate for, and for ostensibly worker-run organizations, the use of data-intensive methods furthers stratification within the organization based on technical expertise. This means that unions and other worker advocacy organizations have to be very careful about balancing the opportunities of data rhetoric with some of the organizational risks that the approaches carry. In the past, unionists and industrial relations experts have cautioned that an established union was necessary for Scientific Management strategies to be used, and even in conditions when an established union was present, it was suggested that the union ought to stick with critiquing existing practices more than proposing alternatives to them. Few contemporary worker advocacy organizations have the luxury of operating under the first condition (having an established union). Nevertheless, many organizations such as Working Washington and Co-Worker, for example, are actively collecting worker data to identify wage violations and push for more equitable payment algorithms [261]. Tools are also being built to use driving data to automatically submit wage claims, supporting worker communication to obtain fair wages [246].

In the following scenario, depicted in the figure 7.2, I describe a speculative narrative of how data rhetoric and data-driven worker participation could play out in a contemporary worker advocacy campaign. In this scenario, a coalition of ride-share drivers gather and consolidate active and passively gathered data

about their work, each person creating a corpus of data that mirrors what is already gathered by their employer. The coalition selectively aggregates this data to construct public action campaign materials and participate in collective bargaining situations.

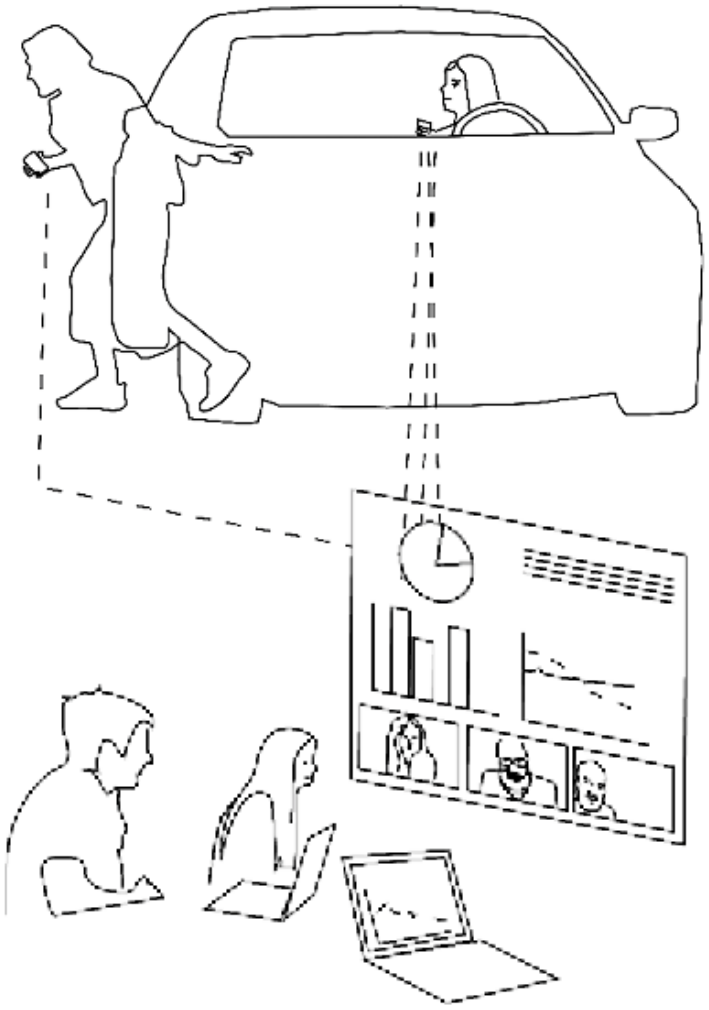

Figure 7.2: From top to bottom: Worker advocacy coalition gathers passive and self-reported data about ride-share work; data-management working group holds meeting to review visualizations using aggregated data; which are used for issue campaigns and bargaining situations with the ride-share platform.

Data-driven arguments drawn from consolidated worker data have the potential to be rhetorically compelling because they can leverage the tools of management to contest employer decisions: for example, consolidated worker data can be used to challenge the structure of payments for work (e.g. what allowance is made for unavoidable delays in ride-share work) or the financial sustainability of management decisions. Gathering and consolidating worker data is also rhetorically effective because it can be used to generate arguments across the workplace as a whole while requiring little effort from individual workers. Drawing on insights from our case study, we believe that this is both the biggest advantage and the biggest risk of applying data methods. The risk of using data-driven methods is that the methods can give the appearance of idealized industrial democracy by aggregating worker data, but the actual use of data-intensive methods poses substantial barriers to actual worker participation. In building these systems, who decides what data is used and who is accountable for preventing misuse? Centering the role of technologists in the data decisions risks building a worker coalition reliant on outside expertise. This problematic, already present in the debate between Gomberg and Barkin, is heightened given that granular data about the workplace is easier to gather passively, that the methods to process the data are harder to learn, and that contemporary worker advocacy efforts are increasingly taking place outside the institutional structures that Gomberg called upon to provide sustained technical expertise and worker training (e.g. unions).

Data experts can offer their skills to the labor movement, potentially reviving earlier approaches of using data rhetoric and mutual gains tactics. However, technologists must exercise caution as these data-intensive methods pose substantial challenges to democratic worker participation. In absence of a well-

organized worker coalition to facilitate training and participation in data techniques among workers, data-driven techniques are likely to rely too heavily on outside expertise to be practical. In the next section, I will draw on the lessons learned through the case studies of this dissertation to present three trade-offs that technologists and worker advocates should consider when employing data driven tactics.

7.2 Navigating the Trade-offs in Data-driven Tactics

In this section, I review three trade-offs in data-driven advocacy that emerge from the historical cases and explain their significance in contemporary workplace advocacy contexts.

Collecting Data

Worker advocacy organizations must make important decisions about what data to collect about the conditions of work in order to make effective arguments and sustain advocacy coalitions. Historically, unions have cautioned against doing in-house data collection if it is possible, for example, to get data directly from the employer instead. It makes sense to see how much is available without having to do additional worker surveillance, as this observation carries privacy risks, as well as organizational ones. In the past, this was arranged through collective bargaining agreements with the employer. However, even with collective bargaining, employers in the past have been reluctant to "open the books" about compensation, work times, and other data they collect about workers. As a consequence, there is historical precedent for union-driven

data gathering (despite its risks). One instructive difference between the early experiments in the garment industry in Cleveland and Naumkaeg and later experiments conducted by the ILGWU Management Engineering department is that where the former involved thorough and methodical analysis of as many work processes as possible, the later category tended to zero in on specific operations for more targeted data collection. This narrowing of the data-collection field was achieved either by interviewing workers about where they thought the problem was, or by focusing on some standard kinds of data.

Another element to data collection that is not addressed by the case studies in the dissertation is the difference between data collection by an advocacy organization versus data gathering through self-report by the workers. Union manuals have described the process of gathering data about wages through surveys, but none of the case studies from the ILGWU use self-reported data as a data source. The advantage of self-reported data, for example the cases of wage spreadsheets described in the introduction, is that self-reported data gives an opportunity for workers and organizers to have conversations about the conditions of work, which can be a valuable opportunity for coordinating and sustaining collective action. On the other hand, self-reported data places the burden of data gathering and maintenance on workers and organizers, which can potentially limit the granularity and accuracy of the data collected. This may be an issue for gathering data in order to reverse-engineer compensation algorithms.

It is also possible to use contemporary data-gathering techniques to automatically gather and aggregate data about work, for example using cell phone sensing and tracking features to collect data about commute times and work

done outside of business hours [83]. In this particular example, the application explicitly avoids the risk of establishing unnecessary surveillant relationships with its users by storing data locally, but the question of what data to aggregate and how to operationalize them remains unaddressed. In the case of the Instacart Paystub Calculator, for example, Working Washington balances this trade-off by having workers actively self-upload pay stubs [7], from which the organization is able to automatically aggregate some insights about the machinations of the compensation algorithm. It is clear that the question of what data to gather is also inflected by the question of how data collection ought to occur, where more options appear to be possible due to new technological affordances.

Leveraging Expertise

Historical precedents for how unions ought to engage with technical expertise make clear that the use of "data experts" as part of advocacy strategy incurs risks and benefits. In the garment industry, the creation of the Management Engineering department, with its in-house data experts, emerged in response to employers hiring engineers who wanted to rigidly apply the "unit system" (a system for pricing work that had previously been developed and then used loosely by the union). The union engineers provided a check against selective and malicious use of engineering tactics by the employer. This approach appears across industrial trade unions. For example, the United Electrical, Radio & Machine Workers of America manual on wage payment plans, time study, and job evaluation discussed in chapter 5, shows how a union can leverage expertise in the time study to stop "rate butchers at work" [309, pp. 52-54]:

What this means for labor advocates is that technical expertise may seem

Figure 7.3: Image from p.52 of United Electrical, Radio & Machine Workers Guide to Wage Payment Plans [309]

Figure 7.4: Image from p.53 of United Electrical, Radio & Machine Workers Guide to Wage Payment Plans [309]

Figure 7.5: Image from p.54 of United Electrical, Radio & Machine Workers Guide to Wage Payment Plans [309]

necessary to counter the technical expertise of employers. This is not a claim that the historical case study can verify though, and certainly it is possible to organize workers without the use of any data-gathering about their work. Still, historical examples point to the strategic work that data experts can do as part of advocacy strategy. This role is well described in Wilensky's work on professionals within the American Labor Movement. As discussed in chapter 3, the engineers historically provided a morale boost to union members:

> "[the engineer] was obnoxious, completely obnoxious to the company. He gave them hell. He'd pull out this [college] textbook, and then another and he'd tell them they didn't know their ass from a hole in the ground. It brought a complete change to our bargaining committee." [319, p 47]

In addition to the morale, the use of data-expertise within an organization allows labor advocates to set the engineers up to "take the heat" [319, p 52] – absorb tension between workers and the advocacy organization by being a third party that the organization can blame when workers are upset. On the other hand, the risk of making use of "facts and figures men" in your advocacy strategy is that they could 1) turn around and say that the workers are being unreasonable 2) inadvertently reveal strategies that workers are using to optimize their work and actually make the company improve efficiency in a way that harms workers and 3) stir rank and file tensions by rousing suspicion in the workers.

More broadly, it is important to think about the effect of relying on technical expertise on your organization. How will the expert interface with different levels of the organization and how will they be received by rank-and-file

(worker) members? Does the hiring of technical expertise introduce financial constraints? Will the use of experts perpetuate the use of experts in the future by permanently shifting the negotiation with the employer from "table-pounding" toward matching data with data?

Proposing Alternatives

Elaborating further on the potential effect of employed experts to propose changes to employer practices, advocacy organizations should be careful about the dangers of participating in management decision-making. I explore this risk in the "Selective Participation" section of chapter 5 – it is also raised by manuals about industrial engineering techniques by industrial labor unions at the time. For example, the same electrical union manual quoted earlier reflects on how the union's participation in management job rating procedures can put local union leadership in an awkward situation:

On one hand, having people in your organization who are not only critiquing but also proposing alternatives to management practice is a rhetorical strategy that wins you something because you can appear "responsible" [319, p. 51]. On the other hand, the point the cartoon raises is that this responsibility may make the organization appear ineffectual or in collusion with the employer. In the past, this risk was deemed so great that industrial relations experts wondered whether unions ought to stick to critiquing exclusively, rather than trying to participate in management functions.

Another element to consider in the participation trade-off is that management may seek to enlist worker participation in management decision-making

Figure 7.6: Image from p.78 of United Electrical, Radio & Machine Workers Guide to Wage Payment Plans [309]

Figure 7.7: Image from p.79 of United Electrical, Radio & Machine Workers Guide to Wage Payment Plans [309]

as a form of placation (which has the effect of improving efficiency or undermining of other advocacy efforts, or both). In light of this, an advocacy organization should be cautious of an employer who seems too eager to collaborate. Based on historical experience, until worker advocacy organizations have the resources to perpetually match the resources of management, joint participation is not a sustainable strategy. To conclude, proposing alternatives is a valuable practical and rhetorical strategy, but it should be used cautiously.

7.3 Tools in the Toolbox

Industrial engineering and data-driven tactics are just a subset of the tactics employed by labor unions to achieve their goals. This dissertation focused narrowly on the role of engineers, and what it could mean to use similar strategies in the present, but these "tools of management" worked in concert with other strategies that labor unions had at their disposal. There is a question to be asked about whether the managerial tools require the concerted use (or potential use) of other tactics. In chapter 5, I suggested that the industrial labor unions were only able to make use of the more bureaucratic methods (ones that required the use of trained personnel like engineers, but also lawyers and arbitration experts) because of prior worker militancy. Looking toward the future of data-driven worker advocacy, it is important to consider how data strategy fits in with the actions of the advocacy organization as a whole.

When one considers the data arm of a labor union in the context of the whole organization, one can also imagine that the ways that a union thinks about worker data, and makes use of data-driven methods, its use of technology

and technical expertise, is reflective of its broader organizational tendencies and practices. In other words, a "top-down" (more centrally administered) union could likely also have top-down approaches to collecting and using worker data. A more "bottom-up" organization might instead gather and make decisions about how to use data in a more decentralized and worker-driven way. And yet, while it is true that the data-driven methods are subject to the organizational tendencies of a group overall; the tricky aspect lies in that fact that the methods and technologies could potentially leave the most practitioners endlessly struggling against those built-in tendencies towards the centralization of knowledge and expert driven decision-making. Both of these tendencies tend to result in a smaller group of data operators acting as stewards of the data collected from a larger group of people being observed.

In the case studies I have analyzed, another practical reason for the closing in of access to workplace data is that some of the data being gathered felt personal. Ruby Forman, and how long it took her to sew the seam, especially compared to her colleagues, may have seemed like information that should available only to a small group of people – especially considering the garment and textile unions' early struggles with its membership resisting the observation of engineers. More generally, it is possible that the desire for privacy and the personal-ness of one's work and workplace conditions (or the vulnerability of sharing ones productivity rates) also makes it tempting to have a smaller set of people be the stewards of workplace data, which in turn reinforces the organizational tendencies of the data methods to centralize knowledge and cleave access according to expertise. Is this inevitably the case for all forms of workplace data collection for advocacy purposes? I would argue that it is not. In the introduction to this thesis, I described the contemporary proliferation of salary

sharing spreadsheets. For data that is either less valuable, or where the benefits of sharing the data could outweigh the costs of sharing it, social norms can and have been be adjusted to support more openness about the conditions of work. If there is more normative openness, it is possible that this could lead to broader participation in the shaping of the data methods. This is an important vector to consider in future analysis about data processes in workplace advocacy.

7.4 Looking Ahead

This thesis leaves several directions for future work. First, as mentioned in the section above, the work and strategies of the engineering-management department of the ILGWU should be analyzed within the broader context and strategic approaches of the union, especially comparing the earlier case studies with the later years of the union. One goal would be to understand the relationship between engineering tactics and "union militancy" – does the former follow a phase of the latter (as I had suggested in chapter 5) or do engineering strategies cease to be used when the possibility of using more forceful tactics (e.g. strikes) is diminished? A second question underlying this dissertation is about the role of craft knowledge – knowledge about how to do a task that is uniquely held by the worker and necessary to do the work – in both workers' responses to automation and the use of data-driven advocacy strategies. We have a good sense for how data driven advocacy works when craft knowledge is receding, but it would be interesting to compare how garment workers in the 40s responded to engineering tactics versus workers in the 70s, when automation was common-

place practice in the garment industry [1]. It would also be interesting to compare garment work with other more and less automated industries.

There are also areas of research that approach the same problematics on the role of worker data in advocacy efforts as this dissertation, but from the perspective of the present. Data-driven worker advocacy strategies have recently had success; for example, aggregated data about platform workers' tasks and compensation have been used to identify wage violations in a push for more equitable payment algorithms [261]. Tools have also been built to use driving data to automatically submit wage claims, supporting worker communication to obtain fair wages [246]. Like in the past, the gathering of worker data in the present is vexed by the following challenges: first, data-collection by a third-party increases the risk of unwanted surveillance [97]; additionally, the use of data-driven approaches to advocate for workers' rights can negatively impact the existing social relations within advocacy organizations. Leveraging data-intensive methods often requires the advocacy organization to rely on data experts, or people who are trained in working with and representing data [188].

Since participation in decisions made by data experts often requires access to technical knowledge, the use of data-intensive methods can lead to the exclusion of non-technically trained participants, including the workers whose data is being gathered, from crucial decision-making around data collection and its use. As a result, the use of data-driven methods poses a challenge to sustaining worker trust and participation in advocacy contexts [205]. By studying how

[1] Here it is important to reiterate that the lack of "craft knowledge" does not mean that workers are unskilled, it means instead that important knowledge about how to do the work is not uniquely held by the workers and not known to management. Many garment operations are still done by hand [181], it is just that the coordination and execution of these difficult-to-automate tasks is done not by the workers, but by employers and machines, making the workers more replaceable and thereby disenfranchised

data-driven approaches impacted advocacy in the past, we have been able to anticipate some of the challenges of applying similar approaches in the present. Contemporary approaches to data-driven worker advocacy, however, must also address new data gathering affordances as well as the current legal and political climate of worker advocacy.

To do this, future research should examine the current role of data experts and data expertise in contemporary advocacy organizations. There will be several interesting differences between these present-day cases and the historical case studies I have examined. Some of these organizations are official labor unions, but many are not. This means their strategy options may be different than those of a labor union, and they operate without the legal protections or institutional resources available to unions. In addition, the workers represented by these organizations often fall outside of the industrial and "light industrial" (garment and textile) workers discussed in this thesis. How do these workers relate to their workplace and their "workplace data", and how do they participate or not participate in data-intensive advocacy work?

Finally, to understand the role of data in the labor movement more broadly, it is important to consider the role of data technologies not only in worker advocacy, but also in supporting worker organizing (for example, in unionization and union campaigns). Technologies like the Google spreadsheet exist not only to support sharing of workplace data, but also for the collection of data about workers for organizing purposes. Beyond the Google spreadsheet, unions and other organizations use both general purpose and custom software to gather data about workers including their workplace conditions, concerns, and levels of support for the organization. This information is used by worker activists

and the advocacy organization to make strategic decisions. Within these organizations, lower-level staff work around and outside of these tools to develop necessary data access for activist workers and calibrate data representations to meet local needs. Ironically, my preliminary research into unions' use of data-driven technologies [189] shows how robust data gathering can alienate the perspectives of lower-level staff and worker activists, resulting in less accurate assessments of the organizing situation on the ground. Further research into these organizations' use of data technologies can shed further light on the role of data-intensive methods in organizational centralizing (and limiting participation in data decision-making).

Ultimately the viability of any data-driven approach has much to do with the organizations themselves, so research into the general practices and strategies of worker advocacy organizations will help researchers and technology designers better understand how to map historical tactics to contemporary advocacy contexts.

APPENDIX A

CHAPTER 1 OF APPENDIX

Text is reproduced from Elastico Gomez's article, "We are, all of us, Machines" in HOMINTERN magazine, published on September 11th, 2019:

"The points system is directly governed by Amazon's AI and by its company software. The idea is each point, out of a maximum of twenty, is a demerit; nine points as a seasonal worker or thirteen points as a regular employee means you're fired. If you want a shift or half a shift off, that's a point hit. If you dip below the productivity rates they are continuously tracking and logging on shift, that's a point hit. If you spend some "time off-task," to get some water or go to the bathroom, that's a point hit. If the supervisors just want to fuck with you, because they don't like you, that's a point hit.

UPS employs a similar system, but the difference is you get a union rep after 30 working days and the whole process is mediated by actual human beings. At Amazon, this is mediated almost entirely by the AI, and the AI is like a very distant and stupid god. This is good for eliminating the human interface – like when you lie to get out of a shift you don't have to worry about how bad you really are at lying; but it dissolves any kind of leverage you might attain from a real social environment. The company's social environment is almost completely virtual, in fact. The company counts on you being out of there in a month or three, so there's less time for you to really get upset about it.

The AI is your boss, your boss's boss, and your boss's boss's boss: it sets the target productivity rates, the shift quotas, and the division of labor on the floor. Your supervisor's job is to clean up for it, make sure that no one notices its calculations and projections exceed basic physical limitations – to realize that its logic precludes humanity. Ultimately what this means to you is that you'll rarely work with the same people

twice, you'll be isolated, put on random tasks from shift to shift, slog for stowing or sorting or picking or packing rates well exceeding your average – because your supervisor told you so, and the program told him before that. You're always working for the machine or trying to work around its surveillance in order to work less.

Sooner or later you'll get fired or drop out. Don't worry about it. Your info's expunged from their system after a year. After that, you're free to apply again. https://homintern.soy/posts/wemachines.html

BIBLIOGRAPHY

[1] Belle strike organizer arrested. page 15.

[2] Belle strike spreads; kaye proposes plant election; dutch refuse to bow to jap ultimatum on trade plans. page 1.

[3] Eggheads Are Leaving Unions. 51(9):34.

[4] Gomberg of ILGWU to speak at workshop. 89(87):41.

[5] Gomberg resigns ILGWU position. 93(55):32.

[6] Guide to the ILGWU. management engineering department records.

[7] Instacart pay calculators.

[8] MeasuringU: Measuring task times without users.

[9] Needlecraft group to meet tomorrow. 70(86):7. Num Pages: 1 Place: New York, United States, New York Publisher: Penske Business Corporation.

[10] Who we are.

[11] The handbook of task analysis for human-computer interaction, 2004.

[12] Encyclopedia of human computer interaction, 2006.

[13] Adam Abruzzi. Objective procedures for estimating industrial productivity. 5(1):108–117.

[14] Adam Abruzzi. *Work measurement: new principles and procedures*. Columbia University Press.

[15] Mark S. Ackerman. The intellectual challenge of CSCW: the gap between social requirements and technical feasibility. 15(2):179–203.

[16] Charlotte Alexander. Transparency and transmission: Theorizing information's role in regulatory and market responses to workplace problems. *Connecticut Law Review*, 48(1):177, 2015.

[17] Ali Alkhatib, Michael S Bernstein, and Margaret Levi. Examining crowd work and gig work through the historical lens of piecework. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pages 4599–4616. ACM, 2017.

[18] Ali Alkhatib, Michael S. Bernstein, and Margaret Levi. Examining crowd work and gig work through the historical lens of piecework. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, pages 4599–4616, Denver, Colorado, USA, 2017. ACM Press.

[19] Ali Alkhatib, Justin Cranshaw, and Andrés Monroy-Hernández. Laying the groundwork for a worker-centric peer economy. *arXiv:1807.08189 [cs]*, 2018.

[20] Antonio Aloisi. Commoditized workers: Case study research on labor law issues arising from a set of on-demand/gig economy platforms. 37:653.

[21] Gerald Andersen. Union aides urge speed in technical innovation. 120(47):24. Num Pages: 1 Place: New York, United States, New York Publisher: Penske Business Corporation.

[22] J. Annett and K. D. Duncan. Task analysis and training design. page 22, 1967.

[23] John Annett. Hierarchical task analysis. In *E. Hollnagel (Ed)., Handbook of Cognitive Task Design*, pages 17–35. Lawrence Erlbaum Associates, Inc., 2003.

[24] C.J. Anson. The development of TIME STUDY. 2(12):19–25. Publisher: MCB UP Ltd.

[25] Peter M. Asaro. Transforming society by transforming technology: the science and politics of participatory design. 10(4):257–290.

[26] Frank Leslie Bailey, International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America, Wallace-Murray Corporation, and Stevenson, Inc, Jordan & Harrison. *Production standards from time study analysis by labor and management.* Local no. 2, U.A.W.-C.I.O., and the Murray Corp. of America, 1942. OCLC: 3717079.

[27] David Floyd Baker. A study of the evolution of industrial engineering.

[28] Helen Baker. A reading list on labor and the public. 248(1):195–198.

[29] Liam Bannon. Reimagining HCI: Toward a more human-centered perspective. *Interactions*, 18(4):50–57, 2011.

[30] Liam J. Bannon. Discovering the human actors in human factors. 18(290).

[31] Liam J. Bannon and Kjeld Schmidt. CSCW-four characters in search of a context. 18(289).

[32] Liam J Bannon and Kjeld Schmidt. CSCW - four characters in search of a context. *DPB DAIMI Report Series*, 18(289):378–382, 1989. OCLC: 7083123381.

[33] Jack Barbash. The ILGWU as an organization in the age of dubinsky. 9:98–115.

[34] Solomon Barkin. Concepts in the measurement of human application. *Industrial and Labor Relations Review*, 7(1):103–118, 1953. OCLC: 5544326559.

[35] Solomon Barkin. Arbitrator's headache—wage incentive cases. *Compensation & Benefits Review*, 2(2):60–64, 1970. OCLC: 5723624789.

[36] Brian A. Barton. Trade unions and the entrepreneurial function. 1(6):20.

[37] Eric PS Baumer and Jed R Brubaker. Post-userism. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pages 6291–6303. ACM, 2017.

[38] Gordon Baxter and Ian Sommerville. Socio-technical systems: From design methods to systems engineering. 23(1):4–17.

[39] Nathan Belfer. Section work in the women's garment industry. 21(2):188.

[40] Daniel Bell. *The end of ideology: on the exhaustion of political ideas in the fifties*. Free Press, rev. ed. edition. http://newcatalog.library.cornell.edu/catalog/1046939.

[41] Genevieve Bell and Joseph Kaye. Designing technology for domestic spaces: A kitchen manifesto. *Gastronomica: The Journal of Critical Food Studies*, 2(2):46–62, 2002.

[42] Warren G. Bennis. A reply: When democracy works. 3(5):33–35.

[43] Alan Benson, Aaron Sojourner, and Akhmed Umyarov. Can reputation discipline the gig economy?: Experimental evidence from an online labor market, 2019.

[44] Elaine Bernard. *Technological Change and Skills Development. EEE700 Adults Learning: The Changing Workplace A.* ERIC.

[45] Ethan S. Bernstein. Making transparency transparent: The evolution of observation in management theory. 11(1):217–266.

[46] Michael S. Bernstein, Joel Brandt, Robert C. Miller, and David R. Karger. Crowds in two seconds: Enabling realtime crowd-powered interfaces. In *Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology*, UIST '11, pages 33–42, Santa Barbara, California, USA, 2011. ACM.

[47] Michael S. Bernstein, Greg Little, Robert C. Miller, Björn Hartmann, Mark S. Ackerman, David R. Karger, David Crowell, and Katrina Panovich. Soylent: A word processor with a crowd inside. In *Proceedings of the 23Nd Annual ACM Symposium on User Interface Software and Technology*, UIST '10, pages 313–322, New York, NY, USA, 2010. ACM.

[48] Olav Bertelsen. Fitts' law as a design artefact: A paradigm case of theory in software design. In *International Conference on Human-Computer Interaction*, pages 11–18. Springer.

[49] Jeffrey P. Bigham, Chandrika Jayant, Hanjie Ji, Greg Little, Andrew Miller, Robert C. Miller, Robin Miller, Aubrey Tatarowicz, Brandyn White, Samual White, and Tom Yeh. VizWiz: Nearly real-time answers to visual questions. In *Proceedings of the 23Nd Annual ACM Symposium on User Interface Software and Technology*, UIST '10, pages 333–342, New York, New York, USA, 2010. ACM.

[50] Jeanette Blomberg, Lucy Suchman, and Randall Trigg. Computers and design in context. pages 267–287. MIT Press, 1997.

[51] Mark Blythe, Andrew Monk, and Jisoo Park. Technology biographies: field study techinques for home use product development. In *CHI'02 Extended Abstracts on Human Factors in Computing Systems*, pages 658–659. ACM, 2002.

[52] John Bowers. The logic of annotated portfolios: communicating the value of'research through design'. In *Proceedings of the Designing Interactive Systems Conference*, pages 68–77. ACM, 2012.

[53] Geoffrey C Bowker and Susan Leigh Star. *Sorting things out: classification and its consequences*. Massachusetts Institute of Technology, 2000.

[54] Harry Braverman. *Labor and monopoly capital: the degradation of work in the twentieth century*. Monthly Review Press, 25th anniversary ed edition.

[55] David Brody. Workplace contractualism: A historical/comparative analysis. *In Labor's Cause: Main Themes on the History of the American Worker (New York, 1993)*, 221, 1992.

[56] Kate Bronfenbrenner and Tom Juravich. It takes more than house calls: Organizing to win with a comprehensive union-building strategy [electronic version]. In K. Bronfenbrenner, S. Friedman, R. W. Hurd, R. A. Oswald, and R.L. Seeber, editors, *Articles & Chapters*, page 187. ILR Press, 1998.

[57] Otis Brubaker, Lane Kirkland, William Gomberg, Nat Weinberg, and et al. What kind of information do labor unions want in financial statements? 87(5):368.

[58] Susanne Bødker, Pelle Ehn, Dan Sjögren, and Yngve Sundblad. Cooperative design—perspectives on 20 years with 'the scandinavian IT design model'. In *proceedings of NordiCHI*, volume 2000, pages 22–24.

[59] Ariela Caglio. To disclose or not to disclose? an investigation of the antecedents and effects of open book accounting.

[60] Ryan Calo and Alex Rosenblat. The taking economy: Uber, information, and power. pages 1623–1690.

[61] Alexia Fernández Campbell. The worldwide uber strike is a key test for the gig economy, 2019.

[62] Bilma Canales. Closing the federal gender pay gap through wage transparency. *Houston law review*, 55(4):969–998, 2018. OCLC: 7669015462.

[63] Stuart Card. The psychology of human-computer interaction.

[64] Stuart K. Card, Thomas P. Moran, and Allen Newell. The keystroke-level model for user performance time with interactive systems. 23(7):396–410, 1980.

[65] John M. Carroll. Conceptualizing a possible discipline of human–computer interaction. 22(1):3–12.

[66] John M. Carroll. Encountering others: Reciprocal openings in participatory design and user-centered design. 11(3):285–290.

[67] Phil Carroll Jr. One view of labor's participation in time and motion study. *Advanced Management: Quarterly Journal*, 6:75–80, 1941.

[68] Melissa Cefkin, Obinna Anya, Steve Dill, Robert Moore, Susan Stucky, and Osariemo Omokaro. Back to the future of organizational work: crowdsourcing and digital work marketplaces. In *Proceedings of the companion publication of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing - CSCW Companion '14*, pages 313–316, Baltimore, Maryland, USA, 2014. ACM Press.

[69] Neil W. Chamberlain. The union challenge to management control. 16(2):184–192.

[70] Dana Chandler and Adam Kapelner. Breaking monotony with meaning: Motivation in crowdsourcing markets. *Journal of Economic Behavior & Organization*, 90:123–133, 2013.

[71] Hasok Chang. How historical experiments can improve scientific knowledge and science education: The cases of boiling water and electrochemistry. *Science & Education*, 20(3-4):317–341, 2011.

[72] Justin Cheng, Jaime Teevan, and Michael S. Bernstein. Measuring crowdsourcing effort with error-time curves. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 1365–1374, New York, NY, USA, 2015. ACM.

[73] Chun-Wei Chiang, Anna Kasunic, and Saiph Savage. Crowd coach: Peer coaching for crowd workers' skill growth. *Proceedings of the ACM on Human-Computer Interaction – CSCW*, 2:37:1–37:17, 2018.

[74] Lydia B. Chilton, Greg Little, Darren Edge, Daniel S. Weld, and James A. Landay. Cascade: Crowdsourcing taxonomy creation. In *Proceedings of the*

SIGCHI Conference on Human Factors in Computing Systems, CHI '13, pages 1999–2008, New York, NY, USA, 2013. ACM.

[75] Lydia B. Chilton, Clayton T. Sims, Max Goldman, Greg Little, and Robert C. Miller. Seaweed: A web application for designing economic games. In *Proceedings of the ACM SIGKDD Workshop on Human Computation*, HCOMP '09, pages 34–35, New York, NY, USA, 2009. ACM.

[76] Richard A. Cloward and Frances Fox Piven. Disruptive dissensus : people and power in the industrial age. In Jack Rothman, editor, *Reflections on community organization: enduring themes and critical issues*. F.E. Peacock Publishers, 1999. OCLC: 607382229.

[77] Morris R Cohen. *The faith of a liberal: selected essays*. Henry Holt and Company. http://newcatalog.library.cornell.edu/catalog/8226951.

[78] Morris R Cohen. *A preface to logic*. Meridian Books. http://newcatalog.library.cornell.edu/catalog/1735219.

[79] Morris R Cohen. *Reason and nature: an essay on the meaning of scientific method*. Free Press, 2d ed. edition. http://newcatalog.library.cornell.edu/catalog/1730503.

[80] Morris Raphael Cohen. Reason and nature. 1931.

[81] Morris Raphael Cohen. A preface to logic. 1944.

[82] Jonathan Evan Cohn. Ultrasonic bracelet and receiver for detecting position in 2d plane, 2018-01.

[83] Christina Colclough. Spotlight beta test II | UNI global.

[84] Richard W. Collins. CSCW: An opportunity for action research. In *Proceedings of Conference on Organizational Computing Systems*, COCS '95, pages 162–167, New York, NY, USA, 1995. ACM.

[85] Coworker.org. About us, 2019.

[86] R. Crawley. Predicting air traffic controller reaction to computer assistance: a follow-up study. *AP Report*, 105, 1982.

[87] Abe Crystal and Beth Ellington. Task analysis and human-computer interaction: approaches, techniques, and levels of analysis. *AMCIS 2004 Proceedings*, page 391, 2004.

[88] Peng Dai, Jeffrey M. Rzeszotarski, Praveen Paritosh, and Ed H. Chi. And now for something completely different: Improving crowdsourcing workflows with micro-diversions. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing*, CSCW '15, pages 628–638, New York, NY, USA, 2015. ACM.

[89] Giorgio De Santillana. *The development of rationalism and empiricism*. University of Chicago Press. http://newcatalog.library.cornell.edu/catalog/1235242.

[90] Valerio De Stefano. The rise of the just-in-time workforce: On-demand work, crowdwork, and labor protection in the gig-economy. *Comparative Labor Law & Policy Journal*, 37:471–504, 2015.

[91] Rosa DeLauro. Text - h.r.3467 - 115th congress (2017-2018): Wage theft prevention and wage recovery act.

[92] John Desmond and Fiona Wilson. Democracy and worker representation in the management of change: Lessons from kurt lewin and the harwood studies. *human relations*, 72(11):1805–1830, 2019.

[93] D.G Malcolm and . Report of FIRST MOTION AND TIME STUDY INSTITUTE. INSTITUTE OF INDUSTRIAL RELATIONS, UNIVERSITY OF CALIFORNIA.

[94] Dan Diaper. Task analysis at the heart of human-computer interaction. In *Encyclopedia of Human Computer Interaction*, pages 579–587. IGI Global.

[95] Carl DiSalvo. The need for design history in hci. *interactions*, 21(6):20–21, 2014.

[96] Margaret Lamburn Disher. *American factory production of women's clothing*. Devereaux Publications.

[97] Lynn Dombrowski, Adriana Alvarado Garcia, and Jessica Despard. Low-wage precarious workers' sociotechnical practices working towards addressing wage theft. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, CHI '17, pages 4585–4598. ACM.

[98] Paul Dourish. *Where the action is: the foundations of embodied interaction*. MIT Press.

[99] Steven Dow, Anand Kulkarni, Scott Klemmer, and Björn Hartmann. Shepherding the crowd yields better work. In *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work*, CSCW '12, pages 1013–1022, New York, NY, USA, 2012. ACM.

[100] John T. Dunlop. *Wage determination under trade unions /*. New York :.

[101] Joseph Stephen Dwyer. An analysis of motion and time study training as given by colleges and industrial organizations.

[102] Richard Dwyer. Workers' education, labor education, labor studies: An historical delineation. 47(1):179–207.

[103] Benjamin G. Edelman and Damien Geradin. Efficiencies and regulatory shortcuts: How should we regulate companies like airbnb and uber. 19:293.

[104] Dennis E. Egan. Chapter 24 - individual differences in human-computer interaction. In MARTIN Helander, editor, *Handbook of Human-Computer Interaction*, pages 543–568. North-Holland.

[105] Pelle Ehn. *Work-oriented design of computer artifacts*. Arbetslivcentrum, 2. ed edition. OCLC: 248656382.

[106] Pelle Ehn. *Work-oriented design of computer artifacts*. Arbetslivscentrum : International distribution, Almqvist & Wiksell International, 1988.

[107] Pelle Ehn, Peter Botsman, and Peter Rawlinson. *Negotiating Change: New Technology and Trade Unions : an Interview with Pelle Ehn*. Local Consumption, 1986.

[108] Motahhare Eslami, Kristen Vaccaro, Karrie Karahalios, and Kevin Hamilton. "be careful; things can be worse than they appear": Understanding biased algorithms and users' behavior around them in rating platforms. 2017.

[109] Cynthia Estlund. Just the facts: The case for workplace transparency. *Stanford Law Review*, 63(2):351–407, 2011. OCLC: 7781107254.

[110] Cynthia Estlund. Extending the case for workplace transparency to information about pay. *UC Irvine Law Review*, 4(2), 2017. OCLC: 8092013097.

[111] Frederick Evans and Kjell Eric Magnusson. *MTM-2 student manual, etc.* Warrington, 1966. OCLC: 558851380.

[112] Dwight T. Farnham. Reduction of industrial wastes1. 5(7):440–448. _eprint: https://ceramics.onlinelibrary.wiley.com/doi/pdf/10.1111/j.1151-2916.1922.tb18556.x.

[113] Oluwaseyi Feyisetan, Elena Simperl, Max Van Kleek, and Nigel Shadbolt. Improving paid microtasks through gamification and adaptive furtherance incentives. In *Proceedings of the 24th International Conference on World Wide Web - WWW '15*, pages 333–343, Florence, Italy, 2015. ACM Press.

[114] Laura Forlano and Megan Halpern. FCJ-189 reimagining work: Entanglements and frictions around future of work narratives. *The Fibreculture Journal*, (26):32–59, 2015.

[115] Sarah E Fox, Kiley Sobel, and Daniela K Rosner. Managerial visions: stories of upgrading and maintaining the public restroom with iot. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, pages 1–15, 2019.

[116] Sarah E. Fox, Kiley Sobel, and Daniela K. Rosner. Managerial visions: Stories of upgrading and maintaining the public restroom with IoT. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, pages 493:1–493:15, Glasgow, Scotland Uk, 2019. ACM.

[117] Georges Friedmann. *Industrial society; the emergence of the human problems of automation (Problèmes humains du machinisme industriel)*. Free Press, 1955. OCLC: 830944.

[118] Snehalkumar (Neil) S. Gaikwad, Mark E. Whiting, Dilrukshi Gamage, Catherine A. Mullings, Dinesh Majeti, Shirish Goyal, Aaron Gilbee, Nalin Chhibber, Adam Ginzberg, Angela Richmond-Fuller, Sekandar Matin, Vibhor Sehgal, Tejas Seshadri Sarma, Ahmed Nasser, Alipta Ballav, Jeff Regino, Sharon Zhou, Kamila Mananova, Preethi Srinivas, Karolina Ziulkoski, Dinesh Dhakal, Alexander Stolzoff, Senadhipathige S. Niranga, Mohamed Hashim Salih, Akshansh Sinha, Rajan Vaish, and Michael S. Bernstein. The daemo crowdsourcing marketplace. In *Companion of the*

2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, CSCW '17 Companion, pages 1–4, New York, NY, USA, 2017. ACM.

[119] Krzysztof Gajos, Katharina Reinecke, and Charles Herrmann. Accurate measurements of pointing performance from in situ observations. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '12, pages 3157–3166, New York, NY, USA, 2012. ACM.

[120] Charlene Gannagé. Changing dimensions of control and resistance: The toronto garment industry. 24(4):41–60.

[121] William Gaver. What should we expect from research through design? In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '12, pages 937–946, New York, NY, USA, 2012. ACM.

[122] Lillian M Gilbreth. TRAINING EMPLOYES IN PRODUCTION WORK. *saetransactions SAE Transactions*, 20:735–760, 1925. OCLC: 7851216721.

[123] April Glaser. The ride-hail strike got just enough attention to terrify uber, 2019.

[124] Evelyn Nakano Glenn and Roslyn L. Feldberg. Degraded and deskilled: The proletarianization of clerical work. *Social Problems*, 25(1):52–64, 1977.

[125] Charles Buxton Going. *Principles of industrial engineering*. McGraw-Hill Book Company.

[126] Lavie Pinchas Golenberg. Task analysis, modeling, and automatic identification of elemental tasks in robot-assisted laparoscopic surgery.

[127] William Gomberg. *Book Review: Methods-Time Measurement*. SAGE Publications Sage CA: Los Angeles, CA.

[128] William Gomberg. Democratic management - gomberg replies. 4(2):48–.

[129] William Gomberg. Job evaluation and wage incentives. In *Proceedings of New York University first annual conference on labor: issues in collective bargaining and Taft-Hartley Act (eds. Enanuel Stein)*. Matthew Bender & Company.

[130] William Gomberg. Measuring the fatigue factor. 1(1):80–93.

[131] William Gomberg. Problems of economic growth and automation. 3(4):4–17.

[132] William Gomberg. *A trade union analysis of time study*. Prentice-Hall.

[133] William Gomberg. A trade unionist looks at job evaluation. 35(1):1.

[134] William Gomberg. The trouble with democratic management. 3(5):30–35.

[135] William Gomberg. UNION INTEREST IN ENGINEERING TECHNIQUES. 24(3):356–365.

[136] William Gomberg. Union participation in high productivity. 248(1):70–75.

[137] William Gomberg. Union policy experimentation in a volatile industry. 9:69–81.

[138] William Gomberg. *The Validity of Time Study Techniques*. Science Research Associates.

[139] William Gomberg. The work rules and work practices problem. 12:643.

[140] William Gomberg. *A labor union manual on job evaluation, the relationship of industrial engineering techniques to collective bargaining.* Labor Education Division, Roosevelt College, 1947. OCLC: 831726.

[141] William Gomberg. *A trade union analysis of time study*. Prentice-Hall, 1955. OCLC: 562377.

[142] William Gomberg. Featherbedding: An assertion of property rights. *The Annals of the American Academy of Political and Social Science*, 333(1):119–129, 1961.

[143] Mary L. Gray, Siddharth Suri, Syed Shoaib Ali, and Deepti Kulkarni. The crowd is a collaborative network. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, CSCW '16, pages 134–147, New York, NY, USA, 2016. ACM.

[144] Jonathan Grudin. From tool to partner: The evolution of human-computer interaction. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems*, page C15. ACM.

[145] Jonathan Grudin. *From tool to partner: the evolution of human-computer interaction*. Number 35 in Synthesis lectures on human-centered informatics. Morgan & Claypool. OCLC: 987883393.

[146] Jonathan Grudin. Turing maturing: the separation of artificial intelligence and human-computer interaction. *interactions*, 13(5):54–57, 2006.

[147] Jonathan Grudin. From tool to partner: The evolution of human-computer interaction. *Synthesis Lectures on Human-Centered Interaction*, 10(1):i–183, 2017.

[148] Jonathan Grudin and Rebecca E. Grinter. Ethnography and design. 3(1):55–59.

[149] Jonathan Grudin and Gayna Williams. Two women who pioneered user-centered design. *interactions*, 20(6):15–20, 2013.

[150] W. Ian Hamilton. Human factors past and present. In *Contemporary Ergonomics 2009: Proceedings of the International Conference on Contemporary Ergonomics 2009*, page 291. CRC Press.

[151] Karin Hansson, Tanja Aitamurto, and Thomas Ludwig. From alienation to relation: Examining the modes of production in crowdsourcing. 2017.

[152] Ellie Harmon and M. Six Silberman. Rating working conditions on digital labor platforms. *Comput. Supported Coop. Work*, 27(3):1275–1324, 2018.

[153] Richard Harper and Kathleen Carter. Keeping people apart. *Computer Supported Cooperative Work (CSCW)*, 2(3):199–207, 1993.

[154] Kenji Hata, Ranjay Krishna, Li Fei-Fei, and Michael S. Bernstein. A glimpse far into the future: Understanding long-term crowd worker quality. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, CSCW '17, pages 889–901, New York, NY, USA, 2017. ACM.

[155] Frederick Herzberg. *Work and the nature of man.* New American Library, 1973. OCLC: 975249.

[156] Julius Hochman. Industry planning through collective bargaining. In *A Program for Modernizing the New York Dress Industry as Presented in Con-*

ference with Employers on Behalf of the Joint Board of the Dressmakers' Union (New York City: January, 1941).

[157] Sarah Holder. The gig-work bill that has uber and lyft spooked, 2019.

[158] Karen Holtzblatt and Hugh Beyer. Contextual design: Using customer work models to drive systems design. In *Conference Companion on Human Factors in Computing Systems*, CHI '96, pages 373–374, New York, NY, USA, 1996. ACM.

[159] John Joseph Horton and Lydia B. Chilton. The labor economics of paid crowdsourcing. In *Proceedings of the 11th ACM conference on Electronic commerce - EC '10*, page 209, Cambridge, Massachusetts, USA, 2010. ACM Press.

[160] Robert Franklin Hoxie. *Scientific management and labor*. D. Appleton, 1915.

[161] Robert Franklin Hoxie. *Trade unionism in the United States*. D. Appleton, 1923.

[162] Nicholas Hudson. 'hottentots' and the evolution of european racism. *Journal of European Studies*, 34(4):308–332, 2004.

[163] Edwin Hutchins and Leysia Palen. Constructing meaning from space, gesture, and speech. In Lauren B. Resnick, Roger Säljö, Clotilde Pontecorvo, and Barbara Burge, editors, *Discourse, Tools and Reasoning: Essays on Situated Cognition*, NATO ASI Series, pages 23–40. Springer Berlin Heidelberg, 1997.

[164] ILGWU. Management Engineering Department records, 1941-1980. http://rmc.library.cornell.edu/EAD/htmldocs/KCL05780-118.html.

[165] ILGWU. Report on real silk hosiery mills. http://rmc.library.cornell.edu/EAD/htmldocs/KCL05780-118.html.

[166] International Association of Machinists and Research Department. *What's wrong with job evaluation; a trade union manual.* 1954. OCLC: 5154416.

[167] International Ladies' Garment Workers' Union. Educational Department. *Report of the Educational Department ILGWU June 1, 1942 to May 31, 1944*. New York, International Ladies' Garment Workers' Union. Educational Department.

[168] International Ladies' Garment Workers' Union, Educational Department. *Structure and Functioning of the ILGWU.*

[169] International Metalworkers' Federation. *Wage systems and the metal unions: a trade union training manual*. International Metalworkers' Federation, 1963.

[170] Allied Industrial Workers of America International Union. *Work measurement; a guide for local union bargaining committees and stewards.* 1967. OCLC: 1093011.

[171] International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America. *The UAW-CIO looks at time study; a guide for union negotiators in plants where time study methods are used ...* 1947. OCLC: 17660798.

[172] Lilly C. Irani and M. Six Silberman. Stories we tell about labor: Turkopticon and the trouble with "design". In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 4573–4586. ACM.

[173] Lilly C. Irani and M. Six Silberman. Turkopticon: Interrupting worker invisibility in amazon mechanical turk. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, pages 611–620. ACM.

[174] Sanford M. Jacoby. Union-management cooperation in the united states: Lessons from the 1920s. 37(1):18–33.

[175] Shagun Jhaver, Yoni Karpfen, and Judd Antin. Algorithmic anxiety and coping strategies of airbnb hosts. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 421:1–421:12, New York, NY, USA, 2018. ACM.

[176] Bonnie E. John and David E. Kieras. Using GOMS for user interface design and evaluation: Which technique? 3(4):287–319.

[177] Bonnie E. John and David E. Kieras. The GOMS family of user interface analysis techniques: Comparison and contrast. *ACM Trans. Comput.-Hum. Interact.*, 3(4):320–351, 1996.

[178] Bonnie E. John and Steven J. Marks. Tracking the effectiveness of usability

evaluation methods. *Behaviour & Information Technology*, 16(4):188–202, 1997.

[179] Bonnie E. John, Konstantine Prevas, Dario D. Salvucci, and Ken Koedinger. Predictive human performance modeling made easy. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '04, pages 455–462, New York, NY, USA, 2004. ACM.

[180] Oswald Jones. Scientific management, culture and control: A first-hand account of taylorism in practice. *Human Relations*, 53(5):631–653, 2000.

[181] Jon Emont {\textbar} photographs by Ismail Ferdous for The Wall Street Journal. The robots are coming for garment workers. that's good for the u.s., bad for poor countries.

[182] J Kallinikos. *The Consequences of Information: Institutional Implications of Technological Change.* Edward Elgar Pub., 2007.

[183] Joseph'Jofish' Kaye. Evaluating experience-focused hci. In *CHI'07 extended abstracts on Human factors in computing systems*, pages 1661–1664. ACM, 2007.

[184] Christopher M Kelty. *The Participant: A Century of Participation in Four Stories*. University of Chicago Press, 2020.

[185] Van Dusen Kennedy. *Union policy and incentive wage methods*. Columbia University Press, New York, 1945.

[186] Van Dusen Kennedy. *Union policy and incentive wage methods,*. Columbia University Press; P.S. King & Staples, Ltd., 1945. OCLC: 400261.

[187] Dara Kerr. Uber's first driver meeting: Behind closed doors, 2018.

[188] Vera Khovanskaya, Lynn Dombrowski, Jeffrey Rzeszotarski, and Phoebe Sengers. The tools of management: Adapting historical union tactics to platform-mediated labor. *Proc. ACM Hum.-Comput. Interact.*, 3(CSCW), November 2019.

[189] Vera Khovanskaya, Phoebe Sengers, and Lynn Dombrowski. Bottom-up organizing with tools from on high: Understanding the data practices of labor organizers. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pages 1–13, 2020.

[190] Paul T Kidd. Technology and engineering design: shaping a better future or repeating the mistakes of the past? *IEE Proceedings A (Physical Science, Measurement and Instrumentation, Management and Education, Reviews)*, 135(5):297–302, 1988.

[191] ROBERT EUGENE KING. A cultural innovation that failed: The rise and fall of "industrial democracy" at the riverside and dan river cotton mills, danville, virginia 1919-1930. ISBN: 9798660906145.

[192] Aniket Kittur, Ed H. Chi, and Bongwon Suh. Crowdsourcing user studies with mechanical turk. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, pages 453–456, New York, NY, USA, 2008. ACM.

[193] Aniket Kittur, Jeffrey V. Nickerson, Michael Bernstein, Elizabeth Gerber, Aaron Shaw, John Zimmerman, Matt Lease, and John Horton. The future of crowd work. In *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*, CSCW '13, pages 1301–1318, New York, NY, USA, 2013. ACM.

[194] Aniket Kittur, Boris Smus, Susheel Khamkar, and Robert E. Kraut. CrowdForge: Crowdsourcing complex work. In *Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology*, UIST '11, pages 43–52, New York, NY, USA, 2011. ACM.

[195] Marvin Klapper. Bobbin show: Technology seen tool for efficiency. 135(56):38. Num Pages: 1 Place: New York, United States, New York Publisher: Penske Business Corporation.

[196] William H. Knowles. The nature of industrial cooperation. *Southern Economic Journal*, 18(3):350–361, 1952.

[197] Steven Komarov, Katharina Reinecke, and Krzysztof Z. Gajos. Crowdsourcing performance evaluations of user interfaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, pages 207–216, New York, NY, USA, 2013. ACM.

[198] Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, and Stephan Wensveen. *Design research through practice: From the lab, field, and showroom*. Elsevier, 2011.

[199] Anand Kulkarni, Matthew Can, and Björn Hartmann. Collaboratively crowdsourcing workflows with turkomatic. In *Proceedings of the ACM*

2012 Conference on Computer Supported Cooperative Work, CSCW '12, pages 1003–1012, New York, NY, USA, 2012. ACM.

[200] Walter S. Lasecki, Rachel Wesley, Jeffrey Nichols, Anand Kulkarni, James F. Allen, and Jeffrey P. Bigham. Chorus: A crowd-powered conversational assistant. In *Proceedings of the 26th Annual ACM Symposium on User Interface Software and Technology*, UIST '13, pages 151–162, New York, NY, USA, 2013. ACM.

[201] Edwin T. Layton. *The revolt of the engineers: social responsibility and the American engineering profession*. Press of Case Western Reserve University. http://newcatalog.library.cornell.edu/catalog/21134.

[202] Sage Lazzaro. Uber drivers plan boycott after fare cuts slash their earnings to below minimum wage, 2016.

[203] Min Kyung Lee, Daniel Kusbit, Evan Metsky, and Laura Dabbish. Working with machines: The impact of algorithmic and data-driven management on human workers. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 1603–1612, Seoul, Republic of Korea, 2015. ACM.

[204] Karen EC Levy. The contexts of control: Information, power, and truck-driving work. *The Information Society*, 31(2):160–174, 2015.

[205] Nelson Lichtenstein. Great expectations: the promise of industrial jurisprudence and its demise, 1930-1960. In Nelson Lichtenstein and Howell John Harris, editors, *Industrial democracy in America: The ambiguous promise*. Cambridge University Press.

[206] Nelson Lichtenstein. *State of the Union: a century of American labor*. Princeton University Press, 2002.

[207] Nelson Lichtenstein and Howell John Harris. *Industrial democracy in America: The ambiguous promise*. Cambridge University Press, 1996.

[208] Chavie Lieber. Grocery startup instacart says it's fixed its payment problems. this gig worker says it hasn't., 2019.

[209] Chavie Lieber. Some delivery apps pocket their workers' tips. a new bill aims to expose the practice., 2019.

[210] Warren Ellsworth Lind. A statistical analysis of work-time distributions.

[211] Sebastian B. Littauer and Adam Abruzzi. Experimental criteria for evaluating workers and operations. 2(4):502–526.

[212] Craig R. Littler. Understanding taylorism. *The British Journal of Sociology*, 29(2):185–202, 1978.

[213] Z. Liu, Y. Wang, M. Dontcheva, M. Hoffman, S. Walker, and A. Wilson. Patterns and sequences: Interactive exploration of clickstreams to understand common visitor paths. *IEEE Transactions on Visualization and Computer Graphics*, 23(1):321–330, 2017.

[214] Mitchell Lokiec. *Labor and technology in the postwar era*. Bobbin Publications.

[215] Mitchell Lokiec. *Productivity and incentives*. Bobbin Publications.

[216] Brenton J Malin and Curry Chandler. Free to work anxiously: Splintering precarity among drivers for uber and lyft. *Communication, Culture & Critique*, 10(2):382–400, 2017. OCLC: 7736345469.

[217] Peter Mambrey, Gloria Mark, and Uta Pankoke-Babatz. User advocacy in participatory design: Designers' experiences with a new communication channel. 7(3):291–313.

[218] Giuseppe Mantovani. Social context in HCl: A new framework for mental models, cooperation, and communication. *Cognitive Science*, 20(2):237–269, 1996.

[219] Bertin Martens. An economic policy perspective on online platforms.

[220] David Martin, Benjamin V. Hanrahan, Jacki O'Neill, and Neha Gupta. Being a turker. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing*, CSCW '14, pages 224–235, New York, NY, USA, 2014. ACM.

[221] Karl Marx. *Capital: volume I*. Penguin UK, 2004.

[222] Claire Mayhew and Michael Quinlan. Fordism in the fast food industry: pervasive management control and occupational health and safety risks for young temporary workers. 24(3):261–284.

[223] Harold B Maynard. *Industrial engineering handbook.* McGraw-Hill, 1956. OCLC: 562114.

[224] Harold B Maynard. *Industrial engineering handbook*. McGraw-Hill, 1971. OCLC: 206045.

[225] Melissa Mazmanian and Christine M. Beckman. "making" your numbers: Engendering organizational control through a ritual of quantification. *Organization Science*, 29(3):357–379, 2018.

[226] John McCarthy. The paradox of understanding work for design. *International Journal of Human-Computer Studies*, 53(1):197–219, 2000. OCLC: 361007530.

[227] Brian McInnis, Dan Cosley, Chaebong Nam, and Gilly Leshed. Taking a HIT: Designing around rejection, mistrust, risk, and workers' experiences in amazon mechanical turk. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, CHI '16, pages 2271–2282, New York, NY, USA, 2016. ACM.

[228] Jean Trepp McKelvey. *AFL attitudes toward production, 1900-1932*. Number 2. Cornell University, 1952.

[229] Dwight V Merrick. *Time Studies as a Basis for Rate Setting*. Engineering Magazine Company, 1920.

[230] Laura G. Militello and Robert JB Hutton. Applied cognitive task analysis (ACTA): a practitioner's toolkit for understanding cognitive task demands. *Ergonomics*, 41(11):1618–1641, 1998.

[231] Michelle Miller and Eric Harris Bernstein. NEW FRONTIERS OF WORKER POWER.

[232] Mareike Mohlmann and Lior Zalmanson. Hands on the wheel: Navigating algorithmic management and uber drivers' autonomy.

[233] Robert Lee Morrow. *Motion economy and work measurement*. Ronald Press Company, 1957.

[234] Patty Murray. Text - s.3064 - 115th congress (2017-2018): Workers' freedom to negotiate act of 2018.

[235] M. Scott Myers. Every employee a manager. *California Management Review*, 10(3):9–20, 1968.

[236] Gerald Nadler. *Work design.* R.D. Irwin, 1963. OCLC: 229620.

[237] Milton J. Nadworny. *Scientific management and the unions, 1900-1932; a historical analysis*. Harvard University Press.

[238] Bonnie A Nardi. *Context and consciousness: activity theory and human-computer interaction*. MIT Press, 1996.

[239] David F. Noble. *Forces of production*. Transaction Publishers.

[240] David F. Noble. Social choice in machine design: The case of automatically controlled machine tools, and a challenge for labor. 8(3):313–347.

[241] David F Noble. *America by design: Science, technology, and the rise of corporate capitalism*. Number 588. Oxford University Press, USA, 1979.

[242] Chris Nyland. Taylorism and the mutual-gains strategy. 37(4):519–542.

[243] Chris Nyland and Kyle Bruce. Democracy or seduction? the demonization of scientific management and the deification of human relations. Publisher: The American Right and Labor: Politics, Ideology, and Imagination ....

[244] Sara O'Brien. On-demand workers are protesting – using the apps they work for - CNN, 2019.

[245] American Society of Mechanical Engineers. Transactions of the american society of mechanical engineers. In *Transactions of the American Society of Mechanical Engineers.*

[246] Edward Ongweso, Jr. Gig workers release tool to calculate stolen wages and unpaid expenses. Library Catalog: www.vice.com.

[247] Elisabeth Israels Perry. Industrial reform in new york city: Belle moskowitz and the protocol of peace, 1913–1916. 23(1):5–31.

[248] Paul Pigors. Labor-management conflict or co-operation. 70:531–534.

[249] Kathleen H. Pine and Max Liboiron. The politics of measurement and action. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 3147–3156. ACM.

[250] Jared Polis. Text - h.r.2275 - 115th congress (2017-2018): Giving workers a fair shot act.

[251] R. Presgrave. "a trade union analysis of time study," by william gomberg (book review). 2(3):439–440. Num Pages: 2 Place: Ithaca, N.Y., United States, Ithaca, N.Y. Publisher: Cornell University, New York State School of Industrial and Labor Relations.

[252] K. Sabeel Rahman. Broken contract: The rise of the networked firm and the transformation of twenty-first century capitalism k. sabeel rahman, brooklyn law school kathleen thelen, MIT.

[253] A. H. RASKIN. DRESS UNION SETS NEW PAY PATTERN: assembly-line employes to get plan similar to that used in piece work DRESS UNION SETS NEW PAY PATTERN. page 1. Num Pages: 1.

[254] Noopur Raval and Paul Dourish. Standing out from the crowd: Emotional labor, body labor, and temporal labor in ridesharing. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*, CSCW '16, pages 97–107, New York, NY, USA, 2016. ACM.

[255] Daniela Retelny, Michael S. Bernstein, and Melissa A. Valentine. No workflow can ever be enough: How crowdsourcing workflows constrain complex work. *Proc. ACM Hum.-Comput. Interact.*, 1:89:1–89:23, 2017.

[256] Daniela Retelny, Sébastien Robaszkiewicz, Alexandra To, Walter S. Lasecki, Jay Patel, Negar Rahmati, Tulsee Doshi, Melissa Valentine, and Michael S. Bernstein. Expert crowdsourcing with flash teams. In *Proceedings of the 27th Annual ACM Symposium on User Interface Software and Technology*, UIST '14, pages 75–85, New York, NY, USA, 2014. ACM.

[257] Juliana Feliciano Reyes. Why a google spreadsheet was the most powerful tool for labor in 2019.

[258] David Ribes and Thomas A Finholt. The long now of infrastructure: Articulating tensions in development. 2009.

[259] Justin Roberts. Accounting for slavery: masters and management. *Slavery & Abolition*, 41(3):686–688, 2020.

[260] Jakob Rogstadius, Vassilis Kostakos, Aniket Kittur, Boris Smus, Jim Laredo, and Maja Vukovic. An assessment of intrinsic and extrinsic motivation on task performance in crowdsourcing markets. In *Fifth International AAAI Conference on Weblogs and Social Media*, 2011.

[261] Kevin Roose. After uproar, instacart backs off controversial tipping policy. *The New York Times*, 2019.

[262] Alex Rosenblat and Luke Stark. Algorithmic labor and information asymmetries: A case study of uber's drivers.

[263] Caitlin Rosenthal. *Accounting for slavery: Masters and management*. Harvard University Press, 2019.

[264] Daniela K. Rosner, Samantha Shorey, Brock R. Craft, and Helen Remick. Making core memory: Design inquiry into gendered legacies of engineering and craftwork. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, pages 531:1–531:13, New York, NY, USA, 2018. ACM.

[265] Emilie M. Roth and Randall J. Mumaw. Using cognitive task analysis to define human interface requirements for first-of-a-kind systems. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 39(9):520–524, 1995. OCLC: 5725488007.

[266] Jeffrey Rzeszotarski and Aniket Kittur. CrowdScape: interactively visualizing user behavior and output. In *Proceedings of the 25th annual ACM symposium on User interface software and technology - UIST '12*, page 55, Cambridge, Massachusetts, USA, 2012. ACM Press.

[267] Jeffrey M. Rzeszotarski and Aniket Kittur. Instrumenting the crowd: Using implicit behavioral measures to predict task performance. In *Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology*, UIST '11, pages 13–22, New York, NY, USA, 2011. ACM.

[268] Niloufar Salehi, Lilly Irani, Ali Al Khatib, and Michael Bernstein. Dynamo: Designing interactive technology to support social movements in digital labor. *Future of Work Project (Open Society Foundations, 2014)*, 2014.

[269] Niloufar Salehi, Lilly C. Irani, Michael S. Bernstein, Ali Alkhatib, Eva Ogbe, and Kristy Milland. We are dynamo: Overcoming stalling and friction in collective action for crowd workers. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, pages 1621–1630. ACM.

[270] Jentery Sayers. Prototyping the past. *Visible Language*, 49(3), 2015.

[271] Jentery Sayers. Design without a future. *interactions*, 23(6):74–76, 2016.

[272] V. Donald Schoeller. GOMBERG, WILLIAM. a trade union analysis of time study. pp. xi, 243. chicago: Science research associates, 1948. $4.25. 258(1):159–160.

[273] School of Economics and Management, Jiangsu University of Science and Technology, Zhenjiang, Jiangsu, China and Shiqi Wang. Empirical research on the impact of open-book accounting on organizational performance. pages 199–204.

[274] Peter Segel. *Labor participation in time standard determination*.

[275] Joel Seidman. The i. LG. WU in the dubinsky period. 9:55–68.

[276] Graham Sewell. The discipline of teams: The control of team-based industrial work through electronic and peer surveillance. 43(2):397–428.

[277] Graham Sewell and Barry Wilkinson. 'someone to watch over me': Surveillance, discipline and the just-in-time labour process. *sociology Sociology*, 26(2):271–289, 1992. OCLC: 5792440034.

[278] Andrew Shepherd. *Hierarchical task analysis*. Taylor & Francis, 2001.

[279] Boris Shishkin. Job evaluation, what it means to unionists. *American Federationist*, 20, Aug 1947.

[280] Faiz Siddiqui. Uber and lyft drivers strike for pay transparency—after algorithms made it harder to understand. *Washington Post*, 2019.

[281] Ludwig Siegele. Technology may help to revive organised labour. *The Economist*, 2018.

[282] M. Six Silberman and I. G. Metall. Fifteen criteria for a fairer gig economy. In M. Graham and J. Shaw, editors, *Towards a Fairer Gig Economy*, pages 16–19. Meatspace Press, 2017.

[283] Jesper Simonsen and Finn Kensing. Using ethnography in contextural design. *Commun. ACM*, 40(7):82–88, 1997.

[284] Sumner Huber Slichter. *The impact of collective bargaining on management*. Brookings Inst Pr.

[285] Sumner Huber Slichter. *Union Policies and industrial management*. Brookings Inst., 1941. OCLC: 253542532.

[286] Tina Smith. Text - s.3077 - 115th congress (2017-2018): Fair pay and safe workplaces act of 2018.

[287] Robert Soden, David Ribes, Maggie Jack, Will Sutherland, Vera Khovanskaya, Seyram Avle, Phoebe Sengers, and Susanne Bødker. Fostering historical research in cscw & hci. In *Conference Companion Publication of the 2019 on Computer Supported Cooperative Work and Social Computing*, pages 517–522, 2019.

[288] Susan Leigh Star and Anselm Strauss. Layers of silence, arenas of voice: The ecology of visible and invisible work. 8(1):9–30.

[289] David Stark. Class struggle and the transformation of the labor process. 9(1):89–130. Publisher: Springer.

[290] Mark Starr. Why union education?: Aims, history, and philosophy of the educational work of the international ladies' garment workers' union. 92(3):194–202.

[291] Arthur L. Stinchcombe. *Information and organizations*, volume 19. Univ of California Press.

[292] Erik Stolterman. The nature of design practice and implications for interaction design research. *International Journal of Design*, 2(1), 2008.

[293] John Storey. The means of management control. *Sociology*, 19(2):193–211, 1985.

[294] Marilyn Strathern. The tyranny of transparency. *British educational research journal*, 26(3):309–321, 2000.

[295] Lucy Suchman. Making work visible. *Commun. ACM*, 38(9):56–64, 1995.

[296] Sumner H. Slichter. *Union Policies And Industrial Management*.

[297] Alex Tabarrok and Tyler Cowen. The end of asymmetric information.

[298] Leila Takayama. The motivations of ubiquitous computing: revisiting the ideas behind and beyond the prototypes. *Personal and Ubiquitous Computing*, 21(3):557–569, 2017.

[299] Chloe Taylor. Uber drivers strike across the UK in protest over workers' rights, 2018.

[300] Frederick Winslow Taylor. *The principles of scientific management*. Harper & brothers. OCLC: 2937172.

[301] Frederick Winslow Taylor. *Scientific management, comprising Shop management, the principles of scientific management [and] Testimony before the Special House Committee*. Harper, 1947. OCLC: 37887689.

[302] Shu-jie Tian, Bo Wang, Li Wang, and Dan Xu. Formalization modeling of maintenance based on agent. In *International Conference on Human-Computer Interaction*, pages 575–582. Springer.

[303] Andrew R. Timming and Ross Brown. Employee voice through open-book accounting: The benefits of informational transparency. 35(2):86–95.

[304] Julia Tomassetti. Does uber redefine the firm: The postindustrial corporation and advanced information technology. 34:1.

[305] Monica Torres. Google salary-sharing spreadsheets are all the rage. here's what you should know.

[306] Henry R Towne. The engineer as economist. *Classics of Organization Theory*, page 49, 2015.

[307] Molly Tran and Rosemary K. Sokas. The gig economy and contingent work: An occupational health assessment. *Journal of occupational and environmental medicine*, 59(4):e63, 2017.

[308] John Gudert Turnbull. *Labor-management relations: a research planning memorandum*. Number 61. Social Science Research Council.

[309] United Electrical, Radio and Machine Workers of America. *U.E. guide to wage payment plans, time study, and job evaluation*. United Electrical, Radio and Machine Workers of America, 2d. ed. edition, 1943.

[310] L Urwick. Management's debt to engineers. *Advanced Management*, page 7, 1952.

[311] Gerrit C. Van Der Veer, Bert F. Lenting, and Bas AJ Bergevoet. GTA: Groupware task analysis–modeling complexity. *Acta psychologica*, 91(3):297–322, 1996.

[312] Martijn van Welie, Gerrit C. van der Veer, and Anton Eliöns. An ontology for task world models. In Panos Markopoulos and Peter Johnson, editors, *Design, Specification and Verification of Interactive Systems '98*, Eurographics, pages 57–70. Springer Vienna, 1998.

[313] Thorstein Veblen. *The engineers and the price system*, volume 31. Transaction Publishers, 1963.

[314] Robbie Warin and Duncan McCann. WHO WATCHES THE WORKERS?

[315] Elizabeth Warren. Text - s.1386 - 115th congress (2017-2018): Schedules that work act.

[316] Paul A Weinstein. *Featherbedding and technological change*. Heath, 1965.

[317] Mark E. Whiting, Dilrukshi Gamage, Snehalkumar (Neil) S. Gaikwad, Aaron Gilbee, Shirish Goyal, Alipta Ballav, Dinesh Majeti, Nalin Chhibber, Angela Richmond-Fuller, Freddie Vargus, Tejas Seshadri Sarma, Varshine Chandrakanthan, Teogenes Moura, Mohamed Hashim Salih, Gabriel Bayomi Tinoco Kalejaiye, Adam Ginzberg, Catherine A. Mullings, Yoni Dayan, Kristy Milland, Henrique Orefice, Jeff Regino, Sayna Parsi, Kunz Mainali, Vibhor Sehgal, Sekandar Matin, Akshansh Sinha, Rajan Vaish, and Michael S. Bernstein. Crowd guilds: Worker-led reputation and feedback on crowdsourcing platforms. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, CSCW '17, pages 1902–1913, New York, NY, USA, 2017. ACM.

[318] William Foote Whyte and Jennie Farley. Union-management cooperation.

[319] Harold L. Wilensky. The staff" expert": A study of the intelligence function in american trade unions.

[320] William Gomberg. William Gomberg Papers 1935-1985. https://www.archives.upenn.edu/faids/upt/upt50/gomberg$_w$.*html*.

[321] Lauren C. Williams. More than 60 percent of uber drivers are thinking about quitting, 2016.

[322] Max L Wilson, Wendy Mackay, Ed Chi, Michael Bernstein, Dan Russell, and Harold Thimbleby. Replichi-chi should be replicating and validating results more: discuss. In *CHI'11 Extended Abstracts on Human Factors in Computing Systems*, pages 463–466. ACM, 2011.

[323] Theresa Wolfson. Role of the ILGWU in stabilizing the women's garment industry. 4(1):33–43.

[324] Theresa Wolfson. Role of the ILGWU in stabilizing the women's garment industry. 4(1):33–43.

[325] Working Washington. Delivering inequality: What instacart really pays, and how the company shifts costs to workers, 2019.

[326] Working Washington. Instacart: Here's our 22 cents—no more tip theft, low pay, and black-box pay algorithms, 2019.

[327] Susan Wyche, Phoebe Sengers, and Rebecca E Grinter. Historical analysis: Using the past to design the future. In *International Conference on Ubiquitous Computing*, pages 35–51. Springer, 2006.

[328] Elizabeth Yale. The history of archives: the state of the discipline. *Book History*, 18(1):332–359, 2015.

[329] Jian Zhao, Zhicheng Liu, Mira Dontcheva, Aaron Hertzmann, and Alan Wilson. MatrixWave: Visual comparison of event sequence data. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 259–268, New York, NY, USA, 2015. ACM.

[330] John Zimmerman and Jodi Forlizzi. Research through design in hci. In *Ways of Knowing in HCI*, pages 167–189. Springer, 2014.

[331] John Zimmerman, Jodi Forlizzi, and Shelley Evenson. Research through design as a method for interaction design research in hci. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 493–502. ACM, 2007.

[332] John Zimmerman, Erik Stolterman, and Jodi Forlizzi. An analysis and critique of research through design: Towards a formalization of a research approach. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems*, DIS '10, pages 310–319, New York, NY, USA, 2010. ACM.

[333] Shoshana Zuboff. *In the age of the smart machine: the future of work and power*. Basic Books.

[334] Robert Zussman. *Mechanics of the middle class: Work and politics among American engineers*. Univ of California Press, 1985.