# Examining Crowd Work Through The Historical Lens of Piecework

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## ABSTRACT
The Internet is enabling the rise of crowd work, gig work, and other forms of on–demand labor. A large and growing body of scholarship has attempted to predict the socio–technical outcomes of this shift, especially along three threads: 1) What are the complexity limits of crowd work? 2) How far can work be decomposed into smaller microtasks? and 3) What will work and the place of work look like for workers? In this paper, we look to the historical scholarship on piecework — a similar trend of work decomposition, distribution, and payment that was popular at the turn of the 20th century — to understand how these questions might play out with modern crowd work. To do so, we identify the mechanisms that enabled and limited piecework historically, and identify whether crowd work faces the same pitfalls or might differentiate itself. This approach introduces theoretical grounding that can help address some of the most pernicious questions in crowd work, and suggests design interventions that learn from history rather than repeat it.

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Crowdsourcing; on–demand labor; gig work

## INTRODUCTION
The past decade has seen a flourishing of *on–demand work*, largely driven by the reformulation of work as the constituent parts of larger tasks. This framing of work into de–contextualized, modular blocks enables computation to hire workers at scale through open calls on the Internet [64, 13, 81]. Distributed paid participants then engage in the work whenever their schedules allow, with little to no awareness of the broader context of the work, and with (often) fleeting identities and associations [104, 93]. In this paper, we use the term on–demand work to join a pair of related phenomena: 1) *crowd work*, on platforms such as Amazon Mechanical Turk (AMT) and other sites of (predominantly) information work; and 2) *gig work*, typically involving platforms for one–off jobs, like driving, courier services, or administrative support. The realization that complex tasks can be accomplished by directing and managing these crowds of workers spurred industry to flock to sites of labor like AMT and Uber to explore the limits of this distributed, on–demand workforce. Researchers have also taken to the space in earnest, developing systems and designs that enable new forms of production (e.g., [11, 14, 119]).

As on–demand work has grown far beyond the domain of information work from which it first sprang, it has given rise to an increasingly complicated and conflicted culture amongst both the workers who enable it and the researchers who empower it. Originally, Howe described crowdsourcing in general terms as "outsourcing [work] to an undefined, generally large group of people in the form of an open call". However, for years its instantiation was limited to the utilization of human intelligence to process data, participate in scientific studies, and perform information work [79, 167, 174, 47, 121]. More recently, crowdsourcing of physically embodied work — driving and cleaning, for instance — has become a focus for on–demand labor markets [93, 153, 63, 147]. This growth prompted increasing efforts to understand the workers who gravitate toward these platforms [129, 141]. Some of this research has been motivated by the identification of the sociality of gig work, and the frustration and disenfranchisement that these systems embody [71, 104, 106]. Other work has focused on the *outcomes* of this frustration, reflecting on the resistance workers express against digitally mediated labor markets [93, 134].

This body of research has sought to answer one central question: What does the future hold for on–demand work and those that do it? Researchers have offered their input on this open question along three major threads:

1. What are the complexity limits of crowd work? Specifically, (a) How complex are the goals that crowd work can accomplish?, and (b) What kinds of goals and industries may eventually utilize it? [123, 146, 76, 173, 171, 112, 54];
2. How far can work be decomposed into smaller microtasks? [82, 11, 24, 100, 83, 91, 21, 26, 113]; and
3. What will work and the place of work look like for workers? [71, 70, 134, 51, 17, 106]

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This research literature has largely sought to answer these questions by examining the present phenomenon. So far, it has not offered a framing for holistically explaining the developments in worker processes that researchers have developed, or the emergent phenomena in social environments; nor has any research, to our knowledge, gone as far as predict future developments.

### Piecework as a lens to understand crowdsourcing

In this paper, we offer a framing for on–demand work as a contemporary instantiation of *piecework*: a work and payment structure which breaks tasks down into standalone contracts, wherein payment is made for *work output*, rather than for *time*. Piecework as a metaphor for crowd work is not new. Indeed, Kittur et al. in 2013 referenced crowd work as "piecework" briefly as a loose analogy to the form of work emerging at the time [81]. But more than this, the framing of on–demand labor as a re–instantiation of piecework gives us years of historical material to make sense of the broader research on this new form of work, and allows us to reflect on–demand work through a mature theoretical lens, informed by decades of rigorous, empirically based research.

More concretely, by looking at on–demand work as an instantiation (or even a continuation) of piecework, and by looking for patterns of behavior that the corresponding literature predicts on this basis, we can 1) make sense of the phenomena so far as part of a much larger series of interrelated events; 2) reflect on similarities in the ongoing work among workers, system–designers, and researchers in this space; and finally, 3) to the extent that history repeats itself, offer predictions of what on–demand work researchers, and workers themselves, should expect to see on the horizon. For example, we will draw on the piecework literature such as case studies of the Santa Fe Railway to understand the historical complexity limits in piecework, and leverage that understanding to suggest which modern complexity limits in crowd work [81] may be fundamental and which may be overcome.

We organize this paper as follows: we first review the literature on piecework to lay groundwork and make clear the analogy to on–demand work. Then, we interrogate the three major research questions above from a piecework frame. We will we will identify similarities and differences between piecework as historically understood and on–demand work as we experience it today. Finally, we will make predictions of future developments based on how those similarities and differences influenced piecework. Finally, we will offer design implications for researchers and practitioners based on our results.

## A REVIEW OF PIECEWORK

The HCI community has used the term "piecework" to describe myriad instantiations of on–demand labor, but this reference has generally been offered in passing. As this paper principally traces a relationship between the historical piecework and the contemporary crowd work (or on–demand labor more generally), this casual familiarity with piecework may prove insufficient. We'll more carefully discuss piecework in this section in order to inform the the rest of the argument. Specifically, we will 1) define "piecework" as researchers in the topic understood it; 2) trace the rise of piecework at a very high level, identifying key figures and ideas during this time; and finally 3) look at the fall of piecework, such as it was, considering in particular the factors that may have led to piecework's eventual demise in the American and European labor markets.

### What is piecework?

Aligning on–demand work with piecework requires an understanding of what piecework is. While "piecework" has had multiple definitions over time, we can trace a constellation of characteristics that recur throughout the literature. We will follow this history of research, collecting descriptions, examples, and provided definitions of piecework, trying to trace the outline of a working understanding of *what piecework is*.

Raynbird offers a concise definition of piecework — which he variously also calls "measure work", "grate work", and "task work" — by contrasting the "task–labourer" with the "day–labourer": "…the chief difference lies between the day–labourer, who receives a certain some of money… for his day's work, and the task–labourer, whose earnings depend on the *quantity* of work done [emphasis added]" [122]. Chadwick gives a more illustrative definition of piecework, offering examples: "… payment is made for each hectare which is pronounced to be well ploughed … for each living foal got from a mare; … for each living calf got … " etc…[25]. This framing perhaps makes the most intuitive sense; "payment for results", as Chadwick calls it, is not only common in practice, but well–studied in labor economics as well [42, 161, 162, 59].

It's worth acknowledging that "this distinction [between piece–rates and time–rates] was not completely clear–cut" [56]. Indeed, we see work that adopts piece–rate compensation in some aspects and time–rate compensation in others. The "Rowan premium system", which essentially paid workers a base rate for time plus (the potential for) an additional pay dependent on output, was just one of several alternatives to stricter time– and piece–rate renumeration paradigms, which muddies the waters for us later as we attempt to categorize cases of piecework [130]. As Rowan's premium system guaranteed an hourly rate regardless of the worker's productive output *as well as* an additional compensation tied to performance, workers under this regime were in some senses "task–labourers", and in other senses (more conventional) "day–labourers".

It may be worth thinking about piecework through the lens of its *emergent* properties to help understand it. Returning to Raynbird, several arguments for the merits of piecework crop up; he points out that…"piece work holds out to the labourer an increase of wages as a reward for his skill and exertion…he knows that all depends on his own diligence and perseverance… [and] so long as he performs his work to the satisfaction of his master, he is not under that control to which the day–labourer is always subject." Raynbird (and others, as we will see) highlight the freedom from control that "task–labourers" enjoy [122, 130].

We see this sense of independence regardless of the time, locale, and industry. Satre offers a look into the lives and culture of "match girls" — young women paid by piecework to assemble matchsticks generally in the late 19th century. Of particular interest was their independent nature, via their reputation "… for generosity, independence, and protectiveness, but also for brashness, irregularity, low morality, and little education" [135]. J. Hagan documents piecework from 1850–1930 in Australia, finding similar assertions of the freedom compositors of newspapers experienced as pieceworkers: "If a piece–work compositor who held a 'frame' decided that he did not want to work on a particular day or night, the management recognised his right to put a 'substitute' or 'grass' compositor in his place" [72]. From these accounts we should be able to identify a sense of independence that resonates across decades, industries, and locales where piecework is found. We'll problematize this supposed advantage as we trace the history of piecework, but for now we can say that piecework affords independence and some sense of autonomy new to people in the working class.

Hart and Roberts offer another series of compelling insights toward the question of the features that sprout from piecework. In their reflection on the features endemic to piecework in the 1930s, which they describe as the "heyday" of piecework's prominence; among them were the following: 1) "female workers who generally had less training" had to be trained in narrower subsets of the general body of skills that conventional (male) apprentices would undertake, and 2) workers with specific slices of skills could be more appropriately matched to suitable tasks [56]. Piecework thus opened the door for people who previously couldn't participate in the labor market — either for lack of training or for other reasons — to do so, and to acquire job skills incrementally. Workers without conventional training — like women, who had no such opportunities to engage in engineering and metalworking apprenticeships as men did — could be trained very narrowly on a very tightly constrained task, demonstrate proficiency, and become experts in their own ways.

In summary, piecework:

1. paid workers for quantity of work done, rather than time done, but occasionally mixed the two payment models;
2. afforded workers freedom in when and how much to work; and
3. structured tasks such that people who didn't have the training to engage in the traditional labor force could still participate.

### The Historical Arc of Piecework

Piecework's history traces back further perhaps than most would expect. Grier describes the process astronomers adopted of hiring young boys to calculate equations in order to better–predict the trajectories of various celestial bodies in the 19th century [52]. While this approach didn't become the same economic powerhouse as later examples would, Airy and others arguably found the kernel of insight that we pursue throughout this discussion: determining the extent to which work can be decomposed, and finding the limits of complexity of that decomposed work. That is, Airy found that he could train youths in elementary mathematics to complete the majority of the calculations he would otherwise have had to solve on his own, and that the greater body of work could ultimately be completed sooner if he arranged his work appropriately.

As increasing attention revealed problems in piecework as it related to workers, workers themselves began to speak out about their frustration with this new regime. It began, arguably, with Riis's photo–documentary work, but this led to industry organizations representing railway workers, mechanical engineers, and others contributing their myriad perspectives [84, 124, 125]. Nevertheless, piecework continued to permeate low–skilled labor.

Piecework's popularity in the United States and Europe plummeted almost as quickly as it had climbed. Hart and Roberts's work substantively explores the precipitous decline of piecework in the last third of the 20th century. In their work, Hart and Roberts offer a number of explanations for the sudden vanishing of piecework. The salient suggestions include: 1) the emergence of more effective, more nuanced incentive models — rewarding teams for complex achievements, for instance; 2) the shifting of these industries (manufacturing, clothing, etc…) to other countries; 3) the quality of "multidimensional" work becoming too difficult to evaluate. [56].

### Why is piecework relevant to crowd work?

Using the definition of piecework that we came up with earlier, we argue that crowd work is fundamentally an instantiation of piecework, and that we can more precisely anticipate the answers to the open research questions we discussed earlier. We'll show that the dimensions of crowd work that the broader HCI community has been studying align with the history of piecework, and that this can greatly inform predictions about the future of crowd work.

### From piecework to on–demand work

Crowd work and gig work are fundamentally an instantion of piecework. First, workers on platforms such as Mechanical Turk and Uber are generally incentivized by unit of work, even if some may be offered an hourly base salary as well. Second, workers are attracted to these platforms by the freedom they offer to pick the time and place of work [104, 17]. Third, system developers as on Mechanical Turk typically assume no professional skills in transcription or other areas, and attempt to build that expertise into the workflow [114, 11].

Given this alignment, many of the same properties of piecework historically will apply to on–demand work as well. In the next section, we perform this application to three of the major questions in crowd work and gig work, identifying similarities and differences between historical piecework and modern on–demand work.

## RESEARCH QUESTIONS

We look at lots of papers that use the term "crowdsourcing" or "crowd work" in the abstracts and titles of their papers, especially the papers that we cited earlier, to try to answer the questions that we posed in the introduction. Then we look to the piecework literature to see whether and to what extent piecework answers the questions we, crowdsourcing researchers, have asked. We then see whether and how crowdsourcing as we know it has differed from piecework, and how that affects the predictions and conclusions made in the piecework literature.

Research in crowdsourcing has spent the better part of a decade exploring how to grow the limits of crowdsourcing and find the boundaries of crowd work and microtasks. This has largely involved identifying challenges to this form of labor, overcoming them through novel designs of work–flows and processes, and repeating the process [e.g. 11, 123, 80]. The question that has emerged among these researchers and through the work that they have produced then has been driving at *whether* there are limits to crowdsourcing (and, if so, what factors determine those limits). Through this lens, we can point to a number of contributions to the field that have extended the boundaries of crowd work.

The exploration of crowdsourcing's potential and limits has principally looked at manipulating and extending along three dimensions: 1) What are the complexity limits of crowd work, 2) How far can work be decomposed into smaller microtasks, and 3) What will work and the place of work look like for workers. We'll explore these aspects of crowdsourcing, discussing the extents to which work can be decomposed, contextually abstracted, and made more resilient to attrition of various forms. We'll also point to corresponding piecework literature addressing these aspects. Finally, we'll discuss how these elements will serve to constrain the upper and lower bounds of crowdsourcing as it relates to the question of the furthest limits of crowdsourcing.

### Identifying the Complexity Limits of Crowd Work

#### *Crowd work's perspective*

Crowdsourcing research has spent the better part of a decade proving the viability of crowdsourcing in complex work. Unless crowdsourcing can demonstrate viability for meaningfully complex tasks, the argument runs, it will be incapable of ensuring a pro-social outcome for work and workers [81]. Kittur et al. first opened the question of whether crowdsourcing could be used for goals that are not simple parallel tasks [80]. Their work demonstrated proof-of-concept crowdsourcing of a simple encyclopedia article and news summary. Seeking to raise the complexity ceiling [111], researchers have since created additional proof-of-concept applications and techniques, including conversational assistants [86], medical data interpreters [86], and idea generation [171, 169, 170], to name a few examples.

This body of research has often invoked insights from Computer Science and applied them to human workflows. The crowd work literature typically identifies target milestones that have presented significant challenges for researchers, leverages an insight from Computer Science (for example, MapReduce [80] or sequence alignment algorithms [85]), and arranges humans as computational black boxes within those approaches. This approach has proven a compelling one because it leverages the in–built advantages of scale, automation, and programmability that software affords.

It is now clear that this approach works with focused complex tasks, but the broader wicked problems [126] remain unsolved. As a first example, idea generation shows promise [171, 169, 170], but there is as yet no general crowdsourced solution for the broader goal of invention and innovation [44]. Second, focused writing tasks are now feasible [77, 11, 112, 148, 1], but there is no general solution to create a high-quality crowd-powered author across domains. Third, data analysis tasks such as clustering [30], categorization [7], and outlining [99] are possible, but there is no general solution for sensemaking. It is not yet clear what insights would be required to enable crowdsourced solutions for these broader wicked problems and other crowdsourced goals such as addressing climate change [66].

Restricting attention to non-expert microtask workers limited the ambitions of research in the area. So, Retelny et al. introduced the idea of crowdsourcing with online paid *experts* from platforms such as Upwork. Expert crowdsourcing enables access to a much broader set of workers, for example designers and programmers. Researchers then apply similar Computer Science techniques but to expert "macro-tasks" [29, 53]. This approach has led to successful crowdsourcing of goals such as the user-centered design process [123], programming tasks [90, 41, 27], and mentorship [146]. However, there remains the open question of how complex the work outcomes from these approaches will be.

#### *Piecework's perspective*

Grier gives early accounts of a piecework strategy in Airy's creation of the British Nautical Almanac [52]. Airy's goal was complex — mathematical calculations to produce tables that would allow sailors to locate themselves by starlight from sea. Many of his contributors did not have high-level mathematical training, so Airy broke down the task into simpler calculations and distributed them by mail, accomplishing the complex goal through piecework tasks that paid little.

However, when piecework entered the American economy, it was not used for complex work. Initially for farm work, as Raynbird and others discuss, the practice remained relatively obscure until it blossomed in the textile industry [122]. Complexity levels remained low at the turn of the 20th century as piecework saturated New York City [125]. However, writers of the time focused their attentive on wage [20] and management regimes [115]. The work remained low-skilled in part because it was infeasible to provide new pieceworkers with the comprehensive education that was familiar through apprenticeships [56].

Measurement limited the complexity of piecework: only tasks that could be measured and priced could be completed via piecework. When Brown investigated what limited the adoption of piecework in industries that otherwise gravitated toward it (e.g., railway engineers), the homogeneity of tasks arose as a major contributing factor [19]. Graves concurs via a case study in Santa Fe Railway, which used "efficiency experts" to develop a "standard time" to determine pay for each task at the company informed by "thousands of individual operations at the Topeka shops" [49]. One might conclude from Graves's observations that complex, creative work — which is inherently heterogeneous and difficult to routinize — would be unsuitable for piecework.

Piecework was also limited to tasks that could be clearly evaluated. The roles required to facilitate piecework in the early 20th century included "piecework clerks, inspectors, and 'experts"' [49]. Hart et al. argues for an ultimate complexity limit: at some point, evaluating multidimensional work for quality (rather than for quantity) becomes infeasible. In his words, "if the quality of the output is more difficult to measure than the quantity [...] then a piecework system is likely to encourage an over–emphasis on quantity produced and an under-emphasis on quality" [57]. Complex work, which is often subjective to evaluate, falls victim to this criteria.

This focus on measurement and tracking had consequences. Graves argued that the first sparks of scientific management could be found in piecework: the approach of paying workers for each piece of output necessitated the rigorous tracking, measurement, and training of workers for which scientific management became famous [49]. If true, the concurrent upswing of scientific management and Fordism through the first two–thirds of the 20th century alongside piecework was not only understandable, but predictable [56].

Piecework researchers also argue that, in addition to constraints on the kind of *work* that's amenable to piecework, only certain kinds of *organizations* are amenable to piecework. Researchers detail three organizational criteria. First, Brown argues that piecework "is less likely in jobs with a variety of duties than in jobs with a narrow set of routinized duties" [19]. Agell points out the phenomenon here as a market effect: "in an environment with multi–tasking, pay schemes based on tightly specified performance may *induce workers to neglect tasks* that are less easy to measure" [2]emphasis added. Second, complexity was limited by access to capital to create the necessary infrastructure. As Graves reports, "... only [the largest and most wealthy railroads] had the resources to [...] pay the overhead involved in installing work reorganization" [49]. Third, organizations required capable managers in charge of the pieceworkers. The West Virginia mines, for example, hired foremen to be the intermediary between upper management and the worker [15]. Specifically, foremen were responsible for allocating resources and understanding when and how to modify work as necessary [166].

The research seems to suggest that it was difficult to apply piecework to more skilled work, particularly because maximizing on the advantages of piecework seemed to reward smaller, more constrained, more narrowly trained tasks. For most of the 19th century, piecework was applied almost exclusively to farm and textile work. Work was simple and widely understood — farm workers didn't need to be trained on how to plow fields, or birth foals; seamstresses knew how to sew together denim [25, 125].

### *Comparing the phenomena*

Piecework makes a number of observations leading to the conclusion that piecework's complexity is fundamentally bounded by several limitations, chief among them the costs of managerial overhead and the transition thereto. Brown and Graves's claims that organizations can't adopt piecework unless they're sufficiently large to absorb the cost of transitioning to a piecework system; Boal and Pencavel and Wray's observations for the importance of competent, effective managerial oversight — a human resource, which made the scaling cost prohibitively expensive for many [15, 166, 49, 19].

Digital media have expanded the scope of viable piecework by pushing drastically on the limits cited by piecework researchers. The research on piecework tells us that we should expect piecework to thrive in industries where the nature of the work is limited in complexity [19]. Given the flourishing of on–demand labor platforms such as Uber, AMT, and others, we ask ourselves what — if anything — has changed. We argue that the Internet has trivialized the costs and challenges of the earlier limiting factors because technology make it easier 1) to do complex work aided by computers and 2) to evaluate and manage workers as they do increasingly complex work, even observing their work to an otherwise unprecedented granularity.

Technology has made it possible for non–experts to do work that was once considered within the domain of experts. Yuan et al. builds on the work of others (*Voyant* and, more relevantly, *CrowdCrit*) to design workflows that yield "expert–level feedback" [173, 168, 98]. This body of work identifies ways to transform a variety of duties comprising complex tasks and distills them into "a narrow set of routinized duties", informed in part by researchers — acting as inspectors — and experts [quotations from 49]. Where Graves would call additionally for the identification of crowdsourcing's version of "piecework clerks", we point out that today algorithms manage workers as pieceworkers once did [93, 49].

Furthermore, technology more directly facilitates the subversion of expertise requirements by giving non–experts access to information that would otherwise be unavailable. Taxi drivers in London endure rigorous training to pass a test known as "The Knowledge" — a demonstration of the driver's comprehensive familiarity. Researchers have identified significant growth of the hippocampal regions of the brains in veteran drivers, generally understood to be responsible for spatial functions such as navigation [102, 101, 143, 144, 165, 164]. Services such as Google Maps & Waze make it possible for people entirely unfamiliar with a city to know more about a city even than experts through the collective data generated by other users ranging topics such as police activity, congestion, construction, etc... [142, 60].

### *Implications for crowd work*

The piecework literature gives us a template for pushing the boundaries of complexity in piecework, but it also signals some of the ultimate limitations of crowd work and piecework in general. While the threshold preventing task requesters from utilizing piecework has dropped thanks to affordances of the Internet, the ceiling on task complexity hasn't moved significantly. If we're to make use of Brown's prescriptions, we would benefit from finding ways to decompose varied tasks into homogeneous microtasks.

We should also consider exploring the limitations that algorithmic management bring along more carefully. While research has touched on this subject, we've yet to make out the bigger picture of this theme [93]. If we can resolve the tension between workers and perilously antagonistic managers, as Boal and Pencavel suggest, then we may be able to break a toxic cycle of mistrustful requesters [for example 45] and develop more considerate platforms as McInnis et al. advocate [106].

Finally, and perhaps most importantly, we need to replicate the success of narrowly slicing education and training for expert work as Hart and Roberts and Grier described in their piecework examples [56, 52] . That is, we need to identify new ways to train crowdworkers for uniquely narrowly defined work. To some extent, an argument can be made that MOOCs and other online education resources provide crowd workers with the resources that they need, but it remains to be seen whether that work will be appropriately valued, let alone properly interpreted by task solicitors [3]. If we can overcome this obstacle, we might be able to empower crowd workers to do complex work such as engineering and metalworking, rather than doom them to match girl reputations: "brash, irregular, immoral, and uneducated" [135].

### Decomposing Work

At its core, on–demand work has been enabled by decomposition of large goals into many small tasks. As such, one of the central questions in the literature is how to design these microtasks, and which kinds of tasks are amenable to decomposition. In this section, we place these questions in the context of piecework's Tayloristic evolution.

#### *Crowd work's perspective*

Many contributions to the design and engineering of crowd work consist of creative methods for decomposing goals. Even when tasks such as writing and editing cannot be reliably performed by individual workers, researchers demonstrated that decompositions of these tasks into workflows can succeed [80, 11, 148, 112]. These decompositions typically take the form of workflows, which are algorithmic sequences of tasks that manage interdependencies [13]. Workflows often utilize a first sequence of tasks to identify an area of focus (e.g., a paragraph topic [80], an error [11], or a concept [170, 172] and a second sequence of tasks to execute work on that area. This decomposition style has been successfully applied across many areas, including food labeling [114], brainstorming [140, 169], and accessibility [87, 85, 88].

If decomposition is key to success in crowd work, the question arises: what can, and can't, be decomposed? Moreover, how thinly can work be sliced and subdivided into smaller and smaller tasks? The general trend has been that smaller is better, and the microtask paradigm has emerged as the overwhelming favorite [149, 150]. This work illustrates a broader sentiment in both the study and practice of crowd work, that microtasks should be designed resiliently against the variability of workers, preventing a single errant submission from impacting the agenda of the work as a whole [68, 89, 154]. In this sense, finer decompositions are seen as more robust — both to interruptions and errors [29] — even if they incur a fixed time cost. At the extreme, recent work has attempted demonstrated microtasks that take seconds [155, 22] or even tenths of a second [82]. However, workers perform better when similar tasks are strung together [89], or chained and arranged to maximize the attention threshold of workers [21]. Despite this, we as a community have leaned *into* the peril of low–context work, "embracing error" in crowdsourcing [82].

The general lesson has been that the more micro the task, and the more fine the decomposition, the greater the risk that workers lose context necessary to perform the work well. For example, workers edit adjacent paragraphs in inconsistent ways [11, 77], interpret tasks in different ways [74], and exhibit lower motivation [78] without sufficient context. Research has sought to ameliorate this issue by designing workflows help workers "act with global understanding when each contributor only has access to local views" [156], typically by automatically or manually generating higher-level representations for the workers to reflect on [30, 156, 77].

As the additional context necessary to complete a task diminishes, the invisible labor of *finding* tasks [104] has arisen as a major issue. Chilton et al. illustrate the task search challenges on AMT.Workers seek out good requesters [104] and then "streak" to perform many tasks of that same type [31].

Researchers have reacted by designing task recommendation systems (e.g., [33]) and others focused on minimizing the amount of time that people need to spend doing anything other than the work for which they are paid [23].

#### *Piecework's perspective*

Brown inquired from another direction, asking what limited the adoption of piecework in industries that otherwise gravitated toward it (in the case studies he examined, this mostly focused on railway engineers), ultimately arguing that factors such as the nature of the work design (specifically, the homogeneity of tasks) and the costs associated with adopting a piecework model were the major contributing factors that determined the use of piecework [19].

Piecework became an important factor in the war effort for the Second World War, cementing its role not only in American factories, but in industrial work around the world. The 1930s represented a boom for piecework on an unprecedented scale, especially among engineering and metalworking industries. As discussed earlier, Hart and Roberts characterize the 1930s — and more broadly the first half of the 20th century — as the "heyday" of the use of piecework. He attributes this to the shortage of male workers, who would have gone through a conventional apprenticeship process affording them more comprehensive knowledge of the total scope of work. One might reflect on the observation that "Rosie the Riveter" — an icon of mid–20th century America who represented empowerment and opportunity for women [61] — was herself a pieceworker [37].

The research community relating to piecework and labor has been wrestling with the decomposition of work for centuries. The beginnings of systematic task decomposition stretch back as far as the 19th century, when Airy employed young boys at the Greenwich Observatory who "possessed the basic skills of mathematics, including 'Arithmetic, the use of Logarithms, and Elementary Algebra' " to compute astronomical phenomena [52].

The work that Airy solicited resonates with modern crowd work for several reasons. First, work output was quickly verifiable; Airy could assign variably skilled workers to compute values, and have other workers check their work. Second, tasks were discrete — that is, independent from one another. Finally, knowledge of the full scope of the project — indeed, knowledge of anything more than the problem set at hand — was unnecessary.

This approach found its audience in the early 20th century with the rise of Fordism and scientific management (or Taylorism). Scientific management suggested that it was possible to measure work at unprecedented resolution and precision. As Brown points out, piecework most greatly benefits the instrumented measurement of workers, but certainly in Ford and Taylor's time, highly instrumented, automatic measurement of workers was all but impossible [19]. As a result, the distillation of work into smaller units ultimately bottomed out with tasks as small as could be usefully measured [49].

Piecework researchers enumerate a number of problems with the decomposition of work, and the conflicting pressures managers and workers put forth. Bewley in particular points out that the approach of paying workers by the piece is "... not practical for workers doing many tasks, because of the cost of establishing the rates and because piecework does not compensate workers for time spent switching tasks". Ultimately, Bewley argues that "[piecework is] infeasible, because ... total output is the joint product of varying groups of people" [12].

*Comparing the phenomena*

Where measurement and instrumentation were limiting factors for historical piecework, computation has changed the situation so that a dream of scientific management and Taylorism — to measure every motion at every point throughout the workday and beyond — is not only doable, but trivial [159]. Where Graves directly implicates measurement as preventing scientific management from being fully utilized, modern crowd work is measuring and modeling every click, scroll, and keyboard event [133, 132]. The result is that on–demand work can articulate and track far more carefully than piecework historically could.

A second shift is the relative ease with which the metaphorical "assembly line" can be changed. Historical manufacturing equipment was not Turing-complete, and could not quickly be assembled, edited, and redeployed. In contrast, today system–designers can share, modify, and instantiate environments like sites of labor in a few lines of code [94, 97]. This opportunity has spurred an entire body of work investigating the effects of ordering, pacing, interruptions, and other factors in piecework that would have been all but impossible to manipulate as few as 20 years ago [36, 21, 29, 28, 82].

Third, modern crowd work has sliced work to such small scales that the marginal activities — things like finding work and cognitive task switching — have become relatively large compared to the tasks themselves [31]. In the historical case of piecework, moving metallurgical tools, mining equipment, or other industry materials would have been prohibitively difficult and slow; workers were encouraged to specialize in a single set of tasks, allowing pieceworkers to sequence their tasks optimally on their own [56]. The result is that crowd workers are more free agents than historically was the case. However, because they spend significant time searching for tasks, the piece rate is less a good estimate of take-home earnings than before.

*Implications for crowd work*

If measurement precision limited the depth of decomposition for piecework historically, as Graves argues, then modern on–demand work stands to become far more finely-sliced and highly decomposed than ever before. Online tools make measurement and validation so easy [133] that these aspects of piecework are solved, or near enough that they no longer limit task decomposition. Now, not just tasks, but entire workers' histories [58], can be collected and analyzed in detail.

However, decomposition has hit a second bottleneck: cognition. Task switching costs and other cognitive costs make it difficult to work tasks so far decontextualized from their original intention [89]. There will of course be tasks that can be decomposed without much context, and these will form the most fine-grained of microtasks. However, other tasks cannot be freed from context — for example, logo design requires a deep understanding of the client and their goals. In part due to this limitation, 99designs workers often recycle old designs rather than make new ones for each client [8].

So, ultimately, the levels of decomposition are likely to follow the contours of context required. Low-context work will be extremely highly decomposed. High-context work will continue to be limited.

### The Relationships of Workers to Work, Peers, and Others

*Crowd work's perspective*

The relationships of workers with their peers and with requesters are nuanced and not especially well–understood. Researchers have begun to appreciate the sociality of crowd workers in labor markets; still, the study of these communities is made more challenging by the limited access to workers on these sites of work inherent to digital spaces made without social affordances [51, 109]. We can break this general body of work into two subgroups: workers' relationships 1) with *requesters*, and 2) with *other workers*. We'll look at workers' relationships with work itself, which we'll discover gives us insight into why people engage in crowd work in the first place.

Some research frames this tension as the Turker's problem (see, for example, Gadiraju et al.'s work, which frames the problem of unpredictable work as the result of "malicious" crowd workers), [45, 139, 67].

Early on, Irani and Silberman highlighted the information asymmetry between workers and requesters on AMT, leading to the creation of *Turkopticon*, a site which allows Turkers to rate and review requesters [71]. Salehi et al. took this critique on information asymmetry and power imbalances a step further, designing *Dynamo* to facilitate Turkers acting collectively to bring about changes to their circumstances — this led to the Academic Requester Guidelines [134]. This unbridled power that requesters have over workers and the resultant stress and frustration that this generates has been part of the undercurrent of research into the tense relationships between workers and requesters [50, 134].

The frustration that workers experience dealing with requesters seems to precipitate frustration and mistrust between crowd workers, as well. Salehi et al. describes "mega–drama" among workers on forums for Turkers; Irani and Irani and Silberman discuss the culture of crowd work and the study thereof. Gray et al. quantifies and maps this social network of Turkers. McInnis et al. takes these observations and considers what a crowd work platform might look like if it were to be designed more inclusively [134, 69, 70, 51, 106]. The overarching theme of the research in this space has been documenting the struggle of crowd workers and attempting to intervene in constructive ways, while walking the balancing act (especially in the cases of Irani and later Irani and Silberman) as we think about the culture of crowd workers.

### *Piecework's perspective*

Clark, for instance, relays his observations of textile mill pieceworkers and his realization that "When he works by the day the Italian operative wishes to leave before the whistle blows, but if he works by the piece he will work as many hours as it is possible for him to stand"

Riis was documenting abhorrent working & living conditions of pieceworkers in New York City, and Norton was providing substantive guidance on various wage regimes, offering guidance on how best to manage pieceworkers [125, 115].

Despite the intense growth of the piecework approach to renumeration, this time was not without turmoil. As previously discussed, a number of worker organizations weighed in on (or, more precisely, against) piecework and the myriad oversights it made in valuing workers' time [84, 124]. As mounting attention increasingly revealed problems in piecework as it related to workers, workers themselves began to speak out about their frustration with this new regime. Riis's photo–documentary work brought light to otherwise–invisible pieceworkers in their homes; this and other events led to organizations representing railway workers, mechanical engineers, and others who began to mount advocacy in defense and favor of workers [84, 124, 125]. Satre tells us of the match–girls strike of 1888, one of the earliest and most famous successful worker strikes and perhaps the beginning of "militant trade unionism" [135]. It wasn't an exaggeration when Weyer, Webb, and Webb later said that "the match–girls' victory turned a new leaf in Trade Union annals" [163]; in the 30 years since the match–girls strike, the Trade Union Movement grew from "20 per cent of adult male manual–working wage–earners [to] over 60 per cent" [160].

While many workers participated in piecework, worker sentiment toward the practice was — by all accounts — mostly negative. The match girls strikes which Satre describes were just one early — albeit critical — case study in this space; the national coal strike of 1912 led to an overwhelming vote among federated coal miner pieceworkers to strike for an individual minimum wage, among other demands [127]. Emmet documents a series of efforts among women in the garment industries in Philadelphia to negotiate collective bargaining rights and recognition of their own labor union [40]. The adoption of piecework's time–studies and other Taylorist and scientific management approaches reliably precipitated strikes and more generally gave workers a clear enemy against which to rally [73].

The questions surrounding the ways pieceworkers related to managers might be best answered by the work that has been done in the emergence and proliferation of labor unions. The primary avenue for workers to interact with managers has been through laborer advocacy groups such as the American Federation of Labor, (one of the forerunners of the largest and most politically influential labor union in the United States). Looking through that lens, we find copious research on the relationships between workers and requesters [95, 4, 105, 73]. One component of collectively negotiating with managers has been the process of collective action, a topic which has been substantively explored but is not quite yet answered [55, 117].

Answering how workers related to one another is arguably more challenging for a number of reasons. For one thing, the research methods we typically associate with the exploratory study of cultures — Anthropology, and namely participant–observation, ethnography, etc. . . — didn't exist quite as we know them at the turn of the 20th century, and wouldn't for several more decades. Still, we can look at primary sources, like *The problem of piece work* to give us some hint of how they related to each other [84].

The driving force of American labor advocacy organizations was to get piecework railroad workers to identify "not only as railroad employees but also as members of the larger life of the community" [84]. Doing this, Ostrom and others argued, would facilitate collective action and perhaps collective governance [118, 55, 117]. Riis had contributed to this sense of shared struggle and endurance by the time *The problem of piece work* was published by documenting pieceworkers in their home–workplaces, literally bringing to light the grim circumstances in which pieceworkers lived and worked [125].

### *Comparing the phenomena*

The differences between crowd workers and pieceworkers seem defined largely by the differences in the places of work. Whereas it arguably became inevitable that workers would have a place to meet, discuss, and collaborate when they began sharing places of work, online spaces make it much harder to do so. Crowd workers can "lurk" and do tasks, or just do the occasional one–off task, without any affiliation with — or even knowledge of — communities of peers [109, 107, 38].

We further find the sources of differences between crowd work and piecework in the nature of the relationship between workers and requesters — or rather, the lack thereof. While historically the management of workers had to be done through a foreman (who necessarily had an intuitive — perhaps sympathetic — relationship with workers), the foreman of the 20th century has largely been replaced by algorithms of the 21st century [93]. The result of this change is that the agents managing work are now cold and logical, if unforgiving. Where a person might recognize that the “attention check” questions proposed by Le et al. ensure that malicious and inattentive are stopped, some implementations of these approaches only seem to antagonize workers [92, 45]. Anderson and Schmittlein told us more than 30 years ago — in 1984 — that “… when performance is difficult to evaluate, imperfect input measures and a manager’s subjective judgment are preferable to defective (simple, observable) output measures” [6].

*Implications for crowd work*

What we’ve done in the field of crowd work might be able to tell us something about piecework just as piecework has told us so much about crowd work. Crowd work research doesn’t just benefit from digital media allowing us to make relationship networks like Gray et al. do; we benefit from the firmer theoretical basis of Anthropology that existed in a radically different form at the turn of the 20th century, when piecework began to emerge. Malinowski, Boas, Mead and Boas and other luminaries throughout the first half of the 20th century effectively defined Cultural Anthropology as we know it today; *participant–observation*, the *etic* and the *emic* understanding of culture, and *reflexivity* didn’t take even a resemblance of their contemporary forms until these works [103, 16, 108].

The research on piecework still offers to guide us on perhaps the most rudimentary aspects of worker management Anderson and Schmittlein drew a dichotomous line between “defective (simple, observable) output measures” and “a manager’s subjective judgment”, but such a dichotomy need not necessarily represent our work management styles [6]. We can develop tools that better inform humans, rather than (perhaps futilely) attempt to delegate all worker management to machines. This is an area we should pursue, but haven’t yet. If the literature on piecework is to be believed, more considerate *human* management may resolve many of the tensions we’ve discovered among among crowd workers.

## IMPLICATIONS FOR RESEARCH

1.

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### Graveyard of old paragraphs

[0] Here, Hu's work, saying of assembly line work that "it is assumed that men are of equal ability and every man can do any of the *n* jobs", parallels the approach that dominated early research into crowd work — namely, using non–expert crowds for complex work [65]. This mindset in Hu's analysis, and indeed the study of factory and mass manufacturing labor through the 20th century, substantively owes its existence to scientific management and the rigorous decomposition of work into tasks, discussed earlier, and persists to this day as it colors researchers' goals and objectives in the study and design of crowd work.

Piecework's influence on the abstraction of work into tasks, described above, is more than just caused by the decomposition of work; work abstraction itself makes it possible for workers to come and go flexibly, prompting work requesters to consider ways to design these now discrete tasks in ways that maximize flexibility, both by allowing (and even anticipating) some inconsistency in worker availability *and* allowing and anticipating some inconsistency in the quality of the work output itself. It's to this area that we now turn our attention.

Piecework has seen work along this dimension spanning decades; Thompson investigate some of the ways that construction can benefit from the principles of scientific management. Thompson's thesis asserts that task work is predicated on the accurate scientific management of work, including the "miscellaneous tasks". Thompson argues — as early as 1913 — that "...one may be challenged to find any class of work involving labor either indoors or out–of–doors where tasks cannot be fixed by proper time–study" [151].

Broken down in this way, work could grow to unprecedented scales, but the quality of the work would remain relatively variable [110]. Textile work being a salient example, it took time for workers to acquire sufficient skill to do every aspect of the work so that the garment would be accepted by the company soliciting that work [157].

A compelling solution emerged in the early 20th century to break tasks down into discrete, manageable routines that could be taught relatively easily, and whose work output could be evaluated in abstraction from the rest of the work [10]. In Ford's assembly line, this meant that workers were not responsible for building a whole car, but a single very narrowly defined action that needed to be done on every car [96]. By the mid–20th century, Schoenberger writes, "... the intensification of the labor process is argued to have hit mental, physical, and social limits." [136].

This approach, "Fordism" (and its better–known contemporary "Taylorism" of similar ethos), can be seen today in crowd work and on–demand labor through the application of micro–tasks. Teevan, Iqbal, and Veh highlight some of the advantages of breaking work into pieces, facilitating evaluation and parallelization [148]. By decomposing and recomposing tasks, and in particular by assigning similarly natured work to the same workers, workers could become "experts" in a small aspect of the work that they did, speeding their work dramatically [89]. Perhaps more important, however, was that the breaking down of work into tasks has made it more practical to evaluate work at each stage [128].

*So how does this affect crowd work?*

The work we've seen so far

- worst case: assembling iPhones (extant)
- average case: railroad workers and assembly lines
- high (complexity) case:

[0]

### CASES NOTES

Cheng et al. found that microtasks — though not necessarily *faster* than "macrotasks" — yield higher quality work, particularly when that work is susceptible to frequent interruptions [29].

### What forms of work design and worker management are viable?

- researchers have looked at how to increase worker productivity (e.g. finding the maximal speed at which gig workers can be expected to work before making errors) [28].
- we've also seen people "embrace error" [82].
- still other research has looked into ways to sandbox workers from the context of their work
- but scholarship looking into the design and management of work and workers isn't new; lots of research into getting pieceworkers to do work more quickly [137].
- Researchers have even asked the age old question of *what motivates* pieceworkers (echoing similar research on Wikipedia and Mechanical Turk) [131, 116, 75]

### What will work and the place of work look like for workers?

The metaphorical mechanics of these dynamics are still at play; workers and managers continue to interact in adversarial manners, despite substantive work into aligning the motivations of workers and requesters

The existing body of research has shed light on on–demand labor from various perspectives, and revealed a number of topics that, through our framing, are clearly situated together. Those topics are, at a high level, as follows:

1. the **processes** involved in making work into tasks, or discretization;
2. the outcomes (and indeed the **fallout**) of that discretization, both on the work itself as well as the workers; and finally
3. the **relationships** between workers and requesters of the work — both *cooperative* and *adversarial* cases.

### The Fallout of Crowd Work

Irani and Silberman point out the disillusion that companies such as Amazon foster on platforms for work like AMT (see also Salehi et al.'s work continuing in the spirit of this observation to generate collective action to improve worker conditions) [71, 134]. Lee et al. find similarly that workers on gig work platforms are frustrated by the systems on which they work, to say little of the policies which these systems enforce [93].

We discussed the benefits of flexibility (both in the sense of having arbitrary workers perform tasks and in the sense that we can design tasks to be more resilient to poor work) in the previous section. It's from that point in the literature that we turn our attention to the perhaps unintended effects of crowd work and the affordances for transience that we build into this mode of work. We'll address two major areas of work under this subject: 1) **??**; and 2) **??**.

### *Low Pay*

Horton and Chilton identified problems with crowd work wages relatively early on, attempting to address this imbalance from a behavioral economic perspective — that is, identifying and presenting a model that describes a worker's "*reservation wage*" [62]. This work has largely informed much of the research into and practice of estimating crowd work compensation [138, 119].

But we turn to Irani and Silberman's discussion of "*Turkopticon*", a system they designed to interrogate worker invisibility and to promote better wages across several dimensions [71]. Of particular relevance here, Irani and Silberman call to attention that "Turkers" are ultimately vulnerable to wage theft and pay rates that translate to well under minimum wage. Returning to Horton and Chilton, we find that the median "reservation wage" in 2010 was $1.38, while the mean was $3.63 [62].

Understanding workers' motivations given these conditions has thus become a goal for some researchers [17]. Sun, Wang, and Peng conclude that "... solvers participate in online tasks not only for money but also for enjoyment or the sense of self–worth" [145]. This might have rung true in 2011, and certainly corroborates Ross et al.'s findings after investigating "who are the crowd workers", but as Silberman points out "we [have since] learned that most tasks on AMT are done by a small group of professional Turkers..." [129, 141].

Now, Irani and Silberman and later Salehi et al. cite insufficient pay as a central point of frustration among workers, via Irani and Cushing's contributions in this space [134, 69, 35, 71].

On–demand workers were not the first to be exploited along the dimension of low pay rates. Frustration over low (and declining) pay was one of the chief grievances among then nascent British labor unions in the early 20th century [152]. This, Ebbinghaus and Visser argued, fueled the rocketing union membership rates through the mid–20th century until 1980 (to which we'll return when we discuss Levi et al.'s reexamination of labor unions) [39, 95]. This realization has similarly fueled a body of research into the various incentive structures available to piecework employers [131].

The parallels between the complaints of low pay among crowd workers and other on–demand workers and the pieceworkers and later factory workers in the 20th century are inescapable. We argue further that the *causes* here — work decomposition, work abstraction, and flexibility — lead inexorably to low and declining pay for workers. Moreover, we point out that low pay leads to other negative outcomes both in on–demand work as well as in piecework and on assembly lines.

### *Variable quality work*

Researchers have struggled with what we might generously call work of "variable quality" along two dimensions. The first, to use the characterization of one of these contributions, we can call "understanding malicious behavior" [45] While some work has cast workers as "malicious" or at least adversarial parties, the evidence thus far suggests that workers behave in unexpected ways as they attempt to assert some control over their interaction with the system (a topic of discussion to which we'll return later) [93]. The second dimension of research in this space generally attempts to eke out the highest quality work possible from workers given the apparent difficulty in predicting work outcomes [82].

The effect low wages have had on piece work and factory workers is well–known; Gantt discuss this exact mechanism in his book on "... where there is no union, the class wage is practically gauged by the wages the poor workman will accept, and the good workman soon becomes discouraged and *sets his pace by that of his less efficient neighbor*, with the result that the general tone of the shop is lowered" (emphasis added) [46].

This research is similar to, but subtly different from, the notion of the "market for 'lemons'" which Fort, Adda, and Cohen discuss; specifically, Akerlof's writing of a "market for 'lemons'" describes a marketplace where the quality of the product or service is unknown to the buyer [43, 5]. The effect of this *perceived* uncertainty is that the *actual* trustworthiness drops precipitously as all of the consistent, reliable, high–quality workers capable of leaving these markets do so, leaving only the ones who cannot or will not establish their trustworthiness.

## Relationships Between Workers and Managers

Suffice it to say that poor pay and poor work are linked, and that we should not be surprised to find this relationship play out online as strongly as it does offline. But the poor treatment of workers by managers — both human and algorithmic — do more than affect the economic relationships between workers and employers. Here, then, we turn to examine this facet of on–demand work and how these dynamics strikingly replicate the relationships researchers in labor advocacy encountered in the study of piecework and factory work.

This topic can be condensed into two major areas: 1) external (scientific) management, and the evaluation of workers as functional modules; and 2) the consequential resistance workers express due to their perceived alienation and distance from managing forces.

### *External Management*

We discussed Fordism and Taylorism earlier in our discussions of **??** and **??**, but here the core of these paradigmatic views — the scientific management of work — becomes relevant. We use "external" here instead of "scientific", however, to more broadly capture the disconnect between managers and workers. By describing it as thus, we can touch on the relationship that workers have with *researchers*, as well, even though that work is not strictly — or just not exclusively — of the same nature as the management and experience as when interacting with requesters.

First, intuitively, the variable–quality work we discussed previously has led to a large and growing body of research attempting to evaluate workers' performance and error rates across numerous dimensions; for example, Cheng, Teevan, and Bernstein explore the error rates of workers by operating on a sliding scale giving workers varying amounts of time to accomplish micro–tasks [28]. Irani and Silberman describe the treatment of workers as sorts of "human APIs" that can, importantly, be rigorously evaluated [70]. Gevins and Smith began to explore the neurophysiological effects of cognitively demanding tasks on workers, informing crowdsourcing research by suggesting the use of cognitive load assessments such as NASA Task Load Index surveys to evaluate workers pre and post–tasks [82, 28].

External management comes in other forms than scientific, as previously mentioned. Researchers in particular have noticed that their relationships with on–demand workers are, at the least, complex. Irani and Silberman point out that their relationships with Turkers are highly complex; specifically, their interactions with field sites in which they work as designers and mediators of change influence the relationships they have with Turkers [70].

The scientific management of pieceworkers has been well–studied under the umbrella of assembly line research, and even physiological study of pieceworkers closely resembles the research into cognitive loads and stress levels that we discussed among on–demand crowd workers [65, 18]. Even the complicated relationships between observers and workers themselves are not necessarily new; Riis's photodocumentary of pieceworkers has even been re–examined through an exercise asking crowd workers to photograph themselves for similar purposes as Riis's — to document and humanize an otherwise abstracted, invisible workforce [9, 71, 125].

Similarly, Pollard's words on the punishment factory workers faced — for example, that "unsatisfactory work was punished . . . by fines or by dismissal" — seems especially relevant given the fears we now know to be ubiquitous on platforms such as AMT, Uber, and other on–demand markets [120, 93, 134, 71, 106].

### *Resistance*

It shouldn't surprise us, then, that workers have resisted the management imposed on them both by other people and their systems, often without recourse or opportunity for feedback, let alone substantive input. Indeed, Lee et al. discover of Uber drivers that many toggle their availability to avoid being dispatched to more distant locations, resisting the intent of the designers of the systems and their "algorithmic and data–driven management" [93].

Resistance has sometimes been more coordinated, as well; we see this in Irani and Silberman's coverage on *Turkopticon*as workers collectively accumulated information about requesters, and in Salehi et al.'s work on *Dynamo*, which generated "Guidelines for Academic Requesters" written by crowd workers [71, 134].

Resistance against managers in piecework and factory labor settings are deeply well–explored, but perhaps the most relevant case study to draw on here is to be found in Waldinger et al.'s case study of "Justice for Janitors", where marginalized workers managed to raise awareness for their plight and secure support for badly needed reforms [158]. The achievements of labor advocacy groups such as labor unions as resistant, even adversarial organizations counter–balancing the management is somewhat well–understood [55, 34]. We argue that these threads of resistance against management in various forms are in fact one.

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