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 crowdwork (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 subsequent sections — and indeed, the entire 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.

What was piecework?

While "piecework" has proven difficult to concretize from the literature, we can trace a constellation of characteristics of piece work that recur throughout the literature. We'll follow the history of research, collecting descriptions, examples, and provided definitions of piecework, trying to trace the outline of a working understanding of *what piecework is*.

One of the earliest definitions of piecework, in 1847, also proves to be the most circumspect in its wording. 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]" [15]. This description offers the first rudimentary definition of piecework from which the practice will grow for more than a century; piece work, as Raynbird offers, "depend[s] on the quantity of work done".

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...[3]. 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 [6, 21, 22, 10].

It's worth acknowledging that — as Hart and Roberts point out — "this distinction [between piece–rates and time–rates] was not completely clear–cut" [9]. The "Rowan premium system", which essentially paid workers a base rate for time with the opportunity for additional pay associated with 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 [19]. Nevertheless, this work offers us an intuition for what piecework is, if not a bright–line rule.

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 piece workcrop 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 [15, 19].

We see this sense of independence regardless of the time, locale, and industry. Satre offers us 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 reputation "... for generosity, independence, and protectiveness, but also for brashness, irregularity, low morality, and little education" [20]. J. Hagan documents piecework from 1850–1930 in Australia, finding similar assertions of the freedom compositors of newspapers experienced as piece workers: "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" [11]. 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 locus otherwise unknown to workers.

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 [9].

Consolidating what we've learned from these sources about piecework, we might be able to arrive at a working definition that will suffice for our needs. Those needs being that the definition be 1) faithful to the historical cases of piecework that we see in the scholarship; and 2) relevant and informative to potential cases of piecework today. We offer the following: that piecework is the paradigm of renumeration that is largely made compelling for its use of "payment for results", leading to and leveraging narrower skill sets required for narrowly defined tasks, and affording workers some amount of freedom to complete tasks (and consequently earn money) at at whatever rate and in whichever manner they wish.

What was piecework's historical arc?

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 [8]. While this approach didn't become an economic powerhouse as later examples would prove, 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.

Piecework took a circuitous path in its rise to the mainstream, each time finding additional ways to leverage the advantages of piecework. First applied to farm work, as Raynbird and others illustrate, the practice remained relatively obscure until it was brought to the textile industry [15]. 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, describing piecework comprehensively [17, 14]. Soon after, we saw the application of piecework systems in textile mills on the realization that "[pieceworkers in Italy] will work as many hours as it is possible for him to stand" [4]. Best practices regarding the measurement and management of piecework rates, and of workers in the engineering industry, were beginning to take shape [2].

Researchers have since struggled to understand the mechanisms and characteristics in piecework which fueled its rise to popularity during this time. 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 [7]. 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 [9]. 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) [1].

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 [13, 16, 17]. Nevertheless, piecework continued to permeate low–skilled labor.

Piecework became an important contributor to the war effort in the Second World War, cementing its role not only in American factories, but in industrial work around the world. While piecework began to catch on at the turn of the 20th century, 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.

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 [13, 16]. Satre describes worker resistance among a largely disempowered community — young women employed by piecework [20].

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 [18]. 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 [5]. The adoption of piecework time–study and other principles associated with Taylor and scientific management itself reliably precipitated strikes and more generally gave workers a clear enemy against which to rally [12].

Piecework's popularity in the United States and Europe plummeted almost as quickly as it had climbed just a few decades earlier. 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. We summarize some of the salient suggestions here: 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. [9].

Why is piecework relevant to crowdwork?

Using the definition of piecework that we came up with earlier, we argue that crowdwork 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 crowdwork 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.

References

[1] Charles Brown. "Firms' Choice of Method of Pay". In: *Industrial & Labor Relations Review* 43.3 (1990), 165S–182S. DOI: 10.1177/001979399004300311. eprint: http://ilr.sagepub.com/content/43/3/165S.full.pdf+html. URL: http://ilr.sagepub.com/content/43/3/165S.abstract.

[2] Francis G Burton. *The Commercial Management of Engineering Works*. Scientific Publishing Company, 1899.

[3] Edwin Chadwick. "Opening Address of the President of the Department of Economy and Trade, at the Meeting of the National Association for the Promotion of Social Science, held at York, in September, 1864". In: *Journal of the Statistical Society of London* 28.1 (1865), pp. 1–

33. ISSN: 09595341. URL: http://www.jstor.org/stable/2338394.

[4] William Alexander Graham Clark. *Cotton Textile Trade in Turkish Empire, Greece, and Italy*. Vol. 10. US Government Printing Office, 1908.

[5] Boris Emmet. "Trade Agreements In The Women's Clothing Industries Of Philadelphia". In: *Monthly Review of the U.S. Bureau of Labor Statistics* 6.1 (1918), pp. 27–39. ISSN: 23291354, 23291362. URL: http://www.jstor.org/stable/41829256.

[6] David N. Figlio and Lawrence W. Kenny. "Individual teacher incentives and student performance". In: *Journal of Public Economics* 91.5–6 (2007), pp. 901 –914. ISSN: 0047-2727. DOI: http://dx.doi.org/10.1016/j.jpubeco.2006.10.001. URL: http://www.sciencedirect.com/science/article/pii/S004727270600140X.

[7] Carl Graves. "Applying Scientific Management Principles to Railroad Repair Shops — the Santa Fe Experience, 1904-18". In: *Business and Economic History* 10 (1981), pp. 124–136. ISSN: 08946825. URL: http://www.jstor.org/stable/23702539.

[8] David Alan Grier. *When computers were human*. Princeton University Press, 2013.

[9] Robert A Hart and J Elizabeth Roberts. "The rise and fall of piecework–timework wage differentials: market volatility, labor heterogeneity, and output pricing". In: (2013).

[10] John S. Heywood, W. S. Siebert, and Xiangdong Wei. "Payment by Results Systems: British Evidence". In: *British Journal of Industrial Relations* 35.1 (1997), pp. 1–22. ISSN: 1467-8543. DOI: 10.1111/1467-8543.00038. URL: http://dx.doi.org/10.1111/1467-8543.00038.

[11] C. Fisher J. Hagan. "Piece Work and Some of Its Consequences in the Printing and Coal Mining Industries in Australia, 1850-1930". In: *Labour History* 25 (1973), pp. 19–39. ISSN: 00236942. URL: http://www.jstor.org/stable/27508091.

[12] Sanford M Jacoby. "Union–management cooperation in the United States: Lessons from the 1920s". In: *Industrial & Labor Relations Review* 37.1 (1983), pp. 18–33.

[13] American Federation of Labor. Railway Employees Dept and United States Railroad Labor Board. *The problem of piece work*. The Problem of Piece Work nos. 1-16. Bronson Canode Print. Co., 1921. URL: https://books.google.com/books?id=NN5NAQAAIAAJ.

[14] George Pepler Norton. *Textile Manufacturers' Bookkeeping for the Counting House, Mill and Warehouse: Being a Practical Treatise, Specially Designed for the Woollen and Worsted and Allied Trades*. Simpkin, Marshall, Hamilton, Kent & Company, 1900.

[15] Hugh Raynbird. *Essay on Measure Work, locally known as task, piece, job, or grate work (in its application to agricultural labour)*. 1847.

[16] Frank Richards. "Is Anything the Matter with Piecework". In: ASME. 1904.

[17] Jacob August Riis. *How the other half lives: Studies among the tenements of New York*. Penguin, 1901.

[18] D. H. Robertson. "A Narrative of the Coal Strike". In: *The Economic Journal* 22.87 (1912), pp. 365–387. ISSN: 00130133, 14680297. URL: http://www.jstor.org/stable/2221944.

[19] James Rowan. "A Premium System of Remunerating Labour". In: *Proceedings of the Institution of Mechanical Engineers* 61.1 (1901), pp. 865–882.

[20] Lowell J. Satre. "After the Match Girls' Strike: Bryant and May in the 1890s". In: *Victorian Studies* 26.1 (1982), pp. 7–31. ISSN: 00425222, 15272052. URL: http://www.jstor.org/stable/3827491.

[21] Martin L Weitzman. "The new Soviet incentive model". In: *The Bell Journal of Economics* (1976), pp. 251–257.

[22] Martin L. Weitzman. "The "Ratchet Principle" and Performance Incentives". In: *The Bell Journal of Economics* 11.1 (1980), pp. 302–308. ISSN: 0361915X. URL: http://www.jstor.org/stable/3003414.