

EXAMINING CROWD WORK AND GIG WORK THROUGH THE HISTORICAL LENS OF PIECEWORK

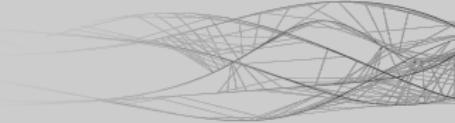
Ali Alkhatib, Michael Bernstein, Margaret Levi

ali.alkhatib@cs.stanford.edu || @_alialkhatib

May 5, 2017

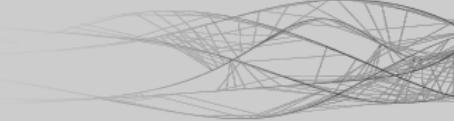
Stanford University

A BRIEF GLOSSARY



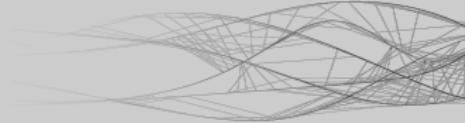
- *Crowd work*: digitally mediated **information work** (for example, work done on Amazon Mechanical Turk, UpWork, or 99designs) [20]

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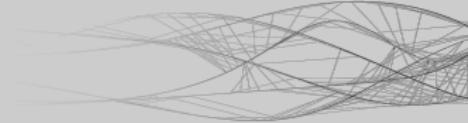
- *Crowd work*: digitally mediated **information work** (for example, work done on Amazon Mechanical Turk, UpWork, or 99designs) [20]
- *Gig work*: digitally mediated (but often **physically embodied**) one-off jobs, such as *driving*, *courier services*, and *administrative support* [7, 31]

OPEN PROBLEMS IN ON-DEMAND WORK



Tasks

OPEN PROBLEMS IN ON-DEMAND WORK



- Complexity

Suzuki et al. [40], Kim and Monroy-Hernández [16], Yuan et al. [45], Yu, Kittur, and Kraut [44], Nebeling et al. [29], and Hahn et al. [11]



Complexity



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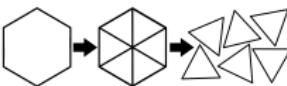
Complexity

- Decomposition

Celis et al. [3], Lykourentzou et al. [27], Law et al. [24], Chang, Kittur, and Hahn [4], and Newell and Ruths [30]



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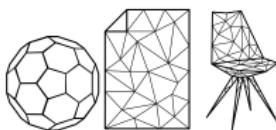


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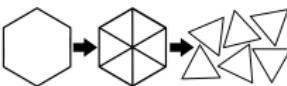
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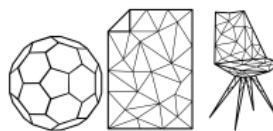


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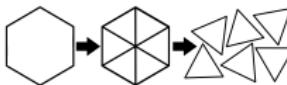
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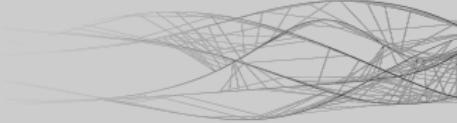
- Relationships

Irani and Silberman [14, 13], Gray et al. [9], McInnis et al. [28], Salehi et al. [36], and Lee et al. [25]



WHAT IS THE FUTURE OF WORK?

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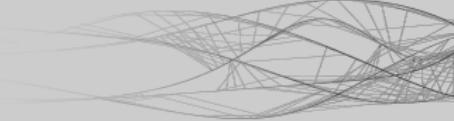


How will **technology** affect the **complexity** of the work that on-demand workers do?

What are the **limits** of complexity in on-demand work?

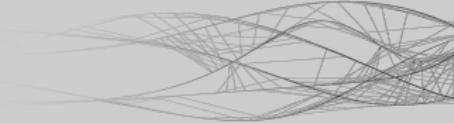
How can we **reach** those limits?

A BRIEF GLOSSARY

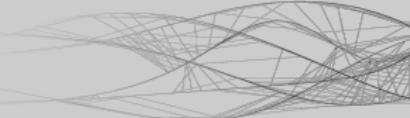


- *Crowd work*: digitally mediated **information work** (for example, work done on Amazon Mechanical Turk, UpWork, or 99designs) [20]
- *Gig work*: digitally mediated (but often **physically embodied**) one-off jobs, such as *driving*, *courier services*, and *administrative support* [7, 31]
- *Piecework*: Payment for *output* rather than for *time*

A TIMELINE OF PIECEWORK



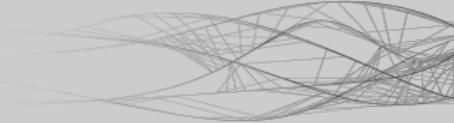
A TIMELINE OF ~~PIECEWORK~~ ON-DEMAND WORK



1888	Taylor [41]	Richards [32]	Jewell [15]
Match girls' strike [37]			

2008	Sheng, Provost, and Ipeirotis [39]	2010	Bernstein et al. [1] Little et al. [26]	Ipeirotis, Provost, and Wang [12]	2011	Kittur et al. [19]	2013	Lasecki et al. [22] Chilton et al. [5] Kittur et al. [20] Irani and Silberman [14]	2015	Lee et al. [25] Salehi et al. [36]
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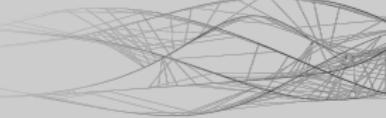
INTRODUCTION



We hope to provide:

- A useful ontological lens for making sense of crowdsourcing and gig work (which we collectively call “*on-demand work*”) as a resurgence of *piecework*.
- A method for making sense of contemporary phenomena through *historical analysis*.

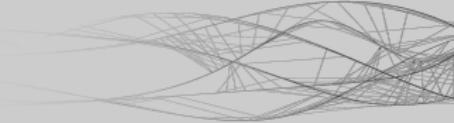
A CASE FOR COMPARATIVE HISTORICAL ANALYSIS



- Historical analysis isn't new
 - In general
Rosenberg [33, 34]
 - In HCI
Wyche, Sengers, and Grinter [43] and Bødker [2]
- Still, it's an underutilized method
 - Provide some basic framing for ostensibly new phenomena
 - Theoretically ground ourselves
 - Flesh out *differences* and their implications

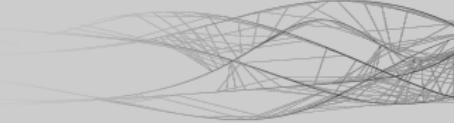
COMPLEXITY

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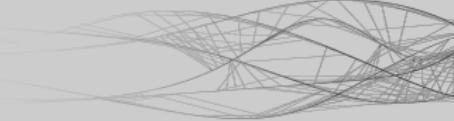
What kinds of problems do we mean when we talk about complexity?

- Can crowds help you write something?
Bernstein et al. [1], Kim et al. [18], and Nebeling et al. [29]



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- Can crowds create things from whole cloth?

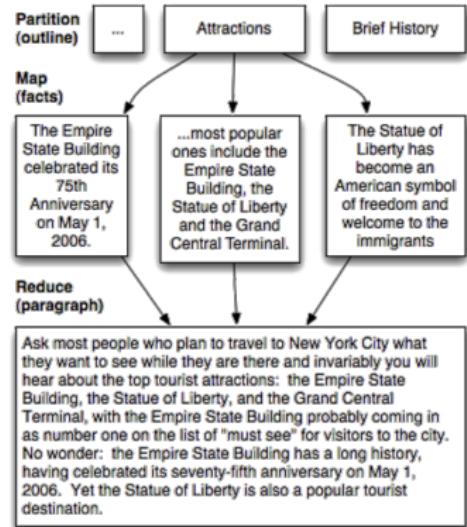
Kim and Monroy-Hernández [16], Kim et al. [17], Hahn et al. [11], and Lasecki,

Kushalnagar, and Bigham [21]

WHAT DOES THE CROWDSOURCING LITERATURE SAY?

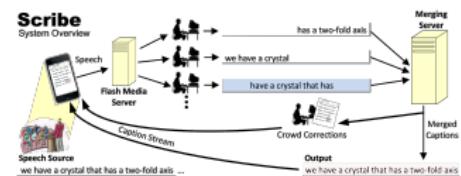
- Build complexity into the process
 - Apply CS methods to people

Kittur et al. [19]



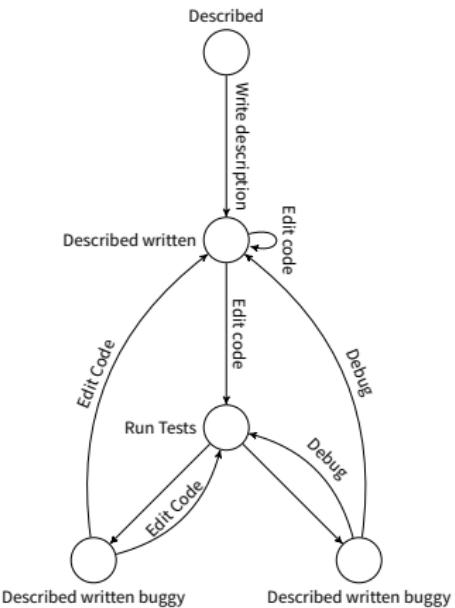
WHAT DOES THE CROWDSOURCING LITERATURE SAY?

- Build complexity into the process
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Kittur et al. [19]
 - Humans as computational units
Lasecki, Kushalnagar, and Bigham [21]



WHAT DOES THE CROWDSOURCING LITERATURE SAY?

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Kittur et al. [19]
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Lasecki, Kushalnagar, and Bigham [21]
 - Crowdsourcing workflows as function state machines
LaToza et al. [23]



WHAT DOES THE PIECEWORK LITERATURE SAY?

George Airy (astronomer) used a very similar approach [10]



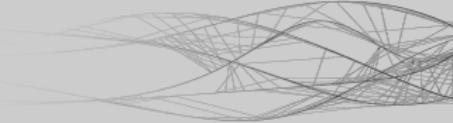
- Employed computers
- 13–20 years old
- Overworked
- Underpaid
- Could be fired at will

GEORGE AIRY — WHIZ KID

Airy built complexity into the process, assigning *human computers* to compute, verify, and correct the right ascension and declination of stars.

No. of Swings.	Approximate Time (Astronomical Reckoning).	Number of Signals.	Mean of Times by SHELTON.	Mean of Times by EARNSHAW.	Interval by SHELTON.	Interval by EARNSHAW.	Rate $\frac{\text{EARNSHAW}}{\text{SHELTON}}$	Logarithm of $\frac{\text{EARNSHAW}}{\text{SHELTON}}$ Rate	Corrected Logarithm of $\frac{\text{EARNSHAW}}{\text{SHELTON}}$ Rate
Oct.	h	h m s	h m s	h m s	h m s	h m s			
1...	1.	23 22	3 19 36-505	21 23 28-764	4 0 23-100	4 0 38-722	1·0010831	0·00047012	
2...	2.	3 21	7 19 59-605	1 24 7-486	3 58 21-652	3 58 37-400	1·0011011	0·00047793	
3...	2.	7 21	11 18 21-257	5 22 44-886	4 45 27-829	4 45 46-421	1·0010855	0·00047117	0·00047387
4...	2.	11 29	16 3 49-086	10 8 31-307	4 17 6-532	4 17 23-234	1·0010827	0·00046995	
5...	2.	16 17	20 20 55-618	14 25 54-541	3 13 21-898	3 13 34-795	1·0011116	0·00048249	
6...	2.	19 25	23 34 17-516	17 39 29-336	3 49 42-503	3 49 57-654	1·0010994	0·00047720	0·00047990
7...	2.	23 31	3 24 0-019	21 29 26-990	3 55 2-071	3 55 17-433	1·0010893	0·00047282	
8...	3.	3 21	7 19 2-090	1 24 44-423	4 2 41-510	4 2 57-445	1·0010944	0·00047503	
9...	3.	7 25	11 21 43-600	5 27 41-868	4 31 5-786	4 31 23-591	1·0010947	0·00047516	0·00046316
10...	3.	11 22	15 52 49-386	9 59 5-459	3 27 49-747	3 28 3-324	1·0010888	0·00047260	
11...	3.	15 24	19 20 39-133	13 27 8-783	3 59 47-292	4 0 3-188	1·0011049	0·00047959	
12...	3.	19 24	23 20 26-425	17 27 11-971	4 3 30-416	4 3 46-620	1·0010686	0·00046384	0·00047194

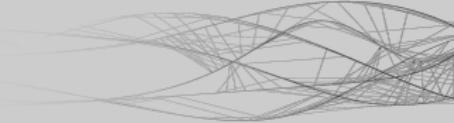
COTTAGE INDUSTRY



Farms



COTTAGE INDUSTRY



Farms



Textiles



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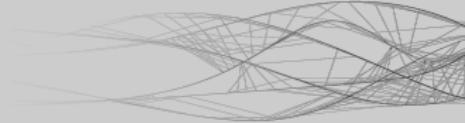


Matchsticks



PLANES, TRAINS, AND AUTOMOBILES

... NOT IN THAT ORDER



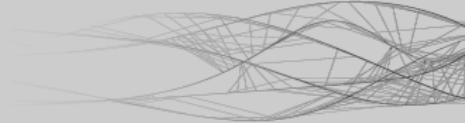
Trains



- “Efficiency experts” measured how long it would take to do various jobs [6]
- These measurements would be used to assign values for each specific task [15]
- Train engineers instituted “The Fix” to correct perceived unfairness [35]

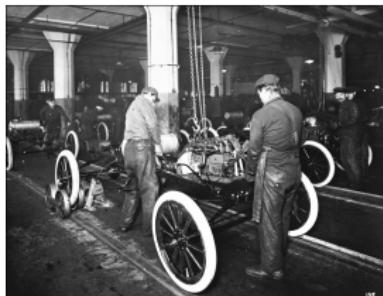
PLANES, TRAINS, AND AUTOMOBILES

... NOT IN THAT ORDER



Automobiles

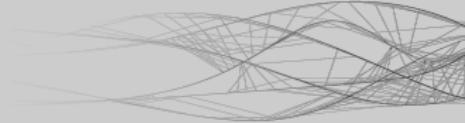
- Fordism,
Taylorism, and
Scientific
Management in
full force



- *Manufacturing* proved amenable to assembly line processes.

PLANES, TRAINS, AND AUTOMOBILES

... NOT IN THAT ORDER

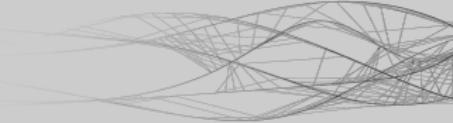


Planes



PLANES, TRAINS, AND AUTOMOBILES

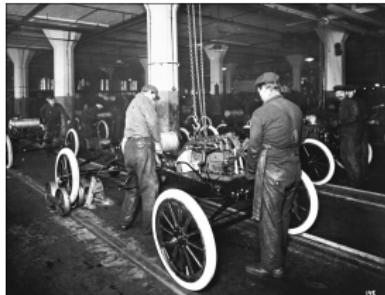
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Trains



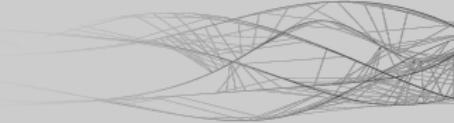
Automobiles



Planes



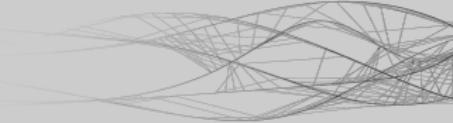
COMPARISONS



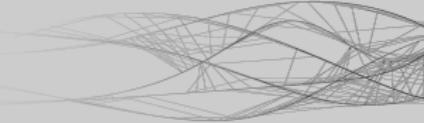
- Limited array of tasks versus arbitrarily complex work
 - *Building* planes versus *fixing* trains
- Has technology changed this?
 - Technology makes complex tasks relatively trivial
 - Measuring workers is easier than ever

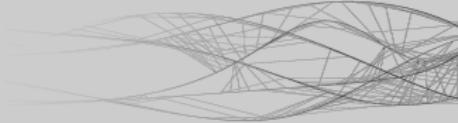
COMPLEXITY

CAB DRIVERS



COMPLEXITY CAB DRIVERS

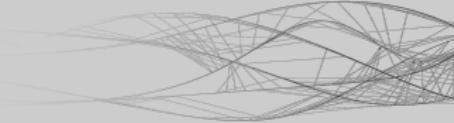




notes

- I'm thinking of pointing to UpWork's screen recording tool as a way to measure workers
- also maybe google analytics and other ways of tracking web-based workers

IMPLICATIONS



- We make stronger assumptions about workers' abilities thanks to technology
- Evaluation remains difficult, but we're trying to find stopgap solutions through decomposition
- We're still not solving the problems of inherently subjectively judged work

REFERENCES

 Michael S. Bernstein et al. "Soylent: A Word Processor with a Crowd Inside". In: *Proceedings of the 23Nd Annual ACM Symposium on User Interface Software and Technology*. UIST '10. New York, New York, USA: ACM, 2010, pp. 313–322. ISBN: 978-1-4503-0271-5. DOI: [10.1145/1866029.1866078](https://doi.acm.org/10.1145/1866029.1866078).

URL:

[http://doi.acm.org/10.1145/1866029.1866078](https://doi.acm.org/10.1145/1866029.1866078).

 Susanne Bødker. "Historical analysis and conflicting perspectives—contextualizing HCI". In: *Human-Computer Interaction* (1993), pp. 1–10.

 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. ACM, 2016, pp. 836–847. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2835202](https://doi.acm.org/10.1145/2818048.2835202).

URL:

<http://doi.acm.org/10.1145/2818048.2835202>.



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. 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>.



Lydia B. Chilton et al. "Cascade: Crowdsourcing Taxonomy Creation". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '13. Paris, France: ACM, 2013, pp. 1999–2008. ISBN: 978-1-4503-1899-0. DOI: [10.1145/2470654.2466265](https://doi.org/10.1145/2470654.2466265). URL:
<http://doi.acm.org/10.1145/2470654.2466265>.

-  William J. Cunningham. "Scientific Management in the Operation of Railroads". In: *The Quarterly Journal of Economics* 25.3 (1911), p. 539. DOI: [10.2307/1883615](https://doi.org/10.2307/1883615). URL: <http://dx.doi.org/10.2307/1883615>.
-  Gerald Friedman. "Workers without employers: shadow corporations and the rise of the gig economy". In: *Review of Keynesian Economics* 2 (2014), pp. 171–188.
-  Mark Fuge et al. "Analysis of collaborative design networks: A case study of openideo". In: *Journal of Computing and Information Science in Engineering* 14.2 (2014), p. 021009.
-  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. 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>.

-  David Alan Grier. *When computers were human*. Princeton University Press, 2013.
-  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. 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>.
-  Panagiotis G. Ipeirotis, Foster Provost, and Jing Wang. “Quality Management on Amazon Mechanical Turk”. In: *Proceedings of the ACM SIGKDD Workshop on Human Computation*. HCOMP ’10. Washington DC: ACM, 2010, pp. 64–67. ISBN: 978-1-4503-0222-7. DOI:

[10.1145/1837885.1837906](http://doi.acm.org/10.1145/1837885.1837906). URL:

<http://doi.acm.org/10.1145/1837885.1837906>.

-  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. ACM, 2016, pp. 4573–4586. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858592](http://doi.acm.org/10.1145/2858036.2858592).

URL:

<http://doi.acm.org/10.1145/2858036.2858592>.

-  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. ACM, 2013, pp. 611–620. ISBN: 978-1-4503-1899-0. DOI: [10.1145/2470654.2470742](http://doi.acm.org/10.1145/2470654.2470742).

URL:

<http://doi.acm.org/10.1145/2470654.2470742>.

-  B.M. Jewell. *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>:

[//books.google.com/books?id=NN5NAQAAIAAJ](https://books.google.com/books?id=NN5NAQAAIAAJ).

-  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. ACM, 2016, pp. 1018–1027. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2820072](https://doi.acm.org/10.1145/2818048.2820072).

URL:

<http://doi.acm.org/10.1145/2818048.2820072>.

- 
- Joy Kim et al. "Mechanical Novel: Crowdsourcing Complex Work through Revision". In: *Proceedings of the 20th ACM Conference on Computer Supported Cooperative Work \& Social Computing*. 2017.
- 
- Juho Kim et al. "Crowdsourcing Step-by-step Information Extraction to Enhance Existing How-to Videos". In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. CHI '14. Toronto, Ontario, Canada: ACM, 2014, pp. 4017–4026. ISBN: 978-1-4503-2473-1. DOI: [10.1145/2556288.2556986](https://doi.acm.org/10.1145/2556288.2556986). URL: <http://doi.acm.org/10.1145/2556288.2556986>.
- 
- Aniket Kittur et al. "CrowdForge: Crowdsourcing Complex Work". In: *Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology*. UIST '11. ACM, 2011, pp. 43–52. ISBN: 978-1-4503-0716-1. DOI:

[10.1145/2047196.2047202](https://doi.org/10.1145/2047196.2047202). URL:

<http://doi.acm.org/10.1145/2047196.2047202>.



Aniket Kittur et al. "The Future of Crowd Work". In: *Proceedings of the 2013 Conference on Computer Supported Cooperative Work*. CSCW '13. 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>.



Walter S. Lasecki, Raja Kushalnagar, and Jeffrey P. Bigham. "Legion Scribe: Real-time Captioning by Non-experts". In: *Proceedings of the 16th International ACM SIGACCESS Conference on Computers & Accessibility*. ASSETS '14. Rochester, New York, USA: ACM, 2014, pp. 303–304. ISBN: 978-1-4503-2720-6. DOI: [10.1145/2661334.2661352](https://doi.org/10.1145/2661334.2661352).

URL:

<http://doi.acm.org/10.1145/2661334.2661352>.

- 
- Walter S. Lasecki et al. “Chorus: A Crowd-powered Conversational Assistant”. In: *Proceedings of the 26th Annual ACM Symposium on User Interface Software and Technology*. UIST ’13. St. Andrews, Scotland, United Kingdom: ACM, 2013, pp. 151–162. ISBN: 978-1-4503-2268-3. DOI: [10.1145/2501988.2502057](https://doi.org/10.1145/2501988.2502057). URL: <http://doi.acm.org/10.1145/2501988.2502057>.
- 
- Thomas D. LaToza et al. “Microtask Programming: Building Software with a Crowd”. In: *Proceedings of the 27th Annual ACM Symposium on User Interface Software and Technology*. UIST ’14. Honolulu, Hawaii, USA: ACM, 2014, pp. 43–54. ISBN: 978-1-4503-3069-5. DOI: [10.1145/2642918.2647349](https://doi.org/10.1145/2642918.2647349).

URL:

<http://doi.acm.org/10.1145/2642918.2647349>.

- 
- 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. 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>.
- 
- 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. 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>.

 Greg Little et al. "TurKit: Human Computation Algorithms on Mechanical Turk". In: *Proceedings of the 23Nd Annual ACM Symposium on User Interface Software and Technology*. UIST '10. ACM, 2010, pp. 57–66. ISBN: 978-1-4503-0271-5. DOI: [10.1145/1866029.1866040](https://doi.acm.org/10.1145/1866029.1866040). URL: <http://doi.acm.org/10.1145/1866029.1866040>.

 Ioanna Lykourentzou 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. ACM, 2016, pp. 260–273. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2818048.2819979](https://doi.acm.org/10.1145/2818048.2819979). URL: <http://doi.acm.org/10.1145/2818048.2819979>.

 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. ACM, 2016, pp. 2271–2282. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858539](https://doi.acm.org/10.1145/2858036.2858539). URL: <http://doi.acm.org/10.1145/2858036.2858539>.

-  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. ACM, 2016, pp. 3834–3846. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858169](https://doi.acm.org/10.1145/2858036.2858169). URL: <http://doi.acm.org/10.1145/2858036.2858169>.
-  Edward Newell and Derek Ruths. “How One Microtask Affects Another”. In: *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. CHI ’16. ACM, 2016, pp. 3155–3166. ISBN: 978-1-4503-3362-7. DOI:

[10.1145/2858036.2858490](http://doi.acm.org/10.1145/2858036.2858490). URL:

<http://doi.acm.org/10.1145/2858036.2858490>.

-  Paolo Parigi and Xiao Ma. “The Gig Economy”. In: *XRDS* 23.2 (Dec. 2016), pp. 38–41. ISSN: 1528-4972. DOI:
[10.1145/3013496](http://doi.acm.org/10.1145/3013496). URL:
<http://doi.acm.org/10.1145/3013496>.
-  Frank Richards. “Is Anything the Matter with Piecework”. In: ASME. 1904.
-  Nathan Rosenberg. *Exploring the black box: Technology, economics, and history*. Cambridge University Press, 1994.
-  Nathan Rosenberg. *Inside the black box: technology and economics*. Cambridge University Press, 1982.

-  Donald Roy. "Efficiency and “the fix”: Informal intergroup relations in a piecework machine shop". In: *American journal of sociology* (1954), pp. 255–266.
-  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. ACM, 2015, pp. 1621–1630. ISBN: 978-1-4503-3145-6. DOI: [10.1145/2702123.2702508](https://doi.acm.org/10.1145/2702123.2702508). URL: <http://doi.acm.org/10.1145/2702123.2702508>.
-  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>.



Aaron D. Shaw, John J. Horton, and Daniel L. Chen.
“Designing Incentives for Inexpert Human Raters”. In:
*Proceedings of the ACM 2011 Conference on Computer
Supported Cooperative Work*. CSCW ’11. ACM, 2011,
pp. 275–284. ISBN: 978-1-4503-0556-3. DOI:
[10.1145/1958824.1958865](https://doi.acm.org/10.1145/1958824.1958865). URL:
<http://doi.acm.org/10.1145/1958824.1958865>.



Victor S. Sheng, Foster Provost, and Panagiotis G. Ipeirotis.
“Get Another Label? Improving Data Quality and Data Mining
Using Multiple, Noisy Labelers”. In: *Proceedings of the 14th
ACM SIGKDD International Conference on Knowledge Discovery
and Data Mining*. KDD ’08. Las Vegas, Nevada, USA: ACM,
2008, pp. 614–622. ISBN: 978-1-60558-193-4. DOI:
[10.1145/1401890.1401965](https://doi.acm.org/10.1145/1401890.1401965). URL:
<http://doi.acm.org/10.1145/1401890.1401965>.

-  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. ACM, 2016, pp. 2645–2656. ISBN: 978-1-4503-3362-7. DOI: [10.1145/2858036.2858121](https://doi.acm.org/10.1145/2858036.2858121). URL: <http://doi.acm.org/10.1145/2858036.2858121>.
-  Frederick Winslow Taylor. "A piece rate system". In: *Economic Studies* 1.2 (1896), p. 89.
-  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. ACM, 2011, pp. 1531–1536. ISBN: 978-1-4503-0268-5. DOI: [10.1145/1979742.1979803](https://doi.acm.org/10.1145/1979742.1979803). URL: <http://doi.acm.org/10.1145/1979742.1979803>.

- 
- Susan Wyche, Phoebe Sengers, and Rebecca E. Grinter. “Historical Analysis: Using the Past to Design the Future”. In: *UbiComp 2006: Ubiquitous Computing: 8th International Conference, UbiComp 2006 Orange County, CA, USA, September 17-21, 2006 Proceedings*. Ed. by Paul Dourish and Adrian Friday. Berlin, Heidelberg: Springer Berlin Heidelberg, 2006, pp. 35–51. ISBN: 978-3-540-39635-2. DOI: [10.1007/11853565_3](https://doi.org/10.1007/11853565_3). URL: http://dx.doi.org/10.1007/11853565_3.
- 
- 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. San Francisco, California, USA: ACM, 2016, pp. 1214–1222. ISBN: 978-1-4503-3592-8. DOI: [10.1145/2882903.2883120](https://doi.org/10.1145/2882903.2883120).

[10.1145/2818048.2820025](https://doi.org/10.1145/2818048.2820025). URL:

<http://doi.acm.org/10.1145/2818048.2820025>.

- 
- 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. 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>.