

## 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 modular 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 [13, 24, 19]. We've seen on-demand work passing by a number of aliases: as *crowd work* — on platforms such as Amazon Mechanical Turk (AMT) and other sites of (predominantly) information work; as *gig work* — typically involving platforms for one-off jobs, like driving, courier services, etc. . . ; as the *sharing economy* — where participants can rent out their valuables (such as a car, a home, etc. . . ) on an ad hoc basis when they don't need it. 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 AMT to explore the limits of this distributed, on-demand workforce. Researchers have taken to the space in earnest, finding opportunities to enable new forms of work using this population of “Turkers” [1, 34, 27].

[al2: this mega-paragraph may need to be reduced since it started as two, did very little/nothing to reduce it.] **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 [15, 37, 40, 6, 28]. More recently, crowdsourcing of embodied work — driving, cleaning, for instance — has become a focus of on-demand labor markets [21, 36, 9, 35]. 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 [30, 32]. 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 [12, 31]. Other work has focused on the *outcomes* of this frustration, reflecting on the resistance workers express against digitally mediated labor markets [21].

**The extant body of work has ostensibly sought to answer one underlying question: What does the future hold for crowd 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 crowd work?** Specifically, 1) how complex are the goals that crowd work can accomplish? and 2) how far will crowd work reach into the everyday lives of people? [MSB: which people? workers? requesters? do you mean, will recruiting crowd work be the domain of experts or everyday end users?] [al2: I think I'm trying to ask how much of the world will do crowd work — the whole world, or just representative slices of lots of different

types of people (experts, non-experts, etc. . . )] [29, 33, 14, 39, 38, 25, 8];

2. **How far can work be decomposed into smaller and smaller microtasks?** [17, 1, 4, 22, 18, 20, 3, 5, 26]; and
3. **What will work and the place of work look like for workers?** [12, 11, 31, 7, 2, 23]

### 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. To the extent that the research community has explored the boundaries of crowd work, it nevertheless has not reflected on the underlying mechanisms determining those boundaries. Similarly, work directed toward the decomposition of tasks has begun to appreciate the limits of decomposition, but on the whole it hasn't considered the relationship between the decomposition of work and the complexity of work. While researchers are quickly picking up on the importance of the relationships between workers in these platforms, this research seems to be unfolding without the benefit of any of the inter-personal labor research that has been informing modern work for the better part of a century.

We offer a framing for crowd work spanning the aforementioned industries collectively as a contemporary instantiation of the historical arc of piecework — a work and payment structure which breaks tasks down into standalone contracts, wherein payment is made for *work output*, rather than for *time*. Piecework as a metaphor for crowd work is not new. Indeed, Kittur et al. in 2013 referenced crowd work as “piecework” briefly as a loose analogy to the form of work emerging at the time [16]. 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 crowd 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 crowd work researchers, and workers themselves, should expect to see on the horizon of on-demand work. For example, we draw upon the piecework literature to focus the research crowd work researchers have done on the complexity of work, and come up with theoretically grounded mechanisms explaining the limitations researchers have struggled to overcome thus far.

We will look at the above questions in crowd work through the lens first of the body of research made by crowd work researchers, and then of the body of work piecework researchers have offered. After validating this lens as a way of reasoning

about crowd work and on-demand labor as a whole, we will identify differences between piecework as historically understood and digitally mediated crowd work as we experience it today, and how those differences influence the predictions that researchers in piecework have already made. Finally, we will offer design implications based on this research.

## References

- [1] Michael S. Bernstein et al. "Soylent: A Word Processor with a Crowd Inside". In: *UIST '10* (2010), pp. 313–322. DOI: [10.1145/1866029.1866078](https://doi.org/10.1145/1866029.1866078). URL: <http://doi.acm.org/10.1145/1866029.1866078>.
- [2] Robin Brewer, Meredith Ringel Morris, and Anne Marie Piper. "'Why Would Anybody Do This?': Understanding Older Adults' Motivations and Challenges in Crowd Work". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 2246–2257. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858198](https://doi.org/10.1145/2858036.2858198). URL: <http://doi.acm.org/10.1145/2858036.2858198>.
- [3] Carrie J. Cai, Shamsi T. Iqbal, and Jaime Teevan. "Chain Reactions: The Impact of Order on Microtask Chains". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 3143–3154. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858237](https://doi.org/10.1145/2858036.2858237). URL: <http://doi.acm.org/10.1145/2858036.2858237>.
- [4] L. Elisa Celis et al. "Assignment Techniques for Crowdsourcing Sensitive Tasks". In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW '16. New York, NY, USA: ACM, 2016, pp. 836–847. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2835202](https://doi.org/10.1145/2818048.2835202). URL: <http://doi.acm.org/10.1145/2818048.2835202>.
- [5] Joseph Chee Chang, Aniket Kittur, and Nathan Hahn. "Alloy: Clustering with Crowds and Computation". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 3180–3191. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858411](https://doi.org/10.1145/2858036.2858411). URL: <http://doi.acm.org/10.1145/2858036.2858411>.
- [6] David Geiger et al. "Managing the Crowd: Towards a Taxonomy of Crowdsourcing Processes." In: *AMCIS*. 2011.
- [7] Mary L. Gray et al. "The Crowd is a Collaborative Network". In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW '16. New York, NY, USA: ACM, 2016, pp. 134–147. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2819942](https://doi.org/10.1145/2818048.2819942). URL: <http://doi.acm.org/10.1145/2818048.2819942>.
- [8] Nathan Hahn et al. "The Knowledge Accelerator: Big Picture Thinking in Small Pieces". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 2258–2270. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858364](https://doi.org/10.1145/2858036.2858364). URL: <http://doi.acm.org/10.1145/2858036.2858364>.
- [9] *House Cleaning, Handyman, Lawn Care Services in Austin, Denver, Kansas City, Minneapolis and San Francisco* — Zaarly. Sept. 2015. URL: <https://www.zaarly.com/>.
- [10] Jeff Howe. *Crowdsourcing: How the power of the crowd is driving the future of business*. Random House, 2008.
- [11] Lilly C. Irani and M. Six Silberman. "Stories We Tell About Labor: Turkopticon and the Trouble with 'Design'". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 4573–4586. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858592](https://doi.org/10.1145/2858036.2858592). URL: <http://doi.acm.org/10.1145/2858036.2858592>.
- [12] Lilly C. Irani and M. Six Silberman. "Turkopticon: Interrupting Worker Invisibility in Amazon Mechanical Turk". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13. New York, NY, USA: ACM, 2013, pp. 611–620. ISBN: 978-1-4503-1899-0. DOI: [10.1145/2470654.2470742](https://doi.org/10.1145/2470654.2470742). URL: <http://doi.acm.org/10.1145/2470654.2470742>.
- [13] David R. Karger, Sewoong Oh, and Devavrat Shah. "Iterative Learning for Reliable Crowdsourcing Systems". In: *Advances in Neural Information Processing Systems 24*. Ed. by J. Shawe-Taylor et al. Curran Associates, Inc., 2011, pp. 1953–1961. URL: <http://papers.nips.cc/paper/4396-iterative-learning-for-reliable-crowdsourcing-systems.pdf>.
- [14] Joy Kim and Andrés Monroy-Hernández. "Storia: Summarizing Social Media Content Based on Narrative Theory Using Crowdsourcing". In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW '16. New York, NY, USA: ACM, 2016, pp. 1018–1027. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2820072](https://doi.org/10.1145/2818048.2820072). URL: <http://doi.acm.org/10.1145/2818048.2820072>.
- [15] Aniket Kittur, Ed H. Chi, and Bongwon Suh. "Crowdsourcing User Studies with Mechanical Turk". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '08. New York, NY, USA: ACM, 2008, pp. 453–456. ISBN: 978-1-60558-011-1. DOI: [10.1145/1357054.1357127](https://doi.org/10.1145/1357054.1357127). URL: <http://doi.acm.org/10.1145/1357054.1357127>.
- [16] Aniket Kittur et al. "The Future of Crowd Work". In: *Proceedings of the 2013 Conference on Computer-Supported Cooperative Work*. CSCW '13. New York, NY, USA: ACM, 2013, pp. 1301–1318. ISBN: 978-1-4503-1331-5. DOI: [10.1145/2441776.2441923](https://doi.org/10.1145/2441776.2441923). URL: <http://doi.acm.org/10.1145/2441776.2441923>.
- [17] Ranjay A. Krishna et al. "Embracing Error to Enable Rapid Crowdsourcing". In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI '16. New York, NY, USA: ACM, 2016, pp. 3167–3179. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858115](https://doi.org/10.1145/2858036.2858115). URL: <http://doi.acm.org/10.1145/2858036.2858115>.

- [18] Pavel Kucherbaev et al. “ReLauncher: Crowdsourcing Micro-Tasks Runtime Controller”. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW ’16. New York, NY, USA: ACM, 2016, pp. 1609–1614. ISBN: 978–1-4503-3592-8. DOI: [10.1145/2818048.2820005](https://doi.org/10.1145/2818048.2820005). URL: <http://doi.acm.org/10.1145/2818048.2820005>.
- [19] Thomas D LaToza et al. “Crowd development”. In: *Cooperative and Human Aspects of Software Engineering (CHASE), 2013 6th International Workshop on*. Citeseer. 2013, pp. 85–88.
- [20] Edith Law et al. “Curiosity Killed the Cat, but Makes Crowdwork Better”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. New York, NY, USA: ACM, 2016, pp. 4098–4110. ISBN: 978–1-4503-3362-7. DOI: [10.1145/2858036.2858144](https://doi.org/10.1145/2858036.2858144). URL: <http://doi.acm.org/10.1145/2858036.2858144>.
- [21] Min Kyung Lee et al. “Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers”. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. CHI ’15. New York, NY, USA: ACM, 2015, pp. 1603–1612. ISBN: 978–1-4503-3145-6. DOI: [10.1145/2702123.2702548](https://doi.org/10.1145/2702123.2702548). URL: <http://doi.acm.org/10.1145/2702123.2702548>.
- [22] Ioanna Lykourantzou et al. “Personality Matters: Balancing for Personality Types Leads to Better Outcomes for Crowd Teams”. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW ’16. New York, NY, USA: ACM, 2016, pp. 260–273. ISBN: 978–1-4503-3592-8. DOI: [10.1145/2818048.2819979](https://doi.org/10.1145/2818048.2819979). URL: <http://doi.acm.org/10.1145/2818048.2819979>.
- [23] Brian McInnis et al. “Taking a HIT: Designing Around Rejection, Mistrust, Risk, and Workers’ Experiences in Amazon Mechanical Turk”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. New York, NY, USA: ACM, 2016, pp. 2271–2282. ISBN: 978–1-4503-3362-7. DOI: [10.1145/2858036.2858539](https://doi.org/10.1145/2858036.2858539). URL: <http://doi.acm.org/10.1145/2858036.2858539>.
- [24] Tanushree Mitra, C.J. Hutto, and Eric Gilbert. “Comparing Person- and Process-centric Strategies for Obtaining Quality Data on Amazon Mechanical Turk”. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. CHI ’15. New York, NY, USA: ACM, 2015, pp. 1345–1354. ISBN: 978–1-4503-3145-6. DOI: [10.1145/2702123.2702553](https://doi.org/10.1145/2702123.2702553). URL: <http://doi.acm.org/10.1145/2702123.2702553>.
- [25] Michael Nebeling et al. “WearWrite: Crowd-Assisted Writing from Smartwatches”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. New York, NY, USA: ACM, 2016, pp. 3834–3846. ISBN: 978–1-4503-3362-7. DOI: [10.1145/2858036.2858169](https://doi.org/10.1145/2858036.2858169). URL: <http://doi.acm.org/10.1145/2858036.2858169>.
- [26] Edward Newell and Derek Ruths. “How One Micro-task Affects Another”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. New York, NY, USA: ACM, 2016, pp. 3155–3166. ISBN: 978–1-4503-3362-7. DOI: [10.1145/2858036.2858490](https://doi.org/10.1145/2858036.2858490). URL: <http://doi.acm.org/10.1145/2858036.2858490>.
- [27] Gabriele Paolacci, Jesse Chandler, and Panagiotis G Ipeirotis. “Running experiments on amazon mechanical turk”. In: *Judgment and Decision making* 5.5 (2010), pp. 411–419.
- [28] Alexander J. Quinn and Benjamin B. Bederson. “Human Computation: A Survey and Taxonomy of a Growing Field”. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI ’11. New York, NY, USA: ACM, 2011, pp. 1403–1412. ISBN: 978–1-4503-0228-9. DOI: [10.1145/1978942.1979148](https://doi.org/10.1145/1978942.1979148). URL: <http://doi.acm.org/10.1145/1978942.1979148>.
- [29] Daniela Retelny et al. “Expert Crowdsourcing with Flash Teams”. In: *Proceedings of the 27th Annual ACM Symposium on User Interface Software and Technology*. UIST ’14. New York, NY, USA: ACM, 2014, pp. 75–85. ISBN: 978–1-4503-3069-5. DOI: [10.1145/2642918.2647409](https://doi.org/10.1145/2642918.2647409). URL: <http://doi.acm.org/10.1145/2642918.2647409>.
- [30] Joel Ross et al. “Who Are the Crowdworkers?: Shifting Demographics in Mechanical Turk”. In: *CHI ’10 Extended Abstracts on Human Factors in Computing Systems*. CHI EA ’10. New York, NY, USA: ACM, 2010, pp. 2863–2872. ISBN: 978–1-60558-930-5. DOI: [10.1145/1753846.1753873](https://doi.org/10.1145/1753846.1753873). URL: <http://doi.acm.org/10.1145/1753846.1753873>.
- [31] Niloufar Salehi et al. “We Are Dynamo: Overcoming Stalling and Friction in Collective Action for Crowd Workers”. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. CHI ’15. New York, NY, USA: ACM, 2015, pp. 1621–1630. ISBN: 978–1-4503-3145-6. DOI: [10.1145/2702123.2702508](https://doi.org/10.1145/2702123.2702508). URL: <http://doi.acm.org/10.1145/2702123.2702508>.
- [32] Six Silberman. *Stop citing Ross et al. 2010, “Who are the crowdworkers?”*. Mar. 2015. URL: <https://medium.com/@silberman/stop-citing-ross-et-al-2010-who-are-the-crowdworkers-b3b9b1e8d300>.
- [33] Ryo Suzuki et al. “Atelier: Repurposing Expert Crowdsourcing Tasks As Micro-internships”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. New York, NY, USA: ACM, 2016, pp. 2645–2656. ISBN: 978–1-4503-3362-7. DOI: [10.1145/2858036.2858121](https://doi.org/10.1145/2858036.2858121). URL: <http://doi.acm.org/10.1145/2858036.2858121>.
- [34] John C. Tang et al. “Reflecting on the DARPA Red Balloon Challenge”. In: *Commun. ACM* 54.4 (Apr. 2011), pp. 78–85. ISSN: 0001-0782. DOI: [10.1145/1924421.1924441](https://doi.org/10.1145/1924421.1924441). URL: <http://doi.acm.org/10.1145/1924421.1924441>.

- [35] *TaskRabbit connects you to safe and reliable help in your neighborhood*. Sept. 2015. URL: <https://www.taskrabbit.com/>.
- [36] *Uber*. Sept. 2015. URL: <https://www.uber.com/>.
- [37] Shao-Yu Wu, Ruck Thawonmas, and Kuan-Ta Chen. “Video Summarization via Crowdsourcing”. In: *CHI ’11 Extended Abstracts on Human Factors in Computing Systems*. CHI EA ’11. New York, NY, USA: ACM, 2011, pp. 1531–1536. ISBN: 978–1-4503–0268–5. DOI: [10.1145/1979742.1979803](https://doi.org/10.1145/1979742.1979803). URL: <http://doi.acm.org/10.1145/1979742.1979803>.
- [38] Lixiu Yu, Aniket Kittur, and Robert E. Kraut. “Encouraging “Outside-The-Box” Thinking in Crowd Innovation Through Identifying Domains of Expertise”. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW ’16. New York, NY, USA: ACM, 2016, pp. 1214–1222. ISBN: 978–1-4503–3592–8. DOI: [10.1145/2818048.2820025](https://doi.org/10.1145/2818048.2820025). URL: <http://doi.acm.org/10.1145/2818048.2820025>.
- [39] Alvin Yuan et al. “Almost an Expert: The Effects of Rubrics and Expertise on Perceived Value of Crowdsourced Design Critiques”. In: *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing*. CSCW ’16. New York, NY, USA: ACM, 2016, pp. 1005–1017. ISBN: 978–1-4503–3592–8. DOI: [10.1145/2818048.2819953](https://doi.org/10.1145/2818048.2819953). URL: <http://doi.acm.org/10.1145/2818048.2819953>.
- [40] M. C. Yuen, I. King, and K. S. Leung. “A Survey of Crowdsourcing Systems”. In: *Privacy, Security, Risk and Trust (PASSAT) and 2011 IEEE Third International Conference on Social Computing (SocialCom), 2011 IEEE Third International Conference on*. Oct. 2011, pp. 766–773. DOI: [10.1109/PASSAT/SocialCom.2011.203](https://doi.org/10.1109/PASSAT/SocialCom.2011.203).