

The Sixth International Conference on Design Creativity

PROGRAMME AND BOOK OF ABSTRACTS

26 - 28 August 2020
University of Oulu, Finland

Jean-François Boujut
Chair of the Programme Committee
Grenoble INP, France

Gaetano Cascini
Co-chair of the Programme Committee
Politecnico di Milano, Italy

Saeema Ahmed-Kristensen
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Conference Chair
University of Oulu, Finland

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Organised by

The Design Society

Glasgow, Scotland, UK

Center for Ubiquitous Computing and INTERACT research unit,
Faculty of Information Technology and Electrical Engineering
University of Oulu



Papers for the ICDC 2020 conference are selected via a two-stage peer review process. All the papers submitted to ICDC 2020 have been reviewed by at least three, in many cases four, members of the Scientific Committee. Based on the comments of the reviewers, the Programme Chairs invited authors of selected papers to improve their contributions in response to the reviewer's suggestions. The version of these manuscripts were then evaluated by the Programme Chairs prior to acceptance.

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PREFACE

Founded by the Special Interest Group (SIG) on Design Creativity and supported by the Design Society, the Sixth International Conference on Design Creativity (ICDC 2020) includes works studying the nature of design creativity from several perspectives: design, engineering, computer science, education, linguistics, management, and cognitive science. ICDC 2020 offers a forum for all those actively studying the topic of creativity within design. The authors were invited to address the special theme of Creativity at the Extremes.

Following rigorous two-stage review process, out of the 82 submissions, 47 papers were accepted for presentations at the conference. Out of these, 27 papers were accepted for podium presentations (33%) and 20 were accepted for short presentations.

The programme includes seven podium presentation sessions focused on:

- Measuring Design Creativity and Its Impact
- Applied Design Creativity
- Diverse Perspectives on Design Cognition
- Responsible Design
- ICT and Creative Tools for Innovation
- User-centred Design Creativity
- Design Creativity in Education

Five short presentation sessions in the programme cover topics of:

- Creative Design Processes and Methods
- Creativity in Collaborative and Participatory Design
- Teaching Design Creativity
- Applied Design Creativity
- Case Studies of Design Creativity

We would like to express our gratitude to the work of the 50 reviewers of the Programme committee that was essential for delivering 3-4 reviews for each contribution. These reviews were used by the Programme committee chairs to make informed decisions about acceptance or rejection of the contributions and by the authors to make appropriate revisions of the papers.

Jean-François Boujut, Grenoble INP, France
Gaetano Cascini, Politecnico di Milano, Italy
Saeema Ahmed-Kristensen, University of Exeter, UK
Georgi V. Georgiev, University of Oulu, Finland
Netta Iivari, University of Oulu, Finland

ORGANIZATION

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University of Oulu, Finland

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CONFERENCE AT A GLANCE

WEDNESDAY, JUNE 26

BST (GMT+1)

11:00 - 11:25	Opening
11:25 - 11:55	Keynote 1
11:55 - 12:40	Podium 1
12:50 - 13:50	Podium 2
13:55 - 14:55	Podium 3
14:55 - 15:30	Short 1

THURSDAY, JUNE 27

BST (GMT+1)

11:00 - 11:05	Opening
11:05 - 12:05	Podium 4
12:15 - 12:55	Short 2
12:55 - 13:55	Podium 5
14:05 - 14:40	Short 3
14:40 - 15:10	Keynote 2

FRIDAY, JUNE 28

BST (GMT+1)

10:25 - 10:30	Opening
10:30 - 11:00	SIG Design Creativity
11:05 - 11:35	Live presentation
11:35 - 12:35	Podium 6
12:50 - 13:50	Short 4
13:20 - 14:20	Podium 7
14:30 - 14:55	Short 5
14:55 - 15:10	Closing
15:10 - 15:25	Announcements

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Wednesday 26th August

TIME (GMT+1)

11:00 - 11:25

Opening

11:25 - 11:55

Keynote 1

The secret power of designers: Explaining in sketches

11:55 - 12:40

Podium 1

Measuring Creativity and Its Impact

12:40 - 12:50

Break

12:50 - 13:50

Podium 2

Applied Design Creativity

13:50 - 13:55

Break

13:55 - 14:55

Podium 3

Diverse Perspectives on Design Cognition

14:55 - 15:30

Short1

Creative Design Processes and Methods



Opening



Keynote

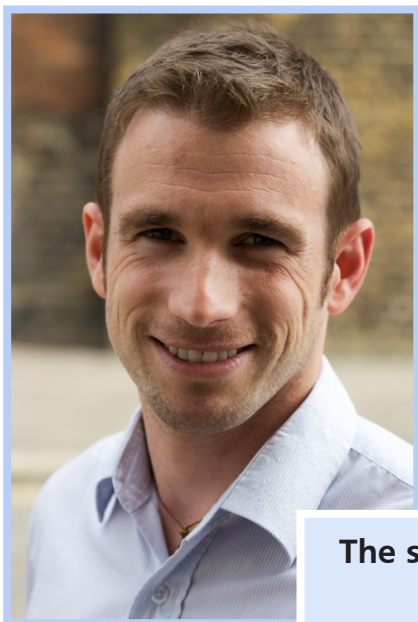


Podium



Short presentation

KEYNOTE SPEAKER



Dr. Jonathan Hey

**The secret power of designers:
Explaining in sketches**

From Da Vinci's journals to a sketch on the back of a napkin that launches a multimillion dollar company, the power to visualise your ideas can give you incredible impact. Drawn from experience across research, teaching, and eight years of a weekly newsletter using sketches to explain I share some of the surprising range of lessons that can be learned from simply visualising your ideas. Externalising and making thought visible creates space to build on your ideas, allows lightweight, fast and free prototyping, helps design teams see why they were all arguing and to see their way to a solution, and helps get through to and engage people when words fail.

Retrospective and Prospective of the Study of Design Creativity: 80 Years into the Past and the Future

Ricardo Sosa^{1,2}

¹Art, Design & Architecture, Monash University Melbourne, Australia

²Design and Creative Technologies, AUT, Auckland, New Zealand

Abstract: Design creativity is a special type of imaginative capacity that plays an important, albeit still little understood, role in design activity. This paper returns to the primary sources to inform a critical review of the early studies of creative reasoning that have heavily influenced what we know and how we know it. It does this to inductively and reflectively formulate a prospective for the future study of design creativity that emphasizes a designerly outlook, facilitation skills, associative reasoning, the unearthing of assumptions, methodological awareness, types and stages of design ideas, design briefs, and purpose of ideation. A rethinking of the premises underlying the study of creative ideation has the potential to transform how we study, teach, and support the creative aspects of design practice in the twenty-first century and beyond.

Keywords: *brainstorming, nominal groups, ideation, research methods, design practice*

On the novelty of software products

Alejandra Beghelli^{1,2} and Sara Jones³

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²Department of Computing, Goldsmiths, University of London, UK

³Cass Business School, City, University of London, UK

Abstract: The identification of the key factors that make a tangible product creative has been the focus of significant research in the area of design. However, the same effort for software products is almost non-existent. With the ever-increasing importance of software applications in day-to-day life, such endeavour becomes more necessary. In this paper we report on preliminary results that build on our understanding of how we evaluate the creativity of tangible products, to identify key criteria that can be used in assessing the creativity of intangible software products. We argue that this provides a basis for designers to work together with software developers in pushing the boundaries of software innovation..

Keywords: *novelty, creativity, software product*

Creativity Assessment via Novelty and Usefulness (CANU) – Approach to an Easy to Use Objective Test Tool

Lorenz Prasch, Philipp Maruhn, Marcel Brönn and Klaus Bengler

Chair of Ergonomics, Technical University of Munich, Germany

Abstract: Creativity, or the ability to generate new and useful ideas or products, is considered a key factor in modern society. The role it plays in the workplace and day-to-day activities is on the rise and - in the light of recent advances in artificial intelligence - will continue to increase. Considering the importance of the subject at hand, the fact that there is no standardized, reliable and scalable measurement tool is astonishing. In this paper, we introduce the creativity assessment via novelty and usefulness (CANU), an approach to an easy-to-use online measurement tool for creative performance. Using specifically tailored tasks, we aim to assess participants' performance in regard to the novelty and usefulness of solutions they produce.

Keywords: *creativity, measurement, user-centered design, tool*

Co-Design Visions of Public Makerspaces in China

Busayawan Lam¹, Youngo Choi¹, Xi Chen¹, Sophia de Sousa², Long Liu³ and Mingqing Ni³

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²The Glass-House Community Led Design, London, United Kingdom

³College of Design and Innovation, Tongji University, Shanghai, China

Abstract: This paper discusses the design and outputs of co-design workshops used to facilitate the co-creation of a shared vision for public makerspaces in China and the design of such space. The workshops were held with Chinese and non-Chinese participants to identify similarities and differences in terms of approaches, outputs and key considerations. Initial results suggested that these workshops were effective at supporting value co-creation, as they excel at engaging participants and enable them to collaborate as equal partners. It was observed that Chinese participants were rather pragmatic and conscious of sustainable growth.

Keywords: *co-design, makerspaces, value co-creation*

Businesspersons' idea generation confidence shifts through a minimum design thinking training

Nanami Furue

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Abstract: Design thinking has long been focused as one of the methods for generating innovation. However, the universal effect of applying design thinking to the real business has sometimes been questioned. This paper aims to get more depth understanding towards change of the confidence at pre/post-minimum -design-thinking training on businesspersons. Through an analysis of answers from questionnaires collected at a half day design thinking workshop for businesspersons in Japan, two new hypotheses were suggested as (i) those who have originally high creative self-efficacy will lose their confidence and feel less easiness on idea generation after design thinking training and (ii) those who are not confident will gain their confidence and feel more easiness on idea generation after design thinking training. This study implied difference of idea generation confidence shifts by difference of the original self-confidence before and after the minimum design thinking training.

Keywords: *design thinking education, creative self-efficacy, behavioural confidence, idea generation, new product development*

Participation of healthcare representatives in health-related design sprints

Mira E. Alhonsuo¹, Melanie A. Sarantou¹, Samantha J. Hookway², Satu A. Miettinen¹ and Maarja Motus³

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²HDK-Valand Academy of Art and Design, University of Gothenburg, Gothenburg, Sweden

³Faculty of Design, Product Design department, Estonian Academy of Art, Tallinn, Estonia

Abstract: This paper examines the participation of various healthcare specialists and representatives in three design sprints aimed to co-design healthcare services through service design approaches. The design sprints were executed during the spring of 2019 in Gothenburg, Sweden; Tallinn, Estonia; and Rovaniemi, Finland, each lasting four to five days. This paper discusses the varied roles of healthcare representatives as participants in health-related design sprints and how these different participatory roles can optimise, support and catalyse design sprint processes to develop health services. The findings show that by being part of a team, healthcare representatives can learn to use design methods and design thinking, which have an impact on future development work for healthcare services. The value of the paper lies in presenting a practical framework for use in design sprints by healthcare representatives towards the development of health-related services.

Keywords: *Service design, healthcare, design sprint, participation*

Fixation in the creative practices and Perceptions of Independent Ceramic Designers

Qianang Sun and Eunyoung Kim

School of Knowledge Science, Institution/Japan Advanced Institute of Science and Technology, Nomi, Japan

Abstract: Fixation, as a mental activity, is usually discussed in the design process and creative expression. Several studies have conducted experiments aiming to find how to reduce the fixation in design processes and enhance creative expression. However, there is little concern about how designers deal with the fixation in their real works so as to improve the understanding of design fixation effect on the design process. Ceramic design, as a practice-based zone of design, has contributed to people's daily lives not only as a utilitarian product, but also as a means to meet increasingly unique and aesthetic needs through creative outcomes. In this study, we propose to explore the designer's perceptions of fixation, which is embedded in their practice process through interviewed independent ceramic designers. Thirteen participants have been recruited, and we have adopted a thematic analysis in this research. The findings show that three elements should be noted in addressing the fixation involving 1) Repetition, 2) Transformation and 3) combination. Furthermore, the design fixation should be discussed with critical thinking by combining case studies in the future. This study will benefit craft designers and related stakeholders, and also provide a reference for design education.

Keywords: *Design, Fixation, Ceramic Design, Design process, Creative expression*

Enhancing creativity by demonstrating individual vulnerability to fixation

Maria A. Neroni and Nathan Crilly

Department of Engineering, University of Cambridge, UK

Abstract: Creative design behaviour can be inhibited by fixation and so reducing the risk of fixation is a focus of much design creativity research. Research in other fields indicates that an effective way of encouraging people to guard against a risk is to demonstrate that they, as individuals, are vulnerable to those risks. To study the effect of demonstrating individual vulnerability to fixation, we conducted an online experimental study using number and word tasks that are known to induce fixation. The first task was used to provide a 'demonstrated vulnerability' treatment (revealing the participants' own fixated behaviour to them) and to provide the explanation for a comparable 'asserted vulnerability' treatment (warning participants about general fixation effects). In the subsequent creative task, the 'demonstrated vulnerability' group outperformed those in the 'asserted vulnerability' group and also those in a control group.

Keywords: *bias, demonstrated vulnerability, fixation, problem-solving, controlled experiment*

Brain Activity in Constrained and Open Design Spaces: An EEG study

Sonia Vieira¹, John S. Gero², Jessica Delmoral³, Shumin Li¹, Gaetano Cascini¹ and António Fernandes⁴

¹Department of Mechanical Engineering, Politecnico di Milano, Italy

²Department of Computer Science and School of Architecture, UNCC, Charlotte, NC, USA

³INEGI-FEUP, Porto, Portugal

⁴Faculty of Engineering, University of Porto, Portugal

Abstract: Creativity is recognized as essential for changing the design space from constrained to open spaces. This study compares the neurophysiological activations of 18 professional industrial designers in two prototypical tasks, a problem-solving constrained layout task and an open design task. The analysis focused on measuring the cognitive demand in three stages of designing in constrained and open design spaces, namely: reading, problem-solving/reflection and layout/sketching. Results indicate significant differences in activations between the constrained task and the design task. Significant differences in activations involved in design reading, reflecting and sketching in open design tasks can be found in the left prefrontal cortex, temporal and occipital cortices. In particular, reading open or constrained requests evoked different levels of conceptual expansion prompting designers to change their design space, while reflecting evoked visual imagination and associative reasoning modes and hemispheric differences from problem-solving leading to expanded activation in sketching, which translates in higher activation in the open design task. These results show significantly different brain activations when designing in constrained and open design spaces.

Keywords: *designing, open space, constrained space, electroencephalography, industrial designers*

An analysis of socio-cognitive activities during co-creative design supported by spatialized augmented reality

Cédric Masclet, Laetitia Baldacchino and Jean-François Boujut

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*Institute of Engineering Univ. Grenoble Alpes

Abstract: This study investigates the mechanisms by which spatial augmented reality (SAR) technology can affect socio-cognitive processes in groups involved in co-creative design sessions. A protocol analysis has been conducted to investigate three different design sessions involving experienced designers and end-users on a product design task: a design session supported by classic design representations (usual design practices), a design session supported by non-spatial augmented reality (AR), and a session supported by SAR technology. While results don't clearly show that SAR or AR technology increase end-user/client commitment, they illustrate the ability for these technologies to allow browsing through more ideas during a co-creative design sessions. Furthermore, it tends to reduce time spent on ideas, compared to a traditional session. We also noted that the introduction of these different technologies does not modify the profiles of the sessions in terms of cognitive activities. This tends to demonstrate that the technology itself does not impair the design activity.

Keywords: *Co-creativity, Spatial Augmented Reality, cognitive activities, interaction analysis*

Sustaining creativity with neuro-cognitive feedback: a preliminary study

Tripp Shealy¹, John Gero², Julie Milovanovic³ and Mo Hu¹

¹Departement of Civil and Environmental Engineering, Virginia Tech, Blacksburg, VA, USA

²Department of Computer Science and School of Architecture, University of North Carolina at Charlotte, Charlotte, NC, USA

³Department of Architecture, Graduate School of Architecture and Ecole Centrale, Nantes, France

Abstract: Ideation is a key phase in engineering design and brainstorming is an established method during ideation. The proposal of ideas tends to peak at the beginning of the brainstorming process and quickly decreases over time. In this preliminary study, we tested an innovative solution to sustain ideation by providing engineering designers feedback about their neuro-cognition. We used a novel neuro-imaging technique called functional near-infrared spectroscopy (fNIRS) to monitor engineering design students during a brainstorming task. Half were given real-time feedback about their brain activation. Our results show that these students applied more cognitive effort in the region of the brain generally associated with memory retrieval and making associations compared to the control group of students that were not provided neuro-feedback. Students that received neuro-feedback also generated significantly more concepts over time and displayed a higher fluency of engineering design solutions.

Keywords: *neuro-cognitive feedback, fNIRS, design engineering, creativity, brainstorming*

An Interaction-based Design Thinking Approach for Architecture as A Complex Adaptive System

Tao Shen¹ and Yukari Nagai²

¹College of Design and Innovation, Tongji University, Shanghai, China

²Knowledge Science, Japan Advanced Institute of Science and Technology, Nomi City, Japan

Abstract: Creativity is a vital part of design studies, and many literatures have approached design creativity from the perspectives of cognition and social behaviors. Several methods and tools have been introduced for enhancing design creativity, most of which focus on two aspects—the process and outcome of design. However, these methods for creative architecture design mainly follow a reductionist approach, and the complex nature of the 21st century architecture is often ignored. In this paper, we first review the simplicity and complexity of architecture, based on which we acknowledge architecture as a complex adaptive system, and present a new design thinking approach for creative architecture design, named “Concept Topology Optimization” (CTO). A case study that utilizes CTO is conducted to explore the application of the proposed method in the architecture space design, and a controlled experiment demonstrates the effectiveness of this method by measuring the idea quality and quantity.

Keywords: *creativity, architecture design, complexity science, topology*

The problematization for the creativity in design

Luiza Grazziotin Selau^{1,2,3}, Julio van der Linden² and Carlos Duarte³

¹Department of Design, Aalto University, Helsinki, Finland

²Department of Design, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

³Department of Design, IADE – Universidade Europeia, Lisbon, Portugal

Abstract: This paper discusses the relations between stages of design projects. The literature review is based on authors who already discussed the subject to present a reflection on the stages of the process, focusing on the stage of problematization in order to establish relationships and show the importance of this stage in projects. It is intended to show that the problematization has an impact on the creativity phase and, consequently, on the results of the project. The literature review shows the link between the problematization and the design process as a whole. Besides proposing that with a well developed problematization the designer acquires the necessary knowledge about the project so that the creativity stage is well-done and the project results are more assertive. In this way, it is considered that the problematization has importance in the whole project process. So article shows the importance of this step for a design project.

Keywords: *Design, Creativity, Problematization, Process, Methods*

A Bottom-up Functional Domain Synthesis Approach for Creative Conceptual Design

Yutong Li and Yuxin Wang

Department of Mechanical and Electrical Engineering, China University of Petroleum, East, Qingdao, China

Abstract: For expanding the solution space of conceptual design, a bottom-up functional synthesis approach through a partition of the functional domain of the design problem for mechanical products based on the equivalence relations in granularities, topologies, and attributes based on the domain synthetic theory in quotient space is proposed. The equivalence partition rules are objective and independent of a designer's experience and knowledge. Different equivalence partition rules will lead to different sub-functions, working principles, and function-structures to be generated. Then, the partition schemes based on the granularity equivalence relations are secondly divided into two quotient spaces corresponding to the time sequence equivalence relation and the space position equivalence relation, respectively. In this way, the synthesized sub-functions, which are formed and contributed by all of the basic operation actions in the divided subsets, can take place in time and space continuously and orderly.

Keywords: *creative conceptual design, functional domain synthesis, time order, space order*

Literature review: Existing methods using VR to enhance creativity

Zhengya Gong and Georgi V. Georgiev

Center for Ubiquitous Computing, University of Oulu, Finland

Abstract: Virtual reality (VR) technology has introduced a range of equipment, contexts, and stimuli with possible applications in the context of design creativity. In response, recent studies have investigated VR as a tool that can be applied to enhance creativity. As a part of such research, this paper reviews existing studies and provides a state-of-the-art literature review based on the componential theory of creativity. Based on studies that investigate the use VR to enhance creativity, we found that VR can be used to improve specific factors to enhance creativity, and a natural environment can be considered a positive factor for enhancing creativity. Therefore, we propose a hypothesis that VR technology could be a useful method to simulate nature for enhancing creativity; experimentation based on the hypothesis is expected to be conducted in the future.

Keywords: *virtual reality, creativity, simulated nature, immersion, context*

Thursday 27th August

TIME (GMT+1)

11:00 - 11:05	Opening
11:05 - 12:05	Podium 4 Responsible Design
12:05 - 12:15	Break
12:15 - 12:55	Short 2 Creativity in Collaborative and Participatory Design
12:55 - 13:55	Podium 5 ICT and creative tools for innovation
13:55 - 14:05	Break
14:05 - 14:40	Short 3 Teaching Design Creativity
14:40 - 15:10	Keynote 2 Creative Collaboration

Opening Keynote

Podium Short presentation

Thursday

Success-oriented eco-ideation sessions: lessons learnt from the use of ten eco-design guidelines

Lorenzo Maccioni and Yuri Borgianni

Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

Abstract: The fields of eco-design and design creativity have not found strategic synergies yet. This applies despite the fact that the paramount objective of eco-design, i.e. sustainable development, might benefit from the radical design changes creativity can engender. In parallel, those significant changes should also support the transformation of products towards designs that exhibit major success chances, which is still in line with the perspectives of sustainable development. The authors have developed ten guidelines to guide eco-design towards creative and successful outcomes and the present paper illustrates the first experimentation thereof. The results of the experiment show that the compliance with the guidelines determines a satisfactory trade-off between environmental friendliness and success chances, as well as fully increasing the novelty of ideas. The outcomes are however affected by a remarked misalignment between the views of the two evaluators, i.e. an industrial player and an academic expert in eco-design.

Keywords: *eco-ideation, success, design creativity, eco-design guidelines*

Revealing the hidden: Using a co-design approach to explore on campus energy use through the representation of consumption data

Ian Gwilt and Aaron Davis

University of South Australia, Adelaide, Australia

Abstract: Cities around the world are looking for ways to reduce the energy consumption associated with the built environment, but there are a number of significant challenges in this. These include, difficulties in making energy consumption data meaningful, particularly when people are not financially liable for consumption, and communicating the complexity associated with energy mix. In this research, data physicalisation principles are applied through a co-design approach to investigate how the users of a university campus understand the concept of energy. Key findings include a tension between a scientific understanding of energy and the experience of various forms of human energy including both physical and metaphysical understandings of energy, and the importance of translating energy data from the quantitative into an emotional context in which people can be encouraged to stop and take note. This is reflected upon in the context of sustainability transitions and behaviour change approaches more generally. The paper also reflects on the process of using a series of creativity tools to facilitate the co-design process, asking the same group of participants to reflect on similar questions using multiple co-design and creativity techniques. The results of this approach show promise as a way of facilitating complex co-design processes with diverse groups of stakeholders.

Keywords: *Data Physicalisation, Co-design, Design Thinking, Sustainability, Visualisation*

Understanding emotional responses and perception within new creative practices of biological materials

Nurul 'Ayn Ahmad Sayuti¹² and Saeema Ahmed-Kristensen¹

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²Industrial Design Department, Faculty of Art & Design, Universiti Teknologi MARA, Malaysia

Abstract: There is an increasing trend for designers to use living systems, through biodesign and biophilia in the urban environment. As new creative processes emerge, the perception and emotional responses of users towards these new systems are somewhat unknown. This paper aims to study the emotional responses and perceptions towards biological materials that are embedded in existing product designs. Data was collected from 58 respondents through an online questionnaire. The findings from this exploratory study show that the significant differences by comparing the respondents with a background in design and non-design towards the level of desirability, practicality, aesthetically pleasing and the common use towards artificial and real biological materials. This paper extends existing understanding of perception and emotional responses to design incorporated living systems and can begin validating existing studies which have brought different perspectives towards the functions, practicality, aesthetical value and emotional attachments of products.

Keywords: *biophilic design, biodesign, biological materials, emotional design, product design*

Sensemaking in the Design Space: In-betweenness and Identity Construction of Design Managers

Tarja Pääkkönen, Melanie Sarantou and Satu Miettinen

Faculty of Art and Design, University of Lapland, Rovaniemi, Finland

Abstract: Identities and notions of the in-betweenness of designers in management positions in Silicon Valley might be shaped by one another given changing sensemaking contexts. As organising becomes less bounded with shorter job tenures designers have been constructing their identities in interactions with diverse stakeholders. Tools, skills and values together with previous experiences continuously shape design manager identities. This research explored design manager in-betweenness by linking it with identity construction, critical sensemaking and social constructionism. While hybrid design managers produce profits and innovations by utilising user data, they also might steer their organisations towards more inclusive values and global responsibility. Internal struggles may follow while there is a need for open interdisciplinary reflection. A broader global understanding of the design space is suggested. Implications for education extend beyond the design field. Deeper reflection on ethics and production consequences across occupational silos enhances critical thinking, enabling collective identity cultivation in organisational sensemaking.

Keywords: *identity construction, in-betweenness, design space, strategy, sensemaking*

Participatory Design Research of Vegetable-based Snack Products with Adolescent Participants

Alice Gilmour, Steve Gill and Gareth Loudon

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Abstract: The childhood obesity epidemic is often attributed to the widespread marketing of High Fat, Salt and Sugar (HFSS) foods. Currently, there is a lack of vegetable-based New Product Development (NPD) targeting adolescent consumers. The study aimed to investigate adolescents' willingness to incorporate three vegetables: cauliflower, potatoes and cabbage into vegetable-based snack products. Two participatory design research sessions were conducted with Welsh adolescents aged 12- to 13-years-old (n=41). The adolescents undertook three activities: (1) listing snack products currently eaten; (2) determining foods they associated with cauliflower, potatoes and cabbage; and, (3) designing a new vegetable-based snack product. Abductive thematic analysis resulted in four themes: taste preferences, commercial branding, convenience, and health consciousness. Developing healthy vegetable-based snack products could potentially improve the dietary quality of adolescents. This is one of the first participatory design research studies to include adolescents in the NPD process for healthy snack products.

Keywords: *Participatory design research, New Product Development, Adolescents, Food choices, Vegetables*

Process for Mapping Challenges of Cross-Border Mobility in the Barents Region

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Abstract: There is a challenge in identifying problems in common to tackle them creatively and jointly in Mobility as a Service (MaaS) development. This all requires collaboration and commitment, which is a wicked problem and a novel perspective in transportation and MaaS development. Mess Map™ is a tool to aid in creating shared understanding in cross-border mobility in the Barents region. Mess Map™ is a giant map that aims to map the whole complexity through a dialogue among the relevant stakeholders involved. In this case study, there were five transportation and MaaS projects besides other relevant stakeholders involved. The meetings were facilitated and run from a service design perspective that has a co-creational and holistic aim. The objective was to understand how the tool can be used in a service design process and how it can help the stakeholders to engage and find common goals.

Keywords: *Cross-border mobility, complex stakeholder management, Mess Mapping™, service design, wicked problems*

Let's hear children's voice. An implementation of a design process model to understand children's views on tangible interaction.

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Tonja Molin-Juustila², Anne-Marie Oikarinen² and Jukka Riekk¹

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Abstract: Children provide innovative insights and perspectives when designing and evaluating prospective technologies and interaction methods. However, working with children as design informants requires careful consideration of the methodologies used in different steps of the design process. In this paper, we present our insights on a case-study of a design process with 24 children (9-12-year-olds), aiming for understanding children's view on new technologies and their perception on tangible interaction. We utilized a lightweight design process model: children first reflected on the use of technologies and participated in an ideation session. Based on the results, researchers built prototypes which were evaluated by the children in the final step of the process. We expect our learnings to help researchers in the field of collaborative design when organizing design activities with children.

Keywords: *children, co-design, design circle, design methodologies, brainstorming, evaluation, tangible interaction*

Drowning prevention by design: the semiotics of prototyping in low-resource environments – case study Zanzibar

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Abstract: This paper presents an overview of an exploratory case study collaboration between Arts University Bournemouth (AUB) and the Royal National Lifeboat Institution (RNLI) in support of an RNLI delivery programme for international community management of drowning prevention in low-resource environments. The study focuses on the development of low-volume public rescue throw-lines that can be community made and maintained, the assembly and use of which are supported by a set of RNLI-developed instruction manuals intended for universal dissemination. The study examines the clarity of the instructions in the context of the makers' interpretation of the manuals within the local constraints of Zanzibar. Preliminary findings indicate that these universally intended instruction manuals, in their current format, are open to interpretation, producing unsafe drowning prevention rescue lines that do not meet safety-critical standards. A re-design of the manuals through creative collaboration in a local context are the outcomes of this research. Discussion is also given as to whether a universal instruction manual should be the desirable outcome.

Keywords: *human-centred design, universal design, design for development, interactive prototyping, instruction manual design*

Emotions: The invisible aspect of co-creation workshops

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Abstract: This article focuses on the emotions service designers experience in their role as facilitators. We will explore emotions in the context of a co-creative environment, and discuss how encounters between participants and facilitators generate different perspectives despite a common environment. Facilitators' perceptions of participant emotions are lacking in accuracy due to the influence of their own emotional experiences during a workshop. This article suggests that knowledge and understanding of the emotional aspect of co-creation workshops could provide facilitators with additional support when conducting workshops, and lead to better outcomes and more meaningful experiences for all involved..

Keywords: *emotions, service design, co-creation, facilitators*

The Effect of Abstraction Methods in Bio-inspired Design – A Workshop and a Team Project Perspective

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Abstract: Bio-inspired design can inspire highly innovative technical solutions. However, biological inspirations in most cases have to be abstracted to transfer useful analogies to the technical domain. Is it worth the effort to use supporting methods, namely BioCards and KoMBi, or can design teams develop bio-inspired solutions of the same quality without these methods? To answer these questions, we conducted workshops with pairs of engineering design students collaborating in an agile development project. The results of our study show that the task-specific quality of solution ideas increased significantly when using the BioCards method. The analysis of the prototypes developed throughout the project shows that the use of both abstraction methods has the highest effect on the abstraction level of analogical transfer and on the depth of understanding of the biological inspiration. These results indicate that the use of abstraction methods is recommendable for bio-inspired design teams in a comparable setting.

Keywords: *biomimetics, agile product development, design-by-analogy, biocards*

Similarity Computation Supporting Creative Activities

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Abstract: Creativity sessions in industry, when they are based solely on people's knowledge, produce less and less value. This is mainly due to the need to further expand the spectrum of knowledge needed to solve problems. We are therefore increasingly witnessing the limits of our knowledge capabilities to meet the demands of today's inventive problem-solving in industry. The research presented in this paper proposes a method of semantic association between problems extracted from an unstructured textual corpus of a patent using Google's Word2vec algorithm followed by cosine similarity to create original pairings between problems from different but semantically close domains. We postulate that such a method is a preamble to the automation of TRIZ and thus avoids the difficulties of not having been updated for a few decades.

Keywords: *Design thinking, fixation, ideation, creativity*

Opportunities with Uncertainties: The Outlook of Virtual Reality in the Early Stages of Design

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Abstract: Adopting immersive Virtual Reality (VR) technology in the early stages of design appeals to designers, as research has shown that immersing people in a virtual environment can efficiently elicit empathy and facilitate deeper understanding of out-group members. However, after exploring and synthesis literature across the fields of design, psychology, and neuroscience, the present study found the opportunities VR opens to be accompanied by uncertainties. In this study, we (1) identified the benefits of adopting immersive VR in the early design stage, such as enhancing empathy and promoting design equity, (2) discovered previously unrealised problems that VR may bring to the design process, especially potential biases owing to emotional connections, and (3) determined a future direction for relevant research: gaining deeper knowledge about operators' mental activities to mitigate biases and uncertainties.

Keywords: *virtual reality, conceptual design, experience, empathy, human-centred design*

The Wrong Theory Protocol: A design thinking tool to enhance creative ideation

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Abstract: Supporting designers to empathize with stakeholder points of view while still developing creative solutions is challenging, particularly when stakeholders' lives and experiences are quite different from their own. In this study, we characterize a new ideation technique, wrong theory protocol (WTP), that has supported student designers to come up with empathetic and creative ideas. Participants included students enrolled in undergraduate and graduate courses at a Hispanic-serving, research university in the southwestern US. In WTP, participants first frame a problem and are then prompted to come up with solutions that would harm and humiliate the intended users before coming up with beneficial ideas. Using artefacts from WTP sessions, we analysed the diversity of both harmful/humiliating and beneficial ideas. WTP participants produced divergent, empathetic ideas, suggesting WTP supports creative ideation.

Keywords: *TRIZ, Inventive Design Method, Artificial Intelligence, Machine Learning*

Forcing Creativity in Agile Innovation Processes through ASD-Innovation Coaching

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Abstract: The challenge to handle uncertainties as well as a rapidly changing and challenging environment in product development is increasingly faced by implementing agile approaches and creativity methods into the companies' organization. To foster the goal of agility in product development processes the approach of Innovation Coaching in ASD – Agile Systems Design helps organizations to leverage their innovation potential. This empirical research defines the concept of ASD-Innovation Coaching, which enables product development teams to introduce and deepening their competencies into an agile and structured innovation process with the aim of implementing a degree of agility that is appropriate to the complexity of the task to be accomplished. The necessary activities of an ASD-Innovation Coach are described and located contentwise in order to enable problem-solving teams in agile development projects of ASD. Coaching the team with a deep understanding of the technical system and agile approaches fosters systematic agility and generates increased creativity into development projects.

Keywords: *ASD-Innovation Coaching, agile approaches, product development, coaching activities, ASD – Agile Systems Design*

On the design of playful training material for information security awareness

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Abstract: This paper presents the rationale for the design of a card deck game sustaining information security training. The efforts have followed design thinking, been inspired by an approach for problem-based learning, and used gamification. The card deck game primarily aims to support entrepreneurs in small and medium-sized manufacturing companies, heading towards the introduction of digital services, yet is also useful for anyone to practice risk awareness. Information security, here in short representing the efforts to protect information and mitigate risks to uphold confidentiality, integrity and availability, is by SMEs often seen as a technical problem, but is depending on human behaviour. Literature on security training, emphasises the relevance of interpersonal dialogues and reflection, such reflection is not supported by traditional education, as for instance reading theory and answering questions. The application of gamification has shown to increase awareness, where the play becomes an eye-opener to progress focused dialogues and learning.

Keywords: *Serious play, Gamification, Design thinking, Educational games, Digital service innovation*

Bridging Design Thinking and EntreComp for Entrepreneurship Workshops: A Learning Experience

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Abstract: Design Thinking (DT) is commonly used in Entrepreneurship Education, however its capacity to support entrepreneurial competencies has not been explored sufficiently. In this study, we used a multi-method approach to gain an in-depth understanding of participants' learning journeys in two early entrepreneurship events. These were structured around DT and specifically IDEO's implementation of Human Centred Design (HCD). Through semi-structured interviews and non-participant observation we were able to link the stages of HCD to specific competencies and identify competencies that manifest across the wider process. We draw conclusions on the contribution of DT in the development of these competencies and make suggestions for using EntreComp to add nuance to DT interventions. Finally we discuss the impact of facilitation, professionalism, customization and logistical factors on the success of DT interventions.

Keywords: *Design Thinking, Entrepreneurship, Entrepreneurship Education, Entrepreneurial Competencies, EntreComp, Human Centred Design*

Teaching creative design and systematic creativity: overview and case study

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Abstract: The growth of eLearning technologies seriously outpaces the research-based recommendation on how to apply these tools for predictable and effective results. The emerging education technologies provide an opportunity for teaching improvement. This research refers to the teaching in the field of creative design. The study helps to understand which education innovative teaching methods and learning strategies are used for teaching creative design and specifically TRIZ. The aim of this paper is to overview the innovative teaching methods for creative design and education technologies used for its teaching. The study overviews the most influential cases of creative design teaching and introduces online and digital teaching approaches based on the case study in LUT University. The learning environments for the course of "Systematic Creativity and TRIZ" are described. The review demonstrated that the most influential approaches to teaching creativity are problem solving and collaborative learning with limited technology implementation and description. The experience of teaching demonstrates that flipped classroom setup increases the engagement measured by students' high video views and involvement in the class.

Keywords: *Creative Design, Systematic Creativity, TRIZ, Teaching, Education Technology; Flipped Classroom*

KEYNOTE SPEAKER



Prof. Jill Perry-Smith

Creative Collaboration

Jill Perry-Smith researches and writes about creative problem-solving, entrepreneurship and social networks. She is fascinated by people dynamics and informal relationships that undergird the formal organization. In another stream of research, she explores how family influences work engagement and the role of company policies that help employees integrate life and work. Her research has appeared in leading management journals such as *Academy of Management Journal*, *Organization Science*, and *Journal of Applied Psychology*; she also has contributed to several books including *Encyclopedia of Creativity*, and *The Oxford Handbook of Creativity, Innovation, and Entrepreneurship*. Jill has been quoted in outlets such as CNN.com, Inc Magazine, and the Atlanta Journal Constitution.

Prior to her academic career, Jill Perry-Smith worked in the oil and gas industry overseeing large refinery expansion projects across the United States. She brings her unique vantage point as a former civil engineer to her approach to research and teaching.

Friday 28th August

TIME (GMT+1)

10:25 - 10:30	Opening
10:30 - 11:00	SIG Design Creativity
11:00 - 11:05	Break
11:05 - 11:35	Live presentation Fab Lab Oulu
11:35 - 12:35	Podium 6 User-centred Design Creativity
12:35 - 12:45	Break
12:45 - 13:20	Short 4 Applied Design Creativity
13:20 - 14:20	Podium 7 Design Creativity in Education
14:20 - 14:30	Break
14:30 - 14:55	Short 5 Case Studies of Design Creativity
14:55 - 15:10	Closing
15:10 - 15:25	Announcement

Opening Keynote

Podium Short presentation

SIG Design Creativity



Prof. Yukari Nagai

SIG Design Creativity

Prof. Yukari Nagai contributes to the developing discipline of design in her capacity as Chair of Design Creativity SIG of the Design Society (2007-), Fellow of Design Research Society (2010-), and member of the Advisory Board of Design Society (2011-); she has been instrumental in organizing a community of design researchers as Editor-in-Chief of International Journal of Design Creativity and Innovation, Taylor & Francis (2013-); she served as Guest Editor on the special issue of *Artifact* (2008) on Design Research Methods; she edited the special issue of *Journal of Engineering Design* (2010) on Design Creativity, held the position of Co-Chair of the ACM Creativity and Cognition Conference (2013) and Vice-Chair of the International Conference of Design Creativity (2012, 2015, 2016).

Facilitating design for the unknown: An inclusive innovation design journey with a San community in the Kalahari Desert

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Abstract: This paper presents a 2-year collaboration that explored how we as design researchers may support an isolated and marginalised indigenous San community to innovate technology products for affluent consumer markets on the other side of the world. The goal was to design a product that brings income to the community, builds skills while facilitating a creative design of self-expression. Community-based co-design was integrated into an inclusive innovation approach. The resulting product was a series of fridge magnet souvenirs using augmented reality technology. As the community was designing not only for a technology but also for an audience unknown to them, we conceptualised the unknown within the process. Our role extended to facilitating negotiations between commercial goals and communities' creative self-expression. We present the appropriated community-based co-design process and reflect on how our facilitation of the unknown affected the process, the creativity and the self-expression by the San participants.

Keywords: *inclusive innovation, community-based co-design, San, Namibia*

Value conflict, convergence and evolution – values shaping cross-disciplinary design

Netta Iivari

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Abstract: Values are shaping and underlying our behaviour, including creative design. In cross-disciplinary design, there may be a multitude of values shaping and underlying design. So far, there is a lack of studies on values in cross-disciplinary design. This study utilizes a value lens to examine cross-disciplinary design of a learning application within which Human Computer Interaction (HCI), educational science and Information Technology (IT) specialists as well as users acted as design participants. The study reveals numerous values implicated in design. Educational science specialists emphasized a multitude of values; sometimes even conflicting ones, in their design for learners, while HCI specialists and IT specialists advocated Security and Self-Actualization values for users. Both value conflicts and convergence emerged and those were identified both between and among these designer groups as well as between designers and users. Evolution and negotiation of values was also observable. Implications for research and practice are discussed.

Keywords: *values, cross-disciplinary design, multiparty design, creative design*

Design for One: Personalisation and experiences of design researchers and participants

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Abstract: Personalisation in design is desired to address the uniqueness of people, and the design for one process is suitable to achieve this. However, more research is needed on people's experience with such a process to learn from it and improve it. We describe and examine the design for one processes of three different design cases, where young design researchers co-design with older adults to create personal designs. We found that the process is beneficial to interpret results better. However, the workload needs to be considered, and we can potentially extend further in personalizing the process by defining the users' creative strengths beforehand. Furthermore, we discuss applying this design for one process with other target groups and discuss the value of the unique findings of each particular case. Hereby, we contribute to how to execute and evaluate the design for one process and further enhance it for application in sensitive settings.

Keywords: *design for one, co-design, personalisation*

Empathy and Idea Generation: Exploring the Design of a Virtual Reality Controller for Rehabilitation Purposes

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Abstract: The paper explores the ideation and design of a Virtual Reality (VR) proof-of-concept controller for rehabilitation of users with limited physical mobility (upper-limb disability). An existing tracker solution is used to map input (actions and movements) in VR. The main challenge was integrating some of the default functionalities existing in current commercial VR controllers, while providing an empathic setup and a use-case for disability rehabilitation, as well as keeping the controller compact, lightweight, and handheld. The prototyping process followed a human-centred explorative design idea generation. Only limited functionality of existing commercial controllers was maintained, with the feasibility and readiness for implementing additional functionalities to use the controller with existing applications and future use cases. An experiment was performed to investigate the usability of the system and the effectiveness and reliability of the controller in empathic re-mapping of real-life disability to VR.

Keywords: *virtual reality, healthcare design, rehabilitation, empathetic design, human-centered design*

The effects of customers' cultural values on their perceptions of lodging service quality: A comparative analysis of customers at traditional Japanese inns

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Abstract: Growth in international travel has led to the need to be aware of cultural elements in designing services. This paper examines how consumers' culture influences their perceptions of lodging service quality with strong cultural characteristics, by comparing the evaluation of Asian and Western guests at Japanese-style inns (ryokan). Results show differences in their perceptions, with Western guests evaluating the service more preferably than Asian customers. The study suggests lodging facilities to consider the culture of their guests when designing their service environment.

Keywords: *tourism, hospitality, lodging industry, culture, service quality*

Analysing Divergent-Convergent Activities in the Architectural Studio, with the aid of the 'Knowledge Construction Activities' model

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Abstract: Design activities and divergent-convergent developmental activities are considered to be of essential importance in developing design solutions, making them an important learning objective in the architectural studio. However, since most studio assessments focus on the quality of the artefact, learners are not provided with adequate feedback as to their achievements in applying these activities during the learning process. In response, this study utilizes the "Knowledge Construction Activities" (KCAs) model as a means to measure the application of the stated activities in learners' performance throughout the course. Learners' design decisions and the modifications applied upon them to generate design development are coded into measurable learning graphs, making it possible to identify peaks of divergent-convergent activity as well as reduced practice. A case study of three undergraduates highlights in detail each subject's performance, providing the means to support a custom-tailored approach to teaching.

Keywords: *KCA analysis, studio, divergent convergent activities, creativity, learning analytics*

Relationship between design thinking and personality traits

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Abstract: This paper is an attempt to gain better insight into design thinking from a micro-viewpoint through the association of design thinking with human beings' personality traits. Based on previous research, we conjecture that personality traits are also associated with the capacity for utilizing design thinking. To test our hypothesis, we focused on the five-stage Design Thinking model proposed by the d.school and utilized FFM (Five-Factor Model) to describe personalities. 28 students, who have experiences of design thinking activities, participated in the study. We used correlation analysis and observed the significant relationship between personality traits and individuals' capacity for utilizing design thinking.

Keywords: *Design thinking, Personality traits, Five-factor model*

A Statistical Analysis for the Car Key Fob Crowdsourced Design Evaluation Results based on the cDesign Framework

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Abstract: The “power of the crowd” has been repeatedly demonstrated and various Internet platforms have been used to applied collaborative intelligence to areas that range from open innovation to conceptual design. However, crowdsourcing applications in the fields of design research and creative innovation have been much slower to emerge. In this paper, the statistical analysis methods (i.e., normal probability plots) were used to validate the crowdsourced design evaluation results in the authors’ previous crowdsourced design case study (i.e., car key fob design task). The discussion about the ranking distributions and results suggested that standard distribution trendlines and r^2 results proved the effects of the ranking evaluation method used in the case study. The distribution determined that the evaluation process and results matched a normal distribution. As the contribution to knowledge, this paper applied the statistical analysis method to measure and approve the crowdsourced design evaluation method and its results.

Keywords: *crowdsourcing, crowdsourced design (cDesign), crowdsourced design evaluation, statistical analysis, normal probability plots and trendlines*

A Renewed Understanding of Creativity is Paramount prior to Introducing Students to a Life Design Attitude

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Abstract: Students of today are faced with the reality of an unpredictable working life in a constantly turbulent and fast-changing world. This has led to an intense focus on entrepreneurship. Yet, we seem to overlook the fact that students are increasingly challenged by stress and depression. We need to rethink education to include knowledge and tools not only for creating a job, but for reshaping life in general. This paper is part of a larger body of research aimed at introducing students to a Life Design Attitude. Research has proved that design can be used in value clarification and lead to changes in inappropriate beliefs and behaviour. In other words, design can be used to create better lives. However, by comparing data from three workshops this paper concludes that prior to introducing students to a design attitude to life there is an urgent need for a renewed understanding of creativity in educational institutions.

Keywords: *creativity, design attitude, reframing, cognition, life design*

Self-assessment of creative performance with a learning-by-doing approach: getting familiar with Novelty, Quality, Quantity and Variety

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Abstract: The paper discusses the outcomes of tailored ideation workshops (duration: 3 hours) for students of Design Engineering, not trained in design creativity dimensions and their assessment. 65 participants generated ideas to address a design problem, first individually and then in groups of 4/5 people. They were asked to cluster their ideas intuitively and then according to the structure of the genealogy tree. The reflections on the ideation experience (structured consistently with the Kolb cycle) helped them to easily consolidate their understanding of typical metrics of creativity (Novelty, Quality, Quantity and Variety). A survey questions them after four months from the workshop and the results show that the metrics are still clear, despite some controversial results appear for quantity. The investigation also shows that novelty has become the main driver to self-assess the effectiveness of their creative ideation performance.

Keywords: *Ideation, Innovation, Creativity Measurement, Experiential Learning, Genealogy tree*

Semantic measures in design conversations as predictors of creative outcomes in design education

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²School of Architecture, Ariel University, Ariel, Israel

Abstract: The analysis of conversations maintained during the design activity can help to gain a better insight into design thinking and its relation to creativity. A semantic analysis approach was employed to inspect the content of communications and information exchange between students and instructors. The goal was to explore design conversations in terms of Abstraction, Polysemy, Information Content and Semantic Similarity measures, and analyse their relation to the creativity of final design outcomes. These were assessed according to their Originality, Usability, Feasibility, Overall Value and Overall Creativity. To this end, design conversations from the 10th Design Thinking Research Symposium (DTRS10) dataset were used. Main results show a significant relationship between Information Content and Originality and Overall Creativity. For instructors, Semantic measures were mainly related to Feasibility, whereas for students the focus was set on the Overall Value of the final solutions.

Keywords: *design creativity; design cognition; semantic measures; semantic analysis; creative measures; design education*

Too many attributes!: Diminishing the cognitive load of metaphor generation in product design

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Abstract: Many successful products result from a creative ideation process guided by the use of metaphors. Metaphors are used to embed meaning or values in a final product, or as a tool to structure design problems and generate creative solutions. In the former case, the source of inspiration is selected because it naturally exhibits the required traits, whereas, in the latter, the source might be randomly chosen. In both cases, the final result is achieved by transferring one or more attributes from the source to the target product. Given that the number of transferrable attributes is very high compared to the capacity of human's working memory, how can we ensure that we are exploring all possible solutions? Are generated metaphors better when all options are in plain sight? In this paper we describe preliminary results drawn from the use of a tool aimed at facilitating metaphor generation for product concepts.

Keywords: *metaphors, combinatorial creativity, product design, attribute*

A Topological Variation-Oriented Approach for Enhancing Creativity in Product Design Education

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Abstract: This study introduces an approach aimed at promoting the effect of product design creativity by using topological properties variations. The topological variation-oriented approach for creativity (TVC) generation showed as a visualized sheet and presented the process of products acting on human. The action process was depicted through four territories on the sheet: human, product, interaction, and experience. Each field is distributed in a vertical direction from left to right in the logical order of human, product, interaction, and experience. Each field is divided into several elements, and corresponding elements of each field are arranged in a horizontal direction. When topological variation occurs on the sheet, there will be some new relationship between elements, and it is very possible to produce new products. Participants use this approach to obtain creative ideas and novel product form. It has strong potential to attract people's attention.

Keywords: *topological perception; product shape; topological properties variations; creativity; product design education*

A Framework to Analyse Digital Fabrication Projects: The Role of Design Creativity

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Abstract: In this study, we formulate a framework to evaluate open-ended projects related to digital fabrication. The framework consists of two dimensions, i.e. human intellect and technology. Human intellect is judged by three sub-dimensions – creativity, computational thinking, and skills. In order to study the technology dimension, the four sub-dimensions include process, outcome, development stage, and reproducibility. To test the proposed framework, a case study was applied on digital fabrication projects done in Fab Academy 2019. Final projects of students are selected to implement the framework since final projects exemplify most of the skills learned by a student of the digital fabrication course. In addition, the proposed framework is also assessed in the light of existing literature done to evaluate learning in similar types of projects. The results establish the relationship among different sub parameters of human intellect and technology, and present the open-ended project evaluation results.

Keywords: *digital fabrication, project-based learning, fab lab, design creativity, evaluation*

Necessity of key stakeholder-based role-plays for NPD projects – A case study for a project team of Non-Industrial Robotics in Japan

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Abstract: Companies have been increasingly opting to utilize project teams to contend with highly turbulent and dynamic conditions while under current uncertainty markets, stakeholders have tremendous influences on the performance of NPD projects. On the other hand, it is normal that the conflicts between different key stakeholders' interests exists and the new interest may be generated among the NPD progress. Due to these reasons, managing the relationships among the stakeholders in NPD projects is extremely complicated work and thus the key stakeholder-based role-plays may be vital for the NPD performance. In this paper we analyze the dynamic of key stakeholders of the first three stages of the non-industrial robotic NPD in Japan and propose should be performed that the key stakeholder-based role-plays is necessary for the future two NPD stages.

Keywords: *Stakeholder, NPD, Simulation, Project team, Role-plays*

