Crowd-powered Interfaces for Creative Design Thinking

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

Halil Erhan
Simon Fraser University
Surrey, Canada
herhan@sfu.ca

Naghmi Shireen
Simon Fraser University
Surrey, Canada
nshireen@sfu.ca

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

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

Abstract
Crowdsourcing is a powerful approach for tapping into the collective insights of diverse crowds. Thus, crowdsourcing has potential to support designers in making sense of a design space. In this hands-on workshop, we will brainstorm and conceptualise new user interfaces and crowdsourcing systems for supporting designers in the design process. The workshop consists of developmental discussions of ideas contributed by the participants. In brainstorming and design sessions in groups, the participants will ideate new crowd-powered systems and user interfaces that support the designer's divergent and convergent thinking.

CCS Concepts
•**Information systems** → *Crowdsourcing;* •**Human-centered computing** → *Graphical user interfaces;* Human computer interaction (HCI);

Author Keywords
Design Thinking; Creativity; Creativity Support; Crowdsourcing.

Introduction
Design is a creative problem-solving process [1]. It is iterative in nature and is comprised of multiple incremental phases, *i.e.,* ideation, exploration, optimisation, and reflection [6]. Typically, design starts by defining preliminary crite-

ria and constraints. These preliminary ideas change as the understanding of the problem space develops, and the solution space expands to contain multiple design alternatives [16, 22]. The subsequent exploration within this solution space leads to exploration and optimisation, until a satisfying design solution is reached. In between frequent iterative switching of design phases, designers constantly reflect on their design decisions for sensemaking [6, 21].

Supporting creativity in design has been considered as one of the grand challenges in Human-Computer Interaction (HCI) [25, 26]. Research on supporting creativity stems from a long line of research on augmenting humans that goes back to the 1950s [12] and 1960s [7]. Given the inherent emphasis of crowdsourcing in collecting insights rapidly, inexpensively and accurately, it has been suggested as a key approach for supporting creativity [2, 30].

Crowdsourcing has been applied to a broad range of creative processes, from supporting research [28] to helping unfold complex scientific problems [4]. Involving the crowd in a creative process leads to several fundamental challenges, especially when it comes to design problem solving. However, it has been considered effective in inducing creative stimuli for design ideation [2, 11].

In this one-day workshop, our focus is to explore how to best exploit crowdsourcing in augmenting the design process, throughout its distinct identified stages: ideation, exploration, optimisation and reflection. On a concrete level, the workshop examines the potential of crowdsourcing in this exciting use case with interactive group discussions and hands-on exploration.

Objectives of the Workshop

In this workshop, we bring together scientists and practitioners interested in supporting creativity in different types of design scenarios through crowdsourcing. The one-day workshop is organised as a hands-on and participant-driven hack-a-thon event. We invite participants to bring forward their ideas already prior to the actual workshop and, during the workshop, design novel crowd-powered applications and user interfaces supporting designers in their design process. This may happen with either simple digital design tools or traditional paper prototyping. While the workshop theme focuses on creativity support through all design phases, we specifically encourage participants to think beyond the ideation phase of the design process. Doing so, we set to inspire the design of next-generation crowd-powered systems that support creativity in either a single or multiple design phases.

The workshop theme fits well with several areas relevant to the conference theme, such as creativity support tools, Human-Computer Interaction, Social Computing, Crowdsourcing, Design Thinking, collaborative applications, co-creating environments and boundary-crossing designs.

Related Work

As knowledge work is being transformed and the World Wide Web has thoroughly permeated our work practices, the interest in supporting creative work through different digital approaches is growing.

The goal of designing creativity support systems is to make “more people more creative more often” [23, 24]. Shneiderman identified eight creative activities that could benefit from being supported by creativity support systems: searching, visualising, consulting peers, thinking, exploring, composing, reviewing, and disseminating [23]. The majority of creativity support systems, however, focus only on the ideation phase [8, 29].

Crowdsourcing is the practice of outsourcing tasks on an

online platform to a crowd of people via an open call for contributions [15]. The crowdsourcing approach comes in several distinct flavours. Among them, microtask and macrotask labour, crowdfunding, crowd contests and games with a purpose (GWAP) are a few to name. Crowdsourcing is especially effective in situations that require human cognition for decision-making, such as creative work. Organisations have recognised the potential of crowds, with companies such as Innocentive, Quirky and OpenIDEO finding success in Open Innovation [3].

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 [19, 23], creating new opportunities for income in regions of the world that previously did not have access to the international labour market. Further, 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 [13]. Crowds offer this diverse set of skills because they are heterogeneous [18, 27], providing different contexts and backgrounds leading to diverse ideas [5].

Key Themes of the Workshop

We structure the workshop around the design process with its four key phases. Please note that many times these phases overlap with each other and are executed in cycles. Still, there exists a fine boundary between each, demanding a specific structure to the design tasks.

The common challenges under these four themes include, but are not limited to, proposing user interfaces for:

- preventing cognitive overload of the individual designer,
- efficiently communicating and explaining design criteria and constraints to the crowd,
- supporting peak-productive moments ("bursts") of an individual's creativity with the collective intelligence of the crowd, *e.g.* the selection among design alternatives,
- automating repetitive tasks in group ideation, and
- designing concepts for interaction and collaboration between Artificial Intelligence and human agents in creative tasks.

Next, we will briefly expand on the design stages that the workshop focuses on.

Ideation

Design ideation involves, but is not limited to gathering relevant information, building initial design criteria, defining design constraints and developing inspirational and creative stimuli for innovative and creative design thinking.

Under this theme, we welcome ideas addressing and exploring interactive ways to support the act of design ideation using collective insights of the crowd. The goal of this theme is to augment the designer's creativity and cognition during ideation with the crowd. The theme aims to develop improved software and user interfaces that empower designers to be more productive and more innovative.

Exploration

Design exploration many times is considered as part of the ideation. It comes after the introduction of preliminary design criteria, based on which expert designers generate a set of base design solutions. These base solutions become seed geometries to generate a large design space

Morning Session
09:00 – 09:30: Welcome and getting to know each other
09:30 – 10:00: Design exercise
10:00 – 10:30: Topic discussion and group formation
10:30 – 11:00: Coffee break
11:00 – 12:00: Work in groups
Afternoon Session
13:00 – 15:00: Work in groups
15:00 – 15:30: Coffee break
15:30 – 17:00: Final presentations and discussion

Table 1: Preliminary schedule of the workshop.

comprised of hundreds and thousands of design alternatives. This exploration may lead to re-definition of the preliminary design criteria and designers may move back and forth between ideation and exploration, until a complete understanding of the design space is achieved.

In this theme, we invite researchers to submit ideas related to crowdsourcing the process of exploration of the solution space. We are interested to investigate how the creation of design alternatives can be supported by a heterogeneous crowd with diverse skill sets.

Optimisation
Exploration and Optimisation both rely heavily on the preliminary design ideation. Optimisation refers to the act of reducing the design space based on selective constraints. Once a satisfying design is achieved the designer may proceed with modifying or optimising the selected design to achieve maximum performance output. This theme invites, but is not limited to, crowdsourcing the design optimisation processes and supporting convergent thinking with the crowd.

Reflection
Reflection refers to sensemaking [21] and happens multiple times and often between frequent switching of design phases, due to the cyclic nature of the design process. This theme will explore interfaces supporting sensemaking and reflection on ideation, exploration and optimisation of design solutions with the collective intelligence of the crowd.

Workshop Organisation

The workshop is organised as an interactive and participatory hack-a-thon. The focus of the workshop is on creating designs and prototypes within the workshop itself.

The preliminary schedule for the workshop is summarised in Table 1. The main purpose of the session in the morning is to acquaint the participants with each other and to discuss the ideas for future crowd-powered design creativity support systems contributed by the participants. After the welcome and a short interactive introduction of the participants, participants will be introduced with a hypothetical yet realistic design scenario and will be asked to brainstorm interaction models to support design creativity using helpful insights from the crowd.

Following this exercise, participants will discuss their contributed ideas and will form teams around a subset of the ideas. The afternoon is occupied by collaborative work in smaller groups. The purpose of these break-out sessions is to sketch out ideas or even build first prototypes of user interfaces and crowd-powered creativity support systems. In a final presentation, the teams will present their solutions and designs to the whole group.

The workshop does not require a special venue or hardware. Only a projector is required (which the organisers can bring, if needed). The workshop organisers will bring a set of supporting materials (stationary items and grid sheets) to support the hands-on sketching and design of low fidelity paper prototypes and mockups. The organisers will further support the participants with a set of crowdsourcing design heuristics in the form of playing cards.

Participants and Recruitment
Supporting creativity with technology is inherently exploratory and transdisciplinary. The workshop is open to a broad audience to stimulate the workshop participants by exposure to new points of view from different disciplines. We invite designers, researchers and industry practitioners interested in participating to apply. We welcome a diverse set of members from the creativity and DIS community, as well as from diverse research fields, such as, but not limited to, Design,

Jonas Oppenlaender

Naghmi Shireen

Maximilian Mackeprang

Halil Erhan

Jorge Goncalves

Simo Hosio

Communication and Social Science, Sociology, Psychology, Computer Science, and Human-Computer Interaction. Participants do **not** require special technical skills, as the prototypes created in the workshop can also be of low fidelity, *e.g.* paper prototypes.

The organisers will publicise the call for participation on a dedicated website and in mailing lists (Computational Design Groups, CSCW, CHI Announcements, etc.). Furthermore, the organisers will actively recruit participants through their own networks in the computational design, HCI, crowdsourcing and Ubicomp communities.

How to Participate
The workshop is hands-on and emphasises informal group discussions over presentations of individual position papers. To this end, participants will **not** be required to submit a formal contribution to the workshop. Instead, participants will be asked to submit at least one idea for the group work in the workshop in an online application form. The submitted ideas will be shared with the other participants in the workshop. The ideas will form the basis for the formation of teams in the workshop. Submitted ideas are not final, and participants are free to change their idea or join other groups. Submitted ideas should be specific rather than broad. The goal is to generate ideas that a small group of 3–5 people can work on at the workshop.

More information and the link to the online application form can be found on https://creativity-workshops.github.io/cc19/.

Organisers

The workshop organisers are experienced researchers in computational design and crowdsourcing across several contexts. Our past workshops [9, 10, 14, 17, 20] brought together diverse teams of researchers and students. Many participants have continued working on their projects beyond the workshops, generating impactful publications and fruitful collaborations.

Jonas Oppenlaender is a PhD candidate at the Center for Ubiquitous Computing, University of Oulu. His research interests include crowdsourcing, Social Computing and crowd-powered creativity support tools.

Naghmi Shireen is a PhD Candidate at School of Interactive Arts and Technology at Simon Fraser University. Her research interests include developing interactive techniques for design space exploration in parametric systems.

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

Halil Erhan is an Associate Professor in the School of Interactive Arts and Technology, Simon Fraser University. His research focuses on design as a cognitive and collaborative process, and aims at augmenting the designer's decision making with engaging tools mainly for 'creating' built-environments and interactive systems.

Jorge Goncalves is a Lecturer in Human-Computer Interaction at the School of Computing and Information Systems in the University of Melbourne. 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.

References

[1] Ömer Akin. 2001. Variants in Design Cognition. In *Design Knowing and Learning: Cognition in Design Education*, Charles M. Eastman, W. Michael McCracken, and Wendy C. Newstetter (Eds.). Elsevier Science, Oxford, 105–124. DOI:http://dx.doi.org/10.1016/B978-008043868-9/50006-1

[2] Salvatore Andolina, Hendrik Schneider, Joel Chan, Khalil Klouche, Giulio Jacucci, and Steven Dow. 2017. Crowdboard: 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. DOI: http://dx.doi.org/10.1145/3059454.3059477

[3] 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. DOI: http://dx.doi.org/10.1287/orsc.1100.0618

[4] 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. DOI: http://dx.doi.org/10.1145/1822348.1822354

[5] 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. DOI:http://dx.doi.org/10.1093/acprof:oso/9780195147308.003.0008

[6] Kees Dorst and Nigel Cross. 2001. Creativity in the Design Process: Co-evolution of Problem–Solution. *Design Studies* 22, 5 (Sep 2001), 425–437. DOI: http://dx.doi.org/10.1016/S0142-694X(01)00009-6

[7] Douglas C. Engelbart. 1962. Augmenting Human Intellect: A Conceptual Framework. Summary Report. Contract AF 49 638 1024 SRI Project 3578. (October 1962).

[8] Jonas Frich, Lindsay MacDonald Vermeulen, Christian Remy, Michael Mose Biskjaer, and Peter Dalsgaard. 2019. Mapping the Landscape of Creativity Support Tools in HCI. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19)*. ACM, New York, NY, USA, Article 389, 18 pages. DOI: http://dx.doi.org/10.1145/3290605.3300619

[9] 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. DOI: http://dx.doi.org/10.1145/2800835.2800966

[10] Jorge Goncalves, Simo Hosio, Maja Vukovic, Shin'ichi Konomi, and Uichin Lee. 2016. WMSC '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. DOI: http://dx.doi.org/10.1145/2968219.2968584

[11] Kosa Goucher-Lambert and Jonathan Cagan. 2019. Crowdsourcing Inspiration: Using crowd generated inspirational stimuli to support designer ideation. *Design Studies* 61 (2019), 1–29. DOI: http://dx.doi.org/10.1016/j.destud.2019.01.001

[12] Joy Paul Guilford. 1950. Creativity. *American Psychologist* 5 (1950), 444–454.

[13] 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. DOI: http://dx.doi.org/10.1073/pnas.0403723101

[14] 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. DOI: http://dx.doi.org/10.1145/2494091.2495993

[15] Jeff Howe. 2006. The Rise of Crowdsourcing. *Wired Magazine* 14, 6 (2006), 1–4.

[16] Justin Matejka, Michael Glueck, Erin Bradner, Ali Hashemi, Tovi Grossman, and George Fitzmaurice. 2018. Dream Lens: Exploration and Visualization of Large-Scale Generative Design Datasets. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 369, 12 pages. DOI: http://dx.doi.org/10.1145/3173574.3173943

[17] Jonas Oppenlaender, Maximilian Mackeprang, Abderrahmane Khiat, Maja Vukovic, Jorge Goncalves, and Simo Hosio. 2018. DC2S2: Designing Crowd-powered Creativity Support Systems. In *Adjunct Proceedings of the 2019 ACM CHI Conference on Human Factors in Computing Systems (CHI'19)*. ACM, New York, NY, USA. DOI: http://dx.doi.org/10.1145/3290607.3299027

[18] 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. DOI: http://dx.doi.org/10.1177/0963721414531598

[19] 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. DOI:http://dx.doi.org/10.1145/1963192.1963335

[20] Terri Peters and Brady Peters. 2013. *Inside Smartgeometry: Expanding the Architectural Possibilities of Computational Design*. John Wiley & Sons, Chichester, UK.

[21] Daniel M. Russell, Mark J. Stefik, Peter Pirolli, and Stuart K. Card. 1993. The Cost Structure of Sensemaking. In *Proceedings of the INTERACT '93 and CHI '93 Conference on Human Factors in Computing Systems (CHI '93)*. ACM, New York, NY, USA, 269–276. DOI: http://dx.doi.org/10.1145/169059.169209

[22] Naghmi Shireen, Halil Erhan, Robert Woodbury, and Ivy Wang. 2017. Making Sense of Design Space: What Designers do with Large Numbers of Alternatives?. In *Computer-Aided Architectural Design. Future Trajectories*, Gülen Çağdaş, Mine Özkar, Leman Figen Gül, and Ethem Gürer (Eds.). Springer Singapore, Singapore, 191–211. DOI: http://dx.doi.org/10.1007/978-981-10-5197-5_11

[23] Ben Shneiderman. 2002. Creativity Support Tools. *Commun. ACM* 45, 10 (Oct. 2002), 116–120. DOI: http://dx.doi.org/10.1145/570907.570945

[24] Ben Shneiderman. 2007. Creativity Support Tools: Accelerating Discovery and Innovation. *Commun. ACM* 50, 12 (Dec. 2007), 20–32. DOI: http://dx.doi.org/10.1145/1323688.1323689

[25] 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. DOI: http://dx.doi.org/10.1007/978-1-84800-136-7_1

[26] 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. DOI: http://dx.doi.org/10.1207/s15327590ijhc2002_1

[27] James Surowiecki. 2005. *The Wisdom of Crowds*. Anchor, New York, NY, USA.

[28] Rajan Vaish, Snehalkumar (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. DOI: http://dx.doi.org/10.1145/3126594.3126648

[29] Kai Wang and Jeffrey V. Nickerson. 2017. A Literature Review on Individual Creativity Support Systems. *Computers in Human Behavior* 74 (2017), 139 – 151. DOI: http://dx.doi.org/10.1016/j.chb.2017.04.035

[30] 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. DOI: http://dx.doi.org/10.1145/2818048.2820025