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 proliferation in on–demand work where workers' statuses are so fleeting that they have been described as "transient". After identifying that myriad tasks — from the mundane to the complex — can be accomplished by directing and managing the "crowd", the research and and industry communities have flocked to sites of labor like Amazon's Mechanical Turk (AMT) to solicit workers. Researchers in particular have taken to the space in earnest, finding opportunities to enable new forms of work as well as using these workers ("Turkers") as representative populations of the public [5, 64, 50].

This approach to managing work (and in particular workers) can be differentiated from other formulations by a constellation of traits: 1) distributing the workforce, 2) distancing workers from the context of the work, and 3) compensating work on a per–task basis rather than for time. These features can be found elsewhere — for instance, distributed workforces are a feature of global labor markets, and abstracting workers from the products of their labor is well–associated with Marx — but these components have been explored only individually (for instance, by Fevre and later Kalleberg), and we focus on the newfound interest in work arranging these components in what holistically seems to be a new mode of work [34, 17, 45].

On–demand work under this formulation has sparked interest across industries ranging from livery (driving for hire, for example Uber), house–cleaning (Handy), and various other services (TaskRabbit) [71, 26, 65]. Today, a rapidly growing transient workforce is forming, itself assembling piece–by–piece as industries and researchers find more and more unexpected ways to benefit from a latent pool of variably skilled workers.

Broadly, this work has imagined the various applications of "gig"–based work, and making it work for "requesters" — academics, industries, and to some extent end–users who might benefit from the product of crowd–powered work [24, 29, 50]. Since then, the application of digitally mediated environments acting as rapid "hiring halls" for on–demand tasks has found purchase far beyond the context of "information work" like Amazon Mechanical Turk (AMT); livery services (Uber), cleaning (Handy), and various other services (TaskRabbit) have garnered the interest of both industry and research.

Researchers have made efforts to understand the *people* that have gravitated toward on–demand work since its emergence and popularization, but as the form of work has grown and changed, so too have the demographics of workers [55, 62]. Some of this research has been motivated by the realization of the sociality of gig work, and the frustration and disenfranchisement that these systems embody [33, 57]. Other work has focused on the outcomes of work, reflecting on the resistance workers express against digitally mediated labor markets [41].

Bringing this broader body of work together, perhaps we can think of this as documenting the "fallout" of on–demand labor; workers increasingly expressing frustration with the disenfranchisement of the work–flows pioneered by researchers in the decade leading up till now, and researchers beginning to appre-

ciate the unforeseen costs of transient labor and the impacts both on the work and the workers.

From various perspectives and with an eye toward myriad stakeholders, this body of work has ostensibly sought to answer one overarching question: What does the future hold for work and those that do it? Whether that research has attempted to articulate the potential to achieve difficult and creative tasks, or wrestled with the frustration that workers face on a near–constant basis, these roads of inquiry have, it seems, looked to the horizon to try to predict where we are heading.

Rather than looking necessarily to the creation of systems (both as genuine agents and as provocateurs (e.g. Soylent and Turkopticon)), we turn to the *past*, uncovering "piecework" as a useful model for understanding the mode of work that has captured the imagination of entrepreneurs and researchers.

Piecework as a lens to understand gig work
These bodies of literature have conversed, and indeed begun to identify that their theories are interrelated in some way, but thus far a convincing model for making sense of — let alone predicting — the phenomena in on–demand labor has proven elusive. For instance, making sense of why workers on AMT (or "Turkers") are frustrated with their workplace is understandable in its own context, but the relationship between the work itself ("turking") and the myriad social outcomes has only briefly been explored [22].

We offer a framing for *all* on–demand work as a modern instantiation of "piecework", referenced briefly by Kittur et al. in 2013 as a loose analogy to the form of work emerging at the time, but not given as much weight as it perhaps could have been [37]. "Piecework" here makes use of a term historically used to describe work done in the home, in manageable tasks, often involving clear instructions and payment only for work completed, not work done (the differentiation then being that one would be paid for the *output* of the work, not the *duration*).

This framing prompts us to note several immediately apparent similarities: 1) this form of work began in the home 2) the worker is paid for each discrete piece of work done, regardless of time or effort; and 3) the worker's status (not only socially, but also economically) is ambiguous, or at least the subject of some controversy.

But more than this, the framing of on–demand labor as piecework (re–instantiated) allows us to attempt to make sense of the broader research on this new form of work by evaluating this work through a much more refined lens. 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... [al2: ???]

CASE STUDIES
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 Processes of Making Gig(s) Work
[49] The HCI community is perhaps most familiar with examples of task–based work such as 99designs, Amazon Mechanical Turk (AMT), and increasingly Uber & Lyft, which all allow requesters in various forms to tap into resources such as cars, computers, and above all "cognitive surplus" with relative ease [27, 14, 32, 60]. This insight, that workers can be geographically distributed and tasks decomposed, has proven remarkably compelling and an effective fulcrum for leveraging the Internet for highly scalable work [8, 38].

This section will largely discuss the processes at work that make distributed, digitally managed work both possible and indeed preferable for "requesters" (in other words, the employers who solicit workers). This body of research spans a broad field within the CSCW and broader HCI community. In this context, we'll look at the body of research through the lens of highlighting contributions which expand what we (as "requesters" of work) can do by managing workers in novel ways. This work broadly consists of three areas: 1) Decomposition, 2) Work Abstraction, and 3) Flexibility. As we explore this work, we'll attempt to relate the advances in the design of crowd work to the research contributions made in the research of assembly line manufacturing, Taylorism, and scientific management during the 20th century [28].

Decomposition
Piecework may be thought of as vertically slicing work such that each person is responsible for the whole task — making a whole garment, in this case. Broken down in this way, work could grow to unprecedented scales, but the quality of the work would remain relatively variable [47]. 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 [74].

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 [3]. 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 [44]. By the mid–20th century, Schoenberger writes, "... the intensification of the labor process is argued to have hit mental, physical, and social limits." [58].

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 [66]. 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 [40]. Perhaps more important, however, was that the breaking down of work into tasks has made it more practical to evaluate work at each stage [54].

Scholarship describing and exploring the decomposition of tasks is perhaps the most established of the above areas among HCI researchers; Kittur et al. specifically drive at this goal by addressing the possibility of "crowdsourcing complex work" [36]. Cheng et al. found that microtasks — though not necessarily *faster* than "macrotasks" — yield higher quality work, particularly when that work might be readily interrupted [10]. Teevan, Liebling, and Lasecki further push the boundaries of decomposed work by exploring "selfsourcing", and further this work with Teevan et al. [67, 68]. While this work doesn't strictly fall under "crowdsourcing", the major contributions here seem uncontroversially to be inspired by the design of crowd work.

Much of the research in the space of designing crowd work has sought to illustrate the potential to take highly creative or skilled work and generate high–quality results. Perhaps the most notable case study here can be found in Retelny et al.'s *Foundry*, which employed "flash teams" to achieve expert–level outcomes via thoughtful decomposition of work as "modular tasks" [52].

Work decomposition, then, is far from new; "decomposition" generally illustrates the same concepts of work that "Taylorism" and scientific management sought to embody — Silberman, Irani, and Ross in particular foresaw this danger and warned of it in 2010 [37, 61, 48]. In both the historical and contemporary cases of decomposed work, work was, at least initially, distributed in the form of tasks to the homes of workers; Riis captured this in his documentary work *How the other half lives: Studies among the tenements of New York* in 1901 [53].

Work Abstraction

Decomposition allows requesters to assign tasks without concern for the broader context. While we'll discuss this aspect of crowd work more critically later, it's worth pointing out that discrete blocks of work containing all the relevant context for a worker allows workers to engage with virtually any component of work without worrying that their lack of higher–level awareness of the goals of the requester might negatively affect their work.

Chilton et al. perhaps best illustrated this with *Cascade* by demonstrating that it's possible to break certain classes of tasks apart in such a way that they yield taxonomies of various subjects, a task previously thought to be safely within the domain of expert workers with top–down awareness of the context of the work as a whole [11]. Verroios and Bernstein further illustrate this potential by forming a task one might consider highly contextually dependent — summarizing the contents of a movie — in such a way that crowd workers could contribute small pieces of work without needing to know the content of the rest of the project [73].

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 [28]. 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.

Flexibility

Earlier we discussed Cheng et al.'s work measuring the impact that interruption has on worker performance. This work both points to and embodies a broader sentiment in both the study and practice of crowd work that microtasks should be designed resiliently against the variability of workers, fully exploiting the abstracted nature of each piece of work [30, 40, 72]. That is to say, micro–tasks should be designed such that a single worker's poor performance, or a good worker's sudden departure, would not significantly impact the agenda of the work as a whole. While Cheng et al. identified 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.

Given the importance of consistent work results, one might intuit that requesters would prefer high–quality workers who can be relied upon to be available (even for contextually independent tasks), which would appear to contradict the benefits of flexibility already discussed; requesters have thus made significant headway toward "embracing error" to allow requesters to maximize the benefits of a flexible, even transient, workforce.

Krishna et al. offer orders–of–magnitude improvements in various binary classification tasks on the principle that diverse workers complete these tasks in order to accurately inform the model on the variety of delays in response times. And rather than building tasks to *tolerate* worker drop–off and attrition, some researchers have designed work predicated on the expectation of this phenomenon: 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 [8].

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" [69].

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) [33, 57]. 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 [41].

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) Low Pay; and 2) Variable quality work.

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*" [25]. This work has largely informed much of the research into and practice of estimating crowd work compensation [59, 50].

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 [33]. 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 [25].

Understanding workers' motivations given these conditions has thus become a goal for some researchers [7]. 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" [63]. This might have rung true in 2011, and certainly corroborates Ross et al.'s findings after investigating "who are

the crowdworkers", but as Silberman points out "we [have since] learned that most tasks on AMT are done by a small group of professional Turkers..." [55, 62].

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 [57, 31, 13, 33].

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 [70]. 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) [16, 43]. This realization has similarly fueled a body of research into the various incentive structures available to piecework employers [56].

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" [19]. 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) [41]. 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 [38].

The effect low wages have had on piece work and factory workers is well–known; Gantt discuss this exact mechanism in his book on *Work, wages, and profits*, pointing out that "... 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) [20].

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 [18, 1]. 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 Decomposition and Flexibility, 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 [9]. Irani and Silberman describe the treatment of workers as sorts of "human APIs" that can, importantly, be rigorously evaluated [32]. 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 [38, 9].

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 [32].

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 [**pieceworkBiologicalHarm**, 28]. 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 [2, 33, 53].

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 [51, 41, 57, 33, 46].

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" [41].

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 [33, 57].

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 [75]. The achievements of labor advocacy groups such as labor unions as resistant, even adversarial organizations counter–balancing the management is somewhat well–understood [23, 12]. We argue that these threads of resistance against management in various forms are in fact one.

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 [29, 15]. 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 [16]. Incidents broadly describing this dynamic can be found in research on AMT [33, 57]. 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 Levi et al.'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" [43]. This perception already appears to be emerging in digitally mediated peer–governed organizations, as Keegan and Gergle and others have illustratively documented [6, 35]. 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 [42]. 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 [4, 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.

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