

---

# DC<sup>2</sup>S<sup>2</sup>: Designing Crowd-powered Creativity Support Systems

**Jonas Oppenlaender**

University of Oulu  
Oulu, Finland  
jonas.oppenlaender@oulu.fi

**Abderrahmane Khiat**

Freie Universität Berlin  
Berlin, Germany  
abderrahmane.khiat@fu-berlin.de

**Jorge Goncalves**

University of Melbourne  
Melbourne, VIC, Australia  
jorge.goncalves@unimelb.edu.au

**Maximilian Mackeprang**

Freie Universität Berlin  
Berlin, Germany  
maximilian.mackeprang@fu-berlin.de

**Maja Vuković**

IBM T.J. Watson Research Center  
Yorktown Heights, NY, USA  
maja@us.ibm.com

**Simo Hosio**

University of Oulu  
Oulu, Finland  
simo.hosio@oulu.fi

## ABSTRACT

Supporting creativity has been considered as one of the grand challenges of Human Computer Interaction. All creativity lies within humanity and crowdsourcing is a powerful approach for tapping into the collective insights of diverse crowds. Thus, crowdsourcing has great potential in supporting creativity. In this workshop, we brainstorm new crowdsourcing systems and concepts for supporting creativity, by bringing together researchers and industry professionals in a full-day workshop. The workshop consists of discussions of ideas contributed by the participants and hands-on brainstorming

---

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the owner/author(s).

*CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland UK*

© 2019 Copyright held by the owner/author(s).

ACM ISBN 978-1-4503-5971-9/19/05.

<https://doi.org/10.1145/3290607.3299027>

sessions in groups for ideating new crowd-powered systems that support creativity. We center the workshop around two themes: supporting the individual and facilitating creativity in groups.

## **CCS CONCEPTS**

• **Information systems** → **Crowdsourcing**; • **Human-centered computing** → **Collaborative and social computing systems and tools**;

## **KEYWORDS**

Creativity Support; Creativity Support Systems; Crowdsourcing; Collective Intelligence.

## **ACM Reference Format:**

Jonas Oppenlaender, Maximilian Mackeprang, Abderrahmane Khiat, Maja Vuković, Jorge Goncalves, and Simo Hosio. 2019. DC<sup>2</sup>S<sup>2</sup>: Designing Crowd-powered Creativity Support Systems. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI'19 Extended Abstracts)*, May 4–9, 2019, Glasgow, Scotland UK. ACM, New York, NY, USA, 8 pages. <https://doi.org/10.1145/3290607.3299027>

## **INTRODUCTION**

Crowdsourcing has been applied to a broad range of creative processes, from supporting research [25] to helping unfold global-scale wicked problems [3, 4, 7]. Organizations have recognized the potential of crowds, with companies such as Innocentive, Quirky and OpenIDEO finding success in Open Innovation [2]. Relevant to our workshop, supporting creativity has been considered as one of the grand challenges in Human Computer Interaction (HCI) [22, 23]. Given the inherent emphasis of crowdsourcing in collecting insights rapidly, inexpensively and accurately, it has been suggested as a key approach for creativity support [1, 29].

In this workshop, we bring together scientists and practitioners interested in creativity. We invite participants working on collaborative and crowd-powered systems that in one way or another enhance creative processes or challenge the academic community's thinking and perceptions about creativity in general. Doing so, we set to inspire the design of next-generation crowd-powered systems that support creativity.

We are confident this workshop will be a great addition to CHI 2019 as a relevant one-day event that allows for participants to bring forward their ideas, designs and practical experiences in the field of supporting creativity through crowdsourcing. While the workshop has a sharp focus, creativity as a collaborative process fits well with submissions from several areas relevant to CHI, such as Human Computer Interaction, social and crowd computing, empirical investigations, systems and tools, collaborative applications, and boundary-crossing designs.

## BACKGROUND

Creativity is needed in various contexts, including – but not limited to – graphic design, user interface design, product design, writing, art, industrial design, ideation, *etc.* In this workshop, by creativity we refer to the process that leads to an artifact that is deemed novel and useful in a given field and domain [5, 19]. Creativity can be an attribute of individuals or teams and is influenced by the social, economic, scientific and technological context [15].

The goal of creativity support systems is to make “more people more creative more often” [20, 21]. Shneiderman identified eight creative activities that could benefit from being supported by creativity support systems: searching, visualizing, consulting peers, thinking, exploring, composing, reviewing, and disseminating [20]. The majority of creativity support systems, however, focus only on the ideation phase [28]. As knowledge work is being transformed and the World Wide Web and ubiquitous devices have thoroughly permeated our work practices, the interest in supporting creative work through different digital approaches is growing.

Crowdsourcing is the practice of outsourcing tasks on an online platform to a crowd of people via an open call for contributions [12]. Research on crowdsourcing is situated in a greater continuum of overlapping research areas that includes human computation and collective intelligence [18]. The crowdsourcing paradigm comes in several distinct flavours, among them microtask and macrotask labour, crowdfunding, crowd contests and games for good. Crowdsourcing is especially effective in situations that require human cognition for decision-making, such as creative work.

The combination of crowdsourcing and creativity support is promising for several reasons. Both the practice of crowdsourcing and creativity support systems were analogously compared to the introduction of the sewing machine [17, 20], creating new opportunities for income in regions of the world that previously did not have access to the international labour market. Creativity support systems facilitate the access to creative work for certain groups of the population and accelerate innovation. Furthermore, humans excel in recombination, analogical transfer and divergent thinking. Machines fall short in these fundamental characteristics needed for creativity. Moreover, creativity is a social process. Studies from psychology show that groups of people with diverse backgrounds provide high quality ideas and can outperform skilled experts [10]. Crowds offer this diverse set of skills because they are heterogeneous [16, 24], providing different contexts and backgrounds leading to diverse ideas [6].

Involving the crowd in a creative process leads to several fundamental challenges. Crowd-powered creativity support systems operate in a space in which there is no right answer to a task. Research has shown that in situations without a ground truth, ambiguous results are still valuable [13]. Subjective tasks are, however, prone to cheating [14]. How can the quality of crowdsourcing results be assessed in such a divergent thinking setting? What forms of collaboration are useful and helpful in crowd settings?

### **Augmenting the Individual**

The goal of this theme is to augment the individual's creativity and cognition with the crowd. The theme aims to develop improved software and user interfaces that empower users to be more productive, and more innovative. Challenges under this theme include, for example:

- Interfaces and software for supporting peak-productive moments (“bursts”) of an individual's creativity with the collective intelligence of the crowd
- Preventing cognitive overload of the individual:
  - Evaluating the quality of contributions from the crowd
  - Helping explore the space of solutions contributed by the crowd

### **Supporting Group Ideation**

This theme will explore supporting the creative work of small and large groups with the crowd. Challenges under this theme include, but are not limited to:

- Determining levels of collaboration to prevent early fixation of the group without limiting the quality through feedback
- Dynamically guiding crowd efforts based on task needs, worker profiles, *etc.*
- Automating repetitive tasks in group ideation

What incentives other than extrinsic motivation could be given to crowdworkers to participate in creative tasks? How will automation (Machine Learning and Artificial Intelligence) and human agents collaborate in creative tasks?

## **OBJECTIVES OF THE WORKSHOP**

This workshop aims to provide a forum for researchers and industry professionals to share, discuss and brainstorm their ideas about improving current and designing future crowd-powered systems that support creative work. Supporting creativity with technology is inherently exploratory and transdisciplinary [15]. This workshop therefore is open to a broad audience to stimulate the workshop participants by exposure to new points of views from different disciplines. We welcome a diverse set of members from the research community and industry, from fields, such as, but not limited to, Sociology, Psychology, Economics, Computer Science, and Human-Computer Interaction. We will center the workshop around the following two themes as a broad estimate of the type of system designs that we hope to stimulate with the workshop: augmenting the individual, and supporting group collaboration (see the Sidebar for more details).

## **PRE-WORKSHOP PLANS**

The workshop will be open to all participants interested in the aforementioned topics. In total, we expect to attract up to 25 participants (including the organizers). Position papers and pre-workshop materials will be made accessible to participants in advance of the workshop.

Advertising and organizational announcements will be handled online on the workshop website: [dc2s2.github.io/2019](https://dc2s2.github.io/2019). The call for participation will be promoted on the major HCI and University mailing lists and advertised in the CHI and crowdsourcing communities. The organizers will also publicize the call in their home organizations and among their peers.

The workshop requires a minimal amount of technical equipment (projector, screen). The workshop organizers will bring their own supply of materials (stationary items, flip charts, *etc.*).

## **WORKSHOP STRUCTURE**

The workshop schedule is summarized in Table 1. The main purpose of the session in the morning is to familiarize the participants with each other and their ideas for future crowd-powered creativity support systems. The emphasis in the brief presentation session will be on group discussion, rather than on presentation of individual position papers. We will subsequently hold a “bad idea” exercise to further stimulate the participants' creativity. In this exercise, groups of 2–4 people will discuss and later present “bad ideas”, *e.g.* ideas that are deemed to not be feasible or practical. This exercise has been proven to help with coming up with new ideas and solutions as many bad ideas are not actually that bad or can be interpreted in a positive way. The afternoon is occupied by collaborative

**Table 1: Workshop Schedule.**

<b>Morning Session</b>	
09:00 - 09:30	Welcome and introductions
09:30 - 10:00	Participants present their vision statements and ideas
10:00 - 10:30	Bad idea exercise
10:30 - 11:00	Coffee break
11:00 - 11:30	Discussion of ideas and formation of groups
<hr/>	
11:30 - 12:30	Lunch
<b>Afternoon Session</b>	
12:30 - 16:00	Break-out session in groups
16:00 - 17:00	Final presentations and discussion

work in smaller groups. The purpose of these break-out sessions is to sketch out ideas or even build first prototypes of crowd-powered creativity support systems.

### POST-WORKSHOP PLANS

The workshop aims to advance the state of the art of crowd-supported creativity. We will collaboratively brainstorm the design of applications, tools, systems and architectures. The primary tangible output of this workshop will be a number of sketches of ideas, designs and first prototypes for crowd-powered creativity support systems.

A summary of the workshop will be made available on the workshop website. Further, the workshop organizers and the authors of the contributions that were elected by the workshop participants for the break-out brainstorming session will compose a joint article, to report on the workshop and its outcomes, for publication in ACM Interactions.

### ORGANIZERS

The workshop organizers are experienced research leaders in crowdsourcing across several contexts. The organizers have successfully organized a number of crowdsourcing-related workshops at top HCI venues [8, 9, 11, 26, 27].

**Jonas Oppenlaender** is a PhD candidate and a member of the Community Instrumentation and Awareness research group in the Center for Ubiquitous Computing at the University of Oulu, Finland. His research interests include crowdsourcing, social computing and leveraging social machines for supporting creative work and engaging citizens in research.

**Maximilian Mackeprang** is a PhD candidate at the Human-Centered Computing (HCC) research group at Freie Universität Berlin, Germany. His current research interests include Human Computer Interaction, mixed initiative approaches to creativity and collaborative ideation systems.

**Abderrahmane Khiat** is a post-doctoral member of the Human-Centered Computing (HCC) research group at Freie Universität Berlin, Germany. He currently works in the IdeasToMarket (Innovonto) project. He graduated with a PhD in Computer Science from the University of Oran, Algeria. His research covered several areas including Semantic Web, ontology matching, collaborative ideation, and Natural Language Processing.

**Maja Vuković** is a Research Manager at IBM T.J. Watson Research Center and an IBM Master Inventor. Maja's research expertise is in IT service innovation, AI planning, and crowdsourcing technologies. Maja was a co-organizer of a number of workshops, *e.g.* Enterprise Crowdsourcing and Ubiquitous

Crowdsourcing, collocated with leading international conferences.

**Jorge Goncalves** is a Lecturer in Human-Computer Interaction at the School of Computing and Information Systems in the University of Melbourne, Australia. He is an Associate Editor for PACM HCI: CSCW and his interests are in crowdsourcing, situated technologies, and social computing.

**Simo Hosio** is a computer scientist with interests in crowdsourcing, situated technologies and social computing. He is an Adjunct Professor of Social Computing at the Center for Ubiquitous Computing in the University of Oulu, Finland.

### **CALL FOR PARTICIPATION**

This one-day brainstorming workshop brings together researchers and industry professionals for advancing the state of the art in crowdsourcing creativity. The workshop activities will support participants to work together to ideate and design new applications and interfaces for supporting creative work with the crowd.

Our intention with this workshop is to bring researchers together to form future cross-boundary collaborations and to kick-start future joint research endeavors. We welcome contributions from different disciplines (*e.g.* from communication and social science, legal studies, computer science, engineering science, and others). We invite designers, researchers and industry practitioners interested in participating to submit original contributions in the form of vision and position papers (max. 4 pages) on potential applications and unsolved challenges. We specifically encourage the participants to share their ideas for projects to facilitate the hands-on brainstorming session in the workshop.

The review of submissions will follow a juried process (see [chi2018.acm.org/selection-processes](http://chi2018.acm.org/selection-processes)). Submissions will be selected based on their relevance to the workshop themes, and the originality and novelty of the submitted ideas. Submissions should follow the ACM SIGCHI Proceedings Extended Abstracts format (available as Latex template and interim template for Microsoft Word).

Manuscripts should be submitted as email attachments in pdf format to the workshop co-chairs at [dc2s2workshop@oulu.fi](mailto:dc2s2workshop@oulu.fi), by February 12, 2019. At least one author of each accepted paper must attend the workshop and all participants must register for both the workshop and for at least one day of the conference. More details about the workshop can be found at [dc2s2.github.io/2019](http://dc2s2.github.io/2019).

### **IMPORTANT DATES**

Submission Deadline: 12 February 2019

Notification of acceptance: 1 March 2019

Workshop Date: 4 May 2019

## REFERENCES

- [1] Salvatore Andolina, Hendrik Schneider, Joel Chan, Khalil Klouche, Giulio Jacucci, and Steven Dow. 2017. Crowdbord: Augmenting In-Person Idea Generation with Real-Time Crowds. In *Proceedings of the 2017 ACM SIGCHI Conference on Creativity and Cognition (C&C '17)*. ACM, New York, NY, USA, 106–118. <https://doi.org/10.1145/3059454.3059477>
- [2] Carliss Baldwin and Eric von Hippel. 2011. Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation. *Organization Science* 22, 6 (2011), 1399–1417. <https://doi.org/10.1287/orsc.1100.0618>
- [3] Seth Cooper, Adrien Treuille, Janos Barbero, Andrew Leaver-Fay, Kathleen Tuite, Firas Khatib, Alex Cho Snyder, Michael Beenen, David Salesin, David Baker, and Zoran Popović. 2010. The Challenge of Designing Scientific Discovery Games. In *Proceedings of the Fifth International Conference on the Foundations of Digital Games (FDG '10)*. ACM, New York, NY, USA, 40–47. <https://doi.org/10.1145/1822348.1822354>
- [4] Justin Cranshaw and Aniket Kittur. 2011. The Polymath Project: Lessons from a Successful Online Collaboration in Mathematics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. ACM, New York, NY, USA, 1865–1874. <https://doi.org/10.1145/1978942.1979213>
- [5] Mihaly Csikszentmihalyi. 1996. *Creativity: Flow and the Psychology of Discovery and Invention*. Harper Collins Publishers, New York, NY, USA.
- [6] Alan R. Dennis and Mike L. Williams. 2003. Electronic brainstorming: Theory, research, and future directions. In *Group creativity: Innovation through collaboration*, Paul B. Paulus and Bernard A. Nijstad (Eds.). Oxford University Press, New York, NY, USA, 160–178. <https://doi.org/10.1093/acprof:oso/9780195147308.003.0008>
- [7] Jerome C. Glenn. 2013. Collective Intelligence and an Application by The Millennium Project. *World Futures Review* 5, 3 (2013), 235–243. <https://doi.org/10.1177/1946756713497331>
- [8] Jorge Goncalves, Simo Hosio, Vassilis Kostakos, Maja Vukovic, and Shin'ichi Konomi. 2015. Workshop on Mobile and Situated Crowdsourcing. In *Adjunct Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2015 ACM International Symposium on Wearable Computers (UbiComp/ISWC'15 Adjunct)*. ACM, New York, NY, USA, 1339–1342. <https://doi.org/10.1145/2800835.2800966>
- [9] Jorge Goncalves, Simo Hosio, Maja Vukovic, Shin'ichi Konomi, and Uichin Lee. 2016. WMS '16: Second Workshop on Mobile and Situated Crowdsourcing. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (UbiComp '16)*. ACM, New York, NY, USA, 1435–1440. <https://doi.org/10.1145/2968219.2968584>
- [10] Lu Hong and Scott E. Page. 2004. Groups of diverse problem solvers can outperform groups of high-ability problem solvers. *Proceedings of the National Academy of Sciences* 101, 46 (2004), 16385–16389. <https://doi.org/10.1073/pnas.0403723101>
- [11] Simo Hosio, Jorge Goncalves, Vassilis Kostakos, Keith Cheverst, and Yvonne Rogers. 2013. Human Interfaces for Civic and Urban Engagement: HiCUE '13. In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication (UbiComp '13 Adjunct)*. ACM, New York, NY, USA, 713–720. <https://doi.org/10.1145/2494091.2495993>
- [12] Jeff Howe. 2006. The rise of crowdsourcing. *Wired Magazine* 14, 6 (2006), 1–4.
- [13] Oana Inel, Khalid Khamkham, Tatiana Cristea, Anca Dumitrache, Arne Rutjes, Jelle van der Ploeg, Lukasz Romaszko, Lora Aroyo, and Robert-Jan Sips. 2014. CrowdTruth: Machine-Human Computation Framework for Harnessing Disagreement in Gathering Annotated Data. In *The Semantic Web – ISWC 2014*, Peter Mika, Tania Tudorache, Abraham Bernstein, Chris Welty, Craig Knoblock, Denny Vrandečić, Paul Groth, Natasha Noy, Krzysztof Janowicz, and Carole Goble (Eds.). Springer International Publishing, Cham, 486–504.
- [14] Aniket Kittur. 2010. Crowdsourcing, Collaboration and Creativity. *XRDS* 17, 2 (Dec. 2010), 22–26. <https://doi.org/10.1145/1869086.1869096>

- [15] William J. Mitchell, Alan S. Inouye, and Marjory S. Blumenthal. 2003. *Beyond Productivity: Information, Technology, Innovation, and Creativity*. National Academy Press, Washington, DC, USA.
- [16] Gabriele Paolacci and Jesse Chandler. 2014. Inside the Turk: Understanding Mechanical Turk as a Participant Pool. *Current Directions in Psychological Science* 23, 3 (2014), 184–188. <https://doi.org/10.1177/0963721414531598>
- [17] Praveen Paritosh, Panos Ipeirotis, Matt Cooper, and Siddharth Suri. 2011. The Computer is the New Sewing Machine: Benefits and Perils of Crowdsourcing. In *Proceedings of the 20th International Conference Companion on World Wide Web (WWW '11)*. ACM, New York, NY, USA, 325–326. <https://doi.org/10.1145/1963192.1963335>
- [18] Alexander J. Quinn and Benjamin B. Bederson. 2011. Human Computation: A Survey and Taxonomy of a Growing Field. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '11)*. ACM, New York, NY, USA, 1403–1412. <https://doi.org/10.1145/1978942.1979148>
- [19] R. Keith Sawyer. 2012. *Explaining creativity: The science of human innovation* (2nd ed.). Oxford University Press, New York, NY, USA.
- [20] Ben Shneiderman. 2002. Creativity Support Tools. *Commun. ACM* 45, 10 (Oct. 2002), 116–120. <https://doi.org/10.1145/570907.570945>
- [21] Ben Shneiderman. 2007. Creativity Support Tools: Accelerating Discovery and Innovation. *Commun. ACM* 50, 12 (Dec. 2007), 20–32. <https://doi.org/10.1145/1323688.1323689>
- [22] Ben Shneiderman. 2009. Creativity Support Tools: A Grand Challenge for HCI Researchers. In *Engineering the User Interface: From Research to Practice*, Miguel Redondo, Crescencio Bravo, and Manuel Ortega (Eds.). Springer London, London, 1–9. [https://doi.org/10.1007/978-1-84800-136-7\\_1](https://doi.org/10.1007/978-1-84800-136-7_1)
- [23] Ben Shneiderman, Gerhard Fischer, Mary Czerwinski, Mitch Resnick, Brad Myers, Linda Candy, Ernest Edmonds, Mike Eisenberg, Elisa Giaccardi, Tom Hewett, Pamela Jennings, Bill Kules, Kumiyo Nakakoji, Jay Nunamaker, Randy Pausch, Ted Selker, Elisabeth Sylvan, and Michael Terry. 2006. Creativity Support Tools: Report From a U.S. National Science Foundation Sponsored Workshop. *International Journal of Human-Computer Interaction* 20, 2 (2006), 61–77. [https://doi.org/10.1207/s15327590ijhc2002\\_1](https://doi.org/10.1207/s15327590ijhc2002_1)
- [24] James Surowiecki. 2005. *The Wisdom of Crowds*. Anchor, New York, NY, USA.
- [25] Rajan Vaish, Snehal Kumar (Neil) S. Gaikwad, Geza Kovacs, Andreas Veit, Ranjay Krishna, Imanol Arrieta Ibarra, Camelia Simoiu, Michael Wilber, Serge Belongie, Sharad Goel, James Davis, and Michael S. Bernstein. 2017. Crowd Research: Open and Scalable University Laboratories. In *Proceedings of the 30th Annual ACM Symposium on User Interface Software and Technology (UIST '17)*. ACM, New York, NY, USA, 829–843. <https://doi.org/10.1145/3126594.3126648>
- [26] Maja Vukovic and Soundar Kumara. 2011. Second International Workshop on Ubiquitous Crowdsourcing: Towards a Platform for Crowd Computing. In *Proceedings of the 13th International Conference on Ubiquitous Computing (UbiComp '11)*. ACM, New York, NY, USA, 617–618. <https://doi.org/10.1145/2030112.2030243>
- [27] Maja Vukovic, Soundar Kumara, and Ohad Greenshpan. 2010. Ubiquitous Crowdsourcing. In *Proceedings of the 12th ACM International Conference Adjunct Papers on Ubiquitous Computing - Adjunct (UbiComp '10 Adjunct)*. ACM, New York, NY, USA, 523–526. <https://doi.org/10.1145/1864431.1864504>
- [28] Kai Wang and Jeffrey V. Nickerson. 2017. A literature review on individual creativity support systems. *Computers in Human Behavior* 74 (2017), 139 – 151. <https://doi.org/10.1016/j.chb.2017.04.035>
- [29] Lixiu Yu, Aniket Kittur, and Robert E. Kraut. 2016. 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)*. ACM, New York, NY, USA, 1214–1222. <https://doi.org/10.1145/2818048.2820025>