Data Rhetoric and Mutual Gains Participation:

Data Advocacy in US Labor History

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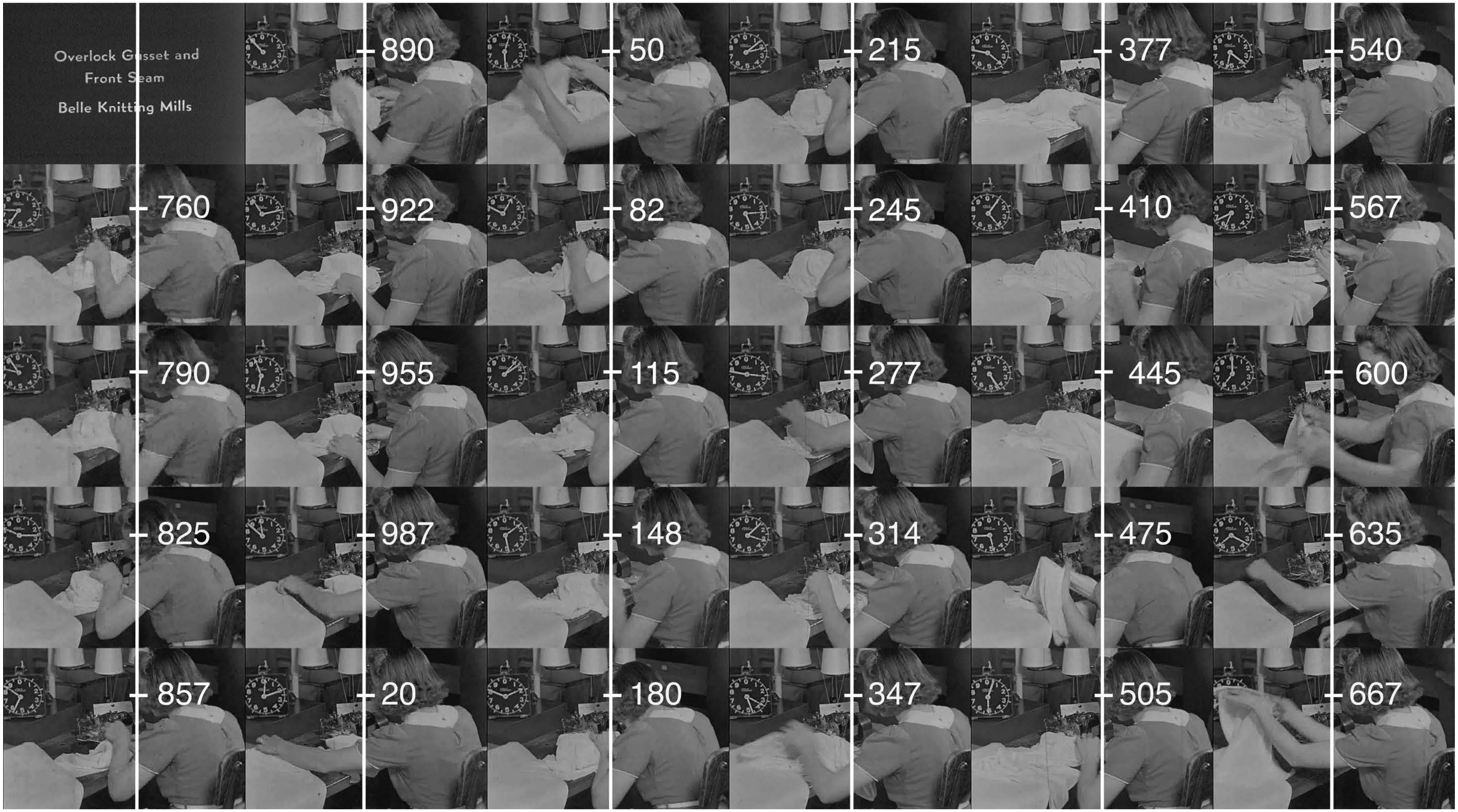
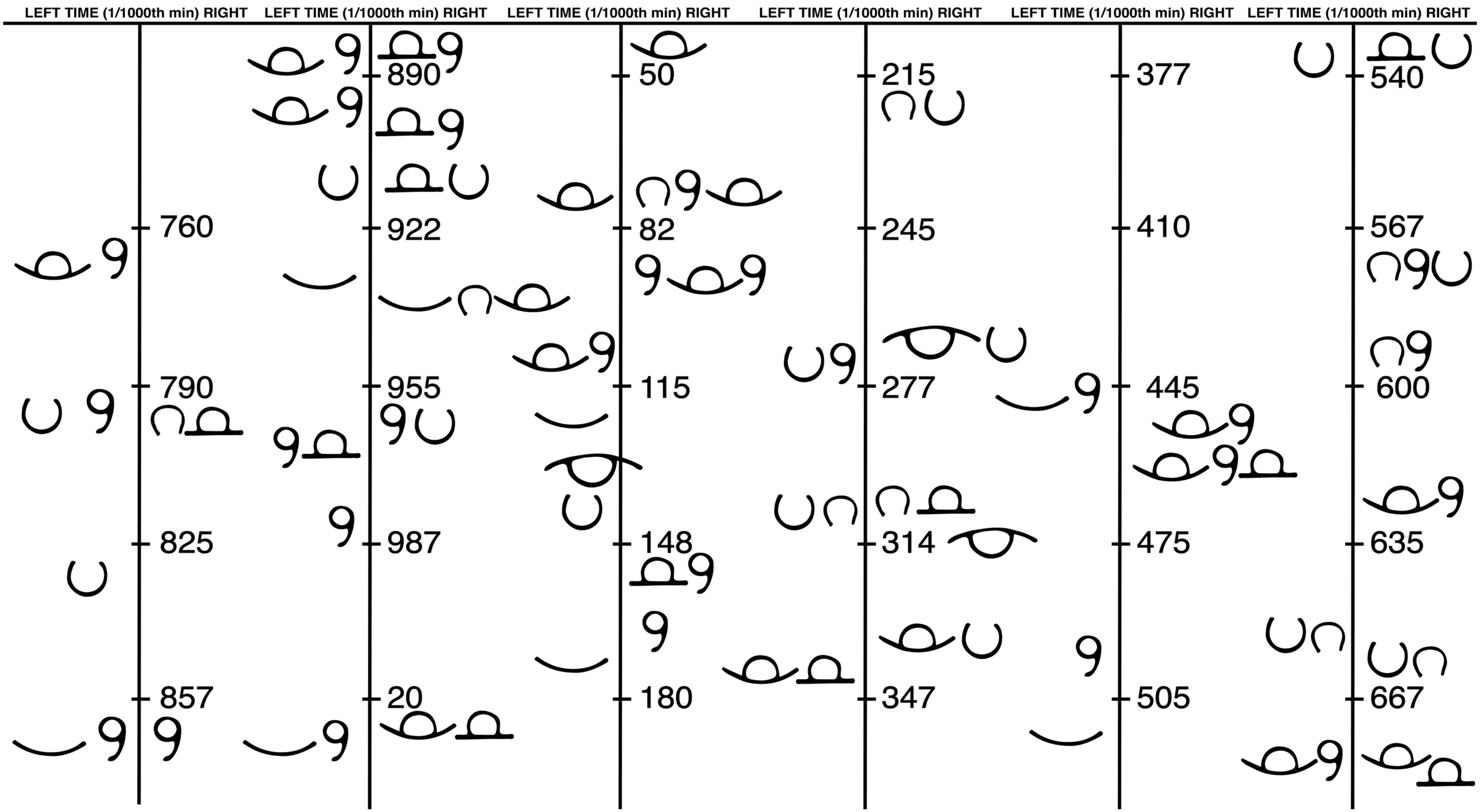
ABSTRACT

To gain historical perspective on the role of technical expertise in the labor movement, we explore the data-driven practices of mid-century American labor unionists who appropriated techniques from scientific management to advocate for workers. Analyzing the data artifacts and academic writings of the Management Engineering department of the International Ladies Garment Workers Union, we describe the rhetorical use of data within a mutual gains model of participation. We draw insights from the challenges faced by the department, assess the feasibility of implementing these approaches in the present, and identify opportunities for the participatory design of workplace advocacy systems moving forward.

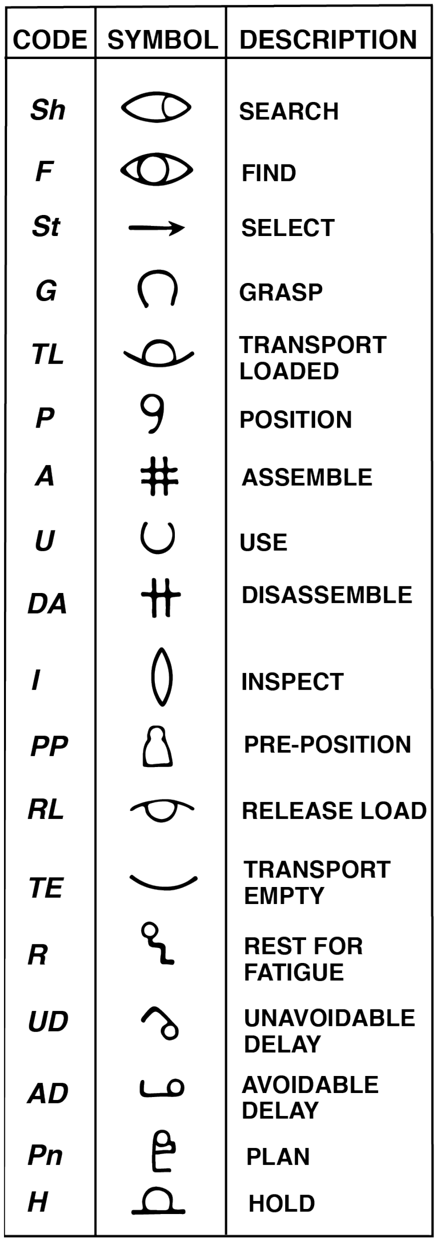
“Two women sewing machine operators being filmed for a time-motion study”, archival materials [27].



Archival film from Belle Knitting documenting an operator sewing an overlock gusset and front seam [29] with transcribed time (microchronometer reading) overlay.



Time (microchronometer reading) from Belle Knitting archival film [29] with Therblig micromotion overlay transcribed from [26].



Therblig chart, adapted from [40].

INTRODUCTION

In 2018, technology workers in Silicon Valley walked out in protest of workplace issues [51], organized against their employers' contracts with defense and border security government agencies[46, 11, 17], looked for opportunities to build cross-sector labor solidarity [15], and built tools to to support worker organizing [16]. While many labor and technology experts expressed optimism about this tech worker foray into the American labor movement [50], others were less sure (*e.g.* [3]). Could technologists effectively leverage their proximity to the modes of production to challenge oppressive practices [23], or are they too comfortable in their own relationship to management and too inexperienced to be trusted for practical support in labor struggles? This debate has been echoed in the academic literature, which continues to raise the question: what is the role of technology and technological expertise in supporting workplace advocacy?

For insight on taking the methods of technology design and imbuing them with the political sensibility to accomplish different goals in the workplace, researchers and practitioners look to the history of Participatory Design (PD). PD traces its roots to Scandinavian worker movement [13, 14] and came into popularity within human computer interaction (HCI) and computer-supported collaborative work (CSCW) due to a shared interest in the context of technology use beyond efficiency [8]. Sitting at the intersection of HCI technology design methods and the tactics of organized labor, PD methods approach technology design process from the perspective of different stakeholders (e.g. workers and managers),enlisting participation of all groups to address situations when these perspectives come into tension [49].

This holistic stance on the impact of technology (sometimes characterized as "second wave") has been contrasted with standard human-factors engineering approaches (characterized as "first wave") which often formulate technology design problems from management-centered perspectives of efficiency and self-maximization [5]. However the history of these "first wave" human-factors engineering methods, and especially the concern for the "human element" of technology design, belongs as much to labor as it does to management [41, p. 145]. Studying organized labor's participation in the early history of industrial engineering can help technology designers understand what is potentially to be gained and lost when technology design methods are put toward workplace advocacy today.

To show how engineers worked with methods that informed human-factors engineering to advance labor perspectives, we examine the tactics used by the management engineering department of the International Ladies Garment Workers Union (ILGWU). We describe the challenges they faced and draw parallels to contemporary workplace technology contexts, translating historical material into the visual language of present day technology design. We show how the sensibility of labor-oriented engineers in the past can be synthesized with participatory technology design principles moving forward, outlining risks and opportunities for technologists designing for data-driven workplace advocacy.

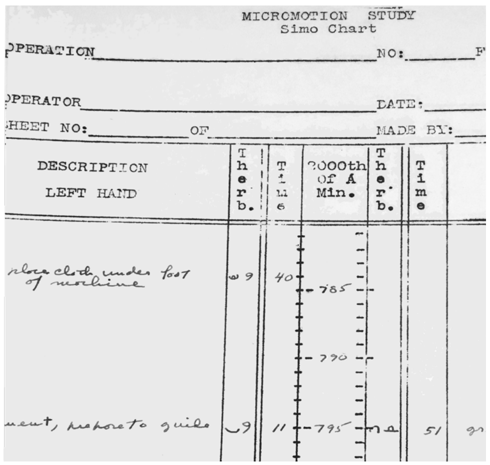
TRADE UNIONS AND TAYLORISM

In this section we describe the practices 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.

Background

In his original formulation of scientific management, Fredrick Winslow Taylor sought to produce a system of"cooperation" between workers and employers where employers gathered detailed knowledge of worker know-how, formalized this knowledge into "laws", and coerced workers into the "one best way" of doing their work [41, p.9]. Unsurprisingly, this form of "cooperation" was met with strong resistance by organized labor. The Taylorists realized that in order to make their methods mainstream, they would have to make some concessions to labor. Taylor's successors worked with union leaders to negotiate a new concept of labor-management cooperation built around worker (and particularly union) participation. The linking of industrial efficiency and labor participation ushered a brief period of"cooperation fever" between industrial engineering and organized labor [48, 39, 41, 12, 33]. The garment industry was a pivotal site for experiments in these early forms of labor management cooperation.

Several decades later, seeking to stabilize the garment industry, the International Ladies Garment Worker's Union (ILGWU) decided revisit the strategy of simultaneously pursuing



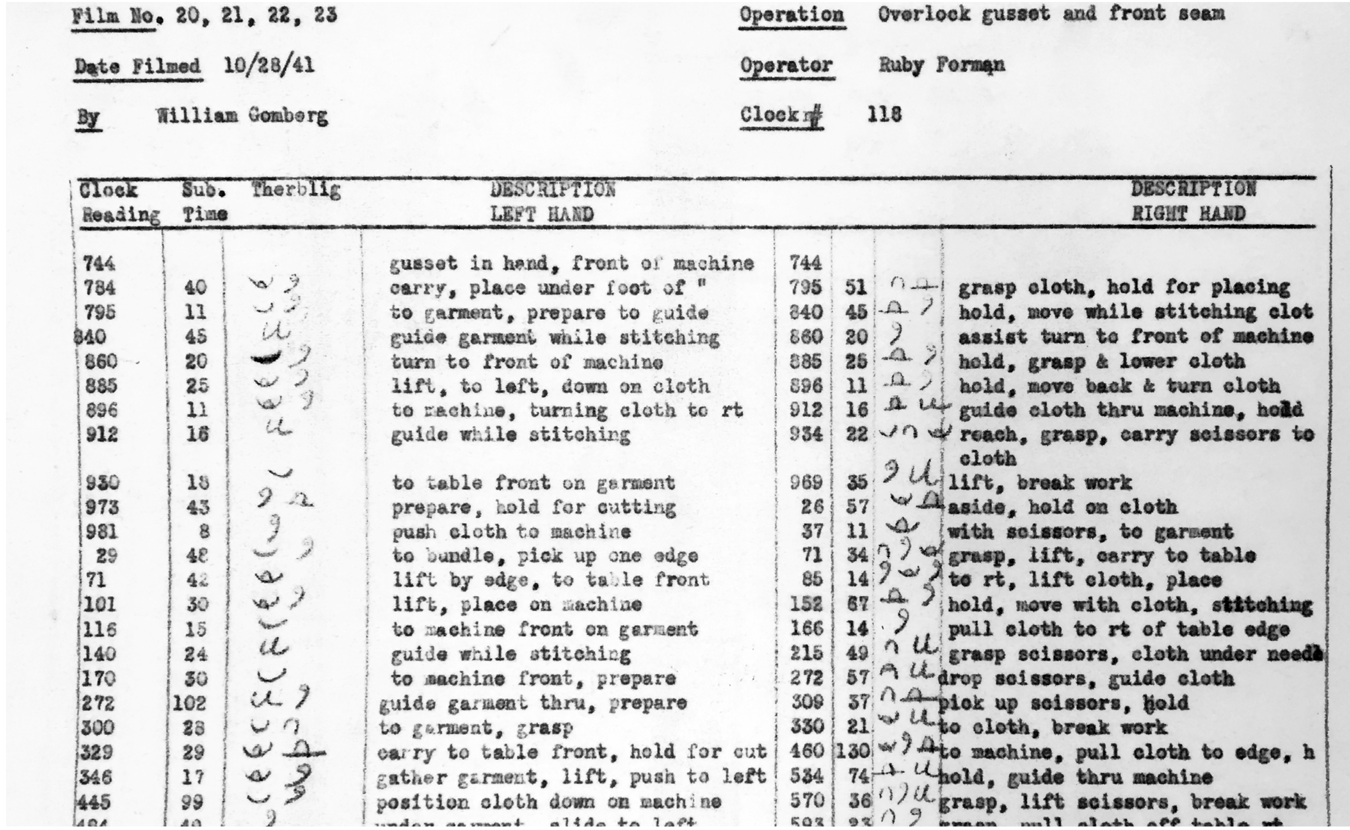
MICROMOTION STUDY
Simo Chart

OPERATION ____ NO: ____

OPERATOR ____ DATE: ____

SHEET NO: ____ OF ____ MADE BY: ____

DESCRIPTION LEFT HAND	Therb.	Time	2000th of A Min.	Therb.	Time
place cloth under foot of machine		40	785		
			790		
...ment, prepare to guide		11	795		51



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 need
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

Clockwise from top-left: film still from Belle Knitting [29]; micromotion transfer sheet from Belle Knitting [26]; SIMO (Simultaneous motion) chart from Belle Knitting [26].

industrial democracy and production efficiency. In 1941, the union chartered the Management Engineering Department, which was charged 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 [22]. Techniques and methods improvements were made by first observing the womens' garments manufacturing operations, and then recommending process efficiencies. The department evaluated and conducted time studies, conducted surveys of industry practices, and used both to negotiate piece rates and develop worker training. The archival records of the department [28], include process charts, Micromotion and Simultaneous Motion charts, Micromotion video [29], project reports, reports to the executive board and other departments, written correspondence, and summaries of work for academic and professional audiences in engineering and management.

Belle Knitting

The images on this page are from a report on the Belle Knitting Corporation conducted by the department in Sayre, Pennsylvania, in 1941 [26]. In this project, the department was tasked with examining the basis for large variations in productivity between different workers performing the same tasks and evaluating the firm's exiting time study practice. 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, operators motions were broken down into motions called Therbligs. Formalized by Frank and Lilian Gilbreth [40], Therbligs (an approximate reversible anagram of "Gilbreth") comprise the elementary motions common to all human activity. The Therrbligs were timed and individual worker processes were documented in Simo (Simultaneous Motion) charts.

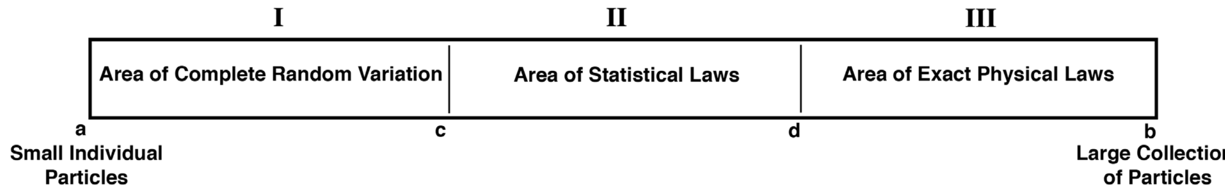


Diagram adapted from [22, p.28]: line *ab* represents the range in size of "a collective of Heisenberg particles"; Area I represents the area of variable chance; Area II represents the area of constant chance; and Area II represents the area of constant cause.

The findings of the Belle Knitting report explain that large variations in operator times were due to the vastly different methods being used by different operators. The report then argues that since the method of micromotion techniques rests on the assumption that there is a single 'one best way' of performing a particular operation and workers are not aware of this method (or seldom use it), then it is management's duty to first make that method available to workers before any time studies could reasonably be conducted. 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 cycle (including fatigue and personal needs). By doing the time study themselves, the union engineers were able to use the techniques to contest management decisions.

Questioning the Time Study

An analysis of the arguments made in the Belle Knitting report show the Management Engineers' careful appeal to the management's own belief in the merits of time study methods. At the same time, the Management Engineering department was assembling an extensive critique of the validity of the time study as a source of scientific knowledge for discerning physical "laws" about the nature of human work [22, 24]. William Gomberg, the first director of this department, begins his critique of the scientific method by explaining how Taylorist logic trades on a superficial similarity between the division of work into simple elementary motions and the appearance of atomic theories of mechanical physics.

While Taylorism continues to draw on the metaphors of mechanical physics, Gomberg writes, the rest of the scientific world has since moved on from a mechanical deterministic view of the universe to a statistical-probability model concerned with measuring the deviations of measurement accuracy. 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 above).

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 cannot make claims to scientific accuracy. Gomberg's critique of Taylorist truth-making resembles arguments about the social construction of scientific facts [45], but his goal was to specifically undercut management's sole claim to establishing ground truth using these techniques in order to justify labors participation in the setting of production standards. Downgraded from natural laws, time study techniques were, at best, "empirical guides to setting up a range within which collective bargaining over production rates can take place" [22, p.170]. Gomberg does not formalize any of labor's methods for solving the problems of collective bargaining, instead centering the role of institutional structures. He cites his department's use of engineering techniques at plants like Belle Knitting as a model for how to move forward in resolving union-management disputes in the absence of scientific laws.

DATA RHETORIC AND MUTUAL GAINS

The coexistence of effusively scientific screeds against the time study in the department's academic writing with the bottom-line oriented calculations of their daily work illustrates the department's varied, rhetorical use of data-driven arguments (what we term 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 [52]. The ILGWUs practice of 'in-house' engineering work, characterized as a mutual gains approach [42], illustrates an uneasy alliance between scientific management and organized labor, complicating the association of Taylorism with management control and exclusion of employees from workplace decision-making.

Mutual Gains Participation

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) [7, pp.79-81]. So while the mutual gains approach could be seen as a moment when unions gave into 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.

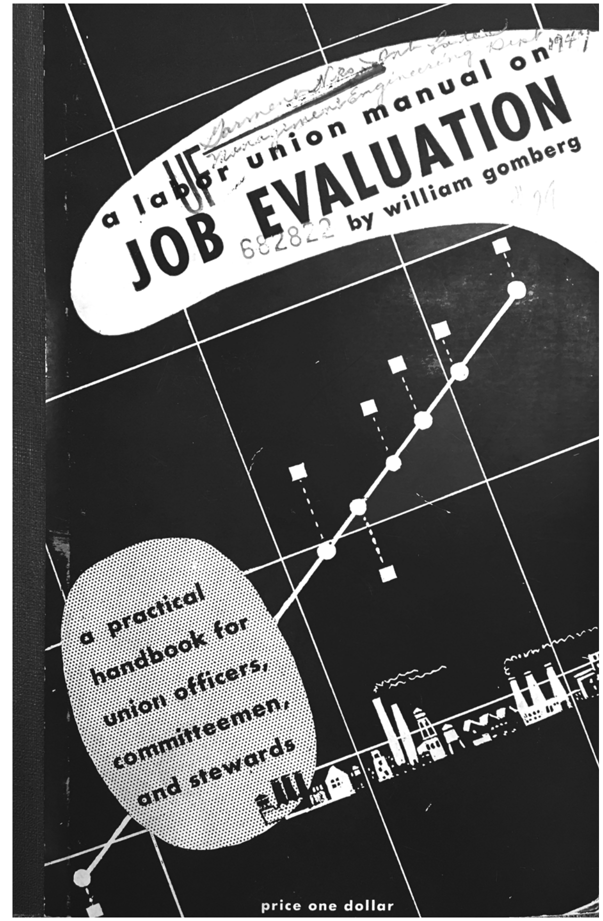
In theory, mutual-gains participation resembles the ideals of participatory design. However, when held against the model of participatory technology design, the nature of worker participation practiced by the management engineering department was far from "participatory". The department was not seeking 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 (but were not garment workers themselves) [33].

Challenges to Labor Participation

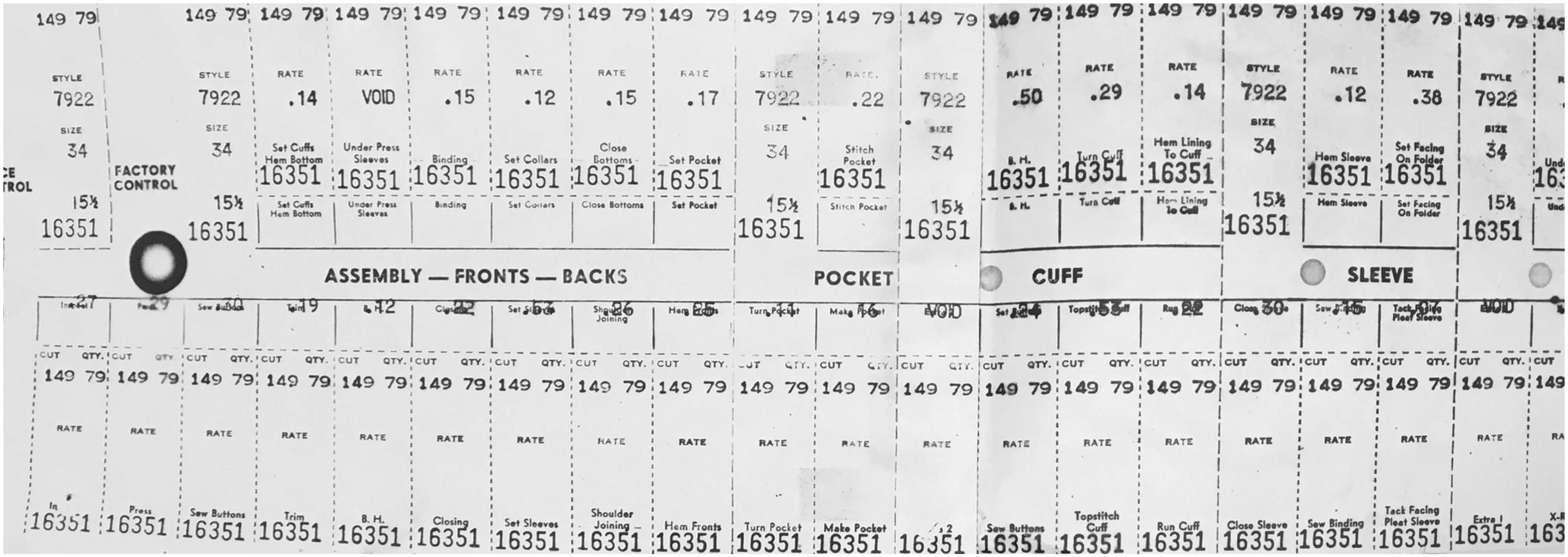
The Management Engineering department attempted to support worker efficacy by writing guides training union members to conduct their own time studies. For example, the manual on the right, written for union officers, contains basic information about calculating job rates along with clauses that could be inserted into collective bargaining agreements to give the union rights in the rate-setting procedure [21]. Regardless, the union was limited in its ability to implement data-rhetoric approaches as conducting a time study was expensive, time-consuming, and, in order to lay claims to accuracy, had to be largely recalculated each time the work process changed.

These rhetorical techniques put the union in an ironic double-bind with management. The tactic of volunteering expertise gave the union leverage, but also left their work vulnerable to appropriation. This was because the time studies, though worker-oriented, could be used to improve production at no cost to management (similar to Amazon's embrace of the third-party Turkopticon system as an alternative to building those features themselves [32]). The union's participation in academic and professional societies was also strained; the department attended conferences and published in journals as organized labor's representatives in Management Science and Industrial Engineering, but while management and engineering experts were willing to acknowledge the rigor of the department's work, they also readily pointed out where the department's findings were reflective of their partisan commitments (e.g. [44]).

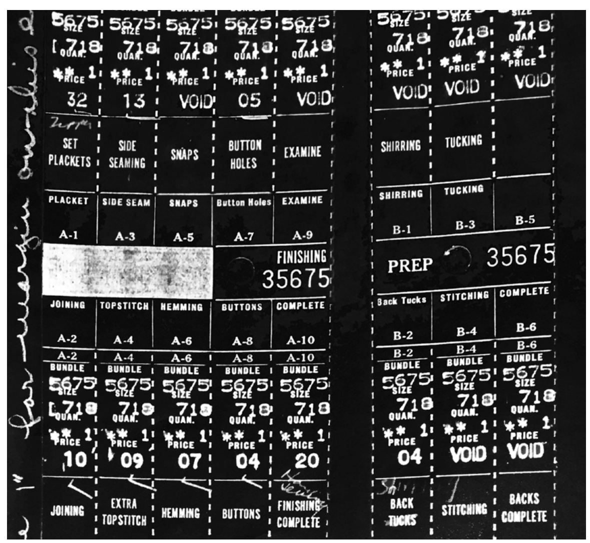
The central challenge to the Management Engineering department came from within the labor movement itself. The cooperation fever of the interwar years had passed and organized labor, which was never resolute in its support of scientific management, was weighing the benefits of leveraging industrial engineering techniques. The final chapters of the same worker guide are devoted to a reprint of a debate [4] between Gomberg and Solomon Barkin, the director of the research department at the Textile Workers Union of America. Barkin argues that rate setting techniques are biased toward management, and that adherence to the "management‘s tools" weakens the unions position in collective bargaining because establishing rigid formulas for calculating rates restricts the number of factors the union can raise for review [21, p.70]. Gomberg responds that the way forward is not to fight the tools, but rather to "reshape [them] into a more useful collective bargaining instrument" [15, p.73], calling on the labor movement to establish an industrial engineering research unit to perform this work on behalf of unions. The debate captures a deeply variegated faith not in the validity but in the practical feasibility of labor-oriented appropriation of industrial engineering methods.



Front cover of "A labor union manual on job evaluation, the relationship of industrial engineering techniques to collective bargaining" by William Gomberg, located in ILGWU archive [25] (reprinted [19]).



Top: sample tickets from the "Survey of Typical Equipment" conducted by the ILGWU Management Engineering department [31]; bottom left: mechanical ticketing machine from the "Survey of Typical Equipment" conducted by the ILGWU Management Engineering department [31]; bottom right: tickets from the study of Mode O Day Corporation by ILGWU Management Engineering department [30].



RECONSTRUCTING THE DATA DRIVEN WORKPLACE

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. 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 [48, 52, 6, 43]. Within the rationalizing factory floor, new ticketing tools where being used internally to track clothing bundles for quality control and to monitor individual work [18].

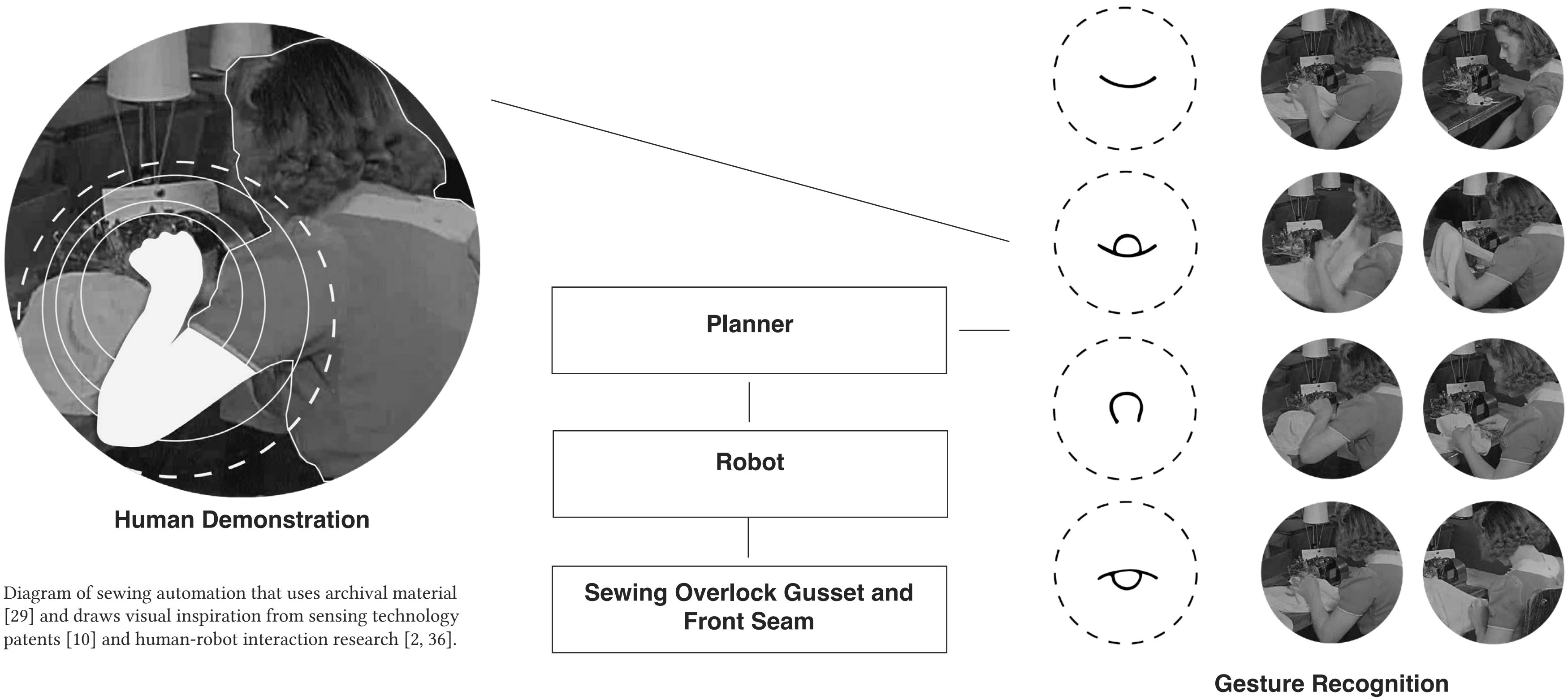
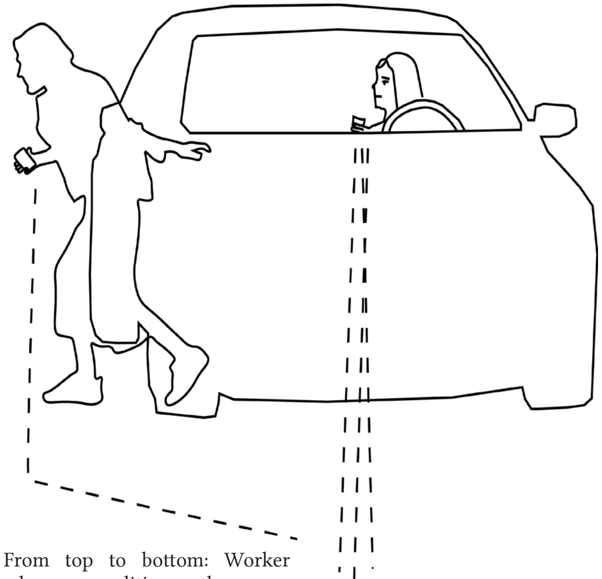


Diagram of sewing automation that uses archival material [29] and draws visual inspiration from sensing technology patents [10] and human-robot interaction research [2, 36].

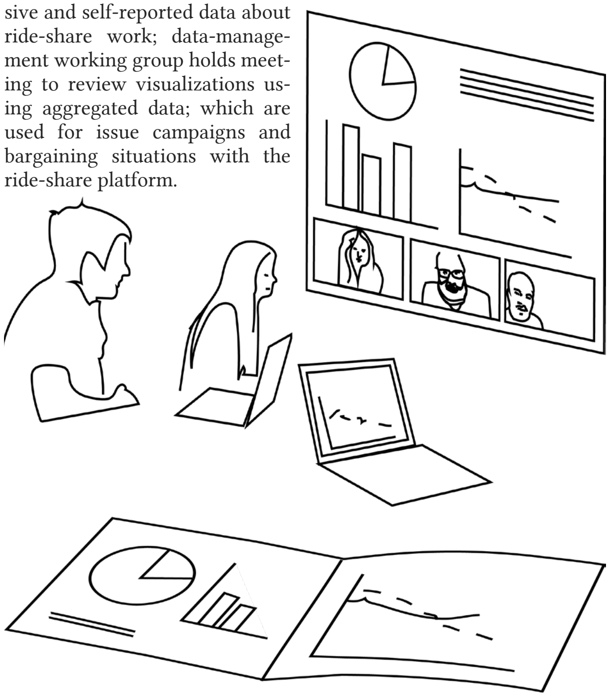
All of these operations relied on and generated vast quantities of workplace data. In order to analyze this data, engineers developed and refined methods of task analysis and work evaluation that were then used in other industries [20, 37]. Analyzing the archive of video footage, time-sheet, and motion 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 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 [10] patented by Amazon for use in its warehouse).

Scientific management directly informed early HCI methods (e.g. [38] qtd. in GOMS-KLM [9]), and while the techniques are generally seen as outmoded, it has been argued that task analysis, the process of breaking work into smaller operations which are measured and represented in a way that is suitable for a subsequent engineering task, lies at the heart of human computer interaction today. Scientific management's influence can also be seen in surrounding disciplines, for example in recent work in Human Robot Interaction (HRI), Therbligs are used as a framework for training a neural network to recognize pick-and-place gestures (transport empty, transport loaded, grasp, and release) which are then implemented by a robot [24].

In the images on the right, we used archival film to recreate gesture identification diagrams. On p3, we combine time and motion study data with microchronometer readings from film to render the process of sewing as a sequence of ordered micromotions. These images borrow aesthetic sensibilities from HRI task sensing research [2, 36] to translate the historical techniques into the language of contemporary methods to demonstrate their continued relevance.



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.



USING HISTORY TO DESIGN THE FUTURE

Because of the parallels in workplace context and technology design methods, we argue that it may be possible to use data rhetoric and mutual gains tactics to appropriate modern workplace data technology to accomplish advocacy goals. Adopting historical strategies in the present day requires accounting for similarities and differences between our current context and the conditions under which the department operated. Notable differences to consider are the retreated presence of organized labor and the unique affordances of automatic data gathering and analysis, compared to the controlled time study followed by manual analysis of the data.

In the images on the left, we show a speculative scenario of how data rhetoric and mutual gains participation could play out in a contemporary data-driven 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 the mirrors that is already gathered by their employer. The coalition selectively aggregates this data to construct public action campaign materials and participate in collective bargaining situations.

Contemporary Challenges

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.

Rethinking Participation

Diverging from the model of participation followed by the Management Engineering department, our speculative scenario shows decisions about using workplace data being made by the workers themselves, in a democratically elected data working committee. Here we see potential for the synthesis of the mutual gains model and the principles of participatory technology design. The participatory technology design approach places an emphasis on lowering the barrier to participation, finding ways to involve workers in the technology design process. The mutual gains model brings a sharpened awareness of material interests such as conditions of work and compensation and the importance of coalitions to represent worker perspectives (an emphasis which has previously been called for within the PD community [35, 47]).

While there are unlikely to be many technological shortcuts to building strong worker coalitions, our scenario points to two potential opportunities for technologists to support labor-oriented data practices: the first is to design systems that lower the barriers for non-experts to assemble data-driven arguments about their work; and the second is to build systems that support consensual and democratic data management within worker advocacy coalitions.

“Women sewing machine operators being filmed by two men for a time-motion study”, archival materials [27].

CONCLUSION

Gomberg (the figure on the right in the photo on the left) describes the role of the industrial engineer as “work[ing] at the bridgehead where technological problems merge into social questions.... This means that the effective industrial engineer must become apt in the fields of anthropology, sociology, and psychology, among others. Above all, in a democratic society he must understand the relationship between efficiency and consent” [23, p.1121]. Understanding how Gomberg and the ILGWU Management Engineering department negotiated this relationship and worked to reshape data-driven methods to meet the needs of workers in the past can shed insights about the challenges and opportunities of doing so, while raising important questions for the future about the nature of participation in data-driven workplace advocacy.

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