

Reexamining Crowd Work: A Historical Framing of On-Demand Labor as Piecework

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ABSTRACT

With growing attention toward on-demand labor — ranging from the “sharing economy” to information work — scholars have made connections to various frameworks and mechanisms such as worker advocacy, empowerment, and Taylorism, to make sense of our observations of on-demand work and the workers that power this movement. We argue that the literature surrounding “piecework” informs and even predicts both the contributions that have been made toward the development of on-demand labor and crowd work as well as the fallout among workers and researchers with regard to the disillusionment and alienation of work.

After evaluating this framing through a series of case studies, we look to the future to identify worthwhile questions and points of inquiry, such as the movement toward factories, that researchers in social computing should consider as we attempt to anticipate and perhaps shape the future of work.

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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 abstract blocks has allowed people to engage in work despite limited time, little to no awareness of the broader context of the work, and (often) fleeting identities and associations [30, 56, 42]. The realization that complex tasks can be accomplished by directing and managing crowds of workers has spurred the research and industry communities to flock to sites of labor like Amazon’s Mechanical Turk (AMT) to explore the limits of this distributed, fleeting workforce. Researchers in particular

have taken to the space in earnest, finding opportunities to enable new forms of work using this population of “Turkers” [3, 72, 60].

This form of work has grown considerably in size, far beyond the domain of “information work” from which it first sprang. While Howe described crowdsourcing as “outsourcing [work] to an undefined, generally large group of people in the form of an open call”, for years the instantiation of this work was limited to the utilization of human intelligence to process data and act on information [34, 86, 90, 16, 61]. More recently, crowdsourcing of embodied work — driving, cleaning, for instance — has become a focus of on-demand labor markets [44, 79, 22, 73]. Today, on-demand work promises to become a .

For all the growth we’ve observed in this labor market, we have also seen a complicated and conflicted culture emerge among its constituent workers. Researchers have made efforts to understand the people that have gravitated toward crowdsourcing platforms since its emergence and popularization, but as the form of work has grown and changed, so too have the demographics of workers [64, 67]. 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 [29, 65]. Other work has focused on the *outcomes* of this frustration, reflecting on the resistance workers express against digitally mediated labor markets [44].

The extant body of work has ostensibly sought to answer one underlying question: What does the future hold for work and those that do it? Researchers have offered their input on this open question along three major threads:

1. What are the limits of crowdsourcing? Specifically, 1) how complex can crowd work get? and 2) how far will crowd work reach into the everyday lives of people? [62, 71, 32, 89, 88, 58, 20];
2. To what extent can we decompose work (especially into micro-tasks)? [37, 3, 9, 49, 38, 43, 7, 10, 59]; and
3. What will work and the place of work look like for the workers? [29, 28, 65, 18, 5, 54]

Piecework as a lens to understand crowdsourcing

This large and growing body of research has conversed to varying degrees with labor scholarship, but has not offered a persuasive framing for holistically explaining the developments in worker processes that researchers have developed, or the phenomena in social environments we have observed;

nor has any research, to our knowledge, gone as far as predict future developments.

We offer a framing for crowd work spanning the aforementioned industries collectively as a contemporary instantiation of “piecework”. Piecework as a metaphor for the type of work at hand 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 [36]. But more than this, the framing of on-demand labor as a re-instantiation of piecework gives us more material to make sense of the broader research on this new form of work by evaluating this work through a much more refined theoretical lens, informed by decades of rigorous, empirically based research.

More concretely, by looking at task-based or “gig” 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) bring into focus the ongoing work among workers, system-designers, and researchers in this space; and finally, 3) offer predictions of what social computing researchers, and workers themselves, should expect to see on the horizon of on-demand work.

We’ll look at a broad range of cases under a number of major themes we propose as broadly describing the types of research being done in crowd work and more generally in what we argue is contemporary piecework. After validating this lens as a way of reasoning about on-demand labor, we’ll attempt to use this perspective to suggest areas of research worth anticipating, and developments we should expect to see in the maturation of digitally mediated work. Finally, we will offer design implications based on this research.

MAJOR RESEARCH QUESTIONS

We look at lots of papers that use the term “crowdsourcing” or “crowdwork” 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.

What are the limits of crowdsourcing?

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. 3, 62, 35]. 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) [finding crowdwork’s limits](#), 2) [slicing work into smaller parts](#), and 3) [worker volatility](#). 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.

Achieving greater complexity

Crowdwork’s perspective. Crowdsourcing research has spent the better part of a decade attempting to prove the viability of crowdsourcing in increasingly complex work. Kittur et al. map the discussion toward this goal in their work on crowdsourcing complex work [35]. The broader body of work has varied significantly in type — providing conversational assistants, interpreting medical data, and telling coherent and compelling stories, to name a few examples [40, 53, 32].

This body of research has involved similar approaches to problems, often involving insights made in Computer Science and applied to human work-flows. The crowdwork literature typically identifies target milestones in CS that have presented significant challenges for researchers, leverages some of the approaches and insights that Computer Science researchers have already made (for example, MapReduce in the case of Kittur et al.’s *CrowdForge*), and arranges humans as computational black boxes within those approaches and processes [35, 62, and others]. This approach has proven a compelling one because it leverages the in-built advantages that technology and digital media afford. *Foundry*’s tools for managing and arranging expert groups into a cohort allow researchers to convincingly argue that expert teams can be rapidly formed, just like non-expert teams [62].

Piecework’s perspective. The research into piecework makes the case that piecework has been limited principally by the challenges of human management and oversight. Graves, who describes piecework as “... based on examination of various shop jobs, which included calculation of the standard time and compensation for each task”, argues that piecework must be rigorously evaluated at a time that demands *other people* perform the evaluation. Graves later enumerates some of the roles required to facilitate piecework in the early 20th century: “... piecework clerks, inspectors, and “experts”...” [17]. This criterion strictly limits the extent to which piecework can grow in complexity; it must, for instance, be quickly evaluable by another person.

Piecework researchers also make claims regarding the organizations that benefit from piecework in the first place. Brown discusses the factors necessary for piecework to thrive: “... incentive pay is less likely in jobs with a variety of duties than in jobs with a narrow set of routinized duties” [6]. Graves adds further, that successful cases of piecework owed themselves in part to the fact that “... only [the largest and most wealthy railroads] had the resources to ... pay the overhead involved in installing work reorganization” [17]. Together, Graves and

Brown make a persuasive argument that piecework is limited in complexity by managerial overhead and the fixed cost of adopting a piecework payment regime.

What's changed. 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 [6]. 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 for two reasons: 1) Technology make it much easier to do complex work aided by computers; and 2) The Internet allows us to leverage the benefits of “economies of scale” at very little cost to the system-designer [45, 55].

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” [89, 87, 48]. 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 17] 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 [44, 17].

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 [51, 50, 69, 70, 85, 84]. 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. ... [68, 21].

Crowdsourcing falters when the routinization of complex work proves difficult. [al2: Something about complexity being difficult to make routine when there are lots of little, varied, unpredictable tasks (nod to Brown)]

Slicing work smaller

Crowdwork's perspective. The crowdsourcing research into work decomposition has largely focused on minimizing the additional context necessary to do tasks, and making it easier to do tasks with less time. This first thread is perhaps best described by Verroios and Bernstein as making crowd workers “... able to act with global understanding when each contributor only has access to local views” [82]. With the exception of a few cases (specifically, Kinnaird, Dabbish, and Kiesler’s work which finds that greater work context fosters more reliably

high-quality work), the micro task paradigm has emerged as the overwhelming favorite [75, 76, 11, 33].

As the additional context necessary to complete a task diminishes, the marginal cost of finding and *doing* tasks has increasingly become the focus of research. Chilton et al. illustrate the challenges on AMT, and some work has gone into ameliorating the problems specific to this work site (*Re-Launcher*), while other work designs tasks around gap time (*Twitch Crowdsourcing & Wait-Learning*) [12, 38, 81, 8]. Yet more work looks at the general framing of tasks, chaining and arranging them to maximally exploit the attention and stress threshold of workers [7]. Rather than attempt to minimize the error rates in micro-tasks, as Kinnaird, Dabbish, and Kiesler suggested, we as a community have leaned *into* the peril of low-context work, “embracing error” in crowdsourcing [37].

Not all of the work toward optimizing crowd work-flows has gone toward minimizing the creative input of crowd workers; a thriving body of literature adopts practices such as pipelining to allow experts to participate in crowd work [62].

Piecework's perspective. 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 17th 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, by hand, astronomical phenomena [19]. These workers became the first *computers*.

The work Airy solicited was interesting 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. [al2: I could point out that the opportunity to check work and repeat the task is a little like find-fix-verify, but is that jumping the gun?] 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.

The insight of breaking tasks down into smaller components didn’t find its audience until the early 20th century, with the rise of Fordism and scientific management (or Taylorism). From scientific management, we found that we could measure work at unprecedented resolution and precision. As Brown points out, piecework

[al2: Marx in here?]

What's changed. [al2: todo]

Volatile quality and availability? How much can you deal with?

[al2: TODO:

1. Crowdwork’s perspective.
2. Piecework’s perspective.
3. What’s changed.

]

A number of researchers have identified worker attrition, variability of worker performance, and uncertainty about good versus bad-faith actors as open questions of crowdwork [15, 26]. [a12: We can and should discuss the distinction between presumably “bad faith” workers & workers who are merely responding in kind to bad requesters — and the broader questions surrounding the roles that requesters as well as workers should play — but let it suffice to say that requesters have been trying to understand and manage what appears to them as inconsistent work. Their ways of responding to that variance in work quality has largely involved making the work more flexible and resilient to work (although some work has gone into investigating the causes, rather than treating the symptoms)]

Earlier we discussed Cheng et al.’s work measuring the impact that interruption has on worker performance [11]. This work illustrates a broader sentiment in both the study and practice of crowdwork, that microtasks should be designed resiliently against the variability of workers, fully exploiting the abstracted nature of each piece of work [27, 41, 80]. That is to say, micro-tasks should be designed such that a single worker’s poor performance, or a good worker’s sudden departure, does not significantly impact the agenda of the work as a whole. While Cheng et al. found costs with breaking tasks into smaller components in the form of higher cumulative time to complete (albeit much shorter real time to complete, owing to parallelization), Lasecki et al. found that at least *some* performance can be recouped by stringing similar tasks together [11, 41, respectively].

Krishna et al. take a different approach; by “embracing error” and forming models describing the latency of workers in classifying objects at rapid speeds, the authors offer orders-of-magnitude improvements in various binary classification tasks [37]. And rather than building tasks to *tolerate* worker drop-off and attrition, some researchers have designed work predicated on the expectation of it instead: Celis et al. describe ways of assigning tasks in such a way that crowd workers would never be given enough information to piece together sensitive information about any single topic [9].

The work thus far seems to attempt to maximize the quality of work among workers through various means: 1) Identifying “bad” workers (fraught with problems as this characterization is) [15], 2) Designing tasks with break points to facilitate the on-boarding and off-boarding that happens anyway [11], and 3) Expecting certain levels of attrition and incorrectness and using that variability to their advantage [37].

Flexibility has been explored through the lens of Fordism, perhaps best illustrated by Tolliday and Zeitlin’s treatment describing turnover rates rising above 300% in the decade leading to the introduction of the assembly line in 1913. Specifically, the utilization of “... ‘semi-special’ machine tools which could be adapted [and] ... added flexibility through seasonal layoffs for production workers and the use of piece rates ... rather than a day wage system” [78].

In the field of piecework, the research covering this topic has both explored a breadth of tasks that might be rendered doable by piecemeal workers *as well as* longitudinally documented the success of these approaches. Here, we

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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 [24]. 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" [77].

Broken down in this way, work could grow to unprecedented scales, but the quality of the work would remain relatively variable [57]. 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 [83].

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 [1]. 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 [47]. By the mid-20th century, Schoenberger writes, "... the intensification of the labor process is argued to have hit mental, physical, and social limits." [66].

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 [74]. 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 [41]. Perhaps more important, however, was that the breaking down of work into tasks has made it more practical to evaluate work at each stage [63].

So how does this affect crowdwork?

The work we've seen so far

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

0

THE BLEAK FUTURE OF CROWD WORK

We've traced a path from piecework itself through the processes that describe the design and implementation of piece work and crowd work as part of the same thread; in tracing this process, we touched

on the relationships between decomposition, work & worker abstraction, flexibility, and followed through both the general fallout of crowd work in the research community as well as the fallout between workers and the managers and other external parties — including researchers.

Throughout these case studies, we have pointed out the parallels between the contemporary research in on-demand labor and the much larger body of research constituting our understanding of topics such as piecework, factory work, and laborer relations. If we agree that this framing is useful and informative, then several topics emerge as relatively open questions in the study of crowd work and on-demand labor. Two of the most pressing questions are 1) the beginnings of factories, and 2) the decline of relevance of worker advocacy organizations. We will discuss those questions here.

The beginnings of factories

We established earlier that abstracted work and low wages tend to result in variable outcomes, which presents problems for employers. Historically, this is what led to factories; by employing a cohort of known workers, we can be reasonably assured that the quality of the work will be better than random. Furthermore, we can invest more resources in training workers and get workers to do more complex work with more context.

Some research already looks at research such as investing in workers, and informally, we know that this happens among industry requesters [25, 13]. AMT, meanwhile, offers requesters the ability to create tasks which are not just hidden from unqualified workers by default, but completely. Requesters have taken to using lists of worker IDs which reference workers who have proven their reliability, representing a sort of proto-organization of loosely connected workers.

This, then, suggests that the beginning of the regularization of workforces — a sort of coalescence of factories — is already happening. If our framing of on-demand labor is accurately describing an underlying relationship with piecework, then we should watch for the emergence and popularization of persistent teams of workers.

The decline of advocacy organizations

The rise of labor unions in the 20th century seems to have been precipitated by severely unjust conditions imposed on workers in factories and elsewhere [14]. Incidents broadly describing this dynamic can be found in research on AMT [29, 65]. If these are prototypical labor advocacy organizations of contemporary on-demand work, the next question we should look to is if — and indeed *how* — these institutions might face challenges in the future.

For insight on this, we return to 2009's study of labor unions, and identify that "Scholars who evaluate union governance by procedural criteria generally find that oligarchy tends to arise and persist even when democratic procedures are in place" [46]. Indeed, Levi et al. writes about the general perception that labor unions were either This perception already appears to be emerging in digitally mediated peer-governed organizations, as Keegan and Gergle and others have illustratively documented [4, 31]. If these organizations and others are to avoid the same fate that labor unions faced, they should take care to study this phenomenon and attempt to avoid it.

IMPLICATIONS FOR DESIGN

If it's agreed that the major topics we've discussed thus far are related and — at least to *some* extent — precipitated in the fashion we argue, then we have a rare opportunity as researchers, and as agents of change in the communities we study, to affect change on the dynamics of crowd and on-demand work as they continue to develop.

Without claiming to have easy, cut-and-dry solutions to these problems, we can nevertheless bring to attention a number of critical opportunities to learn from historical parallels in piecework and factory labor, and make informed decisions regarding whether (or indeed how) we may want to influence outcomes. The challenges we bring to attention here are as follows: 1) codifying investment toward

collective goods into the designs of systems; 2) (re-)decentralizing the internet; and 3) enabling reputation transferral.

Codify the common good

As Lessig points out in his book, digital media give designers the opportunity to design and build into the systems policies and practices to contribute to the collective benefit of the people therein [45]. Historically, the confluence of forces Lessig describes would ultimately result in outcomes such as benefits for workers, funds for sick leave and vacation, and other conveniences. The transient nature of on-demand work would seem to problematize this arrangement, but we can discuss and explore the viability of building into systems the mechanisms necessary to save a portion of payment from every gig, record taxable income, or myriad other generally administrative tasks automatically.

Decentralize the internet — again

Digitally mediated on-demand labor markets have historically been insular and incompatible with one another, forcing workers either to choose one or juggle participation in these markets with great difficulty. An “API” for on-demand labor markets could make it possible for any person or organization to instantiate their own marketplace and inter-operate with. This can be changed, and indeed must, if we are to realize the hopes of early researchers who advocated the democratizing nature and power of the internet [2, 39].

Deal with reputation

Reputation systems in on-demand labor markets are fundamentally broken. To say nothing of the fact that information workers (such as those on AMT) can’t transfer their reputations to qualitatively different forms of labor like driving-for-hire (e.g. Uber), even within the same industry it’s currently not feasible for workers to transfer their reputations or other information from one place to another. This affects more than the reputation and trustworthiness of workers; accounting for things such as taxes, benefits, etc. . . is all but left to the individual workers, who struggle with myriad bureaucratic obstacles. We can design systems that facilitate the aggregation and, more importantly, the transferral of reputation, income, and other features of work.

DISCUSSION

We’ve discussed a number of aspects of on-demand work that offer parallels with historical piecework. Perhaps more importantly, we’ve hopefully demonstrated that the dynamics we observe in on-demand work are interrelated and follow from one another just as necessarily as they did in the development and maturation of piecework and factory work through the 20th century. This framing on on-demand work should, we hope, provide us with the necessary historical context to make better-informed design decisions about how we want “the future of crowd work” to look.

CONCLUSION

Kittur et al. discussed many of the challenges and problems in crowd work in 2013, but didn’t necessarily situate the notion of crowd work in a broader context. This paper attempts to fill that gap, and in doing so hopes to give the research community theoretical grounding to work with and within on-demand labor more successfully. But more than that, we hope to have addressed important questions to inform how we actually might make crowd work a career in which we want our children to work.