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.

While piecework has been studied from myriad perspectives through the lenses of political science, economics (both micro– and macro–), and a plethora of other fields [al2: should I cite examples of all of these?], for the sake of brevity we will discuss the history of piecework in the contexts of the three questions we brought up with crowd work: "what are the limits of crowd work", "how far can work be decomposed into smaller microtasks", and "what will work and the place of work look like for workers".

What was 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]" [21]. 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... [5]. 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 [9, 28, 29, 13].

It's worth acknowledging that "this distinction [between piece–rates and time–rates] was not completely clear–cut" [12]. 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 [25]. 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 [21, 25].

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" [26]. 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" [15]. 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 [12]. 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.

[al2: woah i thought this was a comment; is it okay as is?]

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 [11]. While this approach didn't become the same economic powerhouse as later examples would, Airy [MSB: This is the first time Airy comes up. Who are they?] 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. [MSB: After reading this paragraph, I don't know what it's supposed to be teaching me. What I got out of it is that a bunch of people did piecework, but I don't know why or in fact why these are different than the sources we cite earlier. Can you hone it?] [al2: I wanted that paragraph to be about the rising popularity and application of piecework (especially as it approached its "heyday" [12]), coming from humble beginnings as it found its footing. Given that intent… Should I **refactor** or **rewrite**?]

[al2: I'm thinking of dropping most of the last paragraph and merging it with the next one. Thoughts?]

[al2: Complexity?] **First largely used among farm workers, as Raynbird and others discuss, the practice remained relatively obscure until it was brought to the textile industry [21].** At the turn of the 20th century, when Riis was documenting abhorrent working & living conditions of pieceworkers in New York City, Norton was providing substantive guidance on various wage regimes, [23, 20].

[al2: Complexity?] **Piecework then began to grow: first applied to farm work, as Raynbird and others illustrate, the practice remained relatively obscure until it blossomed in the textile industry [21].** This growth was so marked that by the turn of the 20th century, 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 [23, 20]. 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" [6]. During this period, best practices regarding the measurement

and management of piecework rates, and of workers in the engineering industry, were beginning to take shape [4].

[al2: Complexity + Decomposition?] **Researchers sought to understand the characteristics of piecework that fueled its rise to popularity.** 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 [10]. This argument is certainly compelling; it would seem to make the concurrent upswing of scientific management and Fordism through the first two–thirds of the 20th century alongside piecework not only understandable, but predictable [12]. 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 [3].

[al2: ??? Why is this here? Can it be moved?] **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 [17, 22, 23]. Nevertheless, piecework continued to permeate low–skilled labor.

[al2: Decomposition + Relationships?] **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 [14] — was herself a pieceworker [7].

[al2: Relationships] **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 [17, 22]. 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 advo-

cacy in defense and favor of workers [17, 22, 23]. 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" [26]. 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" [30]; 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" [27].

[al2: Relationships] **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 [24]. 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 [8]. 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 [16].

[al2: ???] **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. [12].

Why is piecework relevant to crowd work?

[MSB: I assume this is forthcoming?] 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 [18, 2]. 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 [19, 1].

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.

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