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 10, 2017

Stanford University

Before We Get Started…

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*

Kittur et al. (2013)

Before We Get Started…

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*
Kittur et al. (2013)

Gig work Digitally mediated (often physically embodied) one–off jobs, such as *driving for hire*, *courier services*, and *administrative support*
Friedman (2014) and Parigi and Ma (2016)

Before We Get Started…

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*
Kittur et al. (2013)

Gig work Digitally mediated (often physically embodied) one–off jobs, such as *driving for hire*, *courier services*, and *administrative support*
Friedman (2014) and Parigi and Ma (2016)

On–demand work Crowd work and gig work, collectively

On–demand work is a modern instantiation of a much older phenomenon — piecework.

The historical arc of piecework can shed light on persistent questions in this ongoing phenomenon of on–demand work.

Old Wine in New Bottles

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*
Kittur et al. (2013)

Gig work Digitally mediated (often physically embodied) one–off jobs, such as *driving for hire*, *courier services*, and *administrative support*
Friedman (2014) and Parigi and Ma (2016)

On–demand work Crowd work and gig work, collectively

Old Wine in New Bottles

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*
Kittur et al. (2013)

Gig work Digitally mediated (often physically embodied) one–off jobs, such as *driving for hire*, *courier services*, and *administrative support*
Friedman (2014) and Parigi and Ma (2016)

On–demand work Crowd work and gig work, collectively

Old Wine in New Bottles

Crowd work Digitally mediated information work, like *image tagging*, *audio transcription*, and *data processing*
Kittur et al. (2013)

Gig work Digitally mediated (often physically embodied) one–off jobs, such as *driving for hire*, *courier services*, and *administrative support*
Friedman (2014) and Parigi and Ma (2016)

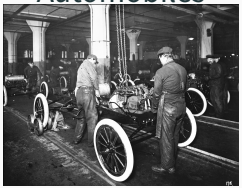
On–demand work Crowd work and gig work, collectively

Piecework Payment for output rather than for time

Payment for *output* rather than for *time*

Textiles

Automobiles

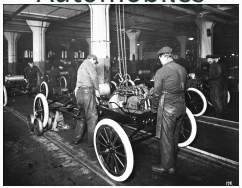


Metalwork

Payment for *output* rather than for *time*

Textiles

Automobiles



Metalwork

Crowd work

amazon mechanical turk

upwork

Gig Work

UBER

What will be the future of work?

What will be the future of work?

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

What will be the future of work?

- How will technology affect the complexity of the work that on–demand workers do?
- What are the limits of complexity in on–demand work?

What will be the future of work?

- How will technology affect the complexity of the work that on–demand workers do?
- What are the limits of complexity in on–demand work?

The answers to these questions may predict the *reach* of on–demand work

Thesis

This question — and others like it — has been asked before.

History can help us answer them today.

We'll reach into the history of piecework — of human computers, match stick makers, and metalworkers — and show how the history of their work can inform answers to questions about the future of digital work.

Introduction

We hope you come away with:

- An ontological lens for making sense of on–demand work as a resurgence of piecework
- A renewed interest in the use of historical analysis to make sense of contemporary phenomena

Comparative Historical Analysis

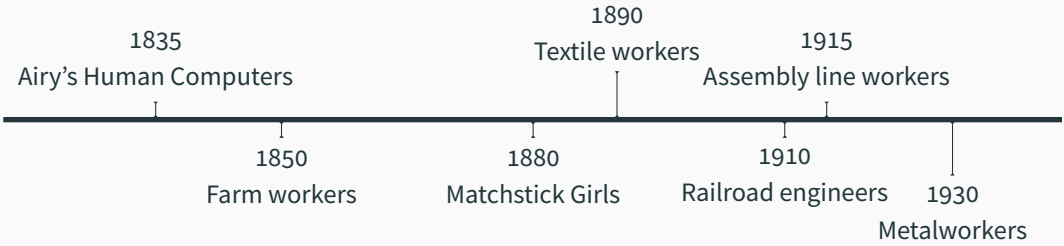
HCI researchers have used historical analysis in the past

Bødker (1993) and Wyche, Sengers, and Grinter (2006)

… But we haven't applied this method to make sense of on–demand work, which is a missed opportunity to…

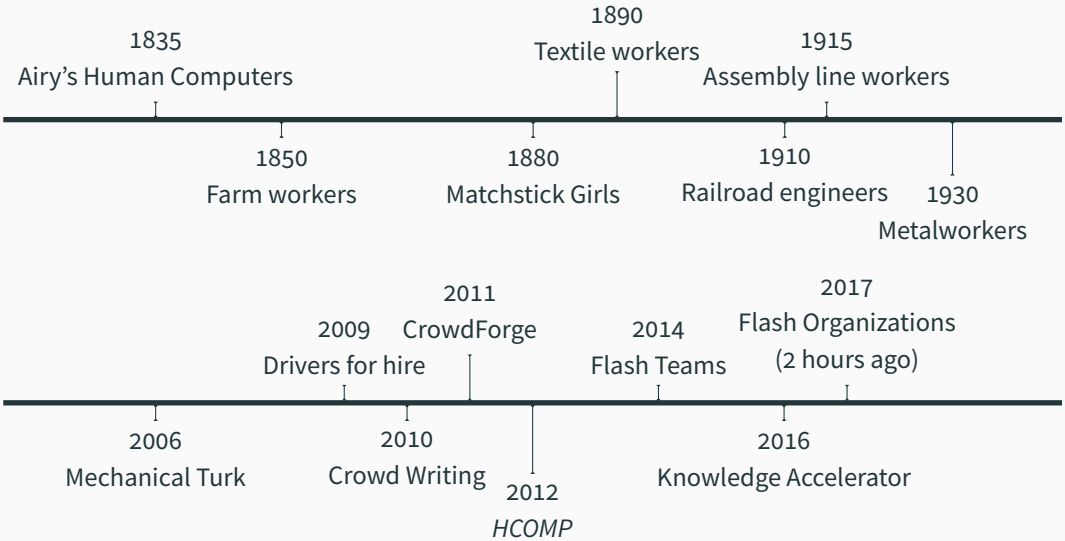
- Provide some basic framing for *ostensibly* new phenomena
- *Explicate* our theoretical grounding
- Flesh out *differences* and their implications

A Timeline of Piecework



On–Demand Work

A Timeline of ~~Piecework~~



Ongoing Threads in Crowdsourcing Research

Complexity

Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kittur et al. (2011), Nebeling et al. (2016), Suzuki et al. (2016), Yu, Kittur, and Kraut (2016), and Yuan et al. (2016)

Relationships

Gray et al. (2016), Irani and Silberman (2016, 2013), Lee et al. (2015), McInnis et al. (2016), and Salehi et al. (2015)

Decomposition

Celis et al. (2016), Chang, Kittur, and Hahn (2016), Law et al. (2016), Lykourentzou et al. (2016), and Newell and Ruths (2016)

Ongoing Threads in Crowdsourcing Research

Complexity

Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kittur et al. (2011), Nebeling et al. (2016), Suzuki et al. (2016), Yu, Kittur, and Kraut (2016), and Yuan et al. (2016)

Relationships

Gray et al. (2016), Irani and Silberman (2016, 2013), Lee et al. (2015), McInnis et al. (2016), and Salehi et al. (2015)

Decomposition

Celis et al. (2016), Chang, Kittur, and Hahn (2016), Law et al. (2016), Lykourentzou et al. (2016), and Newell and Ruths (2016)

Complexity

What do we mean when we say complexity?

Complexity

What do we mean when we say complexity?

- Can crowds help you revise work?
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)

Complexity

What do we mean when we say complexity?

- Can crowds help you revise work?
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs?
  Fuge et al. (2014) and Yuan et al. (2016)

Complexity

What do we mean when we say complexity?

- Can crowds help you revise work?
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs?
  Fuge et al. (2014) and Yuan et al. (2016)
- Can crowds create artifacts de novo?
  Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)

Complexity

… In some cases. Sometimes.

- Can crowds help you revise work?
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs?
  Fuge et al. (2014) and Yuan et al. (2016)
- Can crowds create artifacts de novo?
  Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)

Complexity

- Can crowds help you revise work?
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs?
  Fuge et al. (2014) and Yuan et al. (2016)
- Can crowds create artifacts de novo?
  Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)

… In some cases. Sometimes.

$\Rightarrow$ With variable success

Complexity

… In some cases. Sometimes.

- Can crowds help you revise work? ⇒ With variable success
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs? ⇒ With careful guidance
  Fuge et al. (2014) and Yuan et al. (2016)
- Can crowds create artifacts de novo?
  Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)

Complexity

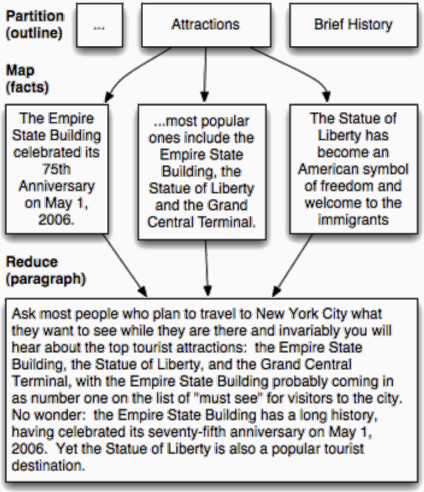
… In some cases. Sometimes.

- Can crowds help you revise work? ⇒ With variable success
  Bernstein et al. (2010), Kim et al. (2014), and Nebeling et al. (2016)
- Can crowds critique designs? ⇒ With careful guidance
  Fuge et al. (2014) and Yuan et al. (2016)
- Can crowds create artifacts de novo? ⇒ Within narrow specifications
  Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kim et al. (2017), and Lasecki, Kushalnagar, and Bigham (2014)

What Does On–Demand Work Say?

Build complexity into the process

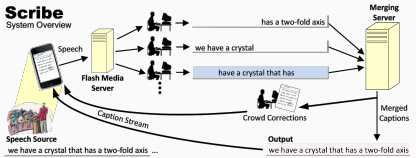
- Apply CS methods to people
  Kittur et al. (2011)



What Does On–Demand Work Say?

Build complexity into the process

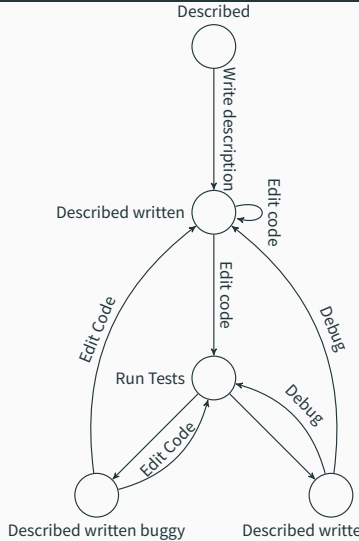
- Apply CS methods to people
  Kittur et al. (2011)
- Humans as computational units
  Lasecki, Kushalnagar, and Bigham (2014)



What Does On–Demand Work Say?

Build complexity into the process

- Apply CS methods to people
  Kittur et al. (2011)
- Humans as computational units
  Lasecki, Kushalnagar, and Bigham (2014)
- Crowdsourcing workflows as function state machines
  LaToza et al. (2014)



What Does Piecework Say?

What we'll find

- Building complexity into the processes

What Does Piecework Say?

What we'll find

- Building complexity into the processes
- Incremental advances until managers *tracked* and *standardized* workers and work

What Does Piecework Say?

What we'll find

- Building complexity into the processes
- Incremental advances until managers *tracked* and *standardized* workers and work
- Insights into task specialization

What Does Piecework Say?

George Airy (astronomer) used a very similar approach

Grier (2013)

- Employed computers
- 13–20 years old
- no particularly strong background in mathematics
- A basic understanding of logarithms, algebra, etc…

George Airy

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

No. of Swing.	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 Rate $\frac{\text{Earnshaw}}{\text{Shelton}}$	Corrected Logarithm of Rate $\frac{\text{Earnshaw}}{\text{Shelton}}$
	Oct. h		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 46·029	1·0010686	0·00046384	0·00047194

Low Complexity

Farms

- Formalization of piecework: *payment for results*
  Chadwick (1865)
- Dynamic piece rates

Low Complexity

Textiles

- Distributed workers
- Assuming common skills

Low Complexity

- Strict management
- Formalizing work methods

Matchstick Girls

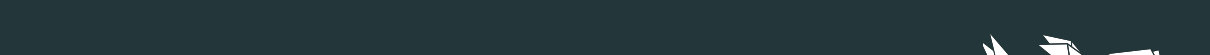
Low Complexity

Farms

Textiles

Matchstick Girls

Planes, Trains, and Automobiles



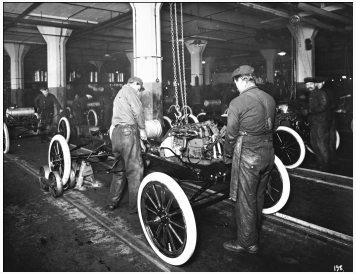
Trains

- “Efficiency experts” measured how long it would take to do various jobs
  Cunningham (1911)
- These measurements would be used to assign values for each specific task
  Jewell (1921)

Planes, Trains, and Automobiles

Automobiles

- Consolidating and training workers (*Fordism*)
  Schoenberger (1988) and Tolliday and Zeitlin (1986)



- Measuring and evaluating workers by very carefully defined instructions (*Taylorism*)
  Taylor (1911)

Planes, Trains, and Automobiles

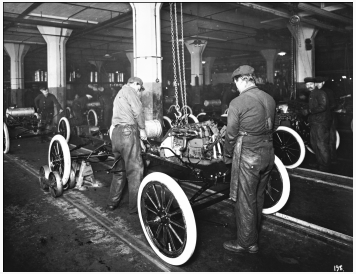
- Men drafted during World War II
- Factories turned to a new workforce who had neither conventional training nor experience
- **Specialized training and assignment**

Planes

Planes, Trains, and Automobiles

Trains

Automobiles



Planes

Comparisons

- Building complexity into the processes
- Challenges dealing with flexibility
    - *Building* planes versus *fixing* trains

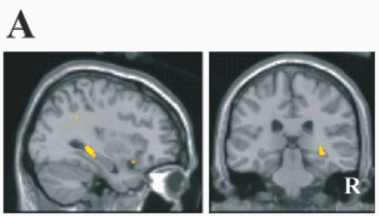
Implications for On–Demand Work

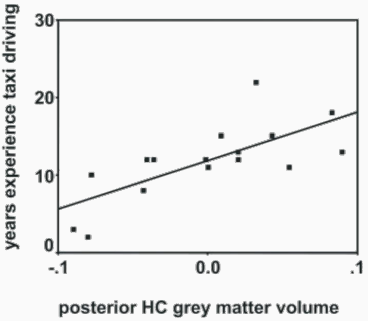
Has technology shifted on–demand work?

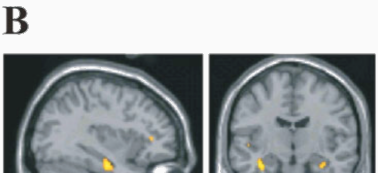
- Technology makes *some* complex tasks relatively trivial
- Measuring workers is easier than ever

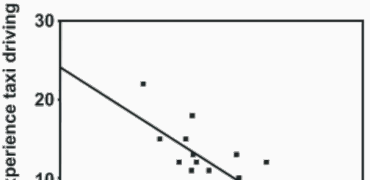
Enhanced Cognition

Enhanced Cognition









Enhanced Cognition

Tracking Work and Workers

[al2: Upwork's screen recording tool as a way to measure workers]

Takeaways

- 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

Ongoing Threads in Crowdsourcing Research

Complexity

Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kittur et al. (2011), Nebeling et al. (2016), Suzuki et al. (2016), Yu, Kittur, and Kraut (2016), and Yuan et al. (2016)

Relationships

Gray et al. (2016), Irani and Silberman (2016, 2013), Lee et al. (2015), McInnis et al. (2016), and Salehi et al. (2015)

Decomposition

Celis et al. (2016), Chang, Kittur, and Hahn (2016), Law et al. (2016), Lykourentzou et al. (2016), and Newell and Ruths (2016)

Ongoing Threads in Crowdsourcing Research

Complexity

Hahn et al. (2016), Kim and Monroy-Hernández (2016), Kittur et al. (2011), Nebeling et al. (2016), Suzuki et al. (2016), Yu, Kittur, and Kraut (2016), and Yuan et al. (2016)

Relationships

Gray et al. (2016), Irani and Silberman (2016, 2013), Lee et al. (2015), McInnis et al. (2016), and Salehi et al. (2015)

Decomposition

Celis et al. (2016), Chang, Kittur, and Hahn (2016), Law et al. (2016), Lykourentzou et al. (2016), and Newell and Ruths (2016)

Discussion

Several goals:

- Give some historical context to on–demand work
- Answer some questions that have been difficult to answer
- Recapture attention toward a valuable sense–making methodology

On–demand work is a modern instantiation of a much older phenomenon — piecework.

The historical arc of piecework can shed light on persistent questions in this ongoing phenomenon of on–demand work.

Thanks!

acknowledgements

name: Ali Alkhatib
email: ali.alkhatib@cs.stanford.edu
twitter: @_alialkhatib

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. URL: http://doi.acm.org/10.1145/1866029.1866078.

References ii

- 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. URL: http://doi.acm.org/10.1145/2818048.2835202.

References iii

Edwin Chadwick. “Openi, 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.

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. URL: http://doi.acm.org/10.1145/2858036.2858411.

References iv

- 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. 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.

References v

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. URL: http://doi.acm.org/10.1145/2818048.2819942.

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

References vi

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. URL: http://doi.acm.org/10.1145/2858036.2858364.

References vii

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. URL: http://doi.acm.org/10.1145/2858036.2858592.

References viii

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. 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.

References ix

- 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. 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.

References x

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. URL: http://doi.acm.org/10.1145/2556288.2556986.

References xi

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. 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. URL: http://doi.acm.org/10.1145/2441776.2441923.

References xii

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. URL: http://doi.acm.org/10.1145/2661334.2661352.

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. 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. 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. URL: http://doi.acm.org/10.1145/2702123.2702548.

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. 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. 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. 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. 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. URL: http://doi.acm.org/10.1145/3013496.

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. URL: http://doi.acm.org/10.1145/2702123.2702508.

References xx

- Erica Schoenberger. In: *Environment and Planning D: Society and Space* 6.3 (1988), pp. 245–262.
- 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. URL: http://doi.acm.org/10.1145/2858036.2858121.
- Frederick Winslow Taylor. *The principles of scientific management*. Harper, 1911.

References xxi

Steven Tolliday and Jonathan Zeitlin. *Between fordism and flexibility*. Oxford, 1986.

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. 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: 10.1145/2818048.2820025. 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. URL: http://doi.acm.org/10.1145/2818048.2819953.