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DESIGN 2024

BOOK OF ABSTRACTS

18TH INTERNATIONAL DESIGN CONFERENCE
20 - 23 MAY 2024 · CAVTAT · DUBROVNIK · CROATIA

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excellence in design

Welcome to DESIGN 2024, a conference that marks a significant milestone on our journey of exploring the vast and vibrant field of engineering design research. As we gather in the picturesque bay town of Cavtat in Croatia, a location that has hosted us since 2000, we find ourselves returning to the roots of our conference's tradition, yet embarking on a new chapter filled with promise and anticipation. This event marks a return to in-person gatherings after the previous two conferences were held online due to the COVID-19 pandemic, reminding us of the resilience and adaptability of our community.

The conference theme, "Excellence in Design", reflects our ongoing commitment to fostering innovation, creativity, and collaboration in the engineering design research community. We are thrilled to announce that DESIGN 2024 has achieved a record-high number of papers that will be presented, while at the same time having the lowest acceptance rate, witnessing our dedication to quality. DESIGN 2024 stands out not just for its academic rigour but also for its unique ability to blend informal networking opportunities with formal discourse, creating a fertile ground for collaboration and idea exchange that lasts all day. Our return to an onsite event in Cavtat offers an unparalleled opportunity to revive the spirit of the community that thrives on face-to-face interactions, allowing for a more profound and enriching exchange of ideas and experiences.

A remarkable aspect of this year's conference is the participation of many PhD students, presenting a great opportunity for our community's emerging scholars to present their ideas, engage in discourse, and receive valuable feedback. The diversity of workshops and meetings organised by the Design Society's Special Interest Groups reflects our commitment to welcoming new viewpoints into our community.

We have observed shifts in research focus, with sustainability and AI in design becoming predominant alongside traditional topics. This alignment with global trends towards digital transformation, environmental consciousness, and social responsibility signals the proximity of our research field to the needs of society. It is inspiring to witness the DESIGN community at the forefront of these shifts, eager to tackle the challenges and opportunities through rigorous research.

The stage is set for us to create a new DESIGN experience; one that builds upon our rich history while forging new pathways for innovation and excellence in design.
We look forward to transforming research papers into lively discussions, forming new collaborations, and collectively advancing our field. The papers presented at DESIGN 2024 are published with Open Access in the Proceedings of the Design Society (ISSN: 2732-527X by Cambridge University Press), ensuring that the knowledge shared here reaches a broad audience.

On behalf of the DESIGN 2024 Programme Chairs and Organising Team, we extend our deepest gratitude to all participants, contributors, and supporters of the conference. Your dedication and enthusiasm are the foundation of our community, and it is with great anticipation that we embark on this journey together.

Welcome to DESIGN 2024 – let's create a new era of excellence in design.

DESIGN 2024 Conference Chairs: ***Mario Štorga*** ***Stanko Škec***


DESIGN
2024
excellence in design

CONFERENCE VENUE

The conference will take place at the Hotel Croatia Cavtat.

REGISTRATION DESK WORKING HOURS

SUNDAY, 19 MAY	18:00 - 20:00
MONDAY, 20 MAY – THURSDAY, 23 MAY	08:00 - 18:00

SPECIAL EVENTS

MONDAY, 20 MAY	09:15 - 17:15 14:00 - 17:15	CONFERENCE WORKSHOPS PHD FORUM
TUESDAY, 21 MAY	17:30 - 19:00	MEETINGS ORGANISED BY DIFFERENT INTEREST GROUPS
WEDNESDAY, 22 MAY	14:00 - 15:15	DESIGN DEBATE

OPENING SESSION

Conference Hall Ragusa

MONDAY, 20 MAY	17:30 - 18:00	A WORD BEFORE **Mario Štorga** – Conference Chair (University of Zagreb FSB) UNIVERSITY OF ZAGREB FSB WELCOME ADDRESS **Zdenko Tonković** – Dean (University of Zagreb FSB) THE DESIGN SOCIETY WELCOME ADDRESS **Gaetano Cascini** – President of the Design Society (Politecnico di Milano)

CLOSING SESSION AND AWARDS

Conference Hall Ragusa

THURSDAY, 23 MAY	17:30 - 18:15	A WORD FROM THE DESIGN SOCIETY **Gaetano Cascini** – President of the Design Society (Politecnico di Milano) DESIGN SCIENCE JOURNAL DISTINGUISHED PAPER AWARDS **Panos Y. Papalambros** – Editor-in-Chief of the Design Science Journal (University of Michigan) CONFERENCE REFLECTION **Tim C. McAloone** – Programme Chair (Technical University of Denmark)

REFRESHMENTS AND LUNCHES

Refreshments and lunches will be served at Hotel Croatia Cavtat from 20 to 23 May.

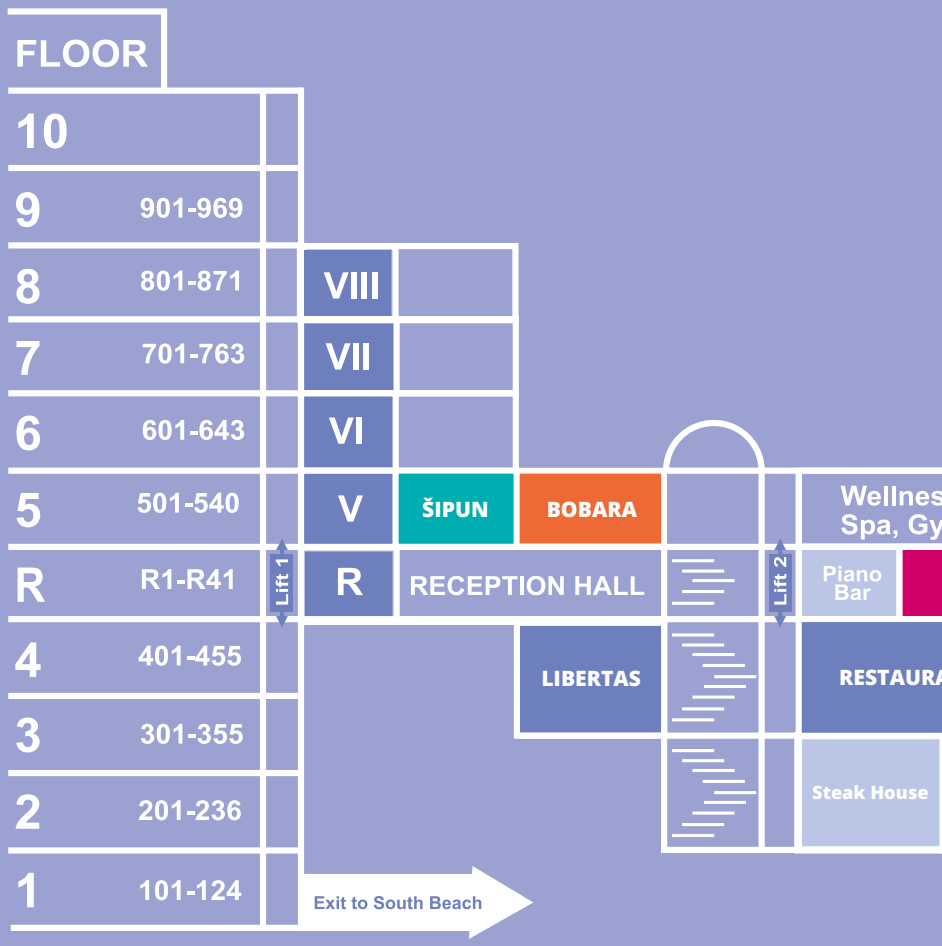
SOCIAL EVENTS

MONDAY, 20 MAY	19:00 - 20:00	WELCOME COCKTAIL – HOTEL CROATIA CAVTAT
WEDNESDAY, 22 MAY	20:00 - 22:00	CONFERENCE DINNER – HOTEL CROATIA CAVTAT
THURSDAY, 23 MAY	20:00 - 22:00	FAREWELL PARTY – SPINAKER BEACHFRONT RESTAURANT, HOTEL CROATIA CAVTAT

GUEST PROGRAMME

Information, schedule, and reservations about excursions are available at the desk. Accompanying guests are very welcome to attend.

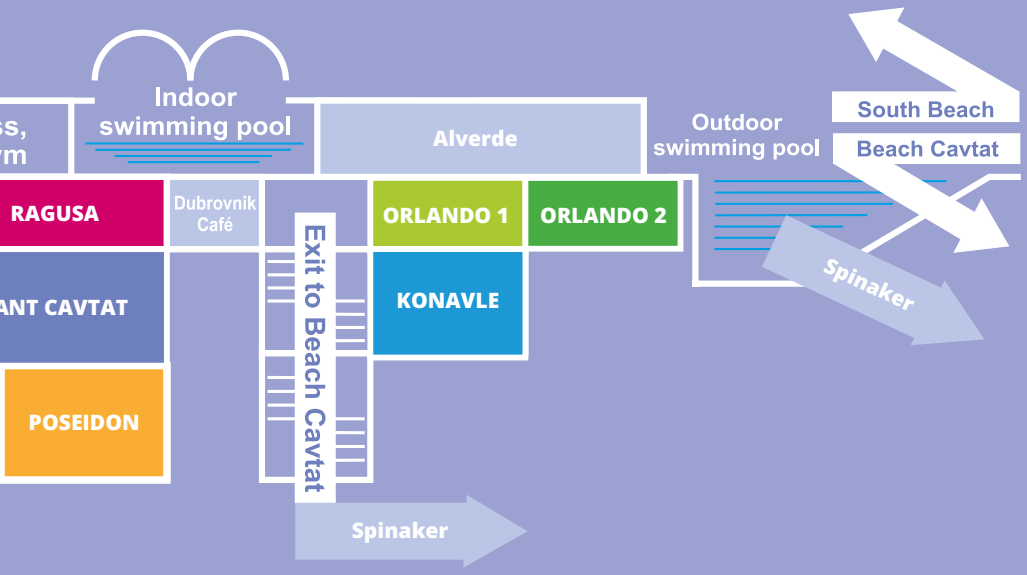
HOTEL CROATIA CAVTAT MAP



● CH Ragusa ● CH Bobara ● CH Orlando I ● CH Orlando 2

CONFERENCE FACILITIES

RESTAURANTS & BARS



	MONDAY, 20 MAY 2024					TUESDAY, 21 MAY 2024					
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8:30											
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9:15	D111	D112	D113	D114	D115	D211	D212	D213	D214	D215	D216
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● CH Ragusa ● CH Bobara ● CH Orlando 1 ● CH Orlando 2

WEDNESDAY, 22 MAY 2024						THURSDAY, 23 MAY 2024						
REGISTRATION						REGISTRATION						8:00
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D311	D312	D313	D314	D315	D316	D411	D412	D413	D414	D415	D416	9:15
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REFRESHMENT BREAK					D3-EM	REFRESHMENT BREAK						10:15
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D321	D322	D323	D324	D325	D326	D421	D422	D423	D424	D425	D426	11:00
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CONFERENCE DINNER						FAREWELL PARTY						20:15
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												21:00

MONDAY, 20 MAY 2024

REGISTRATION		
D111: WORKSHOP 1 - IS EMPATHY A FOUNDATION FOR SHARED SITUATIONAL AWARENESS WITHIN COLLABORATIVE DESIGN?	D112: WORKSHOP 2 - IDENTIFYING HOT AND EMERGING TOPICS IN ENGINEERING DESIGN	
LUNCH - RESTAURANT CAVTAT		
D131: PHD FORUM	D132: WORKSHOP 6 - THE CHALLENGES OF ASSESSMENT IN PROJECT-BASED DESIGN EDUCATION	
D1-O: OPENING		
D1-P: PLENARY SESSION		
WELCOME COCKTAIL		

TUESDAY, 21 MAY 2024

D211: MODELS AND STRATEGIES FOR CIRCULAR ECONOMY	D212: INNOVATIONS IN DESIGN PROTOTYPING AND REVERSE ENGINEERING	D213: SYSTEMS ENGINEERING MODELLING AND ASSESSMENT METHODOLOGIES I
REFRESHMENT BREAK		
D221: SUSTAINABILITY AND SUFFICIENCY IN SYSTEMS DESIGN	D222: ADVANCED METHODOLOGIES FOR SMART PRODUCT AND SYSTEM DESIGN	D223: SYSTEMS ENGINEERING MODELLING AND ASSESSMENT METHODOLOGIES II
LUNCH - RESTAURANT CAVTAT		
D2-P: PLENARY SESSION		
REFRESHMENT BREAK		
D231: SUSTAINABILITY IN ACTION THROUGH DESIGN CASE STUDIES	D232: MANAGING UNCERTAINTY AND ENHANCING ROBUSTNESS IN DESIGN	D233: ADVANCES IN SYSTEM-OF-SYSTEMS ENGINEERING AND DESIGN
	D242: DESIGN RESEARCH QUALITY - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING	D243: AI IN DESIGN - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING

WEDNESDAY, 22 MAY 2024

D311: LLM IN DESIGN PERSPECTIVES AND APPLICATIONS	D312: SUSTAINABLE DESIGN IMPACTS AND HUMAN BEHAVIOUR INCLUSION	D313: HUMAN-CENTRIC AND ROBOTIC SYSTEMS IN MANUFACTURING DESIGN
REFRESHMENT BREAK		
D321: MACHINE LEARNING IN DESIGN AND PRODUCT DEVELOPMENT	D322: CIRCULAR ECONOMY AND SUSTAINABLE DESIGN INNOVATIONS	D323: DESIGN FOR DIGITAL HEALTH SYSTEMS
LUNCH - RESTAURANT CAVTAT		
D3-DD: DESIGN DEBATE		
REFRESHMENT BREAK		
D331: DATA-DRIVEN STRATEGIES AND APPROACHES IN DESIGN	D332: CIRCULAR DESIGN APPROACHES FOR REUSABILITY	D333: INTEGRATING SUSTAINABILITY INTO SYSTEMS ENGINEERING PRACTICES
CONFERENCE DINNER		

THURSDAY, 23 MAY 2024

D411: HUMAN-AI SYNERGY FOR THE FUTURE OF DESIGN	D412: MODULARISATION AND ADAPTABILITY IN COMPLEX SYSTEMS DESIGN	D413: HUMAN-CENTRIC DYNAMICS AND INTEGRATION IN DESIGN MANAGEMENT
REFRESHMENT BREAK		
D421: EXPLORING DIGITAL TWINS IN DESIGN AND MANUFACTURING	D422: SUSTAINABILITY TOOLS AND INDICATORS IN DESIGN	D423: ENHANCING DESIGN THROUGH OPTIMISATION AND AUTOMATION TOOLS
LUNCH - RESTAURANT CAVTAT		
D4-P: PLENARY SESSION		
REFRESHMENT BREAK		
D431: ADVANCING DESIGN WITH GENERATIVE AI APPLICATIONS	D432: SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN EDUCATION	D433: MECHANICAL DESIGN ENHANCEMENTS - OPTIMISATION, ANALYSIS, AND PRACTICE
D4-C: CLOSING AND AWARDS		
FAREWELL PARTY		

MONDAY, 20 MAY 2024

D113: WORKSHOP 3 - MULTI-USER CENTRIC CO-CREATION	D114: WORKSHOP 4 - NEW DIGITAL TECHNOLOGIES IN HEALTH SYSTEMS DESIGN	D115: WORKSHOP 5 - HOW TO USE PROTOTYPES IN PRODUCT DEVELOPMENT?
D133: WORKSHOP 7 - NATURE AS AN INNOVATIVE CATALYST AND MODEL IN DESIGN FOR ADDITIVE MANUFACTURING	D134: WORKSHOP 8 - HUMAN DESIGNERS, SOFTWARE DEFINED VEHICLES AND AI AGENTS	D135: WORKSHOP 9 - SUSTAINABLE DESIGN: A CROSS-CONTINENTAL PERSPECTIVE

TUESDAY, 21 MAY 2024

D214: INTEGRATING DESIGN AND TECHNOLOGY IN INDUSTRY 4.0	D215: HUMAN-CENTRIC APPROACHES IN DESIGN RESEARCH	D216: INNOVATIVE DESIGN APPROACHES IN HEALTHCARE
D224: VIRTUAL REALITY FOR DESIGN AND EDUCATIONAL APPLICATIONS	D225: ADVANCEMENTS IN DESIGN AND MATERIALS FOR ADDITIVE MANUFACTURING	D226: EMOTIONAL AND SUSTAINABLE DESIGN IN HEALTHCARE TECHNOLOGY
	D2-EM: MEET THE EDITORS OF THE DESIGN STUDIES REPLACEMENT JOURNAL	
D234: STRATEGIES FOR DESIGN ORGANISATION AND ENTERPRISE TRANSFORMATION	D235: DESIGN THEORY FRAMEWORKS AND APPLICATIONS	D236: EMPATHY, ACCESSIBILITY, AND AESTHETICS IN INDUSTRIAL DESIGN
D244: DESIGN JUSTICE - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING	D245: PUBLISHING DESIGN RESEARCH	

WEDNESDAY, 22 MAY 2024

D314: CO-CREATION AND CO-DESIGN STUDIES	D315: ADVANCED APPLICATIONS IN DESIGN FOR ADDITIVE MANUFACTURING	D316: NEW STRATEGIES IN DESIGN EDUCATION
	D3-EM: MEET THE EDITORS OF THE AIEDAM JOURNAL	
D324: APPLICATION OF GENERAL AI METHODS IN DESIGN	D325: ADVANCES IN QUALITY AND PERFORMANCE BENCHMARKS IN ADDITIVE MANUFACTURING	D326: EMERGING TECHNOLOGIES AND COLLABORATIVE TOOLS IN DESIGN EDUCATION
D334: EXPLORING THE FRONTIERS OF DESIGN IDEATION AND COGNITION	D335: NAVIGATING DESIGN KNOWLEDGE AND DATA INTEGRATION	D336: EDUCATIONAL CHALLENGES, EXPERIENCES AND PERCEPTION

THURSDAY, 23 MAY 2024

D414: DESIGN FOR BEHAVIOUR CHANGE	D415: ADVANCING DESIGN RESEARCH THROUGH NEW METHODS AND APPROACHES	D416: EXPLORING CULTURAL AND BEHAVIORAL ASPECTS OF DESIGN INNOVATION
D424: DESIGN COGNITION AND AFFECT	D425: ENHANCING ADDITIVE MANUFACTURING WITH KNOWLEDGE-BASED DESIGN TOOLS	D426: INTEGRATING CAD WITH ADVANCED DESIGN METHODOLOGIES
D434: FACTORS INFLUENCING DESIGN CREATIVITY	D435: STANDARDISATION, REPRESENTATION, AND AUTOMATION OF DESIGN INFORMATION	D436: DESIGN STRATEGIES FOR ENHANCED USER EXPERIENCE

08:00 **REGISTRATION**

09:15

D111
WORKSHOP 1 - IS EMPATHY A FOUNDATION FOR SHARED SITUATIONAL AWARENESS WITHIN COLLABORATIVE DESIGN?

Congress Hall Poseidon

Chairs:
Amy Grech,
University of Strathclyde, United Kingdom
Ross Brisco,
University of Strathclyde, United Kingdom
Dorothy Evans,
University of Strathclyde, United Kingdom
Robert Ian Whitfield,
University of Strathclyde, United Kingdom

Hosted by The Design Society
COLLABORATIVE DESIGN SIG

D112
WORKSHOP 2 - IDENTIFYING HOT AND EMERGING TOPICS IN ENGINEERING DESIGN

Congress Hall Bobara

Chairs:
Kilian Gericke,
University of Rostock, Germany
Ola Isaksson,
Chalmers University of Technology, Sweden

Hosted by The Design Society
DESIGN PROCESS SIG and
DESIGN PRACTICE SIG

12:30 **LUNCH - Restaurant Cavtat**

14:00

D131
PHD FORUM

Congress Hall Poseidon

Chairs:
Massimo Panarotto,
Chalmers University of Technology, Sweden
Philip Cash,
Northumbria University, United Kingdom

Hosted by The Design Society

D132
WORKSHOP 6 - THE CHALLENGES OF ASSESSMENT IN PROJECT-BASED DESIGN EDUCATION

Congress Hall Bobara

Chairs:
Elies Ann Dekoninck,
University of Bath, United Kingdom
Francesca Mattioli,
Politecnico di Milano, Italy
Gordon Krauss,
Harvey Mudd College, United States of America
Ross Brisco,
University of Strathclyde, United Kingdom
Erik Bohemia,
Shandong University of Art & Design, People's Republic of China

Hosted by The Design Society
DESIGN EDUCATION SIG

17:15

17:30 **D1-O: OPENING**
Congress Hall Ragusa
Chair: Mario Štorga, University of Zagreb FSB, Croatia

18:00 **D1-P: PLENARY SESSION**
Congress Hall Ragusa
Chair: Julie Stal-Le Cardinal, CentraleSupélec, France

18:45

19:00 **WELCOME COCKTAIL**

20:00

08:00

09:15

D113
WORKSHOP 3 - MULTI-USER CENTRIC CO-CREATION

Congress Hall Orlando 1

Chairs:

Shakuntala Acharya, Indian Institute of Technology Guwahati, India

Akane Matsumae, Kyushu University, Japan

Hosted by The Design Society DESIGN CREATIVITY SIG

D114
WORKSHOP 4 - NEW DIGITAL TECHNOLOGIES IN HEALTH SYSTEMS DESIGN

Congress Hall Orlando 2

Chairs:

Anja Maier, University of Strathclyde, United Kingdom

P. John Clarkson, University of Cambridge, United Kingdom

Maaike S. Kleinsmann, Delft University of Technology, The Netherlands

Hosted by The Design Society HEALTH SYSTEMS DESIGN SIG

D115
WORKSHOP 5 - HOW TO USE PROTOTYPES IN PRODUCT DEVELOPMENT?

Congress Hall Konavle

Chairs:

Kristin Paetzold-Byhain, Technische Universität Dresden, Germany

James Gopsill, University of Bristol, United Kingdom

Hosted by The Design Society HUMAN BEHAVIOUR IN DESIGN SIG

12:30

14:00

D133
WORKSHOP 7 - NATURE AS AN INNOVATIVE CATALYST AND MODEL IN DESIGN FOR ADDITIVE MANUFACTURING

Congress Hall Orlando 1

Chairs:

Tino Stanković, ETH Zurich, Switzerland

Serena Graziosi, Politecnico di Milano, Italy

Hosted by The Design Society DESIGN FOR ADDITIVE MANUFACTURING SIG

D134
WORKSHOP 8 - HUMAN DESIGNERS, SOFTWARE DEFINED VEHICLES AND AI AGENTS

Congress Hall Orlando 2

Chairs:

Kostas Stylidis, Chalmers University of Technology, Sweden

Bastian Quattelbaum, Hochschule Niederrhein University of Applied Sciences, Germany

Hosted by The Design Society DATA-INFORMED DESIGN SIG

D135
WORKSHOP 9 - SUSTAINABLE DESIGN: A CROSS-CONTINENTAL PERSPECTIVE

Congress Hall Konavle

Chairs:

Sophie I. Hallstedt, Chalmers University of Technology, Sweden

Els Du Bois, University of Antwerp, Belgium

Panos Y. Papalambros, University of Michigan, United States of America

Bernard Shibwabo Kasamani, Strathmore University, Kenya

Yakhoub Ndiaye, SUTD, Singapore

Hosted by The Design Society SUSTAINABLE DESIGN SIG and AFRICA-DESIGN INITIATIVE

17:15

17:30

A WORD BEFORE – *Mario Štorga; DESIGN 2024 Conference Chair (University of Zagreb FSB)*

UNIVERSITY OF ZAGREB FSB WELCOME ADDRESS – *Zdenko Tonković; Dean (University of Zagreb FSB)*

THE DESIGN SOCIETY WELCOME ADDRESS – *Gaetano Cascini; President of the Design Society (Politecnico di Milano)*

18:00

TOWARDS THE PREVENTION OF REBOUND EFFECTS BY DESIGN

Dr. Daniela C. A. Pigosso; Associate Professor
(Technical University of Denmark, Department of Civil and Mechanical Engineering, Centre for Absolute Sustainability)

18:45

19:00

20:00

IS EMPATHY A FOUNDATION FOR SHARED SITUATIONAL AWARENESS WITHIN COLLABORATIVE DESIGN?

HOSTED BY THE DESIGN SOCIETY COLLABORATIVE DESIGN SIG

Chairs:

Amy Grech
University of Strathclyde, United Kingdom

Ross Brisco
University of Strathclyde, United Kingdom

Dorothy Evans
University of Strathclyde, United Kingdom

Ian Whitfield
University of Strathclyde, United Kingdom

Session D111

Congress Hall Poseidon

09:15
12:30

20 May

MON

Collaborative engineering enhances industry efficiency, reduces rework, and automates design processes. Yet, challenges like poor communication, divergent goals, and cultural differences often hinder these collaborations. Innovations in collaborative practices could lead to more user-focused, innovative products more swiftly.

This workshop explores empathy and shared situational awareness in collaborative design, questioning if empathy is a cornerstone for shared awareness. Situational awareness is crucial for informed decision-making, involving an accurate understanding of one's environment. In teams, it means members have a shared understanding, essential for tackling unexpected issues together.

Empathy, the ability to understand others' perspectives and adapt actions accordingly, is seen as key to fostering this shared awareness. This session will examine if empathy within teams lays the foundation for shared situational awareness and improves collective decision-making. It will also consider methods to measure empathy and how it affects team dynamics.

The workshop encourages participation through directed questions and aims to understand empathy's role in collaborative design. Ensuring voluntary participation and ethical data practices, this workshop aligns with DESIGN Conference themes, including Human Behaviour, Creativity, and Management. It seeks to deepen our understanding of empathy's impact on collaborative design.

IDENTIFYING HOT AND EMERGING TOPICS IN ENGINEERING DESIGN

HOSTED BY THE DESIGN SOCIETY DESIGN PROCESS SIG AND DESIGN PRACTICE SIG

Chairs:
Kilian Gericke
University of Rostock, Germany
Ola Isaksson
Chalmers University of Technology, Sweden

Engineering designers and research experts are crucial in realizing the business goals of product development organizations. They excel at understanding new and complex needs, combining existing and novel technologies into solutions, often within tight deadlines and amidst competing interests. The workshop aims to highlight significant "hot topics" in design research that are crucial for industry renewal and where industry is focusing its efforts for innovation.

The purpose of this workshop is to identify and prioritize emerging topics in engineering design, explore potential dependencies and connections among these topics, and encourage interdisciplinary collaboration and knowledge exchange. Following a brief inspirational talk, participants will work in groups to identify and justify critical areas, then engage in open discussions with all attendees to outline a path forward. There's also an ambition to extend this dialogue through online global workshops, aiming to involve a wider audience.

The ultimate goal is to compile a roadmap and potentially publish findings in ICED or the Design Science Journal. This effort seeks to communicate these insights to the broader community and beyond. The outcomes will provide valuable input for the SIGs to incorporate into their ongoing meetings, the Design Practices "hot topic" series, and the Design Process group, which leads the global study initiative on future design processes.

Session D112

Congress Hall Bobara

09:15
12:30

20 May

MON

MULTI-USER CENTRIC CO-CREATION

HOSTED BY THE DESIGN SOCIETY DESIGN CREATIVITY SIG

Chairs:
Shakuntala Acharya
Indian Institute of Technology Guwahati, India
Akane Matsumae
Kyushu University, Japan

Designers aim to craft creative solutions where "usefulness" plays a crucial role, necessitating knowledge across domains and consideration of diverse user needs. Given the complexity, participatory methods are often used to include various users in the creation process. However, designers face challenges in recognizing and prioritizing these needs due to users being reserved or unclear in communicating their needs and feedback during the design stages.

To involve users more effectively in co-creation, designers need to create a conducive atmosphere for communication and ask the right questions to elicit valuable responses. This workshop tests a toolkit designed to assist in empathizing with users and analysing their needs, exploring effective questioning for co-creation.

The workshop will involve groups of five each tackling a design problem through co-creation. It includes a brief introduction to the process and toolkit, role-playing and empathy mapping, a break, needs identification and prioritization, group presentations, and a feedback and discussion session.

Expected outcomes are the preliminary testing of the toolkit, enhancing understanding and empathy among participants for various users, and identifying effective questions to bridge communication gaps. This may also highlight potential areas for future research.

Session D113
Congress Hall Orlando 1
09:15 12:30
20 May
MON

NEW DIGITAL TECHNOLOGIES IN HEALTH SYSTEMS DESIGN

HOSTED BY THE DESIGN SOCIETY HEALTH SYSTEMS DESIGN SIG

Chairs:

Anja Maier
University of Strathclyde, United Kingdom

P. John Clarkson
University of Cambridge, United Kingdom

Maaike S. Kleinsmann
Delft University of Technology, The Netherlands

Disruptive technologies like AI, additive manufacturing, and augmented reality are transforming healthcare, bringing both opportunities and challenges. Their integration into health systems introduces potential for systemic bias and exclusion, making it crucial for health designers to understand these technologies from a systemic perspective. This workshop invites health design researchers and practitioners to delve into the implications of these digital advancements.

We'll start by introducing our strategic approach to health systems design, followed by a presentation on novel digital technologies and their potential impact on healthcare. Participants will be divided into groups to explore and present future health system scenarios influenced by these technologies. This exercise aims to identify and analyse potential benefits and risks, leading to a discussion on actionable design insights that can mitigate negative consequences while maximizing positive outcomes.

The workshop concludes with a collective discussion, comparing insights across groups to synthesize a comprehensive understanding of how digital technologies can be harnessed in healthcare. Expected outcomes include a compilation of future scenarios and design implications, laying the groundwork for a future publication. This collaborative exploration aims to equip participants with a deeper understanding of digital technologies' role in shaping future health systems, promoting an inclusive, equitable approach to health innovation.

Session
D114

Congress
Hall
Orlando 2

09:15
12:30

20 May

MON

HOW TO USE PROTOTYPES IN PRODUCT DEVELOPMENT?

HOSTED BY THE DESIGN SOCIETY HUMAN BEHAVIOUR IN DESIGN SIG

Chairs:
Kristin Paetzold-Byhain
Technische Universität Dresden, Germany
James Gopsill
University of Bristol, United Kingdom

Prototypes play a crucial role in product development. They serve not only to verify development results but also support validation by the customer. Within development, prototypes are an effective means of exploration. They are also used to communicate with various stakeholders involved in the development process.

However, prototypes usually reflect the degree of development maturity. As a result, not only high-fidelity prototypes are available during development. Instead, a wide variety of product artifacts created throughout the development process are generally used as prototypes. This raises the question of whether the various product artifacts, which ultimately only reflect parts of the functionality and design of the final product, are understood and interpreted equally by all stakeholders. However, this seems to be a fundamental prerequisite for being able to justify decisions based on the use of prototypes.

As part of the workshop, requirements for prototypes to fulfil the tasks assigned to them (validation, communication, exploration) will be determined, and different types of prototypes will be discussed regarding their usability.

Session D115

Congress Hall Konavle

09:15
12:30

20 May

MON

PHD FORUM

Chairs:

Massimo Panarotto
Politecnico di Milano, Italy; Chalmers University of Technology, Sweden

Philip Cash
Northumbria University, United Kingdom

The DESIGN PhD Forum is designed to nurture the exchange of ideas and research methodologies among budding researchers within the Design Society community. This initiative particularly aims to support PhD students by offering a platform tailored to their unique needs. The forum seeks to enhance the dialogue between young researchers and experts, providing a conducive environment for discussing individual research topics, methodologies, and potential hurdles. It also aims to foster networking and collaboration opportunities, crucial elements for early-career researchers.

Structured to facilitate in-depth discussions, the forum will feature small groups, each comprising four PhD students and one or two experienced researchers. This setup is intended to ensure personalized attention and constructive feedback. Participating students are expected to prepare an elevator pitch to introduce their research projects. This brief, 5-minute presentation is an opportunity for students to outline the impact of their work, its theoretical foundations, the research gaps it aims to fill, and the chosen research approach and methodologies. Presenters are encouraged to include slides, figures, or flowcharts to aid in conveying their research framework, specific research questions, and any anticipated risks or challenges.

This focused event promises to be a valuable opportunity for PhD students to gain insights, feedback, and forge connections that will support their academic journey and beyond.

Session
D131

Congress
Hall
Poseidon

14:00
17:15

20 May

MON

THE CHALLENGES OF ASSESSMENT IN PROJECT-BASED DESIGN EDUCATION

HOSTED BY THE DESIGN SOCIETY DESIGN EDUCATION SIG

Chairs:

Elies Ann Dekoninck
University of Bath, United Kingdom

Francesca Mattioli
Politecnico di Milano, Italy

Gordon Krauss
Harvey Mudd College, United States of America

Ross Brisco
University of Strathclyde, United Kingdom

Erik Bohemia
Shandong University of Art & Design, People's Republic of China

Session D132

Congress Hall Bobara

14:00 17:15

20 May

MON

Design education's assessment practices for open-ended projects, especially capstones or those involving industry partners, vary widely. Assessing student success and learning outcomes achievement often gets obscured by the project's final product. Over-detailed rubrics can lead to markers adjusting scores to reflect student effort accurately, while company stakeholder involvement complicates grading further. Despite widespread adoption of project-based learning, assessment challenges persist, necessitating a shared understanding of best practices.

This workshop aims to address these challenges by reviewing current literature on assessment in project-based design education and gathering first-hand experiences from participants. It will offer a platform to share challenges and solutions, aiming to compile a comprehensive solutions library and highlight knowledge gaps.

Participants, ranging from experts to novice design educators, will contribute insights, which will be used in a group activity to map solutions to identified challenges. This process will spark discussions on knowledge gaps and potential collaborative research opportunities.

Outcomes will include a detailed mapping of challenges and solutions in design education assessment, enriched by real-world educator experiences, paving the way for a deeper understanding and improvement in project-based design education assessment practices.

NATURE AS AN INNOVATIVE CATALYST AND MODEL IN DESIGN FOR ADDITIVE MANUFACTURING

HOSTED BY THE DESIGN SOCIETY DESIGN FOR ADDITIVE MANUFACTURING SIG

Chairs:

Tino Stanković
ETH Zurich, Switzerland

Serena Graziosi
Politecnico di Milano, Italy

Drawing from nature's intricate mechanisms and efficient resource utilization, experts from various fields have long sought to mimic these principles in design and technology. The workshop explores the intersection of nature-inspired solutions and technological advancements, particularly through Additive Manufacturing (AM). This technology has unlocked new possibilities in emulating nature's complex, organic structures and even incorporating living materials into designs, pushing the boundaries of bioinspired engineering. It prompts a discussion on the additive manufacturing community's success in harnessing nature's design repertoire and investigates strategies to integrate these natural principles more effectively into the design process.

The goal is to enhance the development of technical products that are not only inspired by but also function in harmony with nature's models, thanks to AM and digital technologies. Participants will engage in dialogues on maximizing the application of nature's designs, with the workshop aiming to stimulate collaborations, share expert insights, and potentially pave the way for formalizing these discussions into impactful outputs like white papers. This convergence of natural wisdom and technological innovation offers a promising pathway to sustainable and efficient design solutions, reflecting a deepened understanding of nature's contributions to modern engineering challenges.

Session
D133

Congress
Hall
Orlando 1

14:00
17:15

20 May

MON

HUMAN DESIGNERS, SOFTWARE DEFINED VEHICLES AND AI AGENTS

HOSTED BY THE DESIGN SOCIETY DATA-INFORMED DESIGN SIG

Chairs:

Kostas Stylidis
Chalmers University of Technology, Sweden

Bastian Quattelbaum
Hochschule Niederrhein University of Applied Sciences, Germany

Designers thrive on creating useful, innovative solutions, requiring an understanding of diverse domains and the needs of various users. Participatory design often comes into play, incorporating users' perspectives directly into the creative process. However, recognizing and prioritizing these myriad needs present challenges, especially when users may not confidently articulate their needs or feedback in the early and later stages of design.

This workshop introduces a toolkit aimed at helping designers empathize with users and analyse their needs more effectively. It's designed to discover the most effective questions that facilitate co-creation by engaging users in meaningful ways.

The workshop will be structured around interactive group activities involving groups of five, focusing on a specific design challenge. Activities kick off with an introduction to the process and toolkit, followed by role-playing and empathy mapping to foster a deeper understanding of user perspectives. After a short break, the groups will delve into identifying and prioritizing user needs, culminating in presentations of their findings and a comprehensive feedback and discussion segment.

Outcomes include testing the toolkit, fostering empathy, and understanding among participants towards users, and identifying key questions that can improve communication and potentially highlight areas for future research.

Session D134

Congress Hall Orlando 2

14:00 17:15

20 May

MON

SUSTAINABLE DESIGN: A CROSS-CONTINENTAL PERSPECTIVE

HOSTED BY THE DESIGN SOCIETY SUSTAINABLE DESIGN SIG AND AFRICA-DESIGN INITIATIVE

Chairs:

Sophie I. Hallstedt
Chalmers University of Technology, Sweden

Els Du Bois
University of Antwerp, Belgium

Panos Y. Papalambros
University of Michigan, United States of America

Bernard Shibwabo
Stathmore University, Kenya

Bernard Shibwabo Kasamani
Strathmore University, Kenya

Yakhoub Ndiaye
SUTD, Singapore

This workshop seeks to unite the Sustainable Design SIG and AFRICA-DESIGN initiative, emphasizing the importance of integrating diverse cultural, economic, and territorial insights into global sustainable design practices and education. As sustainability becomes increasingly significant, leveraging varied perspectives is key to enhancing design methods. The workshop will benefit from AFRICA-DESIGN's extensive contributions, offering unique sustainable design insights.

Objectives include assessing sustainable design education and practices in different contexts, exploring sustainable solutions in resource-limited settings, and promoting mutual learning on sustainability's various aspects — environmental, social, economic, and resilience. The event also aims to create an actionable plan for worldwide sustainable design efforts and assemble specific event teams.

Through a scenario-based approach, participants will assess and propose enhancements to a product's sustainability in an African setting. The workshop encourages exchanging insights on sustainable design across regions, brainstorming, and planning initiatives to foster connections and share best practices among design professionals. It intends to ignite discussion on the sustainability and replicability of solutions in diverse socio-economic contexts, striving for a broad, inclusive approach to sustainable design.

Session D135

Congress Hall Konavle

14:00
17:15

20 May

MON


excellence in design
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DESIGN
2024
excellence in design

TOWARDS THE PREVENTION OF REBOUND EFFECTS BY DESIGN

Dr. Daniela C. A. Pigosso
Associate Professor, Technical University of Denmark, Department of Civil and Mechanical Engineering, Centre for Absolute Sustainability

Never before has there been a stronger global focus on the development of sustainable solutions, but society's most well-intended efforts to solve sustainability challenges have not yet achieved the expected positive sustainability benefits due to rebound effects. Rebound effects are negative unintended consequences of interventions that arise due to induced changes in system behaviour, which undermine ca. 40% of the potential sustainability gains of sustainable solutions. Despite the increased recognition that rebound effects are defined and can be addressed by design, there is still limited employment of design as a powerful leverage point at which to intervene in production and consumption systems. In this keynote presentation, Daniela will discuss the need for the further advancement of design science towards the design of reboundless solutions (i.e., products, product/service-systems and socio-technical systems that are resilient to rebound effects). In addition to enabling addressing societal needs within the planetary boundaries, the development of reboundless solutions will enable the transition to a new sustainable design paradigm targeted at the systemic level, enabling the design of sustainable production and consumption systems that are resilient to rebound effects.

BIOGRAPHICAL SKETCH

Daniela Pigosso is Associate Professor on Sustainable Design at the Technical University of Denmark (DTU) and a member of DTU's Centre for Absolute Sustainability. She is the Principal Investigator of an ERC Consolidator project (REBOUNDLESS) which aims to prevent the occurrence of rebound effects by design, and co-leads the ready2LOOP project, which aims to enhance readiness of manufacturing value chains for the Circular Economy. Her research and innovation activities are demonstrated in 20+ national and international projects, carried out in close collaboration with industry, governmental and non-governmental organisations. Currently, Daniela serves as a Member of the Advisory Board of the Design Society and at the ASAP Service Management Forum. In addition to several high-impact publications and scientific contributions, Daniela has had an impressive industrial and societal impact throughout her career.

08:15

D211
MODELS AND STRATEGIES FOR CIRCULAR ECONOMY
Congress Hall Ragusa
Chair: Tim C. McAloone, Technical University of Denmark, Denmark

D212
INNOVATIONS IN DESIGN PROTOTYPING AND REVERSE ENGINEERING
Congress Hall Bobara
Chair: Kristin Paetzold-Byhain, Technische Universität Dresden, Germany

D213
SYSTEMS ENGINEERING MODELLING AND ASSESSMENT METHODOLOGIES I
Congress Hall Orlando 1
Chair: Felician Campean, University of Bradford, United Kingdom

10:15

REFRESHMENT BREAK

10:45

D221
SUSTAINABILITY AND SUFFICIENCY IN SYSTEMS DESIGN
Congress Hall Ragusa
Chair: Flore Vallet, CentraleSupélec, France

D222
ADVANCED METHODOLOGIES FOR SMART PRODUCT AND SYSTEM DESIGN
Congress Hall Bobara
Chair: Larry Allen Stauffer, University of Idaho, United States of America

D223
SYSTEMS ENGINEERING MODELLING AND ASSESSMENT METHODOLOGIES II
Congress Hall Orlando 1
Chair: Benoit Eynard, Université de Technologie de Compiègne, France

12:30

LUNCH
Restaurant Cavtat

13:15

14:00

D2-P: PLENARY SESSION
Congress Hall Ragusa
Chair: Stanko Škec, University of Zagreb FSB, Croatia

14:45

REFRESHMENT BREAK

15:15

D231
SUSTAINABILITY IN ACTION THROUGH DESIGN CASE STUDIES
Congress Hall Ragusa
Chair: Sophie I. Hallstedt, Chalmers University of Technology, Sweden

D232
MANAGING UNCERTAINTY AND ENHANCING ROBUSTNESS IN DESIGN
Congress Hall Bobara
Chair: Massimo Panarotto, Chalmers University of Technology, Sweden

D233
ADVANCES IN SYSTEM-OF-SYSTEMS ENGINEERING AND DESIGN
Congress Hall Orlando 1
Chair: Sandro Wartzack, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

17:15

17:30

D242
DESIGN RESEARCH QUALITY - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING
Congress Hall Bobara
Chairs: Philip Cash, Northumbria University, United Kingdom
Romain Pinquié, Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, France

D243
AI IN DESIGN - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING
Congress Hall Orlando 1
Chairs: Filippo Chiarello, University of Pisa, Italy
Alejandro Pradas Gomez, Chalmers University of Technology, Sweden
Yuan Yin, Imperial College London, United Kingdom

19:00

08:15

D214
INTEGRATING DESIGN AND TECHNOLOGY IN INDUSTRY 4.0
Congress Hall Orlando 2
Chair: Martin Steinert, Norwegian University of Science and Technology, Norway

D215
HUMAN-CENTRIC APPROACHES IN DESIGN RESEARCH
Congress Hall Konavle
Chair: Charlie Ranscombe, Swinburne University of Technology, Australia

D216
INNOVATIVE DESIGN APPROACHES IN HEALTHCARE
Congress Hall Šipun
Chair: P. John Clarkson, University of Cambridge, United Kingdom

10:15

10:45

D224
VIRTUAL REALITY FOR DESIGN AND EDUCATIONAL APPLICATIONS
Congress Hall Orlando 2
Chair: Andrew Wodehouse, University of Strathclyde, United Kingdom

D225
ADVANCEMENTS IN DESIGN AND MATERIALS FOR ADDITIVE MANUFACTURING
Congress Hall Konavle
Chair: Tino Stanković, ETH Zurich, Switzerland

D226
EMOTIONAL AND SUSTAINABLE DESIGN IN HEALTHCARE TECHNOLOGY
Congress Hall Šipun
Chair: Valeria Pannunzio, University of Cambridge, United Kingdom

12:30

D2-EM: MEET THE EDITORS OF THE DESIGN STUDIES REPLACEMENT JOURNAL
Congress Hall Šipun
Chair: Philip Cash, Northumbria University, United Kingdom

13:15

14:00

AI IN PRODUCT DEVELOPMENT: A PERSPECTIVE VIEW
Jon Hirschtick; Chief Evangelist at PTC, Cofounder of SolidWorks and Onshape

14:45

15:15

D234
STRATEGIES FOR DESIGN ORGANISATION AND ENTERPRISE TRANSFORMATION
Congress Hall Orlando 2
Chair: Julie Stal-Le Cardinal, CentraleSupélec, France

D235
DESIGN THEORY FRAMEWORKS AND APPLICATIONS
Congress Hall Konavle
Chair: Dorian Marjanović, University of Zagreb FSB, Croatia

D236
EMPATHY, ACCESSIBILITY, AND AESTHETICS IN INDUSTRIAL DESIGN
Congress Hall Šipun
Chair: Åsa Ericson, Luleå University of Technology, Sweden

17:15

17:30

D244
DESIGN JUSTICE - EXPLORING DIRECTIONS FOR A NEW DS SIG MEETING
Congress Hall Orlando 2
Chairs: Sita M Syal, University of Michigan, United States of America
Julia Kramer, University of Michigan, United States of America

D234
D245: PUBLISHING DESIGN RESEARCH MEETING
Congress Hall Konavle
Chair: Panos Y. Papalambros, University of Michigan, United States of America

19:00

OPERATIONALIZING LEVERAGE POINTS IN BUSINESS MODEL DESIGN FOR SUSTAINABLE SYSTEMS CHANGE

Cadence Hsien[1,2], Steve Evans[1]
[1]University of Cambridge, United Kingdom; [2]Singapore Institute of Manufacturing Technology, Agency for Science, Technology & Research, Singapore

Systems change can help to address sustainability challenges and interventions at deep leverage points of a system can be applied to do so. By studying 9 sustainable entrepreneurial businesses, this paper looked at how entrepreneurial firms used their business to intervene at deep leverage points to facilitate systems change. We then proposed how deep leverage points can be operationalized by developing an approach for sustainable business model innovation and how entrepreneurs can consciously target leverage points when designing their business models to influence sustainable systems change.

https://doi.org/10.1017/pds.2024.132

Session D211

Congress Hall Ragusa

08:15 10:15

UNDERSTANDING A SPSS-AIDED PACKAGING-FREE SHOPPING PRACTICE

Ruihua Chen[1], Xueqing Miao[2]
[1]Beijing Shangyi Heart Technology Co. Ltd., China; [2]Delft University of Technology, The Netherlands

Sustainable service-product systems (SPSSs) aided packaging-free shopping are expected to promote sustainable behaviour through enhanced user experience. Yet, understanding about this kind of practice is scarce. In this study, we adopted a qualitative approach through observations and semi-structured interviews with fifteen young consumers. The results present three stages of the practice and identify the challenges in each stage, using the practice theory as a theoretical basis. In light of these, the future offerings of SPSSs are proposed.

https://doi.org/10.1017/pds.2024.125

21 May

TUE

CIRCULAR PRODUCTS: THE BALANCE BETWEEN SUSTAINABILITY AND EXCESSIVE MARGINS IN DESIGN

REVIEWERS FAVOURITE

Arindam Brahma[1], Sophie I. Hallstedt[1], David C. Wynn[2], Ola Isaksson[1]
[1]Chalmers University of Technology, Sweden; [2]University of Auckland, New Zealand

As the world deals with climate change, it is crucial that new products are designed to be more sustainable. Product design strategies which conform to the Circular Economy principles have recently gained attention, which promote sustainability and resource efficiency. However, such strategies require careful consideration of uncertainties and the ways to mitigate them, e.g. by using margins. The pursuit of circularity can inadvertently lead to overdesign as designers strive to mitigate elevated risks, thereby making a product less sustainable. In this paper, we explore this balance.

https://doi.org/10.1017/pds.2024.122

MODELLING AN ECOSYSTEM OF BUSINESS MODELS IN A CIRCULAR VALUE CHAIN: THE CIRCULAR BUSINESS ECOSYSTEM MODEL CANVAS

Avyay Jamadagni[1], Marco Aurisicchio[1], Lars Nybom[2]
[1]Imperial College London, United Kingdom; [2]Ragn-Sells Group, Sweden

To advance the circular economy, there is a need to take an ecosystem view of business models for circularity in which different actors interact dynamically to create economic, environmental and social value. This research introduces the Circular Business Ecosystem Model Canvas, a novel method to prototype a circular ecosystem of business models. The case of ferric chloride, an inorganic coagulant for wastewater treatment, is used to demonstrate the new canvas and show how it supports the development of a more holistic perspective on sustainability-oriented business model innovation.

https://doi.org/10.1017/pds.2024.133

DESIGN AND COLLABORATION STRATEGIES FOR CIRCULAR ECONOMY IMPLEMENTATION ACROSS THE VALUE CHAIN

Giovana M. Gomes, Daniela C. A. Pigosso, Tim C. McAloone
Technical University of Denmark, Denmark

Based on circular economy readiness assessments of six value chain layers, 18 design strategies and five collaboration strategies for circular economy were identified. The design strategies have many applications, from the design of materials, products, and processes to business models, and while some are specific to determined layers, others can be addressed by companies in multiple layers. Furthermore, collaboration across the value chain was found to affect positively the employment of circular economy design strategies, contributing to the fulfilment of solutions' circularity potential.

https://doi.org/10.1017/pds.2024.128

PRODUCT-SERVICE SYSTEMS IN LARGE AUTOMOTIVE OEMS: CHARACTERISING THE DECISION-MAKING PROCESS WHEN DEVELOPING AND INTRODUCING VEHICLE SHARING/POOLING SCHEMES

Lucia C. Burtnik Urueta, Elies Dekoninck
University of Bath, United Kingdom

Automotive OEM introduced Product-Service Systems in the past 20 years, challenging their traditional business model. A qualitative study was developed to characterise the decision-making process across 6 case studies, and similar patterns across different enabled the identification of lessons learned and possible future implications. All PSS initiatives were introduced following an Agile/Lean experimental approach, but the opportunistic nature of trials casts doubts in future validity. New testing methods that generate more robust conclusions need to be developed.

https://doi.org/10.1017/pds.2024.123

PERCEPTION-CENTRIC DESIGN CONSIDERATIONS FOR LOW-COST HAPTIC EMULATION IN PROTOTYPES

Mike Miroslav Wharton, Christopher Michael Jason Cox, James Gopsill, Aman Kukreja, Chris Snider
University of Bristol, United Kingdom

User-testing is crucial in modern product design. The perception-centric design philosophy aims to cut costs and improve responses to low-cost prototypes by including aspects like thermal properties, texture, weight, sound, and haptic feedback. This paper introduces a set of considerations for integrating low-cost vibrotactile haptics into prototypes. Derived using an action-based research process, it addresses product characterisation, actuation, control, and integration. Multi-sensory prototypes in early-stage design could be vital for the sustainable prototyping of the future.

https://doi.org/10.1017/pds.2024.87

NEW METHODOLOGY FOR THE CHARACTERIZATION OF 3D MODEL RECONSTRUCTIONS TO MEET CONDITIONS OF INPUT DATA AND REQUIREMENTS OF DOWNSTREAM APPLICATIONS

Robert Joost, Stephan Mönchinger, Kai Lindow
Fraunhofer Institute for Production Systems and Design Technology IPK, Germany

In the field of 3D model reconstruction, manifold methods have been developed that derive CAD models from 3D scan data. Opposed to classical CAD modelling, where surface and solid modelling exist, a further diversification of modelling techniques is observed, caused by different methods to build up the geometry. This research introduces a new classification, the so-called Level of Complexities. It can be applied to the complete Reverse Engineering process chain and lays the foundation for further research on how to match requirements arising from all process steps and downstream applications.

https://doi.org/10.1017/pds.2024.64

AN APPROACH FOR REVERSE ENGINEERING AND REDESIGN OF ADDITIVE MANUFACTURED SPARE PARTS

Marija Rešetar[1], Filip Valjak[1,2], Marina Grabar Branilović[3], Mario Šercer[3], Nenad Bojčetić[1]
[1]University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, Croatia; [2]University of Zagreb Faculty of Architecture, School of Design, Croatia; [3]Metal Centre Čakovec, Croatia

The spare parts play a vital role in sustaining the operation and longevity of products and systems, but their unavailability can lead to prolonged downtime or expensive replacements. The integration of 3D scanning and Additive Manufacturing (AM) presents a promising path for spare part production. However, to utilise the full potential of AM, sometimes, redesign of the original part is needed. This paper investigates and proposes a new approach that integrates reverse engineering and redesign of an original part based on functional analysis to support the manufacturing of AM spare parts.

https://doi.org/10.1017/pds.2024.73

WHAT CAN WE LEARN FROM OUTSTANDING DESIGNERS? THE RELATIONSHIP BETWEEN DESIGN EXPERTISE AND PROTOTYPING

Birgit Jobst[1], Katja Thoring[2], Petra Badke-Schaub[1]
[1]Delft University of Technology, The Netherlands; [2]Technical University of Munich, Germany

This paper contributes with insights regarding design expertise and prototyping. Seven high performers – Outstanding Designers – were interviewed to learn about their prototyping activities. The Outstanding Designers emphasised prototyping for reflection, gaining certainty, and cooperating with clients. They expressed a strong attachment regarding the use of prototyping that results in specific routines. We call this behaviour the Outstanding Designers' bonding with prototyping. The main insights were synthesised into a model outlining the relation between design expertise and prototyping.

https://doi.org/10.1017/pds.2024.63

A NOVEL HEURISTIC APPROACH TO DETECT INDUCED FORMING DEFECTS USING POINT CLOUD SCANS

Muhammad Shahrukh Saeed[1,2], Sheharyar Faisal[3], Boris Eisenbart[1], Matthias Kreimeyer[2], Muhammad Hamas Khan[4], Muhammad Zeeshan Arshad[4], Racim Radjef[1], Markus Wagner[2], Eiman Nadeem[3]
[1]Swinburne University of Technology, Australia; [2]University of Stuttgart, Germany; [3]National University of Science and Technology, Pakistan; [4]Technical University of Munich, Germany

The research paper delves into the importance of point cloud data obtained from 3D scanning technology ensuring quality control in industrial settings. It presents a new heuristic approach that utilizes the wavelet algorithm and other techniques to detect and characterize induced forming defects accurately. The proposed approach offers more flexibility, ease of use, and better results based on descriptive and prescriptive analyses from DRM. The results demonstrate that the wavelet algorithm was successful in identifying and characterizing forming defects in point cloud data.

https://doi.org/10.1017/pds.2024.75

CRITICALITY-BASED PLANNING OF PROTOTYPE SEQUENCES

Stefan Zorn, Tobias Glaser, Kilian Gericke
University of Rostock, Germany

The understanding of prototyping has changed in recent years to an approach that accompanies the product development process. This paper examines whether classic approaches from product development are also suitable for planning prototyping sequences. The stepwise process-oriented and the problem-oriented approach are discussed. A criticality assessment is proposed as a metric for the prioritization of the functional areas and a procedure is derived from this. The procedure is illustrated using an example. The result is discussed and future steps are suggested.

https://doi.org/10.1017/pds.2024.89

PRODUCT CHANGES FROM VARIOUS VIEWPOINTS ALONG THE PRODUCT LIFECYCLE – AN EMPIRICAL STUDY

Julia Beibl, Dieter Krause
Hamburg University of Technology, Germany

From an economic perspective, the appeal of a product diminishes over time. However, volatile markets and divergent technological advancements make it challenging to anticipate when and to what extent changes will be necessary. Therefore, it is important to be able to integrate changes after a product's launch. This paper provides an overview of different perspectives on the product lifecycle. In addition, the paper presents an empirical study on implementing changes at an automobile manufacturer.

https://doi.org/10.1017/pds.2024.253

AUTOMATIC DERIVATION OF USE CASE DIAGRAMS FROM INTERRELATED NATURAL LANGUAGE REQUIREMENTS

Simon Schleifer[1], Adriana Lungu[2], Benjamin Kruse[2], Sebastiaan van Putten[2], Stefan Goetz[1], Sandro Wartzack[1]
[1]Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; [2]AUDI AG, Germany

Transferring natural language requirements to use case diagrams helps to avoid inherent ambiguities. However, this is usually a manual, time-consuming task that can be accelerated by utilizing Artificial Intelligence in terms of Natural Language Processing. Thus, this contribution proposes a conceptual framework for automatically grouping interrelated functional requirements and deriving use case diagrams by combining formerly isolated approaches. Moreover, the latter are evaluated by a qualitative potential analysis to support their future industrial application.

https://doi.org/10.1017/pds.2024.275

MERGING AGENT-BASED SIMULATION AND VEHICLE DYNAMICS: A HYBRID APPROACH FOR VALUE EXPLORATION IN THE MINING INDUSTRY

Carl Nils Konrad Toller Melén, Raj Jiten Machchhar, Alessandro Bertoni
Blekinge Institute of Technology, Sweden

Innovation plays a vital role in ensuring sustainable mining operations. Electrification and autonomy are two significant trends, but their implementation brings complexity at vehicle and site levels. Therefore, it is crucial to understand how these technologies impact the overall site value creation. This paper suggests a hybrid approach that combines Agent-Based Simulation and vehicle dynamics modeling to explore site configurations. By regarding a mining site as a System-of-Systems, designers can concurrently test different designs to find the optimal combination for a specific scenario.

https://doi.org/10.1017/pds.2024.278

USING PRODUCT PROFILES FOR RETROSPECTIVE CASE STUDIES IN SGE – SYSTEM GENERATION ENGINEERING

Felix Pfaff, Michael Schlegel, Thomas Alexander Völk, Karl Thomas Reinheckel, Albert Albers
IPEK - Institute of Product Engineering, Karlsruhe Institute of Technology, Germany

Supporting product developers in innovating is an important task of design research. An invention and a valid need situation described through a product profile are necessary elements of innovation. But how can we derive recommendations on how to develop "innovative" products if the success of a product can only be measured retrospectively? Retrospective case studies are one approach to investigate relationships between context factors, variations in systems and product profiles, and innovation success. To investigate these, we use product profiles in case studies across system generations.

https://doi.org/10.1017/pds.2024.272

SUPPORTING MODULAR PRODUCT FAMILY REPRESENTATIONS BY METHODICALLY UTILISING META-MODELS

Markus Christian Berschik, Fabian Niklas Laukotka, Marc Züfle, Dieter Krause
Hamburg University of Technology, Germany

Due to the rising multidisciplinarity and connectivity of products especially modular product families, a sophisticated handling of the information is crucial for reducing complexity during the development. System modelling techniques have evolved to assist engineers with managing information. However, nowadays, it is rarely focusing on modular product families. This paper introduces a meta-model based on an ontology, which improves the creation and management of modular product family and its occurring data. The meta-model is presented using the example of a Passenger Service Unit (PSU).

https://doi.org/10.1017/pds.2024.254

INVESTIGATION OF ADVANTAGES OF MODELS AND THE MODELLING PROCESS BY INTRODUCING A MODEL EVALUATION CONCEPT

Thomas Schumacher, David Inkermann
Technische Universität Clausthal, Germany

Within Model-based Systems Engineering different kinds of model will be created to support the execution of engineering activites. This contribution introduces an evaluation concept which focuses on the model informativity and its usefulness within the modelling process. Thereby, it shall be investigated which advantages the integration of model elements based on different levels of abstraction and a reduction of model formalisation enables. For the model creation the analogue modelling method will be applied, which uses physical (tangible) model elements.

https://doi.org/10.1017/pds.2024.276

INVESTIGATING LOW DATA CONSISTENCY IN WORK PLANNING PROCESSES – CAUSES, MEASURES, AND OPPORTUNITIES

Valesko Dausch[1], Christopher Langner[1], Daniel Roth[1], Matthias Kreimeyer[1], Matthias R. Guertler[2]
[1]University of Stuttgart, Germany; [2]University of Technology Sydney, Australia

Digital transformation increases the need for interdisciplinary collaboration along the product lifecycle. It is currently hindered by a low data consistency resulting from the use of heterogeneous systems and data models. Especially in work planning, where several data models are combined, this decreases efficiency. Systems Lifecycle management (SysLM) offers a solution to this remedy. However, a sudden switch to SysLM is not possible in brownfields. Thus, it is necessary to examine the challenges and opportunities to derive case-specific measures that enable its adoption in work planning.

https://doi.org/10.1017/pds.2024.25

Session D214

Congress Hall Orlando 2

08:15 10:15

THE RELATION BETWEEN SERVICE AND DIGITAL TRANSITION: IMPLICATIONS FOR DESIGNERS

Teresa Monti[1], Samuele Colombo[1], Francesca Montagna[1], Gaetano Cascini[2]
[1]Politecnico di Torino, Italy; [2]Politecnico di Milano, Italy

Service and digital transitions create a range of solutions by combining their features and introducing both human and automated agents as intermediaries. The paper classifies non/digital product/service and explores how these transitions change user involvement. A model is proposed to assess the user's role with human (service) and automated (digital) intermediaries. Utilizing user journey phases, the model is applied to four case studies, revealing commonalities in transition occurrences. Evidence suggest a potential adoption in design identifying the key phases per each transitions.

https://doi.org/10.1017/pds.2024.34

21 May

TUE

PROTOTYPING INDUSTRY 4.0: ENHANCING EFFICIENCY AND PRODUCTIVITY IN SMALL ENTERPRISES THROUGH ITERATION AND LOW-COST SOLUTIONS

Håkon Havsgård, Daniel Nygård Ege, Martin Steinert
Norwegian University of Science and Technology, Norway

This paper explores the implementation of Industry 4.0 technologies in Small Enterprises (SEs), focusing on the unique challenges they face. It presents four case studies demonstrating how low-cost, low-effort solutions can enhance efficiency and productivity in small companies. The solutions, developed in a local makerspace, address specific manufacturing challenges that lack affordable or existing off-the-shelf solutions. The paper highlights the value of iterative prototyping in implementing Industry 4.0 solutions and discusses how this approach can help SEs overcome adaptation challenges.

https://doi.org/10.1017/pds.2024.30

EXPLORING SPACE MANUFACTURING: DESIGNING A LUNAR FACTORY FOR SPACE-BOUND PRODUCTS IN THE NEW SPACE ECONOMY

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This study proposes a Moon-based factory for space-bound products, aiming to revolutionize space exploration through In-Space Manufacturing (ISM). It defines key elements for lunar manufacturing by adapting Earth-based factory models to lunar conditions.

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THE KARAKURI IOT TOOLKIT: A COLLABORATIVE SOLUTION FOR IDEATING AND PROTOTYPING IOT OPPORTUNITIES

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This paper presents a collaborative solution developed to enable people without prior Internet of Things (IoT) knowledge to ideate, conceptualise, role-play and prototype potential improvements to their work processes and environments. The solution, called the Karakuri IoT toolkit and method, was tested in two workshops with eight production leaders at a Swedish manufacturing company. Outcomes were analysed from the perspectives of materials interaction and instruments of inquiry. Results indicate the solution can help people conceive and prototype improvement ideas at early design stages.

https://doi.org/10.1017/pds.2024.21

ON-SITE ANALYSIS OF WORK-RELATED STRESS TO DESIGN WORKERS-FRIENDLY MANUFACTURING SYSTEMS

Graziana Blandino, Samuele Colombo, Francesca Montagna
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Industry 4.0 is leading to technological advancement in manufacturing and causing changes in tasks performed by operators. This represents a potential trigger of humans' stress and workload. This paper aims to investigate work-related stress in an industrial environment through a real production case study through ECG, EDA, EMG, and respiratory band. From stress physiological indicators analysis, preliminary suggestions for the case study are provided to make the production system more human-centered, according to Industry 5.0. Further studies may test the effect of the recommended actions.

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HUMAN- AND DESIGN-CENTRIC SOURCE: COMPARISON USING REQUIREMENTS CHECKLIST

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The overall aim is to assess the superior of human- or design-centric source. This research compares the categories covered in a checklist by pain-points and needs identified individually using human- and design-centric sources. Data from 6 projects of a design course is used. It is found that there is no significant difference in the number of categories covered by pain-points and needs but the categories are not the same. This calls for integrating both sources in comparison to using only one source for designing which can potentially help to identify diverse and relevant outcomes.

https://doi.org/10.1017/pds.2024.9

SHAME CUES: DETECTING SHAME IN DISGUISE AND PLAYING WITH NEW PERSPECTIVES TO INFORM THE DESIGN PROCESS

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This paper describes the creation of a tool named Shame Cues, a card deck consisting of 64 cards describing sociocultural concepts related to shame. The tool arose as an experiment to articulate an entanglement of diverse shame discourses into something relevant for designers. Building on the experience of using Shame Cues, the paper discusses how Shame Cues can support exploring the role of shame as given implicitly, through cultural manifestations, and in a practical sense, and how such an investigative lens can inform designers with more critical perspectives.

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INTRODUCING A FRAMEWORK TO TRANSLATE USER SCENARIOS INTO ENGINEERING SPECIFICATIONS WITH "ACTION STEPS"

Ulugbek Vahobjon Ugli Ismatullaev, KwanMyung Kim
Ulsan National Institute of Science and Technology, South Korea

This study presents a three-stage framework to translate user scenarios into engineering specifications. We introduced 'Action Steps' as an intermediate tool to help convert user scenarios into functional requirements and engineering specifications. It facilitates aligning specifications with user needs by filling in the essential product information not revealed in user scenarios. Preliminary testing revealed that the proposed framework improved team understanding and reduced information gaps, showcasing its potential to enhance specification development and process efficiency.

https://doi.org/10.1017/pds.2024.5

A PROPOSED FRAMEWORK FOR DATA-DRIVEN HUMAN FACTORS EVALUATION

Isabelle Ormerod, Henrikke Dybvik, Mike Fraser, Chris Snider
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Human-centred approaches within the design cycle are crucial to enhance usability and inclusivity of products. However, the qualitative nature of traditional human factors evaluation can create bottle necks, prompting the need for more data driven methods. A framework for data-driven human factors is presented, looking to integrate mixed-method approaches. Case studies illustrate its usage in real-world scenarios and challenges are summarised, calling for robust data collection methods, balancing of mixed methods, a need for explainable systems, and interdisciplinary expertise.

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HUMAN INTERACTION WITH THE PHYSICAL WORLD: A BRIEF REVIEW OF STUDIES ON AFFORDANCES

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Gibson used "affordance" to describe how animals perceive and interact with their environment. Since the term was coined, many studies, both theoretical as well as empirical, have been done. We conducted a review of the 56 most cited works on physical affordances to answer: (1) What methods have been used to study affordances, and how have they changed with time? (2) How has the definition of affordances evolved over time? We went through papers decade-wise and compare their key contributions. Finally, we discuss how the definition and research on affordances has evolved in the last 40 years.

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NARRATIVE DRIVES DESIGN DECISION-MAKING

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Scholars in economics, psychology, and business have recently defined narrative as the underlying mechanism by which humans internally process information and drive a decision forward. In this paper, we study narrative's use in design across Design Society publications. We discuss how narrative's role as the driver of design decision-making is an important, but missing, element of the design literature. We explain how engineers will be expected to move the design process forward despite facing decisions where the information is simultaneously too much to process, conflicting, and incomplete.

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TOWARD A DESIGN METHODOLOGY FOR CONFIGURING ASSISTIVE WEARABLES

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Wearable devices have some shared characteristics. They should conform to the wearer's size and shape, not interfere with desired activities, perform intended functions, be easily usable and comfortable, among others. Due to these shared characteristics, a common design methodology should be possible for designing wearables that assists designers in taking a systematic approach. We propose a configuration design method for wearables and sketch its elements. An example of a family of passive exoskeleton suits that assists with walking is presented to illustrate the configuration design process.

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DESIGNING REMOTE PATIENT AND FAMILY CENTRED INTERVENTIONS: AN EXPLORATORY APPROACH

Julian Houwen[1,2], Ragini S. Karki[2], Veronica R. Janssen[1], Valeria Pannunzio[2,3], Douwe E. Atsma[1,2], Maaike S. Kleinsmann[1,2]
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This research explores the dynamic nature of family involvement in remote patient management for cardiovascular disease and its impact on lifestyle behaviour changes. Through an interview study with patients and family members, we categorise family involvement into three types: Inform, Integrate, and Influence, highlighting the dynamic and heterogeneous nature of family involvement across different phases and activities. Overall, we emphasise the need for personalised and adaptable interventions to cater to the diversity of families and propose a modular approach to remote monitoring design.

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CONSIDERATIONS IN THE TESTING OF A MINIMUM VIABLE PRODUCT IN HEALTHCARE

Komal Shah, Manish Arora
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Introducing a Minimum Viable Product in the market and rapidly testing it proves valuable in assessing its value and potential. This involves experiments, gauging growth, and striving to diminish uncertainty in iterative cycles. The application of these approaches in healthcare, however, faces obstacles due to unique challenges including patient safety concerns and regulatory compliances. This paper undertakes a narrative literature review covering experiences of healthcare professionals and presents guiding considerations for medical startups to use in the market validation of their products.

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BRIDGING THE GAP: A MULTIDISCIPLINARY APPROACH TO INTEGRATED CARE SOLUTIONS FOR THE AGING POPULATION

Max John Bateson, Yonghun Lim
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This study addresses the challenges of the ageing population, focusing on enhancing the life of caregivers and the elderly. It proposes a multifaceted solution that allows dependents to live close to their carers, enabling oversight without a need for constant presence. The paper employs empirical studies to ensure a deep understanding of caregiving, capturing the breadth and depth of challenges. Presenting a novel design solution, Hygge, combines physical and system design with technology integration. This prioritises accessibility, cost, maintenance, and adaptability for diverse needs.

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STUDYWELL: A CO-DESIGN PROJECT FOR ENHANCING STUDENT MENTAL HEALTH AND WELLBEING THROUGH SERVICE DESIGN AND RELATIONAL WELFARE

Brita Fladvad Nielsen, Nina Petersen Reed, Ottar Ness, Mari Bjerck, Arnfrid Farbu Pinto, Ipar Memet, Katie Aurora Lineer
Norwegian University of Science and Technology, Norway

Students mental health is declining. StudyWell is a project aiming at positive impact on student mental health in student cities in Norway; by integrating relational welfare with service design, and the study environment as a starting point. We discussfour implementation challenges: First, co-design depends on a shared mindset across disciplinary boundaries. Secondly, balancing the lenses of individuals, community, system and future require facilitation. Thirdly, societal impact requires continuous partner anchoring. Finally, approaches must not further pathologize university student.

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EVALUATING A WEB-BASED GUIDE FOR DESIGNING DIGITAL PATIENT EXPERIENCES: PRELIMINARY RESULTS OF A USER TEST WITH DESIGN STUDENTS

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We created a web-based design guide to transfer our previous research findings to better support design education in the digital health design area for improving patient experience. To seek insights to iteratively improve the design guide, we conducted a workshop with 19 MSc students who specialized in design for healthcare. The guide was perceived as having the potential to improve their understanding of digital PEx improvements, but the content clarity and information presentation need to be improved.

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TOWARDS A UNIFIED ABSOLUTE ENVIRONMENTAL SUSTAINABILITY DECOUPLING INDICATOR

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Manufacturing firms are facing the critical need to manage their business growth while staying within the biophysical limits of the planet. Absolute environmental sustainability decoupling (AESD) combines these goals and is one of the keys for manufacturing firms to achieve their sustainable transition. This study offers an initial contribution to categorise decoupling at the firm level while incorporating absolute environmental sustainability goals. It also explores the role of design in achieving AESD and opens doors for further research on manufacturing firms' sustainability transition.

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INTERDISCIPLINARY TRANSITION INNOVATION, MANAGEMENT, AND ENGINEERING (INTIME) DESIGN: AN INTERSECTION ANALYSIS OF DESIGN APPROACHES FOR WHOLE-SYSTEM SUSTAINABILITY

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Interdisciplinary transition innovation, management, and engineering (InTIME) Design has been developed to overcome sustainability transition challenges in complex systems. The intersections of InTIME Design with a range of reported design for sustainability (DfS) approaches were analysed. Results demonstrate similar core principles across DfS approaches. InTIME Design accomplishes convergence of the studied approaches, and organises the DfS approaches into workflow phases, adds a complimentary wicked problem definition, and deploys systems engineering problem solving.

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DEVELOPING READINESS LEVELS FOR RISK ASSESSMENT IN GREEN TRANSITION ENGINEERING PROJECTS

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This paper aims to develop a risk assessment framework that addresses both the complexities of the risk landscape that green transition portfolios face, but is recognizable and easily understandable by stakeholders. For this purpose, we build upon the framework of NASA Technology Readiness Levels (TRLs). This study analyzes six existing readiness levels framework that are held towards uncertainty factors from the Green Transition. The TRL scale are coupled with Risk, Uncertainty, and Ignorance to score the individual level of uncertainty. The paper ends with suggestion for further studies.

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UNCOVERING REBOUND EFFECTS OF SUFFICIENCY-ORIENTED PRODUCT-SERVICE SYSTEMS: A SYSTEMATIC REVIEW

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[1]*Technical University of Denmark, Denmark;* [2]*Universitat Autònoma de Barcelona, Spain*

The discourse surrounding sustainable consumption and production has evolved to encompass sufficiency strategies in addition to efficiency and effectiveness. Product-service systems (PSSs) can promote sufficiency by replacing traditional product-intensive systems with dematerialized services and changes in ownership structures. Sufficiency-oriented PSS may, however, generate rebound effects which offset potential sufficiency benefits or even result in backfire. This paper examines the connection between sufficiency-oriented PSS and rebound reviewing 12 empirical studies addressing rebound.

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SYSTEMS THINKING TOWARDS HOLISTIC, SUSTAINABILITY-ORIENTED ASSESSMENT AND DECISION-MAKING FOR LIGHTWEIGHTING

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Multiple industries have hailed lightweighting promise to reduce the mass of their product at equivalent or improved performance. Lightweighting as a strategy encompasses lightweight end-product desired attributes and through-life processing decisions. Assessment of lightweighting gathers information for decision-making towards the optimization of these strategies. An exploratory study, using systems thinking is conducted, to identify requirements of lightweighting and its assessment in terms of holistically defining its impact on the sustainability of its background system, the Earth.

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DESIGNING A FRAMEWORK FOR ACTUATORS FOR ADAPTIVE STRUCTURES

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University of Stuttgart, Germany

Adaptive structures have the potential to play a significant role in saving resources in the construction industry in the future. For realisation, this requires actuators that meet the requirements of different buildings with their specific load-bearing structures. In the past, the actuators were mainly developed particularly for one exemplary load-bearing structure. This paper analyses the primary classifications for buildings, followed by challenges of adaptive structures, before outlining the draft of a framework for actuators for adaptive structures to speed up and simplify development.

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CHALLENGES OF THE INTEGRATIVE PRODUCT AND PRODUCTION SYSTEM DEVELOPMENT

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Shorter product lifecycles and a shift from mechatronic to cyber-physical systems are leading to greater product complexity. This complexity can be addressed by more intensive cooperation between product and production system development. Despite intensive development in recent years, these process models have not been able to establish themselves in corporate practice. Therefore, this paper analyses the existing integrative product and production methods to identify the reasons for their lack of use in practice. The analysis has shown that there are nine barriers.

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VARIABILITY IN COMPLEX PRODUCT/SYSTEM DESIGN: CASE STUDY IN AUTOMOTIVE INDUSTRY

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The complexity of the products/systems requires an in-depth understanding of variability and its impact on all phases, from design to maintenance. This study explores Variability Management (VM) emphasizing its challenges. Conducting semi-structured interviews with experts at Renault Group, the research examines variability aspects, semantics, methods, challenges, and possible solutions. The findings offer practical insights into industrial-scale variability management, addressing the use case of the automotive industry.

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DESIGN METHODOLOGY FOR OPTIMAL SENSOR PLACEMENT FOR CURE MONITORING AND LOAD DETECTION OF SENSOR-INTEGRATED, GENTELLIGENT COMPOSITE PARTS

Sören Meyer zu Westerhausen[1], Alexander Kyriazis[2], Christian Hühne[2], Roland Lachmayer[1]
[1]Leibniz University Hannover, Germany; [2]Technische Universität Braunschweig, Germany

Selecting right positions for composite-integrated sensors for monitoring cure during manufacturing and loads during product use presents challenges for engineering design. Since an optimal sensor placement (OSP) methodology for both phases is not emphasised enough in literature, a new methodology is proposed. This methodology is based on a Genetic Algorithm and strain gauges, temperature sensors and interdigitated electrode sensors for cure monitoring and physics-informed neural network-based load detection. Additionally, it includes sensor node positions optimization in a sensor network.

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EVALUATION OF THE METHODICAL FRAMEWORK FOR THE MANAGEMENT OF UNCERTAINTY IN THE CONTEXT OF THE INTEGRATION OF SENSORY FUNCTIONS

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As digitalization progresses, the development and integration of sensory functions in technical systems become increasingly important. Managing uncertainty, especially in the early phase of this process, is crucial to ensure the reliability of the data provided. Therefore, a methodical framework for the identification, analysis and consideration of uncertainty was presented in prior works. In this contribution, the effectivity of the framework is evaluated by applying it to a sensory function for rotational speed and offset measurement of a disk pack coupling using sensor integrating bolts.

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TAILORED METRICS FOR ASSESSING THE QUALITY OF MBSE MODELS

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System models are used to merge relevant engineering artefacts and relationships. Therefore, a high model quality must be ensured. Currently, there is no method for defining company-specific metrics to assess system model quality. In a six-step research approach, a method is defined: (1) literature analysis on quality assessment approaches, (2) derivation of success factors, (3) evaluation of approaches, (4) development of a method, (5) application in automotive industry, and (6) evaluation. The method supports system engineers to derive tailored metrics to objectively assess the model quality.

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Session D223

Congress Hall Orlando 1

10:45 12:30

EXTENDING THE FUNCTION FAILURE MODES TAXONOMY FOR INTELLIGENT SYSTEMS WITH EMBEDDED AI COMPONENTS

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Early consideration of failure modes in the feature development process is essential to identify and trace risks across the physical and embedded AI components of intelligent systems, to enhance the robustness of the feature delivery as well as trust in the AI. This paper introduces an extension of the AIAG/VDA function failure modes taxonomy, to facilitate the integrated analysis of complex intelligent systems with embedded AI. A case study of an autonomous driving feature is discussed as validation of the proposed taxonomy.

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21 May

TUE

TOOL SUPPORT FOR IMPLEMENTING A METHODOLOGY IN MAGNET DEVELOPMENT PROJECTS AT CERN

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Abstract product development models, such as the Integrated Product Engineering Model (iPeM), are insightful yet complex, hindering practical application. The paper introduces a prototypical tool designed to simplify the application of iPeM. A case study at CERN showcases the tool's capability in utilizing the iPeM to streamline the tailoring of standards into methodologies for research environments. The tool's impact is evaluated through interviews at CERN. The findings suggest the tool's benefits, especially for individuals without formal project management backgrounds.

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SYSTEMS ENGINEERING IN DESIGN PRACTICE: A GUIDELINE FOR DEVELOPMENT SERVICE PROVIDERS

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To handle the increased complexity within the automotive industry, this paper introduces a guideline, which aims to support development service providers to examine the introduction and if applicable support the introduction of systems engineering. The initial verification was performed through applying the guideline at Porsche Engineering as an exemplary service provider. As a result, the success factors "knowledge basis" and "knowledge transfer" have been improved by two points on a 1-5 Likert-scale by introducing a SE process-specific knowledge platform and a defined knowledge transfer.

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REVIEWING THE SUITABILITY OF ICT-CENTERED DESIGN METHODS FOR SMART PSS DEVELOPMENT

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The emergence of smart Product-Service Systems (smart PSS) presents numerous challenges for enterprises. The complexity of designing smart PSS adds to the need for consistent support for manufacturers. Both academia and practitioners highlight the importance of methodological support for successful development of smart PSS. This paper therefore investigates the suitability of existing support for smart PSS. Based on a systematic literature review, 17 support methods are identified and their key characteristics are discussed in the context of real PSS use cases.

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6 DEGREE OF FREEDOM POSITIONAL OBJECT TRACKING FOR PHYSICAL PROTOTYPE DIGITISATION

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University of Bristol, United Kingdom

Underpinning much work on the use of Virtual Reality technologies in design prototyping, is the need to reliably track the 3D position of a physical object in real space, then allowing synchronisation with a digital counterpart. With many tracking methods requiring changes to object geometry, this work develops and benchmarks four minimally invasiveness 6 DoF tracking approaches, before discussing their use in a prototyping context. Results show that using AI and point cloud methods, accuracies of 20mm at 20Hz are achievable on low-end hardware with no alterations to the prototype needed.

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LEARNINGS FROM DEVELOPING A CUSTOM VIRTUAL ASSEMBLY ENVIRONMENT FOR MOUNTABILITY ISSUES OF COOLING CABINETS

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Various industries use computer simulation for verifying product properties in early phases of development. Traditionally, such properties include the stability of mechanical structures or the efficiency of aircraft turbines. More recently, research also focuses on the mountability of industrial products using virtual assembly. While research on virtual assembly already started in the mid-1990s, the applicability in different industries remains largely unclear today. To advance the state-of-the-art, in this paper we present learnings from developing a virtual assembly environment for cooling cabinets.

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MIXED REALITY PROTOTYPING: A FRAMEWORK TO CHARACTERISE SIMULTANEOUS PHYSICAL/VIRTUAL PROTOTYPING

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Immersive reality (XR) technologies, particularly Mixed Reality (MR), offer promising opportunities for enhancing design prototyping. While recent studies often focus on Virtual Reality this work explores the application of MR, where focus lies on interlinking both the physical and digital to maximise benefit. Following a review of XR in design, a descriptive framework is presented to characterise MR prototyping. Two case studies are then presented to highlight the value of bridging the physical and digital worlds, before directions for further research in MR-based prototyping are outlined.

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A VIRTUAL REALITY EXPERIENCE TO RAISE SUSTAINABILITY AWARENESS WITHIN THE FASHION INDUSTRY

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Politecnico di Milano, Italy

Nowadays, there is a pressing need to incorporate sustainable practices and promote environmental awareness. The fashion industry, characterized by resource-intensive consumption, significantly contributes to global sustainability threats. The authors proposed the adoption of Virtual Reality (VR) to design and develop the Fashion Footprint application, an experience aimed at enhancing sustainability awareness and fostering behavioral change. The findings suggest that VR technology is valuable in promoting sustainability awareness and driving positive behavioral shifts in the fashion industry.

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APPROACH OF A VIRTUAL REALITY DIDACTIC TOOLKIT – IMPLEMENTATION AND REFLECTION

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Virtual reality plays an increasingly important role in design education. However, a holistic view, starting with the didactic concept, the selection of a VR tool suitable for the learning task and a final reflective evaluation of the learning experience, rarely takes place. In this paper, the authors present an approach for a VR didactics toolkit that covers and takes into account all three points as a whole. The application and research environment here was the bachelor's degree module Ergonomics and Industrial Design at the Ostfalia University of Applied Sciences.

https://doi.org/10.1017/pds.2024.283

ANALYSING SHRINKAGE COMPENSATION IN ADDITIVE MANUFACTURING: A COMPARATIVE STUDY OF REVERSE ENGINEERING AND GAUGE-BASED METHODS

Alessio Zanini, Marco Marconi, Gianluca Rubino
Università degli Studi della Tuscia, Italy

Additive Manufacturing has transformed modern manufacturing with its well-known advantages. However, shrinkage remains a critical challenge, causing dimensional inaccuracies that should be properly compensated to assure geometric fidelity. This study aims to assess the reliability of a Reverse Engineering (RE) technique for dimensional compensation. A gauge-based measurement approach has been used to validate the RE method. Results confirm that the RE method is promising, while highlighting the intrinsic errors of the RE technique, and suggesting ways to evaluate and prevent them.

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OPTICAL AND MECHANICAL TESTING OF 3D PRINTED PARTS MADE OF HIGH-VISCOSITY SILICONE TO IDENTIFY PROCESS PARAMETERS AND DESIGN ADVICE FOR 3D PRINTING AND PRINTER DEVELOPMENT

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Technische Hochschule Nürnberg Georg Simon Ohm, Germany

The additive manufacturing of parts made from close-to-production materials poses a great challenge. One example are highly viscous silicones, as used in injection moulding. For small production quantities, the manufacturing of injection moulds is uneconomical. This paper presents tensile specimens printed with an in-house developed dispensing system, which are analysed for air cavities (micro-CT scans) and mechanical properties. Based on the results, advice for the design and slicing parameters of parts using high-viscosity silicones in AM by means of material extrusion are developed.

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DESIGN AND EVALUATION OF NON-PLANAR MATERIAL EXTRUSION ON A 3-AXIS PRINTER

Samuel Bengtsson, Axel Nordin, Jože Tavčar
Lund University, Sweden

The use of material extrusion (MEX) has increased rapidly due to the affordability of 3D printers. This has led to a growing demand for improved print quality, high fidelity, strength, or fast print times. In this study, a non-planar approach for better surface quality is investigated. The hardware of a 3-axis MEX printer was developed together with testing new software for non-planar slicing. The aim was to identify the most influential parameter combinations using design of experiments. A novel method for measuring surface quality was presented together with future research work.

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EXPLORING HIGH-STIFFNESS PELLETS AS FILAMENTS IN FUSED FILAMENT FABRICATION

Martin Lilletvedt Rasmussen[1], Simen Gjethammer Grønvik[1], Henrik H. Øvrebø[1], Ben Hicks[2], Chris Snider[2], Martin Steinert[1], Christer W. Elverum[1], Sindre Wold Eikevåg[1,2]
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In Fused Filament Fabrication, there is increasing interest in the potential of composite filaments for producing complex and load-bearing components. Carbon fibre-filled polyamide currently has highest available strength and stiffness, but promising variants are not in filament form. This paper investigates filament production of commercially available, high-filled PA-CF pellets by modifying a tabletop filament extruder. We show filament production is possible by improving cooling. The FFF printed specimens show an average UTS of 135.5 MPa, higher than most commercially available filaments.

https://doi.org/10.1017/pds.2024.182

AN ANALYTIC COST MODEL FOR BOUND METAL DEPOSITION

Mikhailo Sartini, Iacopo Bianchi, Alessio Vita, Michele Germani, Marco Mandolini
Università Politecnica delle Marche, Italy

Metal material extrusion is a family of metal additive manufacturing that includes atomic diffusion additive manufacturing (ADAM) and bound metal deposition (BMD). In the literature, there are just a few cost models for ADAM and no one for BMD. The paper presents an analytic cost model for BMD. It considers the entire process: pre-processing, printing and post-processing. The total manufacturing cost is split into material, machine, labour, energy and consumables items. The cost model validation on a 3D-printed part determined an accuracy of 98%.

https://doi.org/10.1017/pds.2024.184

CO-DESIGNING FOR THE NHS: THE DEVELOPMENT OF SUSTAINABLE THEATRE GARMENTS

Paul Rodgers[1], Euan Winton[2], Lewis Urquhart[1], Jonathan O'Reilly[3], Carole Anderson[3]
[1]University of Strathclyde, United Kingdom; [2]Heriot-Watt University, United Kingdom; [3]NHS Scotland, Golden Jubilee, United Kingdom

NHS Scotland, one of the keystone healthcare providers in the UK, have recently set a wide variety of sustainability targets in an effort to mitigate waste and the intensive energy demands of healthcare. Medical garment production, management and design is an area in which design researchers can explore and offer solutions. This paper presents a series of co-design explorations to examine design alternatives to single-use theatre caps, the majority of which are currently disposed of routinely. Using a series of probes, major insights into how theatre cap design may be improved is presented.

https://doi.org/10.1017/pds.2024.168

Session D226

Congress Hall Šipun

10:45 12:30

SURVEYING FACTORS THAT INFLUENCE HEALTHCARE PERSONNEL IN THE TRANSITION TO REUSABLE SURGICAL GOWNS

Charlotte Harding, Ingrid Moons, Regan Watts, Gunter De Win, Els Du Bois
University of Antwerp, Belgium

This study surveyed 190 healthcare professionals to examine attitudes towards reusable surgical gowns, aiming to reduce medical waste. Comfort (scoring 5.32 out of 7) and misconceptions about gowns serving as personal protective equipment (87% hold this belief) are crucial influencers. External motivators, trust, emotions, and workload also impact perceptions. The study recommends enhancing reusable gown design for comfort, multifunctionality, and hygiene trust. It calls for communication strategies to normalise reusables in healthcare and urges a transition to sustainable practices.

https://doi.org/10.1017/pds.2024.161

21 May

TUE

EMOTIONAL DESIGN OF MEDICAL DEVICES: EXOSKELETONS AND POST-STROKE RECOVERY DEVICES

Frederik Kiersgaard Lund, Luke Edward Eric Feast, Milo Marsfeldt Skovfoged, Hendrik Knoche, Mostafa Mohammadi, Lotte N. S. Andreasen Struijk, Linda Nhu Laursen
Aalborg University, Denmark

The paper explores the integration of emotional design elements in the development of medical devices to enhance user acceptance and adherence. It emphasizes the importance of a user-centered approach, acknowledging both functional and emotional needs. The study compares two cases within healthcare design, highlighting the impact of emotional design on users' perception of medical devices. Despite the different stages of development in the two cases, both employed a higher level of refflective design, aiming to create a lasting impact on users' identity using the products.

https://doi.org/10.1017/pds.2024.164

DESIGNING HEALTHCARE SYSTEMS FOR EARLIER DIAGNOSIS AND PREVENTION OF DEMENTIA

Coco Newton[1,2], Jiwon Jung[1,3], Maaike S. Kleinsmann[1,4], P. John Clarkson[1,2]
[1]Delft University of Technology, The Netherlands; [2]University of Cambridge, United Kingdom; [3]Erasmus University Medical Center, The Netherlands; [4]Leiden University Medical Center, The Netherlands

Recent clinical trials have successfully slowed Alzheimer's disease dementia progression, but only in early-stage patients. Society must therefore shift to early diagnosis. By framing this is as an engineering design challenge, we argue that a systems approach will identify solutions by providing the means to validate dementia medical technologies from multiple levels and perspectives: society, government, public health, healthcare, and patient ecosystems. We show that new data-enabled design methods can facilitate these different granularities of thinking and outline the need for designers.

https://doi.org/10.1017/pds.2024.166

DESIGNING POSITIVE EMOTIONAL EXPERIENCES OF WEARABLE MEDICAL TECHNOLOGY FOR TYPE 1 DIABETES

Ryan Charles Williams, Yonghun Lim
Bournemouth University, United Kingdom

With the current strain on the healthcare service, wearable technology presents a solution. However, there is a lack of adoption from user groups due to a focus on clinical and financial factors. This study explores the implementation of positive design in medicine, outlining contributing factors to positive emotional experiences. Using a qualitative methodology in the form of semi-structured interviews with users and experts, a construct was defined consisting of five key psychological needs, including control, stimulation, competence, social factors, and purpose & growth.

https://doi.org/10.1017/pds.2024.172

MEET THE EDITORS OF THE DESIGN STUDIES REPLACEMENT JOURNAL

Chair:
Philip Cash
Northumbria University, United Kingdom

This is your opportunity to meet some of the Senior Editors who will help launch a new journal to keep on the high-quality work of Design Studies*. Come and find out what is being planned, talk to us about your research ideas, give us any suggestions, and how to get involved.

The new journal [with the working title Designing] builds on the legacy and expands on the vision of Design Studies, using the break with Elsevier to revitalise and rethink the journal to embrace a wider range of subjects, approaches, and disciplines whilst remaining focused on the process of design. Designing will cover all aspects of studying the activity of design including design practices, design methods, design in disciplines, design thinking, design theory, technologies for design, histories of designing and design research, research through design, pedagogies of design, collaborative design, and diversities relating to design. Designing will also embrace emerging fields of design activity, including financial design, prompt design, circular design, bio design, feminist design, decolonial design, and more-than-human design. Studies will tend to be empirical- and evidence-based, though well-argued theoretical, critical, and philosophical papers will be welcomed. All submissions will need to demonstrate rigour in approach and research methodology, but above all papers must make an original contribution to the study of design processes.

*see the context for this here:
https://www.designresearchsociety.org/articles/the-future-of-design-studies-update

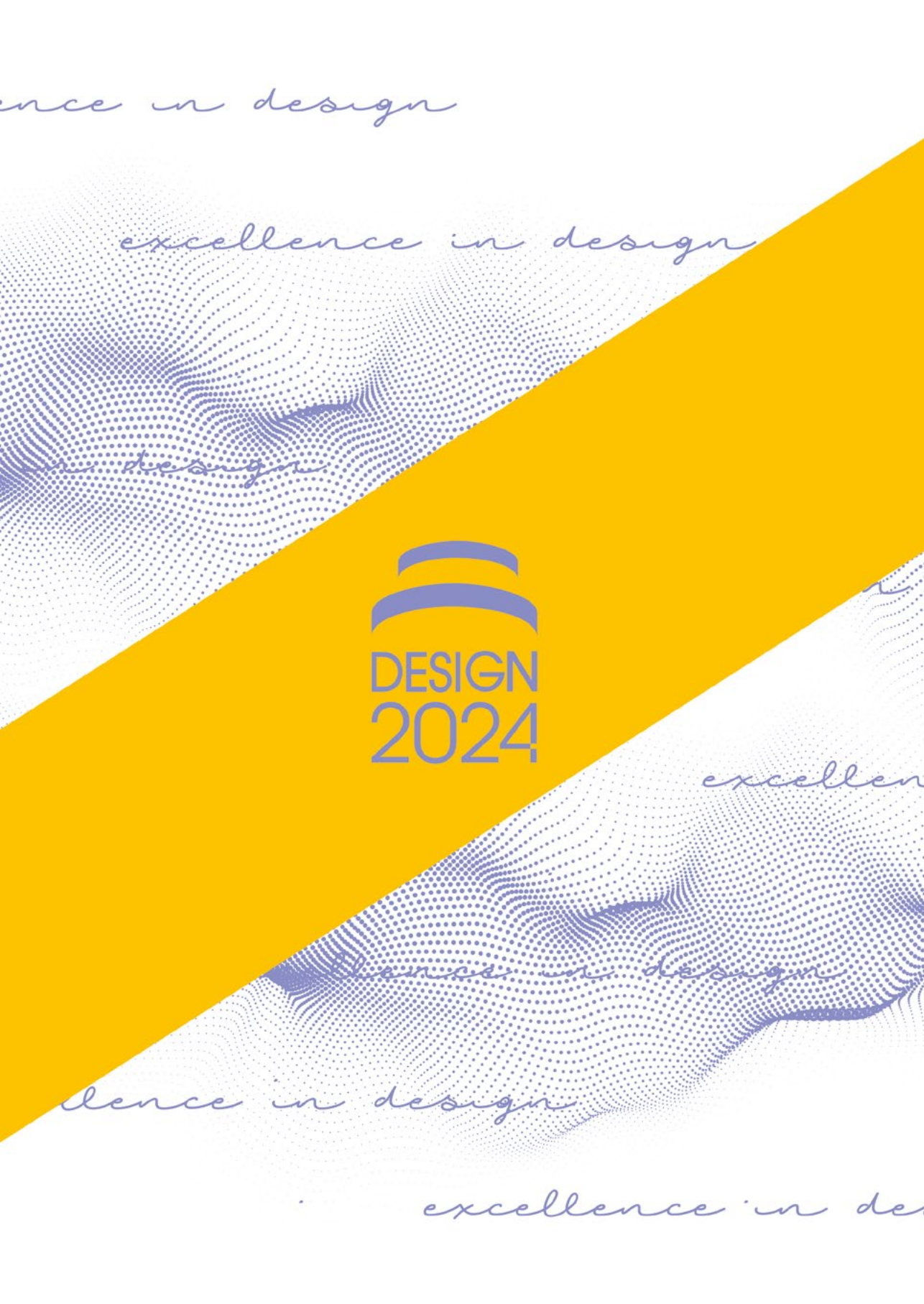
Session D2-EM

Congress Hall Šipun

12:30 13:15

21 May

TUE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AI IN PRODUCT DEVELOPMENT: A PERSPECTIVE VIEW

Jon Hirschtick
Chief Evangelist at PTC, Cofounder of SolidWorks and Onshape

The recent fast advancements of Artificial Intelligence (AI) in many domains makes us all naturally curious abouts the potential for AI in product design. The current state of AI usage in product design tools is relatively limited. But it's coming: product designers should be excited about what lies ahead. In this talk, Jon Hirschtick will delve into an overall view of AI in product development. Where is it being used already? What are some of the exciting research projects happening in AI and product design? What is the full range of potential applications? And, for those of us who build tools for product development, what are the things we need to be considering in this new world of AI?

BIOGRAPHICAL SKETCH

A technology pioneer and leading entrepreneur in the computer-aided design (CAD) industry, Jon Hirschtick has spent his career building software products that companies use every day to design their hardware products. Founder and former CEO of several successful companies, including Onshape (acquired by PTC) and SolidWorks (acquired by Dassault Systems), Jon is now Chief Evangelist at PTC, where he helps usher in the next generation of major advancements in product design. When he is not working on CAD and PDM tools, Hirschtick entertains customers and peers with stories from his days on the famed MIT Blackjack team, featured in the movie "21" and the History Channel's "Breaking Vegas". Hirschtick holds bachelor's and master's degrees from MIT, where he majored in mechanical engineering.

WHAT ITALIAN FURNITURE COMPANIES DO TOWARDS SUSTAINABLE TRANSITION? DESIGN ACTIONS AND STRATEGIES SHOWCASED DURING MILAN DESIGN WEEK 2023

Silvia Maria Gramegna, Francesca Mattioli, Xue Pei
Politecnico di Milano, Italy

Manufacturing companies find themselves at the crossroads of innovation and sustainability in an era of growing emphasis on corporate social responsibility. This paper delves into Design for Sustainability, aiming to understand the practices Italian design furniture companies are implementing towards sustainability through case studies analysis of sustainable actions (SA) showcased in Milan Design Week 2023. The study categorizes SA according to the Design for Sustainability Framework, determining their role in furniture companies' transformative learning approaches towards sustainability.

https://doi.org/10.1017/pds.2024.129

Session D231

Congress Hall Ragusa

15:15
17:15

INTEGRATION OF SUSTAINABILITY INTO PRODUCT DEVELOPMENT: INSIGHTS FROM AN INDUSTRY SURVEY

Sachira Vilochani[1,2], Tim C. McAloone[1,2], Daniela C. A. Pigosso[1,2]
[1]Technical University of Denmark, DTU Construct, Denmark; [2]Technical University of Denmark, Centre for Absolute Sustainability, Denmark

Sustainable Product Development (SPD) enables the systematic incorporation of sustainability into product development and can be achieved by implementing a number of management practices. An industry survey was conducted to investigate the capability of manufacturing companies to apply a consolidated set of 61 SPD management practices. The results indicate that despite the high interest for SPD, the uptake of SPD practices in industry is still behind the state-of-the-art literature. Hence, a greater improvement opportunity exists in the industrial uptake in SPD.

https://doi.org/10.1017/pds.2024.154

21 May

TUE

USING THE LOW-TECH CONCEPT TO CREATE SCENARIOS: AN ANALYSIS OF ITS POTENTIAL TO DESIGN FOR SUSTAINABLE URBAN FUTURE

Flore Vallet[1,2,3], Tjark Gall[2]
[1]Pôle Léonard de Vinci, France; [2]Laboratoire Genie Industriel, CentraleSupélec, Université Paris-Saclay, France; [3]IRT SystemX, France

Designers must be equipped with methods to contribute to sustainability transitions. Scenario planning arose as approach to integrate future uncertainties while the low-tech concept promotes technological discernment. This paper looks at how low-tech fuelled scenario planning. Analysing institutional and archetypical scenarios shows a partial integration through high and low-tech extremes. However, more nuanced considerations are lacking. This paper shows that low-tech can bring an interesting dimension to future scenarios and thus contributes to method development for sustainable design.

https://doi.org/10.1017/pds.2024.151

DRIVING SUSTAINABLE MOBILITY: A STUDY OF ELECTRIC VEHICLE ADOPTION IN RURAL INDIA

Aniruddh Dnyandeo Satpute, Parinita Rai, Prasad Onkar
Indian Institute of Technology Hyderabad, India

The global push for sustainable and eco-friendly transportation solutions has made the adoption of electric vehicles imperative. In India, EV adoption has shown promise, fueled by diverse product offerings and supportive government policies. However, rural India lags behind in EV adoption, despite being a significant market. To unlock the untapped potential, understanding the needs, attitudes, and barriers of rural consumers is crucial. This research conducts a study of rural Indian consumers and offers valuable design insights for automotive companies to formulate effective future strategies.

https://doi.org/10.1017/pds.2024.145

COMPARISON OF E-SCOOTER TYRE PERFORMANCE USING ROLLING RESISTANCE TRAILER

George Stilwell[1], Shayne Gooch[1], Martial Lafitte[2]
[1]University of Canterbury, New Zealand; [2]CESI Graduate School of Engineering, France

E-scooters are a cost-effective means of urban transport, however, there have been questions about their safety, performance, and energy efficiency. This paper investigates the rolling resistance of scooter tyres so that the performance of scooters can be more accurately determined. A rolling resistance trailer was manufactured to directly measure tractive force and closely approximate the rolling resistance force for nine commonly used scooter tyres at low speed on a smooth concrete surface. The results of this study will enable a better understanding of the energy losses of these devices.

https://doi.org/10.1017/pds.2024.148

DATA-DRIVEN LIFE CYCLE ASSESSMENT FOR MECHATRONIC SYSTEMS: A COMPARATIVE ANALYSIS OF ENVIRONMENTAL IMPACT ASSESSMENTS

Artur Krause[1], Steffen Wagenmann[2], Katharina Ritzer[1], Albert Albers[2], Nikola Bursac[1]
[1]Hamburg University of Technology, Germany; [2]Karlsruhe Institute of Technology, Germany

The growing emphasis on sustainability integrates eco-design and life cycle analysis into product development. Despite the value of LCAs, data limitations lead to assumptions, impacting accuracy. This study compares an estimation-based LCA with a data-driven approach, focusing on a laser machine's operational phase. The significant influence of resource consumption during operation underscores the necessity of optimization. Applying a data-driven approach reveals a 24% difference compared to the estimation-based method, emphasizing the challenges in obtaining accurate data for effective LCAs.

https://doi.org/10.1017/pds.2024.136

REDUCING UNCERTAINTY REGARDING CUSTOMER EXPECTATIONS FOR A SUSTAINABLE CAR INTERIOR DESIGN INTEGRATED IN A DATA-INFORMED DESIGN APPROACH

Bastian Quattelbaum[1], Lara Amelie Geiger[1], Kostas Stylidis[2,3], Rikard Söderberg[2]
[1]Hochschule Niederrhein University of Applied Sciences, Germany; [2]Chalmers University of Technology, Sweden; [3]Intended Future AB, Sweden

Sustainability is influencing the automotive industry. Car manufacturers are increasingly prioritizing sustainable materials. The production of these still pose environmental challenges. This paper addresses the trends related to sustainable car interiors. It emphasizes the importance of understanding how customers perceive these new materials. Seven in-depth interviews were conducted, followed by a survey with 106 participants to obtain generalized insights. The results will reduce the uncertainty regarding customer expectations for sustainable car interiors.

https://doi.org/10.1017/pds.2024.72

FUTURE-ROBUST PRODUCT PORTFOLIO DEVELOPMENT: INSIGHTS INTO THE ADVANCEMENT OF PRODUCT PORTFOLIOS IN COMPANIES – AN INTERVIEW STUDY

Michael Schlegel[1], Markus Just[1], Ingrid Wiederkehr[2], Carsten Thümmel[1], Christoph Kempf[1], Christian Koldewey[2], Roman Dumitrescu[2], Albert Albers[1]
[1]Karlsruhe Institute of Technology, Germany; [2]Heinz Nixdorf Institute, Paderborn University, Germany

A volatile environment and an increasing number of products along with a growing range of functions pose a challenge for companies when it comes to further development. Existing methods are no longer sufficient to cope with these challenges. In order to develop new methods, the process and challenges in the advancement of product portfolios must be understood. In this paper we conduct an interview study with ten experts to gain a better understanding of the advancement of product portfolios. Triggers, changes and actions are examined and goals and requirements for new methods are derived.

https://doi.org/10.1017/pds.2024.77

DECISION MAKING SUPPORT FOR DESIGNERS AT THE EARLY DESIGN STAGE REGARDING NARROWING DOWN THE RANGE VALUES OF DESIGN VARIABLES

Yoshiyuki Shimada[1], Daichi Akutsu[1], Shinnosuke Kodama[1], Shuichi Kondo[2], Shigeki Hiramatsu[2], Seiji Fukui[2], Hiroshi Unesaki[2], Takashi Hatano[2], Kazuhiro Aoyama[3], Masato Inoue[1]
[1]Meiji University, Japan; [2]Mazda Motor Corporation, Japan; [3]The University of Tokyo, Japan

This study presents a search method for a solution space that aligns with a designer's design intent. The proposed method uses multiobjective optimization to determine the size of the narrowed solution space and the weakness of the constraint relationships between the design variables. The suitability of the proposed method is tested by applying it to the design problem of an electric motor for an EV, aiming to provide designers with solution spaces that offer a high degree of freedom in the later design stages and that have weaker constraint relationships among the design variables.

https://doi.org/10.1017/pds.2024.79

USING CLUSTER ANALYSIS TO ENHANCE A METHOD FOR THE MANAGEMENT OF DISTURBANCE FACTORS VIA PRODUCT STRUCTURES

Richard Breimann, Laura Luran Sun, Eckhard Kirchner
Technische Universität Darmstadt, Germany

To achieve higher functionality in mechatronic systems, the management of disturbance factors plays a crucial role. For this purpose, a method was developed in prior works to address this management via the optimisation of product structures. However, this method lacks applicability due to the complexity of one step of the method. It is the goal of this paper to present a software tool, utilizing cluster-analysis to sort components into assemblies, with which this step is supported. Additionally, the method is generally adapted to address a wider spectrum of phenomena in mechatronic systems.

https://doi.org/10.1017/pds.2024.55

MODELING UNCERTAIN REQUIREMENTS

Lukas Block
Fraunhofer IAO, Germany

Anticipating all technical requirements that a product must meet throughout its lifespan has become difficult due to a rise in market, regulatory, and technological uncertainty. As a result, the attribute values of these requirements may be highly uncertain at the start of product development. We propose a mathematical model that captures and quantifies this uncertainty in a clear and comprehensive manner. We evaluate the approach by encoding uncertain requirements for an automotive project. Misconceptions regarding probabilities are alleviated and the requirements are unambiguously defined.

https://doi.org/10.1017/pds.2024.53

DATA- AND SIMULATION-BASED MATERIAL BEHAVIOUR PREDICTION

Anton Dybov, Carina Fresemann, Rainer Stark
Technische Universität Berlin, Germany

In research environments and laboratories e.g. for material sciences the in- and output of simulation data is manually managed. Therefore, physical experiments as well as simulations might be carried out several times, learnings are not systematically gathered, and experiments do not systematically build on learnings from data. This paper proposes to engage an ontology in conjunction with a simulation to use data from already carried out experiments and on that basis predict material behaviour under certain condition and plan further physical experiments.

https://doi.org/10.1017/pds.2024.59

EXPLORING INDICATORS OF SYSTEM-OF-SYSTEMS RESILIENCE: OUTCOMES OF A HEALTH SYSTEMS DESIGN WORKSHOP AT AN INTERNATIONAL CONFERENCE

Valeria Pannunzio[1], Alexander Komashie[1], Sebastian Walsh[1], Richard Milne[1], Timoleon Kipouros[1], Guillaume Lamé[2], Anja Maier[3,4], Carol Brayne[1], P. John Clarkson[1]
[1]University of Cambridge, United Kingdom; [2]CentraleSupélec, France; [3]University of Strathclyde, United Kingdom; [4]Technical University of Denmark, Denmark

This contribution departs from an existing model, the Design Framework for Systems-of-Systems Resilience, to explore systems resilience issues across the health, environmental, and economic domains. The reported research activities include 1) a rapid review to collect a set of systems indicators and 2) a design workshop employing causal loop diagramming to map expected causal influences between indicators. Through this exercise, we examine key themes in this research domain and outline directions for further enquiry, while involving members of the design research community in an open dialogue.

https://doi.org/10.1017/pds.2024.270

DESIGNING FOR SYSTEMS-OF-SYSTEMS RESILIENCE: FROM THE INDIVIDUAL TO THE PLANET

Valeria Pannunzio, Timoleon Kipouros, Amber Khan, Laurie Friday, Carol Brayne, P. John Clarkson
University of Cambridge, United Kingdom

This contribution builds on the Design Framework for System-of-Systems Resilience to investigate the potential of a new systems resilience measuring approach inspired by the Frailty Index. To explore this research direction, we provide a brief overview of the evolution of the notion of resilience, offer a characterisation of systems resilience as an opposite of systems frailty, and perform a rapid review to identify and inspect existing multi-domain indices of community resilience. Finally, we suggest piloting the proposed system-of-systems resilience index in the Fens in the United Kingdom.

https://doi.org/10.1017/pds.2024.271

A TRADESPACE EXPLORATION APPROACH FOR CHANGEABILITY ASSESSMENT FROM A SYSTEM-OF-SYSTEMS PERSPECTIVE: APPLICATION FROM THE CONSTRUCTION MACHINERY INDUSTRY

Raj Jiten Machchhar, Carl Nils Konrad Toller Melén, Alessandro Bertoni
Blekinge Institute of Technology, Sweden

The rapid development of new technologies such as electrification, autonomy, and other contextual factors pose significant challenges to development teams in balancing competing aspects while developing value-robust solutions. One approach for achieving value robustness is designing for changeability. This paper presents a tradespace exploration from a Systems-of-Systems perspective to facilitate changeability assessment during early design stages. The approach is further demonstrated on a fleet of haulers operating in a mining site.

https://doi.org/10.1017/pds.2024.268

PRINCIPLES FOR THE DESIGN OF SYSTEM OF SYSTEMS EXEMPLIFIED USING MODULARISATION

Matthias Günther[1], Tobias Seidenberg[1], Harald Anacker[1], Roman Dumitrescu[1,2]
[1]Fraunhofer IEM, Germany; [2]Heinz Nixdorf Institute, Paderborn University, Germany

In the context of system of systems (SoS) engineering, the incorporation of design principles is critical to guide the engineering process. This paper presents a systematic literature review to synthesize a list of principles tailored for SoS. 26 principles were identified as generic principles and 39 were mapped to the specific challenges in SoS engineering. Through an evaluation using the principle of modularisation in the design of a charging infrastructure, the study offers insights into the real-world effectiveness of these principles, showing their relevance in SoS engineering tasks.

https://doi.org/10.1017/pds.2024.259

BRIDGING SIMULATION GRANULARITY IN SYSTEM-OF-SYSTEMS: CONJUNCT APPLICATION OF DISCRETE ELEMENT METHOD AND DISCRETE EVENT SIMULATIONS IN CONSTRUCTION EQUIPMENT DESIGN

Mubeen Ur Rehman, Raj Jiten Machchhar, Alessandro Bertoni
Blekinge Institute of Technology, Sweden

The paper addresses a critical challenge in System-of-Systems (SoS) simulations arising from the different granularity levels in SoS simulations, integrating non-coupled Discrete Element Method results into SoS-level Discrete Event Simulations using surrogate modeling. Illustrated with a wheel loader bucket use-case in mining, it enhances early design decision-making and lays the groundwork for improving SoS simulations in construction equipment design. This paves the way for broader research and application across diverse engineering design domains.

https://doi.org/10.1017/pds.2024.273

AI-BASED ANALYSIS AND LINKING OF TECHNICAL AND ORGANISATIONAL DATA USING GRAPH MODELS AS A BASIS FOR DECISION-MAKING IN SYSTEMS ENGINEERING

Sebastian Katzung[1], Hüseyin Cinkaya[1], Umut Volkan Kizgin[2], Alexander Savinov[3], Julian Baschin[2], Thomas Vietor[2]
[1]ENBACE GmbH, Germany; [2]Technische Universität Braunschweig, Germany; [3]Siemens Mobility GmbH, Germany

The increased complexity of development projects surpass the capabilities of existing methods. While Model Based Systems Engineering pursues technically holistic approaches to realize complex products, aspects of organization as well as risk management, are still considered separately. The identification and management of risks are crucial in order to take suitable measures to minimize adverse effects on the project or the organization. To counter this, a new graph-based method and tool using AI, tailored to the needs of complex development projects and organizations is introduced here.

https://doi.org/10.1017/pds.2024.265

IMPLEMENTING AN OPEN INNOVATION PROCESS IN THE PREMIUM MARINE INDUSTRY

Jonathan Burgess, Rob Fanner, Christian McLening
Arts University Bournemouth, United Kingdom

Design and manufacturing innovations are important competitive attributes in the premium marine sector. The adoption of an open innovation process has the potential to deliver behavioural and technological transformation. This pilot study illustrates an open innovation approach to explore the benefits of digital innovation when designing new products within the premium marine industry. The research demonstrates how an open innovation approach will flourish when focused on co-creation in collaboration with a network of cross-functional partners.

https://doi.org/10.1017/pds.2024.24

RELATION BETWEEN PURPOSE OF INDIVIDUAL AGILE ELEMENTS AND THE NEED FOR THEIR ADAPTATION IN PRODUCT DESIGN & DEVELOPMENT

Marvin Michalides[1], Stefan Weiss[1], Emir Gadzo[1], Kristin Paetzold-Byhain[2], Alexander Koch[1]
[1]Bundeswehr University Munich, Germany; [2]Technische Universität Dresden, Germany

Empirical studies show that adaptations of existing agile methods are necessary for developing physical products creating obstacles and challenges. This paper aggregates the gathered findings from several cross-sectional industry surveys and establishes a relationship between the extent of utilization of individual agile elements based on Scrum and the need to adapt these elements in applying agile procedural models. The emphasis of examination resides in the purpose perspective of agile elements with the aim of facilitating context-specific adaptations more effectively.

https://doi.org/10.1017/pds.2024.33

ALIGNING PRODUCTION REQUIREMENTS WITH PRODUCT AND PRODUCTION MATURITIES: ENHANCING PRODUCTION PREPARATION DURING PRODUCT DEVELOPMENT

Rohith Areth Koroth, Fredrik Elgh, Martin Lennartsson, Dag Raudberget
School of Engineering, Jönköping University, Sweden

Product development is multidisciplinary with high uncertainties necessitating coordinated decision-making between design and production. This paper presents a method to work with production requirements to support production preparation during product development aligned with different product and production maturities. The work was conducted in collaboration with two global manufacturing firms. The method supports identification, definition, and structuring of production requirements and the collaboration between design and production engineers for requirement prioritization and follow-up.

https://doi.org/10.1017/pds.2024.22

SCIENTOMETRIC EXPLORATION OF RESPONSIBLE INNOVATION: MAPPING THE KNOWLEDGE LANDSCAPE

Nuša Fain[1], Nikola Vukašinović[2], Andrej Kastrin[3]
[1]Carleton University, Canada; [2]University of Ljubljana, Faculty of Mechanical Engineering, Slovenia; [3]University of Ljubljana, Faculty of Medicine, Institute of Biostatistics and Medical Informatics, Slovenia

While research into responsible innovation is not new, there have been recent calls to explore responsible product development, across different development stages and pillars of responsible innovation. In this paper, we use scientometric analysis to explore how the responsible innovation knowledge structure has evolved over the past 50 years. Our aim is to explore the relevance of the topic and propose future research orientations. Findings show that responsible innovation is an emerging topic warranting further investigation.

https://doi.org/10.1017/pds.2024.29

TOWARDS AGILE AUTOMOTIVE DEVELOPMENT: BENEFITS, CHALLENGES AND ORGANIZATIONAL CHANGES

Franziska Scharold, Kristin Paetzold-Byhain
Technische Universität Dresden, Germany

Agile methods are increasingly being used in automotive development. This research delves into the current state of agile transformation in the automotive industry regarding benefits, challenges, organizational adaptations, and successful measures to establish the agile approach. The results of an online survey reveal that benefits are already evident after 6 months and that challenges are mainly organizational in nature and organizational structures need to be adapted. Main drivers of success are pilot projects on a small scale and top management support as well as training managers.

https://doi.org/10.1017/pds.2024.37

EXPLORING THE BARRIERS TO INNOVATION ADOPTION IN THE UK CONSTRUCTION INDUSTRY

K-M White, P. John Clarkson
University of Cambridge, United Kingdom

The UK construction industry is an important aspect of the UK economy; however, it is struggling to keep pace with wider economic growth and if it does not change it will not be able to keep up with demand. There is a gap between academia and practice, and little understanding of how to successfully innovate within the industry. Following a workshop with 25 construction industry professionals on the barriers to innovation in the construction industry, key themes were developed through thematic analysis including regulation, fragmentation and constant change.

https://doi.org/10.1017/pds.2024.250

A THEORY LANDSCAPE OF DESIGN: MAPPING THE THEORETICAL DISCOURSE OF THE DISCIPLINE

Katja Thoring[1], *Roland M. Mueller*[2]
[1]*Technical University of Munich, Germany;* [2]*Berlin School of Economics and Law, Germany*

This paper presents a mapping of theory use in the design discipline based on the corpus of the published ICED and DESIGN conference papers since 2010. We searched the resulting 4,451 papers for occurrences of theories and compared them with an existing ontology of named theories through natural language processing (NLP). The results yielded a variety of analyses, illustrating, for example, the most-used theories and which disciplines these theories stem from. This paper presents a rich overview of the theories relevant to the design discipline and a novel approach to bibliometric analyses.

https://doi.org/10.1017/pds.2024.17

Session D235

Congress Hall Konavle

15:15
17:15

RESEARCH STORY TELLING: USING THE RESEARCH JOURNEY MAP TO COMMUNICATE INFORMATION, DATA, SYSTEMS, AND ARTIFACTS

Jonathan Cagan
Carnegie Mellon University, United States of America

The Research Journey Map is introduced to guide researchers on creating engaging, meaningful and impactful presentations and publications. Built on the foundational work of the Hero's Journey by Joseph Campbell, this template helps technical researchers communicate information, data, systems and artifacts that result from research so that audiences grasp and embrace the research findings.

https://doi.org/10.1017/pds.2024.236

21 May

TUE

OPERATIONALIZING COMMUNITY-BASED OPEN SCIENTIFIC DESIGN RESEARCH BENCHMARKS: APPLICATION TO MODEL-BASED ARCHITECTURE DESIGN SYNTHESIS

Romain Pinquié[1], *Lionel Roucoules*[2], *Pierre-Alain Yvars*[3], *Raphaël Chenouard*[4]
[1]*Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, France;* [2]*Arts et Métiers ParisTech, France;* [3]*ISAE-Supméca, France;* [4]*École Centrale de Nantes, France*

The point has repeatedly been made that validation is a crucial success factor in demonstrating the scientific contribution and ensuring the adoption of results. Still, researchers in design science validate their research findings too infrequently. We must all evaluate our claimed contributions on open benchmarks to improve validation quality and foster cumulative research. In this paper, we propose a meta-model to standardise and operationalise the concept of open scientific benchmarks in design science and to guide communities of researchers in the co-development of scientific benchmarks.

https://doi.org/10.1017/pds.2024.12

FUTURE DESIGN NARRATIVES: AN INTERDISCIPLINARY APPROACH TO A DECOLONIAL GLOSSARY

Victoria Rodriguez Schon, Manuela Celi
Politecnico di Milano, Italy

As design evolves, language serves as a bridge between envisioned futures and the ontological elements of design that shape them. This manuscript presents an alternative glossary that gathers words from diverse disciplines and practices intersected by a decolonial lens that challenges hegemonical narratives. The glossary of the world to come results from a three-day workshop that focused on language as a formal, normative, and subversive tool capable of defining future behaviour and destabilizing the present. The terms are some among the many that exist to form this decolonial world.

https://doi.org/10.1017/pds.2024.15

REPLICATION STUDIES IN ENGINEERING DESIGN – A FEASIBILITY STUDY

Jonas Rode[1], Ingo Jonuschies[1], Sven Matthiesen[2], Kilian Gericke[1]
[1]University of Rostock, Germany; [2]Karlsruhe Institute of Technology, Germany

This paper examines the replicability of studies in design research triggered by the replication crisis in psychology. It highlights the importance of replicating studies to ensure the robustness of research results and examines whether the description in a publication is sufficient to replicate. Therefore, the publication of a reference study was analysed and a replication study was conducted. The design of the replication study appears similar to the reference study, but the results differ. Possible reasons for the differences and implications for replication studies are discussed.

https://doi.org/10.1017/pds.2024.14

FEEDBACK THOUGHT AT THE INTERSECTION OF SYSTEMS AND DESIGN SCIENCE

Igor Czermainski de Oliveira, Daniel Guzzo, Daniela C. A. Pigosso
Technical University of Denmark, DTU Construct, Denmark

This paper explores the interplay of feedback principles in design and systems science. From their roots in engineering, biology, and economics, it investigates intersections between design, cybernetics and servomechanisms. The synthesis emphasizes the need for considering feedback in anticipating unintended consequences and proposes an integrative view reconciling fundamental assumptions from the different fields through simulation. This holistic approach underscores the pivotal role of feedback in understanding and addressing complex phenomena, such as rebound effects, in design science.

https://doi.org/10.1017/pds.2024.4

APPLICATION OF UNIVERSAL DESIGN PRINCIPLES ON COMPUTER MOUSE INTERFACE: DEVELOPING A UNIVERSAL MOUSE POINTING AND CONTROL SYSTEM TO PROVIDE AFFORDANCE TO THE LEFT-HANDED USERS

Abhinav Basak, Shatarupa Thakurta Roy
Indian Institute of Technology Kanpur, India

The graphical user interface was introduced to democratize access to computer systems by simplifying hardware and visual interfaces. Technological advancements further reduced the constraints, primarily benefiting the mainstream users. However, the specialized needs of the critical users have always been neglected. This paper delves into the ergonomics of the mouse pointer and the computer mouse, focusing on left-handed computer users as a critical user category to develop and propose a universal design solution to integrate left-handers as a mainstream user category in a computer interface.

https://doi.org/10.1017/pds.2024.234

EMPATHIC EMPOWERMENT: AN EXPLORATION AND ANALYSIS OF A SITUATED INTERACTION THROUGH EMPATHIC MODELLING AND ROLE-PLAY

Amy Grech, Andrew Wodehouse, Ross Brisco
University of Strathclyde, United Kingdom

Empowerment is crucial for eliciting designer empathy. This research explores a distinctive integration of empathic modelling and role-play, termed Empathic Empowerment. Through a qualitative study, this research introduces a novel evaluation system, entitled the Empathic Empowerment Scale, designed to support the optimal level of designer empathy in a situated interaction drawn from habitual user experiences. The goal of this research is to empower designers to create the next generation of human-oriented solutions with enhanced inclusivity and social value, through practical experiences.

https://doi.org/10.1017/pds.2024.240

EMPOWERING DESIGN LITERACY: A TOOLKIT FOR PROMOTING THE DESIGN OF POSITIVE EXPERIENCES THROUGH RULES OF THUMB

Björn Kokoschko[1], Martin Wiesner[2]
[1]Otto von Guericke University Magdeburg, Germany; [2]Anhalt University of Applied Sciences, Germany

This paper presents a toolkit of heuristics for enabling non-professionals to design for wellbeing, merging design, psychology, and ergonomics. It demystifies design, focusing on happiness and long-term wellbeing, making design principles accessible to all. This toolkit narrows the divide between design theory and practice, advocating design as a tool to enhance life for individuals and society.

https://doi.org/10.1017/pds.2024.242

INTO THE WONDER – EXPLORING THE DESIGN OF PLAYABLES

Jesper Falck Legaard
Design School Kolding, Denmark

This paper explores the concept of 'playables,' defined as tangible objects intentionally designed for immersive play, distinct from traditional utilitarian objects. It delves into how playables, unlike everyday items, transcend functionality, fostering creativity and curiosity in immersive play. It explores how playables differ from acknowledged design principles, drawing upon Dieter Rams and Don Norman. By recognizing the need for distinct design perspectives for playables, the paper contributes to unlocking their potential to enable wonder in immersive play experiences.

https://doi.org/10.1017/pds.2024.243

UNVEILING KEY USER EXPERIENCE ISSUES TO FACILITATE USER-CENTRED DESIGN OF INERTIAL MOTION CAPTURE SYSTEMS

Charu Tripathi, Manish Arora, Amaresh Chakrabarti
Indian Institute of Science, Bangalore, India

Inertial motion capture has garnered considerable attention within the manufacturing industry for ergonomic assessments due to high reliability and fewer constraints compared to alternative posture tracking direct measurement tools. However, these wearable systems, while ensuring reliability and precision in the results, also introduce a degree of invasiveness. Hence, user experience becomes an important aspect for design and development of such systems. This paper reveals major user experience issues resulting from an experimental study for promoting user-centred design of wearable systems.

https://doi.org/10.1017/pds.2024.248

THE AESTHETICS OF ROBOT DESIGN: TOWARDS A CLASSIFICATION OF MORPHOLOGIES

Dean Aaron Ollah Mobed[1], Andrew Wodehouse[1], Anja Maier[1,2]
[1]University of Strathclyde, United Kingdom; [2]Technical University of Denmark, Denmark

Robots are becoming increasingly prevalent in the workplace. As Industry 5.0 pursues human-centric technologies, a greater understanding of what effects aesthetics has on those interacting with robots is needed. This paper sets out robot morphology as a way to characterise key form types, and proposes seven classifications: anthropomorphism, zoomorphism, phytomorphism, artemorphism, functiomorphism, amorphism, and neomorphism. Through an assessment of the current robot aesthetic landscape, design dimensions are identified with examples that can inform future robot design.

https://doi.org/10.1017/pds.2024.244


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DESIGN RESEARCH QUALITY - EXPLORING DIRECTIONS FOR A NEW DS SIG

Chairs:

Philip Cash
Northumbria University, United Kingdom

Romain Pinquié
Univ. Grenoble Alpes, CNRS, INP, G-SCOP, France

The new SIG proposal aims to foreground design research quality discussions, characterized by the following criteria:

- They enhance the quality of design research, celebrating the value derived from the field's diversity in perspectives, methodologies, outputs, and impact.
- They are vital to the research endeavour, distilling and translating quality insights into concrete, actionable guidance for design research practice.
- They are dynamic and reflexive, foregrounding the evolution of practices in design research, as well as reflecting relevant developments in related fields.
- They are relevant to design practice, connecting needs and opportunities in practice with research needs, outcomes, and impact.
- They are transparent and accessible for the whole design research community, accelerating and democratizing the evolution of design research practices.

In this first meeting related to the new SIG we will:

- Work to concretise and prioritise the current situation in this area and set an agenda for the development of the SIG as well as the development of quality supporting resources for the community.
- Take a deeper dive into the development of a open data structure and set of repository resource to operationalise design research quality guidelines and foster community-based cumulative design research.
- Explore how members of the community can get involved with developing research quality in our field and how the field can better recognise and support such contributions.

AI IN DESIGN - EXPLORING DIRECTIONS FOR A NEW DS SIG

Chairs:
Filippo Chiarello
University of Pisa, Italy
Alejandro Pradas Gomez
Chalmers University of Technology, Sweden
Yuan Yin
Imperial College London, United Kingdom

The advent of Generative Artificial Intelligence is setting new frontiers for our community, promising to revolutionise how we conceive, evaluate, and educate in engineering design disciplines. During the event, we will discuss the possibility of opening a new SIG on Generative Artificial Intelligence & Design that aims to explore and harness these technological advancements to enrich the design research community and foster a collaborative environment.

Our meta objective is to cultivate active research on GenAI within the design research community, fostering collaboration, engagement, and knowledge sharing. We aim to empower diverse members of our community and facilitate a comprehensive understanding and application of GenAI to augment the traditional and future landscapes of design.

During the meeting, we will discuss the following points:

- Focus Areas: The Role of Generative AI in Design, Large Language Models (LLMs) in Design, GenAI in Design Education, Making GenAI Accessible for Designer.
- Activities and Initiatives: workshops, webinars, and symposia aimed at knowledge sharing and community building. We plan to facilitate networking and idea exchange sessions, host conferences and SIG sessions at major design events, and engage in collaborative research projects that explore the potential of AI in design.
- Plan of Action: extend our group, define our activity calendar, and engage in regular reporting to capture and share insights from our initiatives.

Session D243

Congress Hall Orlando 1

17:30 19:00

21 May

TUE

DESIGN JUSTICE - EXPLORING DIRECTIONS FOR A NEW DS SIG

Chairs:
Sita M Syal
University of Michigan, United States of America
Julia Kramer
University of Michigan, United States of America

Integrating justice in the field of design is critically important to ensure the systems and technologies designers create and implement fairly serve all people. There is a need to better understand how justice is incorporated in scholarly design work. Our previous work has looked at how design academics write about justice in their research, with a particular focus on engineering design.1 The motivation for this special section is to engage with design academics and understand how they talk about justice in design research. Engaging with the Design Society community at DESIGN 2024 is an excellent opportunity to leverage the community's expertise, to collectively foster discussion on justice in design, and to identify key opportunities to advance work in justice and design.

The meeting objectives are:

- to learn how design academics understand justice in research through an interactive activity focused around analyzing a design justice framework, and
- to collect data on design academics' perspectives of justice in their design work to analyze and later disseminate back to the community to catalyze future work in this area.

The expected outcome of the special section is a scholarly article (intended journal: Design Science) in which we analyze qualitative data collected during the session discussion activities and present preliminary findings about how design academics describe justice in research. This article will also highlight areas of future justice-oriented research for the broader design community to pursue.

Session
D244

Congress
Hall
Orlando 2

17:30
19:00

21 May
TUE

PUBLISHING DESIGN RESEARCH

Chair:

Panos Y. Papalambros
University of Michigan, United States of America

PANELISTS:

John Gero
UNC Charlotte, United States of America

Daniela C. A. Pigosso
Technical University of Denmark, Denmark

Gaetano Cascini
Politecnico di Milano, Italy

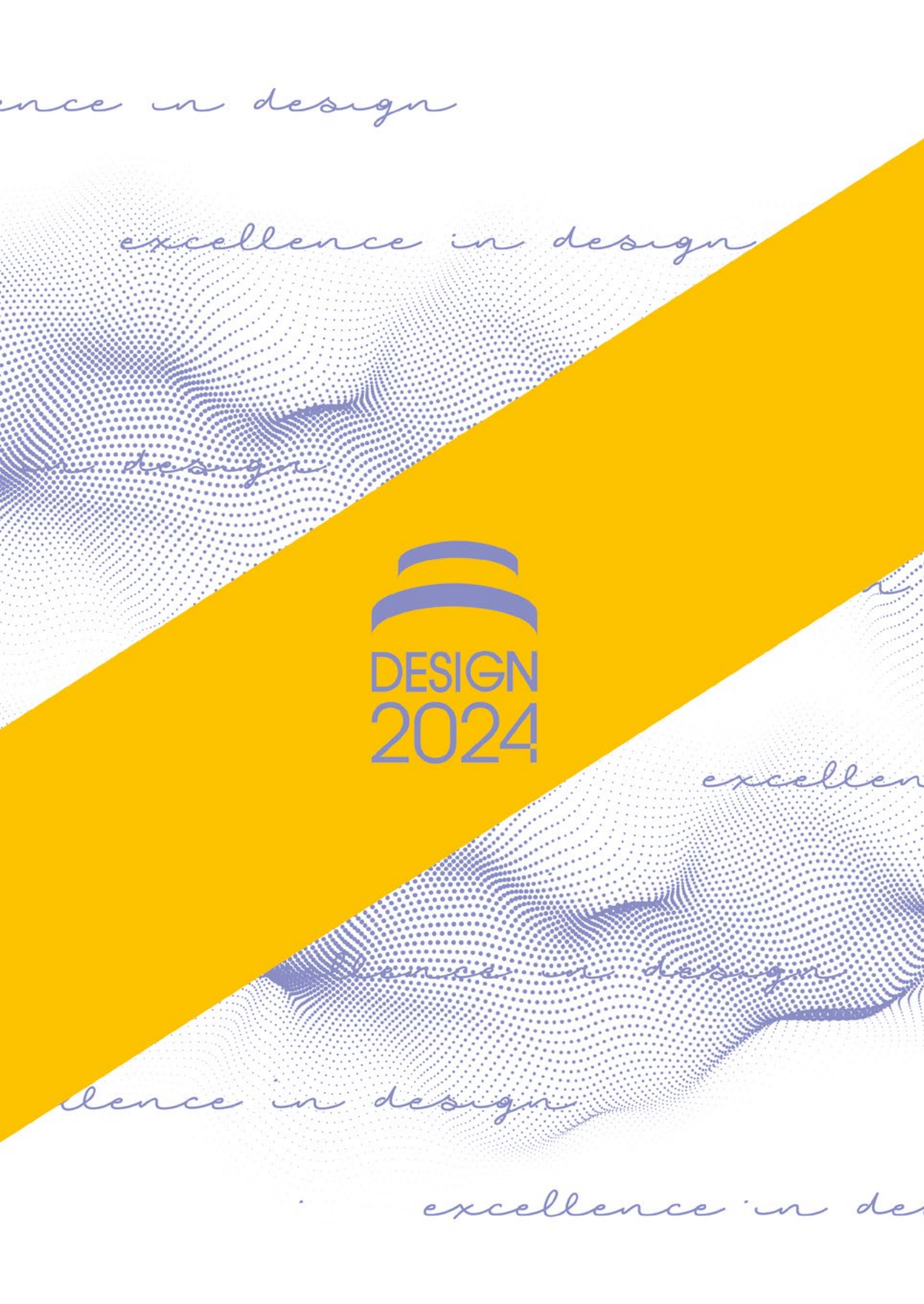
Allison Keene
Cambridge University Press, United States of America

Session D245

Congress Hall Konavle

17:30
19:00

Academic publishing is a rapidly changing landscape, presenting new challenges for journal authors, researchers, reviewers, and editors. Questions of artificial intelligence and the ethical applications of LLMs, managing reviewer fatigue and turnaround times, and the varying requirements of quantitative vs qualitative research in a multidisciplinary field are central to the author and editor experiences. Join representatives from prominent design journals such as Design Science to discuss the publishing process and answer a central question in design research: how can journals remain adaptable to best serve their authors and communities?


DESIGN
2024

08:15

D311
LLM IN DESIGN PERSPECTIVES AND APPLICATIONS
Congress Hall Ragusa
Chair: Binyang Song, Virginia Tech, United States of America

D312
SUSTAINABLE DESIGN IMPACTS AND HUMAN BEHAVIOUR INCLUSION
Congress Hall Bobara
Chair: Wendy Gunn, Aalborg University, Denmark

D313
HUMAN-CENTRIC AND ROBOTIC SYSTEMS IN MANUFACTURING DESIGN
Congress Hall Orlando 1
Chair: Jonathan Borg, University of Malta, Malta

10:15

REFRESHMENT BREAK

10:45

D321
MACHINE LEARNING IN DESIGN AND PRODUCT DEVELOPMENT
Congress Hall Ragusa
Chair: Gualtiero Fantoni, University of Pisa, Italy

D322
CIRCULAR ECONOMY AND SUSTAINABLE DESIGN INNOVATIONS
Congress Hall Bobara
Chair: Els Du Bois, University of Antwerp, Belgium

D323
DESIGN FOR DIGITAL HEALTH SYSTEMS
Congress Hall Orlando 1
Chair: Anja Maier, University of Strathclyde, United Kingdom

12:30

LUNCH
Restaurant Cavtat

14:00

D3-DD: DESIGN DEBATE
Congress Hall Ragusa
Chair: P. John Clarkson, University of Cambridge, United Kingdom

15:15

REFRESHMENT BREAK

15:45

D331: DATA-DRIVEN STRATEGIES AND APPROACHES IN DESIGN
Congress Hall Ragusa
Chair: James Gopsill, University of Bristol, United Kingdom

D332: CIRCULAR DESIGN APPROACHES FOR REUSABILITY
Congress Hall Bobara
Chair: Daniela C. A. Pigosso, Technical University of Denmark, Denmark

D333: INTEGRATING SUSTAINABILITY INTO SYSTEMS ENGINEERING PRACTICES
Congress Hall Orlando 1
Chair: Nikola Bursac, Hamburg University of Technology, Germany

17:45

20:00

CONFERENCE DINNER

22:00

08:15

D314
CO-CREATION AND CO-DESIGN STUDIES

Congress Hall Orlando 2

Chair: Milene Gonçalves, Delft University of Technology, The Netherlands

D315
ADVANCED APPLICATIONS IN DESIGN FOR ADDITIVE MANUFACTURING

Congress Hall Konavle

Chair: Helena Hashemi Farzaneh, MTU Aero Engines, Germany

D316
NEW STRATEGIES IN DESIGN EDUCATION

Congress Hall Šipun

Chair: Gordon Krauss, Harvey Mudd College, United States of America

10:15

D3-EM: MEET THE EDITORS OF THE AIEDAM JOURNAL
Cambridge University Press Stand; Chair: Amaresh Chakrabarti, Indian Institute of Science, India

10:45

D324
APPLICATION OF GENERAL AI METHODS IN DESIGN

Congress Hall Orlando 2

Chair: Matthias Kreimeyer, University of Stuttgart, Germany

D325
ADVANCES IN QUALITY AND PERFORMANCE BENCHMARKS IN ADDITIVE MANUFACTURING

Congress Hall Konavle

Chair: Yuri Borgianni, Free University of Bozen|Bolzano, Italy

D326
EMERGING TECHNOLOGIES AND COLLABORATIVE TOOLS IN DESIGN EDUCATION

Congress Hall Šipun

Chair: Prasad Onkar, Indian Institute of Technology Hyderabad, India

12:30

14:00

DESIGN DEBATE (5TH EDITION): NAVIGATING THE SHIFT FROM PRODUCT TO SYSTEMS

DEBATE TEAMS:

Saeema Ahmed-Kristensen (University of Exeter, United Kingdom) and Martin Steinert (Norwegian University of Science and Technology, Norway)

Jonathan Cagan (Carnegie Mellon University, United States of America) and Valeria Pannunzio (University of Cambridge, United Kingdom)

15:15

15:45

D334: EXPLORING THE FRONTIERS OF DESIGN IDEATION AND COGNITION

Congress Hall Orlando 2

Chair: Gaetano Cascini, Politecnico di Milano, Italy

D335: NAVIGATING DESIGN KNOWLEDGE AND DATA INTEGRATION

Congress Hall Konavle

Chair: Mario Štorga, University of Zagreb FSB, Croatia

D336: EDUCATIONAL CHALLENGES, EXPERIENCES AND PERCEPTION

Congress Hall Šipun

Chair: Nuša Fain, Carleton University, Canada

17:45

20:00

22:00

LARGE LANGUAGE MODELS IN COMPLEX SYSTEM DESIGN

Alejandro Pradas Gomez[1], Petter Krus[2], Massimo Panarotto[1], Ola Isaksson[1]
[1]Chalmers University of Technology, Sweden; [2]Linköping University, Sweden

This paper investigates the use of Large Language Models (LLMs) in engineering complex systems, demonstrating how they can support designers on detail design phases. Two aerospace cases, a system architecture definition and a CAD model generation activities are studied. The research reveals LLMs' challenges and opportunities to support designers, and future research areas to further improve their application in engineering tasks. It emphasizes the new paradigm of LLMs support compared to traditional Machine Learning techniques, as they can successfully perform tasks with just a few examples.

https://doi.org/10.1017/pds.2024.222

AUTOMATIC IDENTIFICATION OF ROLE-SPECIFIC INFORMATION IN PRODUCT DEVELOPMENT: A CRITICAL REVIEW ON LARGE LANGUAGE MODELS

Dominik Ehring, Ismail Menekse, Janosch Luttmer, Arun Nagarajah
University of Duisburg-Essen, Germany

In the era of digitization and the growing flood of information, the automatic, role-specific identification of information is crucial. This research paper aims to investigate whether the adaptation of LLM is suitable for classifying information obtained from standards for corresponding role profiles. This research reveals that with systematic fine-tuning, prediction accuracy can be increased by almost 100%. The validation was carried out using a two-digit number of standards for three predefined roles and demonstrates the significant potential of LM for labelling content with regard to roles.

https://doi.org/10.1017/pds.2024.203

BENCHMARKING AI DESIGN SKILLS: INSIGHTS FROM CHATGPT'S PARTICIPATION IN A PROTOTYPING HACKATHON

Daniel Nygård Ege, Henrik H. Øvrebø, Vegar Stubberud, Martin Francis Berg, Martin Steinert, Håvard Vestad
Norwegian University of Science and Technology, Norway

This study provides insights into the capabilities and performance of generative AI, specifically ChatGPT, in engineering design. ChatGPT participated in a 48-hour hackathon by instructing two participants who acted out its instructions, successfully designing and prototyping a NERF dart launcher that finished second among six teams. The paper highlights the potential and limitations of generative AI as a tool for ideation, decision-making, and optimization in engineering tasks, demonstrating the practical applicability of generating viable design solutions under real-world constraints.

https://doi.org/10.1017/pds.2024.202

HOW GOOD IS CHATGPT? AN EXPLORATORY STUDY ON CHATGPT'S PERFORMANCE IN ENGINEERING DESIGN TASKS AND SUBJECTIVE DECISION-MAKING

Wanyu Xu, Maulik Chhabilkumar Kotecha, Daniel A. McAdams
Texas A&M University, United States of America

This study explores how large language models like ChatGPT comprehend language and assess information. Through two experiments, we compare ChatGPT's performance with humans', addressing two key questions: 1) How does ChatGPT compare with human raters in evaluating judgment-based tasks like speculative technology realization? 2) How well does ChatGPT extract technical knowledge from non-technical content, such as mining speculative technologies from text, compared to humans? Results suggest ChatGPT's promise in knowledge extraction but also reveal a disparity with humans in decision-making.

https://doi.org/10.1017/pds.2024.233

DATASETS IN DESIGN RESEARCH: NEEDS AND CHALLENGES AND THE ROLE OF AI AND GPT IN FILLING THE GAPS

Mohammad Arjomandi Rad, Tina Hajali, Julian Martinsson Bonde, Massimo Panarotto, Kristina Wärmefjord, Johan Malmqvist, Ola Isaksson
Chalmers University of Technology, Sweden

Despite the recognized importance of datasets in data-driven design approaches, their extensive study remains limited. We review the current landscape of design datasets and highlight the ongoing need for larger and more comprehensive datasets. Three categories of challenges in dataset development are identified. Analyses show critical dataset gaps in design process where future studies can be directed. Synthetic and end-to-end datasets are suggested as two less explored avenues. The recent application of Generative Pretrained Transformers (GPT) shows their potential in addressing these needs.

https://doi.org/10.1017/pds.2024.194

NATURE'S LESSONS, AI'S POWER: SUSTAINABLE PROCESS DESIGN WITH GENERATIVE AI

Mas'udah Mas'udah, Pavel Livotov
Offenburg University of Applied Sciences, Germany

In the realm of process engineering, the pursuit of sustainability is paramount. Traditional approaches can be time-consuming and often struggle to address modern environmental challenges effectively. This article explores the integration of generative AI, as a powerful tool to generate solution ideas and solve problems in process engineering using a Solution-Driven Approach (SDA). SDA applies nature-inspired principles to tackle intricate engineering challenges. In this study, generative AI is trained to understand and use the SDA patterns to suggest solutions to complex engineering challenges.

https://doi.org/10.1017/pds.2024.215

EXPLAINING THE REBOUND EFFECTS OF SUSTAINABLE DESIGN: A BEHAVIOURAL PERSPECTIVE

Imke G. H. Van der Loo, Daniela C. A. Pigosso
Technical University of Denmark, DTU Construct, Denmark

Despite its importance, the understanding of the behavioural mechanisms underlying rebound effects triggered by sustainable design is still limited. Through a systematic literature review, this study analyses and discusses 18 behavioural mechanisms. The key gaps of behavioural research on rebound effects are (1) limited in-depth analysis of different mechanisms (2); lack of clearly defined concepts; and (3) neglect of various research topics. To bring the behavioural understanding of rebound effects and sustainable design to a higher level, four key steps for future research are suggested.

https://doi.org/10.1017/pds.2024.152

DESIGNING PRODUCTS FOR MATERIAL SIMPLIFIERS: ANTINOMY OR PROSPECTIVE FOR DESIGN?

Céline Perea[1], Cédric Masclet[2]
[1]Univ. Grenoble Alpes, Grenoble INP, CERAG, France; [2]Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, France

Considering the growing change towards material simplicity of consumers which consists in rejecting the consumer society by decreasing material needs and their consumption we interrogate in this research the possibility of products to support its transition of consumers. We address in a matrix product characteristics adaptation to pathways of consumers stemming from non-voluntary to radical disadopters. The main question of this work interrogates how products can address the disadoption/material simplicity phenomenon.

https://doi.org/10.1017/pds.2024.143

INTERPRETATION OF SUSTAINABILITY PHILOSOPHIES INTO PRODUCT DESIGN FOR AWARENESS, COHESION, AND EQUITY

Laura Isabel Acevedo[1,2], Daniela C. A. Pigosso[1,2], Tim C. McAloone[1,2]
[1]Technical University of Denmark, DTU Construct, Denmark; [2]Technical University of Denmark, Centre for Absolute Sustainability, Denmark

Throughout time, the definition of sustainability has been interpreted differently and different philosophies have consequently emerged, each with its own vision of a sustainable society. At the same time, manufacturing firms have focused on environmental improvements, but social aspects have often been neglected. This study identifies 11 philosophies and 51 product design strategies contributing to sustainability awareness, cohesion, and equity, set to ensure social sustainability integration at a manufacturing firm level.

https://doi.org/10.1017/pds.2024.118

ASSESSMENT OF EMPOWERMENT VIA INCLUSION OF PEOPLE IN PRODUCT LIFECYCLE PROCESSES

Naz Yaldiz, Amaresh Chakrabarti
Indian Institute of Science, Bangalore, India

To address the issue of unbalanced development during a product's lifecycle, a change in the approach to product development processes is necessary. One way to achieve this is by development of the product that encourages the inclusion of people in the entire lifecycle. Inclusion is intended to influence societal empowerment via sharing of power among the people included in the lifecycle. This study proposes a framework for assessment of empowerment by the inclusion of people within a product lifecycle.

https://doi.org/10.1017/pds.2024.155

SUSTAINABILITY CRITERIA FOR INTRODUCING NEW TECHNOLOGIES IN LOW-INCOME CONTEXTS

Adam Mattias Mallalieu[1,2], Amanda Jonasson[1,2], Sara Petersson[1,2], Marlene Rosendal[2], Sophie I. Hallstedt[1,3], Lars Almefelt[1], Ola Isaksson[1]
[1]Chalmers University of Technology, Sweden; [2]Engineers Without Borders, Sweden; [3]Blekinge Institute of Technology, Sweden

Introducing new technologies in low-income contexts have potential for positive social impact, and such efforts are made by humanitarian engineering non-governmental organisations (NGOs). The impact can increase if a systemic sustainability perspective is considered in the design process. Sustainability criteria are identified using a literature study combined with an empirical study together with a Swedish NGO. These criteria are synthesized into a simplified Sustainability Fingerprint tool which is evaluated and deemed to be useful when introducing new technologies in low-income contexts.

https://doi.org/10.1017/pds.2024.138

IDENTIFYING REBOUND EFFECTS IN PRODUCT-SERVICE SYSTEMS: ACTORS, MECHANISMS, TRIGGERS AND DRIVERS

Daniel Guzzo, Daniela C. A. Pigosso
Technical University of Denmark, DTU Construct, Denmark

The implementation of product-service systems (PSS) is prone to the occurrence of rebound effects (RE). This research aims to systematically identify the rebound mechanisms in a PSS context. Through the case study of a use-oriented PSS offer, we showcase a structured way to address RE that led to a comprehensive mapping of 23 mechanisms. The analysis demonstrates an approach to mapping rebound triggers, drivers, and mechanisms within the actors' realms that designers can apply to ensure the potential sustainability gains of PSS offers.

https://doi.org/10.1017/pds.2024.130

A PROPOSED FRAMEWORK USING SYSTEMS ENGINEERING TO DESIGN HUMAN-CENTRIC MANUFACTURING SYSTEMS FOR NOVEL PRODUCTS TO REDUCE COMPLEXITY AND RISK

Malin Hane Hagström, Dag Bergsjö
Chalmers University of Technology, Sweden

The environment for powertrain production system engineers is changing radically. This initial prescriptive study proposes a systems engineering framework based on two previous case studies which are under review for publication concerning design of battery plants. The framework was developed based on ISO/IEC/IEEE 15288 standard using Concept of Operations and Model-Based Systems Engineering in a workshop setting, with a focus on visualisation to understand the practical and emotional needs of the humans in the system. The framework was validated by twelve senior project members.

https://doi.org/10.1017/pds.2024.262

A MATRIX-BASED APPROACH TO STEP-WISE ASSESS THE SAFETY OF COLLABORATIVE ROBOTS IN MANUFACTURING

Matthias R. Guertler[1,3], Philipp Bauer[1,3], Alan Burden[2,3]
[1]University of Technology Sydney, Australia; [2]Queensland University of Technology, Australia; [3]Australian Cobotics Centre, Australia

Collaborative robots (cobots) allow for flexible manufacturing, supporting more customised product designs. Although safety is key for socio-technical human-cobot workplaces, existing safety assessment support like standards and guidelines require extensive experience and can be experienced as overwhelming. To make cobot risk assessments more accessible, especially for novices, and increase traceability from hazard to risk to mitigation, this paper presents a matrix-based approach that decomposes this daunting activity into smaller better manageable steps.

https://doi.org/10.1017/pds.2024.258

SERVICE CENTRIC DESIGN METHODOLOGY FOR INTEGRATED ROBOT-INFRASTRUCTURE SYSTEMS

Abhishek Gupta, Dietmar Göhlich
Technische Universität Berlin, Germany

The ongoing development of technology and AI facilitates the emergence of service robots in various application fields. Hence, the development of robot-infrastructure product-service systems (PSS) will become increasingly important. Based on the existing literature we propose a new methodological approach for a joint development of robot and infrastructure in the context of a socio-technical system with various stakeholders. We suggest digital models and physical prototypes to synchronize service and product development. The applicability is demonstrated for autonomous waste management robots.

https://doi.org/10.1017/pds.2024.260

TOWARDS AN ONTOLOGY TO CAPTURE HUMAN ATTRIBUTES IN HUMAN-ROBOT COLLABORATION

Stephanie Hall, Mandeep Dhanda, Vimal Dhokia
University of Bath, United Kingdom

A core predicate of Industry 5.0 (I5.0) is the integration of human, environmental and social factors with new technologies. The integration of collaborative robots offers increased productivity but raises questions on safety and how robots can respond to varying cognitive and physical attributes. This paper discusses the significance of structured ontologies in managing complex information for proactive, safe, and productive human-robot collaboration. The paper highlights the future work to be undertaken to ensure the safe and fluid integration of humans and robots within I5.0.

https://doi.org/10.1017/pds.2024.261

DESIGN FOR ROBOTIC DISASSEMBLY

Lykke Margot Ricard, Emilie Folkmann, Lars Carøe Sørensen, Sofie Bach Hybel, Roberto de Nóbrega, Henrik Gordon Petersen
University of Southern Denmark, Denmark

This study envisions a unified paradigm for design for automated disassembly. The goal is to integrate disassembly insights related to precious material recovery with the design phase for sustainable lifecycle management.Targeting plastic products with embedded electronics, the collaboration between design and robotic engineers aims to program a robot for disassembly for the LEGO® motor (45603) as demonstration, emphasizing a disassembly map as a vital tool. By considering the limitations and strengths of robots, this research pioneers a design for disassembly framework.

https://doi.org/10.1017/pds.2024.274

EVALUATION OF A MULTI-USER REQUIREMENTS AXIOMATIC DESIGN DECISION SUPPORT TOOL FOR MANUFACTURING PROCESS SELECTION

Edward Abela, Philip Farrugia, Pierre Vella, Glenn Cassar, Maria Victoria Gauci
University of Malta, Malta

Manufacturing process selection presents numerous challenges to designers, including product complexity, consideration of production volumes and part tolerances. This paper introduces a design support tool based on the axiomatic design model to systematically transform requirements into functions and technological capabilities. The results from an evaluation of the implemented prototype tool in the field of medical device design demonstrates its usefulness in selecting the most suitable candidate manufacturing process for a given artifact, while taking into account multiple user requirements.

https://doi.org/10.1017/pds.2024.51

BREAKING CULTURAL BARRIERS: AN INTEGRATED METHODOLOGY FOR CHALLENGE-DRIVEN CO-CREATION PROJECTS

Annika Bastian, Christoph Kempf, Paulin Rudolph, Albert Albers
IPEK - Institute of Product Engineering, Karlsruhe Institute of Technology, Germany

The fact that successful Industry-Academia Collaborations (IACs) are beneficial for the participants is widely accepted. However, without a target-oriented methodology, the chances for success are low. This paper's focus is the early phase in the creation of such a methodology which is done in a structured way. Furthermore, the goal is to understand the great influence culture plays in creative problem-solving in distributed teams in IACs.

https://doi.org/10.1017/pds.2024.91

"IDEAS ARE REALLY..." – SUPPORTING COLLABORATIVE DIALOGUES AND COMMUNITY OF PRACTICE FOR INNOVATION VIA CO:RE CARDS

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PDR, Cardiff Metropolitan University, United Kingdom

The study explores the affordances of CO:RE Cards in prompting collaborative dialogues surrounding R&D and innovation among creative industry practitioners. The use of CO:RE Cards was evaluated in three sessions within a collaborative dialogue environment. It was analysed that they have prompted the building of a collective language and understanding among creative practitioners through collaborative knowledge construction and mutual learning. We discuss the potentially significant role of CO:RE Cards in nurturing a Community of Practice (CoP) for innovation in the creative industries.

https://doi.org/10.1017/pds.2024.113

CREATIVITY OF PRODUCTS AS MEANT BY ORDINARY PEOPLE: TO WHAT EXTENT DO NOVELTY AND USEFULNESS MATTER?

Aurora Berni, Yuri Borgianni, Demis Basso
Free University of Bozen|Bolzano, Italy

In the design literature, creativity of products is recognized as a combination of novelty and usefulness. However, this mainly applies to the engineering field and within a community of experts. This study investigates how ordinary people understand creativity embodied in products. In an experiment with 70+ participants, 8 products and 5 metrics were dealt with. Novelty resulted as the main predictor of creativity. Usefulness turned to play a minor effect on perceived creativity. It emerged that usefulness has to make ordinary people like a specific product in order to link it to creativity.

https://doi.org/10.1017/pds.2024.92

CO-DESIGN IN VIRTUAL ENVIRONMENTS WITH 3D SCANNED CHILDCARE ROOMS IN SOCIAL VIRTUAL REALITY

Yuki Taoka[1], Momoko Nakatani[1], Takumi Sato[1], Kaho Kagohashi[1], Fuyumi Iwasawa[1], Shouichi Hasegawa[1], Shigeru Owada[2], Shigeki Saito[1]
[1]Tokyo Institute of Technology, Japan; [2]Sony Computer Science Laboratories, Inc., Japan

This research proposes a virtual environment (VE) for co-designing in early childhood education and care settings using a social VR platform with 3D-scanned childcare rooms. Co-design workshops were analyzed focusing on perceived presence and experience and workshop outcomes. The results indicate a high level of presence in the VE, with unique advantages like facilitating 3D prototyping. However, challenges such as unbalanced prototyping tools distribution were also noted. The study highlights the potential of VEs with 3D scanned rooms in co-design.

https://doi.org/10.1017/pds.2024.114

PLAYING AGAINST THE RULES: A NEW PERSPECTIVE ON THE POTENTIAL OF GAMES AND PLAY AS CONVIVIAL AND CRITICAL TOOLS FOR IMAGINING FUTURES

Anna O. Meshcheryakova, Fabian Hemmert
University of Wuppertal, Germany

In recent years, we have observed an increased interest within the field of design research in both the concept of conviviality and playful approaches as a pathway to co-design and participation. While play is often associated with freedom of expression and creativity, the implication of rules and mechanics in games poses questions regarding the tension between player agency and designed gameplay. This paper aims to provide reflection on these topics through a lens of 'critical play' and presents a model to explore games' potential as convivial tools for imagining collective futures.

https://doi.org/10.1017/pds.2024.8

CRISIS: A DRIVER FOR TOURISM INNOVATION AND SERVICE DESIGN?

Åsa Ericson, Johan Lugnet, Maria Ek Styvén, Thomas Zobel
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Tourism entrepreneurs adapted to regulations during COVID-19 by introducing creative solutions. The crisis was said to be a unique opportunity for innovating sustainable businesses. This study investigates crisis as a driver for innovation and its relevance to service design. Interviews with entrepreneurs are the empirical base that highlights that finetuning existing services is an established approach instead of innovative service design. Few expressed lessons were learned from the creative solutions made during the pandemic, suggesting that strategies for innovation need to be developed.

https://doi.org/10.1017/pds.2024.237

ADDITIVE MANUFACTURING OF INDIVIDUAL BONE IMPLANTS MADE OF BIORESORBABLE CALCIUM PHOSPHATE CEMENT USING THE EXAMPLE OF LARGE SKULL DEFECTS

Stefan Holtzhausen, Philipp Sembdner, Martin Pendzik, Holger Wilhelm Rudolf Schmidt, Kristin Paetzold-Byhain
Technische Universität Dresden, Germany

In the field of individualized medical implants for bone replacement, additive manufacturing offers far-reaching advantages for bridging bone defects and supporting the production of natural form and function. The article uses the example of a large, customized cranial implant to show the challenges of manufacturing with osteoinductive bone cements. The process is shown, starting with planning and design, through to functional integration using adapted manufacturing strategies to create defined porosity.

https://doi.org/10.1017/pds.2024.178

Session D315

Congress Hall Konavle

08:15
10:15

STRESS CONCENTRATIONS AND DESIGN FOR ADDITIVE MANUFACTURING: A DESIGN ARTEFACT APPROACH TO INVESTIGATION

Didunoluwa Obilanade[1], Owen Rahmat Peckham[2], Adam McClenaghan[2], James Gopsill[2], Peter Törlind[1]
[1]Luleå University of Technology, Sweden; [2]University of Bristol, United Kingdom

The accelerated rate of product development and design complexities offered by Additive Manufacturing (AM) has allowed for innovation in the space industry. However, the surface roughness of parts poses a challenge, as it impacts performance and is tied to design choices. Design tools for traditional manufacturing methods fall short in AM contexts, prompting the need for alternative design processes. This work proposes an experimental approach to design for AM investigation using design artefacts to explore a process-structure-property-performance relationship.

https://doi.org/10.1017/pds.2024.181

22 May
WED

TOPOLOGY OPTIMISATION OF MULTIPLE ROBOT LINKS CONSIDERING SCREW CONNECTIONS

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Technical University of Munich, TUM School of Engineering and Design, Department of Mechanical Engineering, Laboratory for Product Development and Lightweight Design, Germany

This paper presents a method for the lightweight design of robotic links subject to dynamic loads and requirements on the overall system stiffness. It includes (1) a decomposition scheme to enable separate component optimization and (2) an approach based on topology optimization for optimal load path design of screw connections. The approach reduces computing cost and mass of designs with screw connections.

https://doi.org/10.1017/pds.2024.190

ADDITIVE MANUFACTURING IN FLUID POWER WITH NOVEL APPLICATION TO HYDRAULIC PUMP DESIGN

Anton Wiberg, Liselott Ericson, Johan A. Persson, Johan Ölvander
Linköping University, Sweden

Additive Manufacturing (AM) enhances component functionality in engineering. This study explores AM benefits for hydraulic pumps, by reviewing literature on fluid power and existing AM successes in pumps, pipes, and manifolds. While hydraulic pump research is scarce, the study redesigns a pump, mirroring successes in other hydraulic areas. Predicted outcomes include a 45-85% pressure drop reduction, 35% weight reduction, and fewer parts compared to traditional pumps, achieved with minor design changes. Larger-scale redesigns promise even greater improvements.

https://doi.org/10.1017/pds.2024.191

DESIGN CHALLENGES IN LEVERAGING BINDER JETTING TECHNOLOGY TO INNOVATE THE MEDICAL INSTRUMENT FIELD

Lorenzo Cocchi, Marco Mariani, Serena Graziosi, Roberto Viganò, Nora Lecis
Politecnico di Milano, Italy

Despite its significant advantages in terms of design freedom and the wide range of processable materials, the Binder Jetting technology has not yet received substantial attention in the healthcare field, especially concerning the fabrication of metal components. Hence, the paper investigates how this technology could be exploited to innovate the medical instrument field. Based on selected case studies, some preliminary design indications are derived on how to properly consider the various phases (i.e., printing, depowdering, and sintering) and related challenges of the Binder Jetting process.

https://doi.org/10.1017/pds.2024.176

IMPROVING SUSTAINABILITY OF ADDITIVE MANUFACTURING PROCESSES BASED ON DIGITAL TWINS – A CASE STUDY

Jessica Kos[1], Philipp Schröder[1], Jakob Trauer[2], Felix Endress[1], Markus Mörtl[1], Markus Zimmermann[1]
[1]Technical University of Munich, TUM School of Engineering and Design, Laboratory for Product Development and Lightweight Design, Germany; [2]:em engineering methods AG, Germany

Additive manufacturing (AM) became a key technology in the development of innovative products. Advancements have been made to improve economic feasibility. However, ecological sustainability is still an open issue of AM. To improve sustainability, it is crucial to track, visualize, and evaluate emissions along the lifecycle. This paper presents a novel Digital Twin based approach enabling prediction of the product carbon footprint (PCF) and prescriptive measures to improve sustainability. By improving part and process design, a significant PCF reduction was achieved.

https://doi.org/10.1017/pds.2024.211

CONCEPTUALIZATION OF AN ARTIFICIAL INTELLIGENCE-ASSISTED TUTORING SYSTEM FOR TEACHING TECHNICAL DRAWING SKILLS TO UNDERGRADUATE STUDENTS

Jonas Fastabend, Benedikt Müller, Daniel Roth, Matthias Kreimeyer
University of Stuttgart, Germany

In design education, technical drawing training requires a large amount of resources. The aim of this paper is to propose a concept for an artificial intelligence-based tutoring system that partly automates technical drawing education. The educational needs of the students are defined via an error analysis of 100 corrected drawing exercises and the definition of 3 error clusters with 134 different error types. Three sub-concepts with a collection of training exercises are proposed for the tutoring system to mitigate these errors. The resulting concept is validated by a survey with 29 students.

https://doi.org/10.1017/pds.2024.287

UNDERSTANDING THE ART OF DESIGN THINKING FACILITATION: A NOVEL INSTRUMENT FOR OBSERVING INSTRUCTIONAL STRATEGIES USED BY FACILITATORS

Sharon Guaman-Quintanilla[1,2], Isabel Alcivar[3], Katherine Chiluiza[4]
[1]Escuela Superior Politecnica del Litoral, i3lab Entrepreneurship and Innovation Center, Ecuador; [2]Ghent University, Department of Accountancy, Corporate Finance and Taxation, Belgium; [3]Escuela Superior Politecnica del Litoral, Faculty of Mechanical and Production Sciences Engineering, Ecuador; [4]Escuela Superior Politecnica del Litoral, Center of Information Technologies, Ecuador

Design Thinking (DT) is considered an innovative and effective pedagogical approach. To enhance the understanding of instructional strategies used by university DT facilitators, we developed the Design Thinking Facilitation Behaviour List, an instrument that matches strategies with observable behaviours in a DT course. We present the design process and validation of the instrument. Results show the instrument's effectiveness in capturing instructional strategies in a DT course, paving the way for future research and improved teaching practices.

https://doi.org/10.1017/pds.2024.288

TOWARDS SIMULATION GAMES IN ENGINEERING DESIGN EDUCATION – DESIGN AND EVALUATION OF A SE SIMULATION GAME

David Inkermann, Theresa Ammersdörfer
Technische Universität Clausthal, Germany

Simulation games (SG) present a learning environment allowing 'what-if' analysis of solutions and decisions that may not be feasible in reality. Positive effects of SG are affected by the context of use, users, and the game design itself. Aim of our research is to investigate to which extent it is possible to represent interdependencies occurring between activities, methods, tools, and roles in real engineering projects by a SG and which prior knowledge is needed for the intended learning outcomes. Our research uses a SG prototype and interviews with industry experts and graduated students.

https://doi.org/10.1017/pds.2024.289

FOSTERING INNOVATION THROUGH BIO-INSPIRED PROJECTS IN ENGINEERING DESIGN EDUCATION

Jacquelyn Nagel[1], Ramana Pidaparti[2]
[1]James Madison University, United States of America; [2]University of Georgia, United States of America

This paper discusses the C-K theory approach and developing templates for student's use in design courses, specifically for the conceptual design phase. Examples of C-K templates are reviewed to demonstrate the process leading to a design solution. Analysis of student's work using these templates are presented and discussed with respect to design learning attributes and design innovation during the conceptual design. Student reflections from their final design reports indicated that students did develop knowledge and skills in bio-inspired design, collaboration, and interdisciplinary mindsets.

https://doi.org/10.1017/pds.2024.297

IMPROVING KNOWLEDGE TRANSFERS IN STUDENT ENGINEERING TEAMS THROUGH THE APPLICATION OF THE INKTI – INTERDEPARTMENTAL KNOWLEDGE TRANSFER IMPROVEMENT METHOD

Monika Klippert, Robert Stolpmann, Albert Albers
Karlsruhe Institute of Technology, Germany

Managing knowledge successfully is key for an organization to increase its innovative potential. The InKTI method supports the improvement of knowledge transfers in product and production engineering. To ensure acceptance, applicability, and contribution to success in practice, it is necessary to validate the InKTI method. This paper focuses on evaluating the contribution to success in a Live-Lab study with student engineering teams. Based on the results two consecutive field studies have been conducted to evaluate not only the success but also support, and applicability of the InKTI method.

https://doi.org/10.1017/pds.2024.291

LEARNING IN A DIGITAL FABRICATION COURSE ON BUILDING TANGIBLE ARTEFACTS

Vijayakumar Nanjappan[1,2], Georgi V. Georgiev[1], Hernan Casakin[3], Sohail Ahmed Soomro[1,4]
[1]Center for Ubiquitous Computing, University of Oulu, Finland; [2]School of Computer Science and Information Technology, University College Cork, Ireland; [3]Ariel University, Israel; [4]Sukkur IBA University, Pakistan

This paper examines how students' ideas evolve into physical prototypes within a digital fabrication design course. Examining the materials used, customization approaches, iterations, and team dynamics of 26 student projects reveals interplays between ideas, available tools, materials and constraints. Findings show the predominance of techniques, design preferences, concept refinement, and teamwork challenges. The implications highlight the value of hands-on iteration for alignment with reality and the need to support collaboration skills alongside technical prototype development.

https://doi.org/10.1017/pds.2024.298

MEET THE EDITORS OF THE AIEDAM JOURNAL

Chair:
Amaresh Chakrabarti
Indian Institute of Science, Bangalore, India

Join us during the refreshment break for an exclusive opportunity to meet the editor of the AI EDAM (Artificial Intelligence for Engineering Design, Analysis and Manufacturing) Journal. This informal gathering will take place at the Cambridge University Press stand. It's a great chance for participants to connect, discuss publishing opportunities, and gain insights into the latest trends in engineering and AI research. Don't miss this unique networking session designed to inspire and inform.

Session
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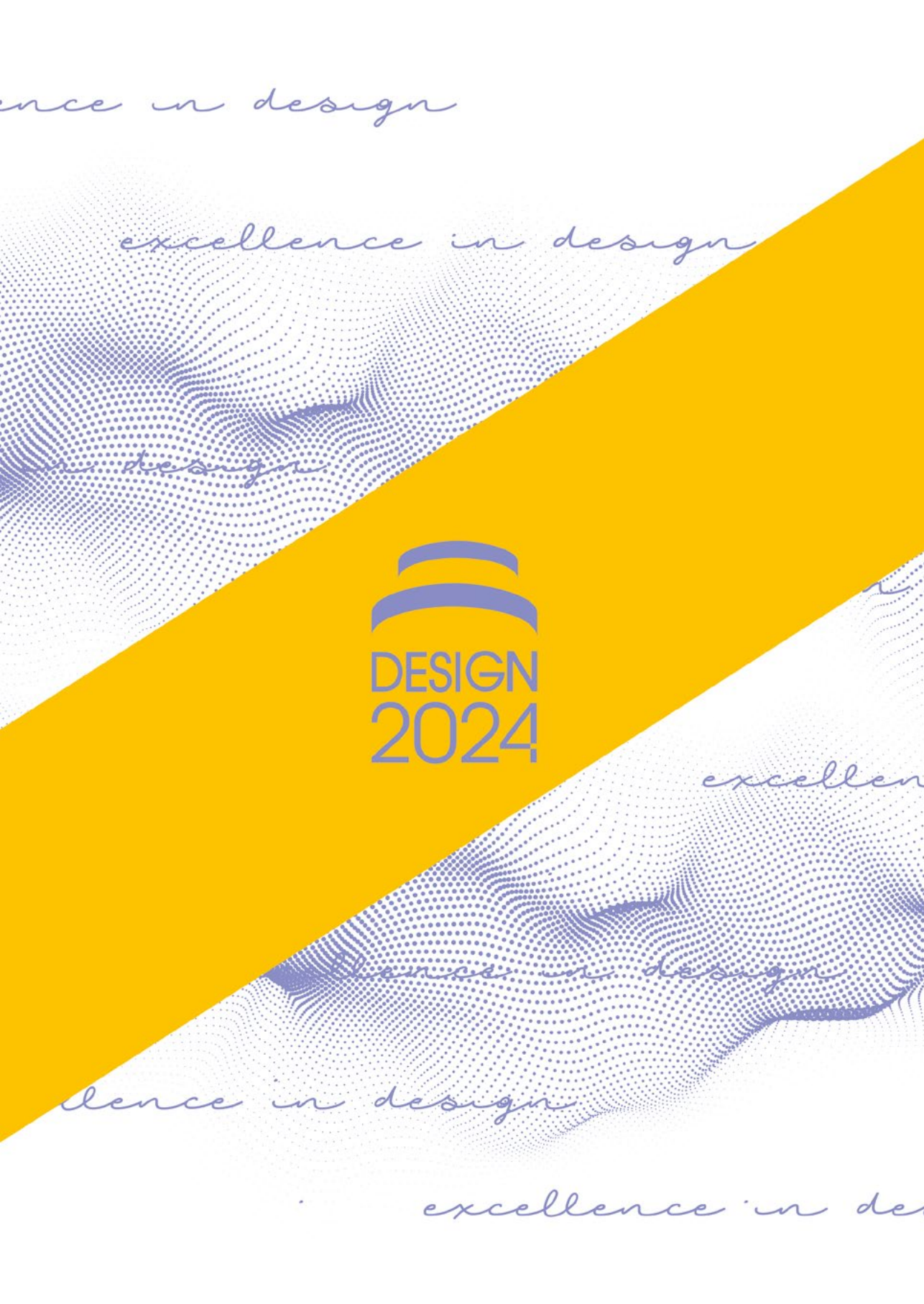
10:45
11:15

22 May

WED


DESIGN
2024

MINIMIZING OCCUPANT LOADS IN VEHICLE CRASHES THROUGH REINFORCEMENT LEARNING-BASED RESTRAINT SYSTEM DESIGN: ASSESSING PERFORMANCE AND TRANSFERABILITY

Janis Mathieu[1,2], *Parul Gupta*[3], *Michael Di Roberto*[1], *Michael Vielhaber*[2]
[1]*Porsche Engineering Group GmbH, Germany;* [2]*Saarland University, Germany;* [3]*Ilmenau University of Technology, Germany*

The optimization of mechanical behavior in safety systems during crash scenarios consistently poses challenges in vehicle development. Hence, a reinforcement learning-based approach for optimizing restraint systems in frontal impacts is proposed. The trained agent, which adjusts five parameters simultaneously, is capable of minimizing loads on a seen and unseen anthropomorphic test device on the co-driver position and is thus able of transferring knowledge. A hundred times higher rate of convergence to reach a similar optimum compared to a global optimization algorithm has been achieved.

https://doi.org/10.1017/pds.2024.216

A LOW-COST NON-INTRUSIVE SPATIAL HAND TRACKING PIPELINE FOR PRODUCT-PROCESS INTERACTION

James Gopsill, Aman Kukreja, Christopher Michael Jason Cox, Chris Snider
University of Bristol, United Kingdom

Hands are the sensors and actuators for many design tasks. While several tools exist to capture human interaction and pose, many are expensive and require intrusive measurement devices to be placed on participants and often takes them out of the natural working environment. This paper reports a novel workflow that combines computer vision, several Machine Learning algorithms, and geometric transformations to provide a low-cost non-intrusive means of spatially tracking hands. A ±3mm position accuracy was attained across a series of 3-dimensional follow the path studies.

https://doi.org/10.1017/pds.2024.209

A CONCEPTUAL MCDA-BASED FRAMEWORK FOR MACHINE LEARNING ALGORITHM SELECTION IN THE EARLY PHASE OF PRODUCT DEVELOPMENT

Sebastian Sonntag, Erik Pohl, Janosch Luttmer, Jutta Geldermann, Arun Nagarajah
University of Duisburg-Essen, Germany

Despite the potential to enhance efficiency and improve quality, AI methods are not widely adopted in the context of product development due to the need for specialized applications. The necessary identification of a suitable machine learning (ML) algorithm requires expert knowledge, often lacking in companies. Therefore, a concept based on a multi-criteria decision analysis is applied, enabling the identification of a suitable ML algorithm for tasks in the early phase of product development. The application and resulting advantages of the concept are presented through a practical example.

https://doi.org/10.1017/pds.2024.228

MACHINE LEARNING-BASED VIRTUAL SENSORS FOR REDUCED ENERGY CONSUMPTION IN FROST-FREE REFRIGERATORS

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[1]Elettrotecnica ROLD, Italy; [2]Politecnico di Milano, Italy

This study explores Machine Learning (ML) integration for household refrigerator efficiency. The ML approach allows to optimize defrost cycles, offering energy savings without complexity or cost escalation. The paper initially presents a State-of-the-Art of ML potential to improve functionality and efficiency of refrigerators. Since frost is the cause of significant energy losses, a ML-based Virtual Sensor was developed to predict frost formation on the evaporator also in low -level refrigerators. The results show the environmental significance of ML in enhancing appliance efficiency.

https://doi.org/10.1017/pds.2024.193

AUTOMATING THE ASSEMBLY PLANNING PROCESS TO ENABLE DESIGN FOR ASSEMBLY USING REINFORCEMENT LEARNING

Rafael Parzeller[1,2], Dominik Koziol[1], Tizian Dagner[1], Detlef Gerhard[2]
[1]Siemens AG, Germany; [2]Ruhr-Universität Bochum, Germany

This paper introduces a new concept for the automation of the assembly planning process, to enable Design for Assembly (DfA). The approach involves the application of reinforcement learning (RL) to assembly sequence planning (ASP) based on a 3D-CAD model. The ASP algorithm determines assembly sequences through assembly by disassembly. The assembly sequence is then used for the generation of subassemblies by considering the product contact information. The approach aims to support the creation of the manufacturing bill of materials (MBOM) by automating the assembly planning process.

https://doi.org/10.1017/pds.2024.220

CONSUMER BEHAVIOUR IN THE CONTEXT OF CIRCULAR ECONOMY: A SYSTEMATIC LITERATURE REVIEW

Nicole Sofia Rohsig Lopez, Jérémy Legardeur
University of Bordeaux, ESTIA Institute of Technology, France

Circular business models (CBMs) focus on cycling, extending, intensifying, and/or dematerialising material and energy loops to reduce resource inputs and waste and emission leakage. We aim to explore consumer behaviour in circular economy through a systematic literature review to determine barriers and motivators to implementing CBMs, analysing twenty-eight articles. We identified internal motivations, such as economic and environmental concerns; and external factors facilitating engagement with circularity, such as better awareness, and products with design for circularity.

https://doi.org/10.1017/pds.2024.144

Session D322

Congress Hall Bobara

10:45 12:30

TACTILITY IN PERCEPTION OF BIOBASED COMPOSITES

Manu Thundathil[1], Nicholas John Emerson[1], Ali Reza Nazmi[1], Bahareh Shahri[1], Jörg Müssig[2], Tim Huber[3]
[1]University of Canterbury, New Zealand; [2]Hochschule Bremen, Germany; [3]Luxembourg Institute of Science and Technology, Luxembourg

Biobased composites - sustainable alternatives to fossil-based materials, could gain better acceptance if their perceptual handicaps could be overcome. This paper considers the role of tactility in contrast with visual stimuli, as well as the perceptual qualities influenced by tactility. The analysis revealed a significant impact of tactility in forming attributes such as naturality, roughness and strength. Attributes like beauty and complexity remain less affected by touch, and more visual-dominant. These findings may help designers in creating desirable products with sustainable materials.

https://doi.org/10.1017/pds.2024.149

22 May

WED

SCENARIO BUILDING GUIDELINES FOR SUSTAINABLE INNOVATION

François Haeberle, Giácomo Parolin, Daniela C. A. Pigosso
Technical University of Denmark, DTU Construct, Denmark

The integration of sustainability into highly uncertain technology development is key to support manufacturing companies to reduce their environmental impacts. The use of future scenarios to support decision-making in early design for sustainability is promising, but there is a lack of systematic guidelines on how to build them. Through literature review and empirical research scenario-building guidelines were designed. The guidelines are step-by-step activities to be performed in workshops. Results suggest the guidelines were successful in building consistent, plausible, and useful scenarios.

https://doi.org/10.1017/pds.2024.131

INCORPORATING SUSTAINABILITY INTO PRODUCT LIFECYCLE MANAGEMENT: A SYSTEMATIC LITERATURE REVIEW

Anne Seegrün, Louis Hardinghaus, Theresa Riedelsheimer, Kai Lindow
Fraunhofer IPK, Germany

Amidst environmental, regulatory, and societal pressures, integrating sustainability into Product Lifecycle Management (PLM) is key, evolving into Sustainable PLM (sPLM). This paper uses a systematic literature review and text-mining (C-value method) to categorise sPLM research into clusters, assess their integration at organisational levels, and evaluate the level's maturity. Findings highlight a gap in operational sPLM research. Future studies should bridge the gap between theory and industrial application, enhance sPLM operationalisation, and explore emerging technologies' impact on sPLM.

https://doi.org/10.1017/pds.2024.146

CHARACTERISING THE LOW-TECH APPROACH THROUGH A VALUE-DRIVEN MODEL

Alexandre Gaultier, Cédric Masclet, Jean-François Boujut
Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, France

In this article, we argue that the low-tech narrative redefined by a French low-tech movement in recent years can be considered as a legitimate research object for design research. Based on the French low-tech movement's literature, we present the definitions of the low-tech concept as an approach driven by principles and highlight two theorical limitations of this type of definition. Based on a value-sensitive design approach, we present transdisciplinary research results through a value-driven low-tech model and discussed its limitations and possible use as a tool for engineers.

https://doi.org/10.1017/pds.2024.238

DESIGN AS A PRACTICE FOR IMPLEMENTING COMPLEX DIGITAL HEALTH: PRELIMINARY RESULTS FROM AN INTERVIEW STUDY IN THE NETHERLANDS

Fredrik K. Karlsson[1], Valeria Pannunzio[2], Dirk Snelders[1], Maaike S. Kleinsmann[1]
[1]Delft University of Technology, The Netherlands; [2]University of Cambridge, United Kingdom

Challenges in implementing digital health in clinical practice hinder its potential. The complexities posed by implementation could benefit from using design practices. To explore the current role of design practices in digital health implementation, designers in the Netherlands were interviewed. The preliminary results indicate that designers contribute to digital health implementation processes, especially in the early stages. Design practices are mainly used for engaging the users, testing concepts, aligning the ideas of stakeholders, and adapting interventions to fit within the contexts.

https://doi.org/10.1017/pds.2024.163

REQUIREMENTS ELICITATION IN BOARD GAME DESIGN FOR CHILDREN WITH DEVELOPMENTAL LANGUAGE DISORDER (DLD)

Edward Abela, Emanuel Balzan, Philip Farrugia, Donia Stellini, Daniela Gatt
University of Malta, Malta

Developmental Language Disorders (DLDs) affects a significant number of children during early childhood. Speech and Language Pathologists (SLPs) are vital in providing the adequate treatment through Speech and Language Therapeutic Toys (SALTTs) including board games, which have substantial benefits for children undergoing therapy. However, designers require support in designing board games which specifically target child therapy. A framework is proposed to assist designers in designing more efficient, inclusive and usable games which in turn are aligned with therapy goals defined by SLPs.

https://doi.org/10.1017/pds.2024.157

IMPLEMENTING THE MODEL-BASED SYSTEMS ENGINEERING (MBSE) APPROACH TO DEVELOP AN ASSESSMENT FRAMEWORK FOR HEALTHCARE FACILITY DESIGN

Tahere Golgolnia[1,2], Timoleon Kipouros[1], P. John Clarkson[1], Gesine Marquardt[2], Maja Kevdzija[3]
[1]University of Cambridge, United Kingdom; [2]Technische Universität Dresden, Germany; [3]TU Wien, Austria

The global elderly population rises, increasing dementia cases. Built environment impact on dementia health outcomes is known, forming the basis for evidence-based design studies. There's a need for a comprehensive assessment framework due to the complexity of interactions among Architectural Variables (AVs) and Health and Care Outcomes (HCOs). This paper proposes using Model-Based Systems Engineering (MBSE) to create such a framework. It collects data from 105 studies on 40 AVs, 36 HCOs, and 396 interactions. MBSE offers a holistic understanding, aiding healthcare facility design decisions.

https://doi.org/10.1017/pds.2024.160

DESIGN OF A HEALTHCARE ECOSYSTEM TO IMPROVE USER EXPERIENCE IN PEDIATRIC UROTHERAPY

Lola Bladt[1], Rose-Farah Blomme[1], Anka J. Nieuwhof-Leppink[2], Alexandra Vermandel[3,4], Gunter De Win[3,4], Lukas Van Campenhout[1]
[1]Faculty of Design Sciences, University of Antwerp, Belgium; [2]Wilhelmina Children's Hospital, University Medical Center Utrecht, Netherlands; [3]University Hospital Antwerp, Belgium; [4]Faculty of Medicine and Health Sciences, University of Antwerp, Belgium

This paper addresses challenges in pediatric urotherapy, focusing on low patient compliance and motivation. Informed by creative sessions with children aged 9-13y, a novel urotherapy ecosystem concept is designed. It includes a smart drinking bottle, context-aware reminder watch, home uroflowmeter, smartphone app, and clinician portal. Interconnected products, embodied interaction, stigma-free design, and a digital training buddy aim to enhance engagement, motivation, and patient experience. This concept showcases the potential of integrating diverse design methodologies in healthcare design.

https://doi.org/10.1017/pds.2024.159

TOWARDS DESIGNING FOR HEALTH OUTCOMES: IMPLICATIONS FOR DESIGNERS IN EHEALTH DESIGN

Hosana Cristina Morales Ornelas, Maaike S. Kleinsmann, Gerd Kortuem
Delft University of Technology, The Netherlands

eHealth development faces the challenge of generating evidence about health effectiveness in real-world settings. Designers can potentially support this challenge but must understand health approaches to evidence generation about health outcomes. This case study investigates how health and care professionals conceptualise health outcomes and their evidence generation in eHealth. Our results identify three key conceptual dimensions: effect, meaning, and collection. We discuss how these inform future design competencies to support evidence generation about health outcomes in eHealth design.

https://doi.org/10.1017/pds.2024.165

TOWARDS A PROCESS FOR THE CREATION OF SYNTHETIC TRAINING DATA FOR AI-COMPUTER VISION MODELS UTILIZING ENGINEERING DATA

Sebastian Schwoch, Maximilian Peter Dammann, Johannes Georg Bartl, Maximilian Kretzschmar, Bernhard Saske, Kristin Paetzold-Byhain
Technische Universität Dresden, Germany

Artificial Intelligence-based Computer Vision models (AI-CV models) for object detection can support various applications over the entire lifecycle of machines and plants such as monitoring or maintenance tasks. Despite ongoing research on using engineering data to synthesize training data for AI-CV model development, there is a lack of process guidelines for the creation of such data. This paper proposes a synthetic training data creation process tailored to the particularities of an engineering context addressing challenges such as the domain gap and methods like domain randomization.

https://doi.org/10.1017/pds.2024.226

SURROGATE-BASED DESIGN OPTIMIZATION OF THE BINDER COVER COMBINING PERFORMANCE AND PRODUCTION COST

Pavel Eremeev[1,2], Hendrik Devriendt[1,2], Alexander De Cock[3], Frank Naets[1,2]
[1]KU Leuven, Belgium; [2]Flanders Make@KU Leuven, Belgium; [3]Flanders Make, Belgium

This study integrates surrogate models into combined design optimization of a binder cover, considering production cost and performance constraints. Results reveal that models trained on substantial datasets achieve designs close to the global optimum. Incorporating model variance into constraints prediction in surrogate-based optimization improves robustness and accuracy, especially with noisy functions. This modification enhances the likelihood of obtaining feasible designs, reducing computational demands and showcasing the potential of smaller datasets in predicting local optima.

https://doi.org/10.1017/pds.2024.205

AN AI-BASED PROSTHESIS FRAMEWORK FOSTERING AN ADAPTIVE AMPUTEE HEALTHCARE SERVICE

Nicholas Patiniott[1], Jonathan C. Borg[1], Emmanuel Francalanza[1], Joseph P. Zammit[1], Pierre Vella[1], Alfred Gatt[1], Kristin Paetzold-Byhain[2]
[1]University of Malta, Malta; [2]Technische Universität Dresden, Germany

Despite technological and medical advances, amputations continue to increase. Amputees face significant challenges when acquiring and using prosthetic devices, challenges which are made worse as their emotional needs, aspirations, mobility, prosthesis requirements and problems change over time. These challenges require custom solutions for each individual amputee, a fact that current amputee centered prosthesis services tend to ignore. The work reported in this paper contributes an AI based Prosthesis Development Service Framework to cater for the current and evolving needs of amputees.

https://doi.org/10.1017/pds.2024.221

CRITICAL COMPONENT DETECTION IN ASSEMBLIES: A GRAPH CENTRALITY APPROACH

Robert Ballantyne, Adam McClenaghan, Oliver Schiffmann, Chris Snider
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This study examines the use of graph centrality to identify critical components in assembly models, a method typically dominated by computationally intense analyses. By applying centrality measures to simulated assembly graphs, components were ranked to assess their criticality. These rankings were compared against Monte Carlo sensitivity analysis results. Preliminary findings indicate a promising correlation, suggesting graph centrality as a valuable tool in assembly analysis, enhancing efficiency and insight in critical component identification.

https://doi.org/10.1017/pds.2024.195

AUTOMATIC MOVEMENT PATTERN ANALYSIS FOR DATA-DRIVEN SYSTEM OPTIMISATION – AN EXAMPLE FOR FATTENING LIVESTOCK FARMING MONITORING SYSTEM

Gurubaran Raveendran, Sören Meyer zu Westerhausen, Johanna Wurst, Roland Lachmayer
Leibniz University Hannover, Germany

This paper introduces a method for analysing motion patterns that can be utilised to optimise data-driven systems. The aim is to use surveillance cameras and artificial intelligence to track multiple objects in a reliable manner, thereby preserving the authenticity of movement patterns for numerous and similar objects. In a case study, this method is applied to optimize lighting conditions in animal husbandry. Furthermore, this approach can be utilized not only in animal husbandry but also in other domains.

https://doi.org/10.1017/pds.2024.224

ADDITIVELY MANUFACTURED 3D MICRO SCARF ADHESIVE JOINTS

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Hybrid manufacturing enables to overcome additive manufacturing (AM) constraints regarding the maximum feasible part dimension and/or complexity through part separation and subsequent adhesive joining of AM sub-parts. To ensure structural integrity of the joint at a minimum use of substrate volume, the AM inherent freedom of design can be exploited by realizing 3D micro scarf adhesive joints. The performance of this novel adhesive joint design was assessed by conducting optical measurements and static tensile tests using samples fabricated by laser-based powder bed fusion of metals (PBF-LB/M).

https://doi.org/10.1017/pds.2024.174

Session D325

Congress Hall Konavle

10:45 12:30

THE ENERGY PERFORMANCE ASSESSMENT METHOD TO ESTABLISH THE BEST PART BUILD ORIENTATION IN ADDITIVE MANUFACTURING

Marco Mandolini[1], Mikhailo Sartini[1], Marta Rossi[2], Claudio Favi[3], Marco Marconi[4]
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The growing use of additive manufacturing (AM) processes pushes research towards studying methods to reduce their environmental impact. The part build orientation is a significant process variable, which can be chosen through the Energy Performance Assessment (EPA), a straightforward method. The paper presents a method for identifying the best part build orientation considering energy consumption. The EPA has been adapted for this purpose, resulting in an approach based on four steps. The method was employed to determine the best printing direction for three parts and two AM technologies.

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22 May

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DEMOCRATISING DRY ADHESION DEVELOPMENT WITH CONSUMER-GRADE AM

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Norwegian University of Science and Technology, Norway

The production of reusable gecko-inspired dry adhesives has traditionally been done with complex nanofabrication methods such as lithography and PDMS casting. This article presents a way of producing and testing dry adhesive samples using consumer-grade AM machines and equipment typically available in a Makerspace. The samples produced exhibit adhesive properties depending on the preload and surface structure, and we conclude that consumer-grade AM is suitable for rapid prototyping and testing of dry adhesion. However, it is limited by the scale and accuracy compared to traditional methods.

https://doi.org/10.1017/pds.2024.188

PLAY WELL, PRINT WELL: USING LEGO BRICKS AS AN INTUITIVE BENCHMARKING TOOL FOR 3D PRINTERS

Alan Air[1,2], *Andrew Wodehouse*[1]
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In 3D printing, calibration is crucial for accurate prints, particularly those with complex or intricate features. This paper focuses on developing, manufacturing, and testing a benchmarking model to assess the dimensional accuracy of 3D printers. The aim is to evaluate the 3D printed model against a universally recognized real-world equivalent – a LEGO® brick – using its interlock function as a test with an engaging element. An interlock benchmarking framework aids further analysis of the model's performance, and a checklist for the model is provided for additional visual analysis.

https://doi.org/10.1017/pds.2024.173

PRINTING STUDY AND DESIGN GUIDELINE FOR SMALL HOLLOW STRUCTURES IN MEDICAL TECHNOLOGY

Eve Sobirey, Marie Wegner, Fabian Niklas Laukotka, Dieter Krause
Hamburg University of Technology, Germany

In recent years, interest in additive manufacturing has increased. To overcome challenges such as the correct use of the technology, guidelines are needed to help the user in the fabrication process. However, such guidance is not currently available for all applications. This paper dives into design methods in AM and their transfer to an application example in the field of medical technology. The aim of this paper is to analyse the transferability of a design method for vessel models to small vessel models. To this end, an initial printing study is carried out on simplified hollow structures.

https://doi.org/10.1017/pds.2024.187

STUDENTS' PERCEPTION OF RISKS IN COMPUTER-SUPPORTED COLLABORATIVE DESIGN TEAMS

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The recent Covid-19 pandemic created an unprecedented transition to distributed design team collaboration in education and industry, and with the sudden change in working environments, researchers must consider novel risks introduced to the design process. This research established that student perception of risk differs through personal experience and the impact of risks are greater when working online. Recommendations are made on how these risks could be mitigated further to allow the successful implantation of distributed design through computed-supported environment in education.

https://doi.org/10.1017/pds.2024.296

ANALYSIS OF COLLABORATIVE CAD USER ACTIONS IN DESIGN SPRINT: INSIGHTS FROM AN EDUCATIONAL SETTING

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University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, Croatia

Design sprints complement traditional teaching methods, especially in project-based learning courses. While this approach can potentially change Computer-Aided Design (CAD) usage, it is still underexplored. Therefore, this study explores the influence of design sprints on embodiment-focused CAD activities in project-based learning by examining differences in patterns of CAD user actions, focusing on design space and action types. The case involves two higher-graded and two lower-graded student design teams monitored with a non-invasive method across a two-day design sprint event.

https://doi.org/10.1017/pds.2024.300

A GAMIFIED APPROACH TO ASSESSING MENTAL ROTATION IN VIRTUAL REALITY

Kristin Alicia Bartlett[1], Almudena Palacios-Ibáñez[2], Jorge Dorribo Camba[3]
[1]University of Kentucky, United States of America; [2]Universitat Politècnica de València, Spain; [3]Purdue University, United States of America

We present a new spatial skills assessment tool, the Virtual Reality Mental Rotation Assessment. Results suggest that the gamified immersive experience enabled increased levels of engagement and motivation and the instrument was likely not biased in favor or people with past virtual reality (VR) experience. Using VR did not appear to introduce additional problems beyond those present in a traditional spatial test, as moving one's body to change perspective did not correlate with improved performance. Our findings have implications for training and assessing spatial skills in engineering.

https://doi.org/10.1017/pds.2024.284

THE IMPACT OF SPECIALIZED SOFTWARE ON CONCEPT GENERATION

Julian Martinsson Bonde[1], Richard Breimann[2], Johan Malmqvist[1], Eckhard Kirchner[2], Ola Isaksson[1]
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Software implementations of traditional engineering design methods can potentially enrich the original methods. A study was conducted to better understand how concept generation can be facilitated using software. Participants of the study were asked to generate concepts using either specialized software, or by using traditional means, for applying function-means modeling and morphological matrices. A concept concretization metric was used to evaluate the results, which indicated that there are both positive and negative aspects of performing concept generation using specialized software.

https://doi.org/10.1017/pds.2024.69

VR HEADSET VS. PC SCREEN AS VIRTUAL LEARNING TOUR INTERFACE FOR CHINESE ARCHITECTURE HERITAGE INVESTIGATION

Yuetong Chen, Min Hua
Shanghai Jiao Tong University, China

In design education, integrating digital tools has revolutionized pedagogical approaches. This study examines the impact of VR HMDs and PC screens on learning ancient Chinese architecture using a virtual tour. Involving 22 students, it assessed simulator sickness, user experience, and spatial awareness. Results show VR had a more positive spatial learning experience but the same learning outcomes. VR enhances presence but increases simulator sickness. The study underscores VR's potential and limitations in ancient Chinese architectural education, suggesting future research directions.

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DESIGN DEBATE (5TH EDITION): NAVIGATING THE SHIFT FROM PRODUCT TO SYSTEMS

DEBATE TEAMS:

Saeema Ahmed-Kristensen *(University of Exeter, United Kingdom) and*
Martin Steinert *(Norwegian University of Science and Technology, Norway)*

Jonathan Cagan *(Carnegie Mellon University, United States of America) and*
Valeria Pannunzio *(University of Cambridge, United Kingdom)*

In the dynamic realm of design, the dialogue between tradition and innovation remains pivotal. The DESIGN Conference's 5th Design Debate, themed "Product is Dead. Long Live Systems!", is set to catalyze this conversation. This session is not just an event; it's a testament to the evolving paradigms within design research and practice, offering a platform for rigorous discourse on the shifting focus from individual products to complex systems.

Historically, the debates have traversed various dimensions of design - from advocating for the development of tangible products, technologies, and services over abstract theories, models, and methods, to scrutinizing the current state of design research's preoccupation with descriptive analysis over innovative design methodologies. A critical reflection has also been cast on the essence and impact of design methods formulated by researchers for the engineering design practice, alongside a call for a more empirical learning approach from real-world practitioners as opposed to theoretical experimentation with students.

This year's edition promises to be especially provocative, challenging the conventional priority given to product design by advocating for a systemic perspective that better reflects the interconnected and multifaceted challenges of today's world.

The debate is more than a mere exchange of ideas; it's an invitation to the design community to reflect, question, and possibly reorient their perspectives on the essence and direction of design research and practice. As we prepare to embark on this intellectual journey, we invite all attendees to engage actively, bringing their insights, questions and reflections to what promises to be a landmark session in the discourse of design evolution.

FORMAT

- The topic will be proposed and then opposed (approximately 8 minutes each).
- Supporting statements, seconding the two viewpoints, will then be given (4 minutes each).
- The floor (the audience) will then be invited to question the proposers and opposers.
- A single final statement will be made.
- A vote will then be taken to determine which side has “won” the debate.

TOWARDS DIGITAL REPRESENTATIONS FOR BROWNFIELD FACTORIES USING SYNTHETIC DATA GENERATION AND 3D OBJECT DETECTION

Javier Villena Toro, Lars Bolin, Jacob Eriksson, Anton Wiberg
Linköping University, Sweden

This study emphasizes the importance of automatic synthetic data generation in data-driven applications, especially in the development of a 3D computer vision system for engineering contexts such as brownfield factory projects, where no data is readily available. Key points: (1) A successful integration of a synthetic data generator with the S3DIS dataset, leading to a significant enhancement in object detection of previous classes and enabling recognition of new ones; (2) A proposal for a CAD-based configurator for efficient and customizable scene reconstruction from LiDAR scanner point clouds.

https://doi.org/10.1017/pds.2024.232

D³IKIT: DATA-DRIVEN DESIGN INNOVATION KIT

Boyeun Lee, Saeema Ahmed-Kristensen
University of Exeter Business School, United Kingdom

The utilization of data in design is a crucial aspect of shaping the product and service development. Despite the lack of extensive research on this subject, this study aims to bridge the gap by introducing the 'D³IKIT', a data-driven design process and toolkit. Through workshops, this process and toolkit offer a practical method for creating innovative product and service concepts using data and machine learning. Developed and tested with the participation of 42 individuals, the 'D³IKIT' provides valuable insights for both practitioners and academics.

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CHALLENGES FOR CAPTURING DATA WITHIN DATA-DRIVEN DESIGN PROCESSES

Christopher Langner[1], Yevgeni Paliyenko[1], Benedikt Müller[1], Daniel Roth[1], Matthias R. Guertler[2], Matthias Kreimeyer[1]
[1]University of Stuttgart, Germany; [2]University of Technology Sydney, Australia

Cyber-Physical-Systems provide extensive data gathering opportunities along the lifecycle, enabling data-driven design to improve the design process. However, its implementation faces challenges, particularly in the initial data capturing stage. To identify those, a comprehensive approach combining a systematic literature review and an industry survey was applied. Four groups of interrelated challenges were identified as most relevant to practitioners: data selection, data availability in systems, knowledge about data science processes and tools, and guiding users in targeted data capturing.

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ASSESSING TEXT-IMAGE PATENT DATASETS WITH TEXT-BASED METRICS FOR ENGINEERING DESIGN APPLICATIONS

Marco Consoloni[1,2], Vito Giordano[1,2], Gualtiero Fantoni[1,2]
[1]University of Pisa, Italy; [2]Business Engineering for Data Science Lab (B4DS), Italy

Images provide concise representations of design artifacts and emerge as the primary mode of communication among innovators, engineers, and designers. The advanced of Artificial Intelligence tools which integrates image and textual information can significantly support the Engineering Design process. In this paper we create 5 different datasets combining both images and text of patents and we develop a set of text-based metrics to assess the quality of text for multimodal applications. Finally, we discuss the challenges arising in the development of multimodal patent datasets.

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NAVIGATING FROM DATA-DRIVEN DESIGN TO DESIGNING WITH ML: A CASE STUDY OF TRUCK HMI SYSTEM DESIGN

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[1]Halmstad University, Sweden; [2]Malmö University, Sweden

Data-driven design is believed to be empowered by machine learning (ML) with advanced pattern classification and prediction. However, research on how ML can be used to support automotive human-machine interface (HMI) design is lacking. We presented a case study of truck HMI design to understand the current data use and expectations of ML in the design process. Findings show decentralized data practices, the role of expertise in decision-making, and the envisioned reactive use of ML, where we underscore the implications for advancing human-ML collaboration in designing future truck HMI systems.

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THE DHSMART MODEL FOR SMART PRODUCT-SERVICE SYSTEM (SMART PSS): DYNAMIC, DATA-DRIVEN, HUMAN-CENTRED

Nadia Mirshafiee, Ji Han, Saeema Ahmed-Kristensen
University of Exeter, United Kingdom

Despite its transformative impact, a systematic approach to Smart PSS development remains elusive. Addressing this, the study introduces a dynamic conceptual model named DHSmart and its accompanying canvas, adaptable to various contexts and technological advancements. Notably, it offers a structured approach to designing 'Smart' in Smart PSS, capturing the interplay between data, humans, and smart systems while directing digitalisation that achieves competitive advantage. It also serves as a unifying framework, enabling meaningful interdisciplinary contributions in theory and practice.

https://doi.org/10.1017/pds.2024.217

REMANUFACTURING AS A CIRCULAR DESIGN STRATEGY IN HEALTHCARE: INTEGRATING SOCIO-TECHNICAL AND ENVIRONMENTAL-ECONOMIC ASSESSMENTS

Amanda Worsøe Andersen[1], Siri Fritze Jørgensen[2], Wendy Gunn[3], Monia Niero[4]
[1]Viegand Maagøe A/S, Denmark; [2]Public Procurement, Region Hovedstaden, The Capital Region of Denmark, Denmark; [3]Aalborg University, Denmark; [4]Sant'Anna School of Advanced Studies, Italy

This paper examines the role of remanufacturing in healthcare as a key circular design strategy, particularly for medical devices, assessing its socio-technical, environmental, and economic dimensions of sustainability. Through a detailed case of ultrasound catheters, it demonstrates how remanufacturing can lead to resource conservation, cost savings, and enhanced product lifecycles in health care without compromising quality and patient safety. The study argues for systemic changes in healthcare practices to fully integrate remanufacturing, underscoring its role beyond a technical solution.

https://doi.org/10.1017/pds.2024.120

Session D332

Congress Hall Bobara

15:45 17:45

A TRANSITION APPROACH FOR REUSE AND REPAIR OF MANUFACTURED PRODUCTS

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The landscape of reuse and repair (R&R) activities for manufactured products is vibrant: new European laws, research projects, local initiatives. Our aim is to capture the current and future challenges of the field through an industrial workshop held at the ICED23 conference. A collective reflection was conducted with three French stakeholders: a Product Responsibility Organization, a social and solidarity organization, and a private company producing water-driven dosing pumps. The study results in a multi-level perspective on the R&R value chain and four R&R future scenarios.

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22 May
WED

DURABILITY AS A TECHNO-SOCIO-ECONOMIC CONCEPT

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While the "useful life" of products plays an important role in the balance of sustainability and lifecycle assessment, the concept of durability, as the main measure of useful life, is still ill-defined. This paper critically considers the limitations of the current definitions and approaches to durability, by reflecting on the complex interactions of the viewpoints of engineering design teams, users, society and business economics. A new definition is proposed for durability relating to the useful life goals for a product within its techno-socio-economic context.

https://doi.org/10.1017/pds.2024.124

ASSESSING SUSTAINABLE RECYCLABILITY OF BATTERY SYSTEMS: A TOOL TO AID DESIGN FOR DISASSEMBLY

Fabio Marco Monetti, Pablo Zaguirre Martínez, Antonio Maffei
KTH Royal Institute of Technology, Sweden

This study, conducted with Northvolt, examines battery system recyclability and disassembly dynamics. It introduces indices for material and product recyclability, along with disassembly time assessment. The goal is to create a design tool to streamline the evaluation of battery disassembly, aiding in designing recyclable and serviceable components. These methodologies serve as a blueprint for enhancing battery systems' overall sustainability and circularity design, presenting a base for future product development in alignment with environmental and economic objectives.

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DESIGN STRATEGIES FOR CONSUMERS' CONTINUED USAGE OF REUSABLE PACKAGING SYSTEMS (RPSS)

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[1]Delft University of Technology, The Netherlands; [2]Amsterdam Business School, University of Amsterdam, The Netherlands

Reusable packaging systems are emerging as a promising solution to combat the growing issue of packaging waste. While consumers generally recognise the environmental advantages of reuse, their actual reuse behaviours may result in insufficient reuse and an unintentional undermining of sustainability efforts. We conducted two creative workshops, created a large number of potential design interventions and further developed them into 16 design strategies for consumers' continued usage of RPSs through thematic analysis. These findings can inspire future research and the development of RPSs.

https://doi.org/10.1017/pds.2024.140

ASSESSING THE DISASSEMBLY PERFORMANCE OF WASHING MACHINES THROUGH THE DESIGN FOR CIRCULAR DISASSEMBLY METHODOLOGY

Giovanni Formentini, Thorvald Alrø Martiny, Christian Møller, Teodor Vernica, Devarajan Ramanujan
Aarhus University, Denmark

To enable the circular economy paradigm, it is important to design easy-to-disassemble products. A new method, known as Design for Circular Disassembly (DfCD), has been proposed to enhance product disassembly performances toward circularity. The method was tested on a small-sized product, showing promising results. However, its applicability to medium-sized products remains unclear. The goal of this article is to assess the effectiveness of DfCD on medium-sized products, particularly washing machines. Results showed DfCD can be extended to medium-sized products, increasing model complexity.

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INTERDISCIPLINARY SYSTEM LIFECYCLE MANAGEMENT – A SYSTEMATIC LITERATURE REVIEW

Fabian Wyrwich[1], *Aschot Kharatyan*[1], *Roman Dumitrescu*[2]
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The increasing proportion of software in technical products means that both the products and the associated development processes are becoming more complex. An integration of the existing lifecycle considerations Application Lifecycle Management and Product Lifecycle Management into an interdisciplinary System Lifecycle Management promises to make the complexity manageable. To obtain an overview of the current benefits, challenges, requirements, approaches and open research gaps in the context of an ALM-PLM integration, this contribution presents the results of a Systematic Literature Review.

https://doi.org/10.1017/pds.2024.280

LEVERAGING DESIGN THINKING IN MBSE: MITIGATING DATA AND INFORMATION UNCERTAINTIES – AN INTEGRATION MODEL APPROACH

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Bundeswehr University Munich, Germany

The evolving needs of customers and stakeholders necessitate the collaboration of diverse system elements within a cyber-physical, socio-technical network. Socio-technical systems are characterized by numerous complex interdependencies as well as by endogenous and exogenous influences. A key issue that developers must address is the mitigation of data and information uncertainties. The authors introduce an approach that operationalizes Design Thinking as a supporting sufficient condition within the context of designing system models in the realm of Model-Based Systems Engineering.

https://doi.org/10.1017/pds.2024.256

SUPPORTING CIRCULAR ECONOMY STRATEGIES FOR DESIGN OF SUSTAINABLE MECHATRONIC SYSTEMS USING MBSE

Zvonimir Lipšinić[1], *Stephan Husung*[2], *Neven Pavković*[1], *Christian Weber*[2]
[1]*University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, Croatia;* [2]*Technische Universität Ilmenau, Germany*

The paper investigates approaches for implementing circular economy strategies, such as designing mechatronic products for longer service life by replacing, upgrading, or remanufacturing subsystems. The research aims at applying MBSE to provide the necessary support for dealing with the complexity of these approaches. Requirements and challenges for the development of MBSE support in this context are examined. An example of an EV battery system model shows the benefits and challenges of comprehensive system modelling and traceability in the context of circular economy strategies.

https://doi.org/10.1017/pds.2024.267

JUSTICE-EMBEDDED REQUIREMENTS ENGINEERING (JERE) FOR SYSTEM DESIGN

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We have a unique opportunity to consider justice in our design of a cleaner energy system. This paper introduces the Justice-Embedded Requirements Engineering (JERE) process, which was created to enable engineers to consider project goals, requirements, and potential project impacts on historically marginalized, climate-vulnerable communities. Given JERE's focus on energy technologies, we demonstrate the process using a concentrating solar power example. JERE provides engineers with a tool to better ensure justice is embedded in the system design process from the beginning.

https://doi.org/10.1017/pds.2024.252

ENABLING THE DESIGN FOR CIRCULARITY THROUGH CIRCULARITY MEASURES: BREAKING DOWN THE R-STRATEGIES INTO USEFUL DESIGN MEASURES

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[1]University of Stuttgart, Germany; [2]Fraunhofer IAO, Germany; [3]Germany

Implementing a product design that incorporates circular economy aspects is a highly intricate task. Its complexity stems from various aspects, such as the interdependent solution space and the challenge to evaluate the impact of circular design in early development phases. To facilitate informed decision-making, a support system is necessary that integrates product-oriented circular measures, and derives their effect on the product's design and its circularity. We present an approach for such a support system, including its evaluation on the design of an automotive center console.

https://doi.org/10.1017/pds.2024.277

UTILIZATION OF THE SYSTEM ARCHITECTURE IN THE CONTEXT OF VALIDATION IN THE BUSINESS-TO-BUSINESS (B2B) SECTOR

Lynn Humpert[1], Daria Wilke[1], Sarah Brueggemann[2], Harald Anacker[1], Roman Dumitrescu[1]
[1]Fraunhofer IEM, Germany; [2]HARTING Applied Technologies, Germany

The European Green Deal aims to reduce global emissions by minimizing the use of resources. Early validation of products helps to reduce rework, costs and therefore resources. However, validation of complex mechatronic products is challenging due to interdependencies. Companies are applying systems engineering to meet this challenge. Current validation approaches are insufficient in the early design phases. This paper presents an approach to validation using the system architecture in the B2B sector. A machine tool and a custom built machine are presented as evaluation examples.

https://doi.org/10.1017/pds.2024.263

HOW DESIGNERS THINK CREATIVELY: AN EXPLORATORY STUDY IN THE USE OF VISUAL AND EMOTIONAL MENTAL IMAGERY

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Mental Imagery is a focus for design cognition research, with most research focusing on visual mental imagery, it has been highlighted that mental imagery encompasses more aspects than visual, including emotion known as multimodal mental imagery. So as researchers and educators we need to understand the cognitive process and how to best stimulate it. This paper looks at design students use of visual and emotional mental imagery and its impact on their ability to produce creative outcomes during the ideation stage of the design process.

https://doi.org/10.1017/pds.2024.98

THE USE OF OCCURRENCES OF IDEAS FOR CONSTRUCTING AND CHARACTERIZING THE DESIGN SPACE

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This study explores the construction, characterization, and measurement of the design space using a novel approach that centres on First Occurrences (FOs) and Re-Occurrences (ROs) as metrics. Expert architects' cognitive behaviours during the design process were investigated empirically to gain insights into design space evolution. Findings reveal a consistent generation and revisiting of ideas, signifying an ongoing development of the design space. Future research should incorporate diverse methodologies and broader participant sample for a more comprehensive understanding.

https://doi.org/10.1017/pds.2024.93

EXPLORING METACOGNITIVE PROCESSES IN DESIGN IDEATION WITH TEXT-TO-IMAGE AI TOOLS

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This research aims to explore the existence of metacognition during the use of text-to-image generators in the design ideation stage. We recruited five participants with a design background to use Midjourney as an ideation tool and to produce three sketches at the end of their task. Through semi-structured interviews and retrospective verbalization, we collected data on their thought processes. The qualitative analysis revealed clear indications of metacognitive engagement, such as monitoring and evaluating, which opens the path for future research into the impact of AI on design cognition.

https://doi.org/10.1017/pds.2024.94

THE INFLUENCE OF CULTURE ON CREATIVITY IN IDEATION: A REVIEW

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The relationship between culture and creativity has sparked the interest of researchers for decades. Although researchers have attempted to establish a connection between culture and creativity, the precise relationship between the two remains ambiguous. The current paper examined extant literature on the subject matter and synthesized the relations between culture and creativity in ideation over the past twenty years. The present study expounds upon the utilized samples, measures implemented to assess creativity and culture, and the study results.

https://doi.org/10.1017/pds.2024.100

DS-VIZ: A METHOD FOR VISUALISING DESIGN SPACES

Esdras Paravizo, Nathan Crilly
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Problems, solutions, and design itself have been framed as spaces in design research. Visualising the design space and how designers explore it, can give insight into the design process. This paper reports on a novel method for creating Design Space Visualisations (DS-Viz) that generates 2D and 3D representations of design spaces. We show how DS-Viz can be used to investigate designer behaviour, design processes and outcomes using a game-based design activity as an example. We discuss DS-Viz implications for design research highlighting potential benefits to design education and practice.

https://doi.org/10.1017/pds.2024.106

EFFECT OF TEAM DIVERSITY ON TEAMS' DESIGN SPACE: A COMPUTATIONAL APPROACH

Marija Majda Škec[1], Mario Štorga[1,2], John S. Gero[3]
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Understanding team diversity has become essential for modern-day organisations. This study explores the impact of knowledge diversity in design teams through computational simulations. By analysing design space characteristics, we study how diverse teams perform compared to less diverse counterparts. Results reveal that highly diverse teams exhibit increased efficiency, quicker convergence, and larger but sparser design spaces. This work contributes to understanding the impact of knowledge diversity in design teams and sets the stage for future systematic studies of diversity.

https://doi.org/10.1017/pds.2024.112

VISUALIZING AND ANALYSING DATA-DRIVEN SHIFT FROM DECENTRALIZED TO CENTRALIZED AUTOMOTIVE E/E ARCHITECTURES

Tejas Pravin Phadnis[1,2], Nils Feyerabend[2], Joachim Axmann[1]
[1]Technische Universität Braunschweig, Germany; [2]Volkswagen Aktiengesellschaft, Germany

Decentralized E/E architectures (EEAs) are facing challenges and bottlenecks in implementing new features and technologies. The shift towards centralized EEAs has many challenges and needs to be handled pragmatically by considering concurrency with the existing EEAs. To address the challenges of architectural shift, the paper showcases the quantitative comparison of EEAs and visualizes the flow of shifting sub-function and hardware blocks using the Sankey diagram. The observations from the diagram as a result will support OEMs to analyse and take decisions on the shift while developing EEAs.

https://doi.org/10.1017/pds.2024.48

Session D335

Congress Hall Konavle

15:45 17:45

UNDERSTANDING AND DEFINITION OF SCANNING AND MONITORING OF THE FUTURE SPACE IN THE CONTEXT OF THE PRODUCT ENGINEERING PROCESS

Albert Albers, Carsten Thümmel, Jessica Schmidt, Stefan Eric Schwarz, Michael Schlegel, Andreas Siebe, Tobias Düser
Karlsruhe Institute of Technology, Germany

Using foresight methods such as scenarios, possible futures can be described and anticipated. Needs and requirements as well as product properties can be derived from that, which is necessary to plan successful products for future customers. Changes that occur in the future development can be identified with monitoring and the expected future can be adjusted. A consistent understanding of the use of monitoring for the product engineering process does not exist and is developed in this paper. Thereby, monitoring is considered in the context of validation and located in iPeM.

https://doi.org/10.1017/pds.2024.39

INTELLIGENT COMPETENCY MAPPING FOR IMPROVING KNOWLEDGE MANAGEMENT IN CONSULTING FIRMS

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[1]CentraleSupélec, France; [2]Sibylone, France

This study explores the application of competency mapping models, incorporating in knowledge management for consulting firms. It evaluates 15 different models, focusing on their suitability for consulting contexts based on data collection, advantages, risks, and limitations. The findings indicate that AI and ML-enhanced competency mapping models are particularly more effective in consulting firms. Finally, the article proposes three key applications of these models for improving knowledge management in consulting firms via empowering communities and collaboration.

https://doi.org/10.1017/pds.2024.46

22 May
WED

ENHANCING KNOWLEDGE MANAGEMENT IN THE ENGINEERING DESIGN PROCESS THROUGH A COMMUNICATION PLATFORM

Sinan Ugurlu[1], Manfred Grafinger[1], Detlef Gerhard[2], Pinar Demircioglu[3]
[1]TU Wien, Austria; [2]Ruhr-Universität Bochum, Germany; [3]Technical University of Munich, Germany

In today's competitive market, design firms are under pressure to enhance the speed of their decision-making processes to foster innovative products. Due to specialized nature of contemporary technology, enterprises are directed to consider Design for X factors during the product development process like environmental impact and production efficiency. This transformation leads to an increase in gaining knowledge from different fields. This paper presents a comprehensive framework for efficiently acquiring and applying knowledge, aimed at improving knowledge management and sharing practices.

https://doi.org/10.1017/pds.2024.50

THE EVOLUTION OF DESIGN PATTERNS IN JOINT DECISION-MAKING SPACES

Hermann Wolfram Klöckner[1,2], Katja Thoring[2]
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This paper outlines the evolution of decision-making spaces through selceted instantioations, analyzing the role of design in their utility and identifying preliminary patterns in spatial layout. It builds on the combination of two research fields: A) Decision support systems and B) Creative Spaces. The paper aims to take a first step towards combining these two existing research fields by focusing on the spatial design aspects that foster the convergent aspect of creativity and to provide guidance for further research on the design of decision-making spaces.

https://doi.org/10.1017/pds.2024.42

INTEGRATION OF PRODUCT DEVELOPMENT DATA FOR FURTHER ONTOLOGICAL UTILIZATION

Jessica Pickel, Sebastian Bickel, Stefan Goetz, Sandro Wartzack
Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

The amount of data within the product development process requires a structured approach to coordinate them. Knowledge management solutions, such as ontologies, are a suitable way of linking data and representing semantic relationships. However, making all relevant data usable to ensure their target-oriented application is still a challenge. Thus, this contribution presents an approach to identify and classify heterogeneous data in product development. Besides this single ontology approach, interface solutions for data integration into an ontology are proposed.

https://doi.org/10.1017/pds.2024.49

GAPS BETWEEN REFLECTION FRAMEWORKS AND STUDENTS' PRACTICE: IMPLICATIONS FOR DESIGN EDUCATION

Akira Ito[1], Yuki Taoka[1], Echo Wan[2], Malak Sadek[2], Celine Mougenot[2], Shigeki Saito[1]
[1]Tokyo Institute of Technology, Japan; [2]Imperial College London, United Kingdom

This paper aims to identify gaps between the reflection frameworks and students' practice. Through a systematic literature review (PRISMA) and a qualitative survey of students, 12 reflection frameworks were reviewed, and the 13 challenges students faced at design projects in two design schools were identified. The results indicate three gaps between theory and students' practice: skills of designers, granularities of reflection items, and supports of bridging reflection to next actions. This study provides insights for future development of support tools to bridge the gaps in design education.

https://doi.org/10.1017/pds.2024.290

CHALLENGES IN DESIGN METHODS: PERSPECTIVES OF DESIGN STUDENTS

Mayank Mayookh, V. Srinivasan
Indian Institute of Technology Delhi, India

The aim of this study is to identify: (a) challenges in understanding and using design methods, and (b) features expected in an enhanced repository of design methods, by design students. These are identified through interviews and a survey. The major findings are (a) less (time for) practice leads to weak understanding and challenges in using design methods and (b) students expect to have a method recommendation system based on problem context. The findings from this study will guide in developing a user-centric, enhanced repository of design methods to aid design practice and pedagogy.

https://doi.org/10.1017/pds.2024.295

INCORPORATING TRANSITION DESIGN IN THE EDUCATION OF AN ESTABLISHED DESIGN SUBJECT TO EMPOWER DESIGN STUDENTS WITH SYSTEMS THINKING

Qingfan An, Pedro Sanches
Umeå University, Sweden

Designers' roles are at a turning point of transforming design from an expert-driven design process within an assumed social and economic order to design practices that advocate design-led societal transition toward more sustainable futures. Design education should be adapted accordingly. Introducing the transition design concept into established design education promotes the sustainable society transition by involving more systems thinking from designers in various sectors. This study reports on a pilot practice and reflection on introducing the transition design concept to design students.

https://doi.org/10.1017/pds.2024.282

"THIS IS MY PHD PROJECT... OR IS IT?" UNDERSTANDING PERCEIVED DOCTORAL PROJECT OWNERSHIP THROUGH PSYCHOLOGICAL OWNERSHIP MAPPING

Michelle Rose Cedeno, Talya Porat, Weston Baxter
Imperial College London, United Kingdom

This paper investigates PhD student's perceived feeling of project ownership and how it influences their project management. Drawing on psychological ownership (PO) theory and the PO mapping method, this study identifies distinct project ownership paths among students, revealing how project engagement can be improved. The findings demonstrate the importance of carefully considered and timely student-supervisor expectation discussions to help influence project ownership. To this end, the paper offers several routes of ownership that can influence project ownership among PhD students.

https://doi.org/10.1017/pds.2024.285

DESIGN FOR THE REAL WORLD: A PROBLEM-BASED LEARNING APPROACH

Shakuntala Acharya
Indian Institute of Technology Guwahati, India

Problem-based Learning is an established learner-centred pedagogical approach for developing skills and competencies. This paper presents the evolutionary development of a Massive Open Online Course, titled "Design for the Real World: A Problem-based Learning Approach", with the aim to empower learners to independently pursue problem-based inquiry using design methods and tools, thereby fostering creativity and life-long learning.

https://doi.org/10.1017/pds.2024.281

ENGINEERING DESIGN EDUCATION AT GERMAN UNIVERSITIES: POTENTIAL FOR A COMMON BASIS TO CREATE PERSONALIZED E-LEARNING CONTENT

Frederike Kossack, Beate Bender
Ruhr-Universität Bochum, Germany

E-learning materials require a high initial development effort but can then be used by a large number of students with little effort. It therefore seems reasonable to develop and use these across universities. Particularly in the field of Engineering Design Education, standardized principles through norms and guidelines lead to a high degree of transferability. For the development of such e-learning offers, however, the context of application must be identified. As a fundament for the development, this publication analyzes Engineering Design Education in Germany.

https://doi.org/10.1017/pds.2024.292

08:15 – 10:15

D411
HUMAN-AI SYNERGY FOR THE FUTURE OF DESIGN
Congress Hall Ragusa
Chair: Ji Han, University of Exeter, United Kingdom

D412
MODULARISATION AND ADAPTABILITY IN COMPLEX SYSTEMS DESIGN
Congress Hall Bobara
Chair: Dieter Krause, Hamburg University of Technology, Germany

D413
HUMAN-CENTRIC DYNAMICS AND INTEGRATION IN DESIGN MANAGEMENT
Congress Hall Orlando 1
Chair: Monica Bordegoni, Politecnico di Milano, Italy

10:15 – 10:45 **REFRESHMENT BREAK**

10:45 – 12:30

D421
EXPLORING DIGITAL TWINS IN DESIGN AND MANUFACTURING
Congress Hall Ragusa
Chair: Kostas Stylidis, Chalmers University of Technology, Sweden

D422
SUSTAINABILITY TOOLS AND INDICATORS IN DESIGN
Congress Hall Bobara
Chair: Elies Ann Dekoninck, University of Bath, United Kingdom

D423
ENHANCING DESIGN THROUGH OPTIMISATION AND AUTOMATION TOOLS
Congress Hall Orlando 1
Chair: Markus Zimmermann, Technical University of Munich, Germany

12:30 – 14:00 **LUNCH**
Restaurant Cavtat

14:00 – 14:45

D4-P PLENARY SESSION
Congress Hall Ragusa
Chair: Sandro Wartzack, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

14:45 – 15:15 **REFRESHMENT BREAK**

15:15 – 17:30

D431
ADVANCING DESIGN WITH GENERATIVE AI APPLICATIONS
Congress Hall Ragusa
Chair: Tomislav Martinec, University of Zagreb FSB, Croatia

D432
SUSTAINABLE DESIGN AND SOCIAL INNOVATION IN EDUCATION
Congress Hall Bobara
Chair: Neven Pavković, University of Zagreb FSB, Croatia

D433
MECHANICAL DESIGN ENHANCEMENTS – OPTIMISATION, ANALYSIS, AND PRACTICE
Congress Hall Orlando 1
Chair: Shayne Gooch, University of Canterbury, New Zealand

17:30 – 18:15

D4-C: CLOSING AND AWARDS
Congress Hall Ragusa
Chair: Tim C. McAloone, Technical University of Denmark, Denmark

20:00 – 22:00 **FAREWELL PARTY**

● CH Ragusa ● CH Bobara ● CH Orlando 1 ● CH Orlando 2

08:15

D414
DESIGN FOR BEHAVIOUR CHANGE
Congress Hall Orlando 2
Chair: KwanMyung Kim, Ulsan National Institute of Science and Technology, South Korea

D415
ADVANCING DESIGN RESEARCH THROUGH NEW METHODS AND APPROACHES
Congress Hall Konavle
Chair: Peter R. N. Childs, Imperial College London, United Kingdom

D416
EXPLORING CULTURAL AND BEHAVIORAL ASPECTS OF DESIGN INNOVATION
Congress Hall Šipun
Chair: Céline Mougenot, Imperial College London, United Kingdom

10:15

10:45

D424
DESIGN COGNITION AND AFFECT
Congress Hall Orlando 2
Chair: Harald Schaub, University of Bamberg, Germany

D425
ENHANCING ADDITIVE MANUFACTURING WITH KNOWLEDGE-BASED DESIGN TOOLS
Congress Hall Konavle
Chair: Roland Lachmayer, Leibniz University Hannover, Germany

D426
INTEGRATING CAD WITH ADVANCED DESIGN METHODOLOGIES
Congress Hall Šipun
Chair: Detlef Gerhard, Ruhr-Universität Bochum, Germany

12:30

14:00

DESIGN FOR ADDITIVE MANUFACTURING: IMPLICATIONS FOR SUSTAINABILITY
Dr. David W. Rosen; Professor Emeritus,
(Georgia Institute of Technology, College of Engineering, George W. Woodruff School of Mechanical Engineering)

14:45

15:15

D434
FACTORS INFLUENCING DESIGN CREATIVITY
Congress Hall Orlando 2
Chair: Georgi V. Georgiev, University of Oulu, Finland

D435
STANDARDISATION, REPRESENTATION, AND AUTOMATION OF DESIGN INFORMATION
Congress Hall Konavle
Chair: Filip Valjak, University of Zagreb Faculty of Architecture, Croatia

D436
DESIGN STRATEGIES FOR ENHANCED USER EXPERIENCE
Congress Hall Šipun
Chair: Weston Baxter, Imperial College London, United Kingdom

17:30

17:30

A WORD FROM THE DESIGN SOCIETY
Gaetano Cascini – President of the Design Society (Politecnico di Milano)
DESIGN SCIENCE JOURNAL DISTINGUISHED PAPER AWARDS
Panos Y. Papalambros – Editor-in-Chief of the Design Science Journal (University of Michigan)
DESIGN 2024 CONFERENCE REFLECTION
Tim C. McAloone – Programme Chair (Technical University of Denmark)

18:15

20:00

22:00

FROM HUMAN-CENTRED TO HUMANITY-ECOSYSTEM CENTRED DESIGN. HOW CAN WE DIALOGUE WITH AI?

Zeynep Oğrak[1], Yener Altıparmakoğulları[2]
[1]İzmir Institute of Technology, Turkey; [2]Mimar Sinan Fine Arts University, Turkey

With the swift entry of artificial intelligence (AI) into everyday life, human-product interactions are becoming increasingly complex. We suggest an ecosystem-minded, humanity-centered design approach to better understand this complexity. Simultaneously with the development of interaction types, discussions and developments on theories of mental models are crucial to understanding and improving the nature of these interactions. In this paper, we address the gap in mental model theories and extend Norman's conceptual model at three dialogue levels: dialogue in language, mind, and use.

https://doi.org/10.1017/pds.2024.219

Session D411

Congress Hall Ragusa

08:15
10:15

CONCEPT FOR ENHANCED INTUITION IN DEVELOPMENT MANAGEMENT THROUGH EXPLORATORY DATA ANALYSIS USING AN EXTENDED FACTOR ANALYSIS OF MIXED DATA

Michael Riesener, Maximilian Kuhn, Benjamin Nils Johannes Lender, Günther Schuh
RWTH Aachen University, Germany

With the shift from mechanical value delivery to mechatronic value delivery, development environments are becoming more complex. Intuitive decision-making in development management is becoming increasingly challenging. Meanwhile, the use project management software is spreading, bringing about a new level of project data for development projects, holding to potential to enhance human decision making. To this end, the paper presents an extension to factor analysis of mixed data, which can facilitate usage of exploratory data analysis to improve decision-making in development project planning.

https://doi.org/10.1017/pds.2024.225

HARMONIZING HUMAN-AI SYNERGY: BEHAVIORAL SCIENCE IN AI-INTEGRATED DESIGN

Dirk Van Rooy, Kristof Vaes
University of Antwerp, Belgium

This paper explores the role of integrating behavioral science to refine human-AI interaction, essential for ensuring safety and efficiency. Advocating for empathetic, user-centric design, the paper illustrates how behavioral insights can effectively inform AI-integrated designs, making AI applications more intuitive and ethically aligned with diverse human needs. This approach can ultimately enrich interaction across systems, fostering a more harmonious human-AI synergy.

https://doi.org/10.1017/pds.2024.231

DESIGNERS' PERCEPTIONS OF A SENSOR-ENABLED DIARY METHOD FOR ENHANCING USER RESEARCH

Yuki Taoka, Tomoyuki Tanaka, Momoko Nakatani, Shigeki Saito
Tokyo Institute of Technology, Japan

This study proposes a diary method enabled with IoT sensors for user research in design. It addresses the limitations of diary methods by incorporating sensor data to trigger user self-reports. The focus is on how sensor data influences self-reports and designers' perceptions. Results show that sensor-enabled diaries offer more diverse content and overview of users' lives and designers perceived the proposed method potentials, suggesting significant potential for IoT in user research.

https://doi.org/10.1017/pds.2024.229

HUMAN-AI COLLABORATION BY DESIGN

Binyang Song[1], Qihao Zhu[2], Jianxi Luo[2]
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Human-AI collaboration (HAIC) is a promising strategy to transform engineering design and innovation, yet how to design artificial intelligence (AI) to boost HAIC remains unclear. Accordingly, this paper provides a new, unified, and comprehensive scheme for classifying AI roles. On this basis, we develop an AI design framework that outlines expected AI capabilities, interactive attributes, and trust enablers across various HAIC scenarios, offering guidance for integrating AI into human teams effectively. We also discuss current advancements, challenges, and prospects for future research.

https://doi.org/10.1017/pds.2024.227

STIMULATING DESIGN IDEATION WITH ARTIFICIAL INTELLIGENCE: PRESENT AND (SHORT-TERM) FUTURE

Aurora Berni[1], Yuri Borgianni[1], Federico Rotini[2], Milene Gonçalves[3], Katja Thoring[4]
[1]Free University of Bozen|Bolzano, Italy; [2]University of Florence, Italy; [3]Delft University of Technology, The Netherlands; [4]Technical University of Munich, Germany

The role of Artificial Intelligence (AI) in design is clearly growing. One of the tenets of the paper is that stimulation could be among the design processes mostly benefitting from the introduction of AI. Available contributions have been reviewed to understand the current support AI can give in design inspiration and ideation. We also reflected on what AI should and ahould not do in the future: a framework is proposed. Based on the reviewed contributions, in no case, AI is seen as a substitute of designers. Most contributions originate from the IT domain and have a demonstrative purpose.

https://doi.org/10.1017/pds.2024.196

APPLYING A PRODUCT MODULARIZATION APPROACH ON THE CASE OF A BATTERY PACK

Julia Beibl[1], Katharina Zumach[1], Sven Wehrend[1], Marc Züfle[1], Eugen Hein[2], Benedikt Plaumann[2], Dieter Krause[1]
[1]Hamburg University of Technology, Germany; [2]Hamburg University of Applied Sciences, Germany

When designing battery packs, opposing target-conflicts and design goals arise due to the different disciplines involved in the development process. Looking at the available technologies for battery pack design, different solutions can be found on the market. The development of a battery pack for use in various scenarios therefore presents an interesting use case to evaluate product modularisation approaches. Hence, this paper discusses the application of the Integrated PKT Approach based on a fictious use case of a modular battery pack to derive potential starting points for its improvement.

https://doi.org/10.1017/pds.2024.52

FROM TEARS TO TIERS – ARCHITECTURAL PRINCIPLES FOR FEDERATED PLM LANDSCAPES

Erik Herzog, Johan Tingström, Johanna Wallén Axehill, Åsa Nordling Larsson, Christopher Jouannet
Saab AB, Sweden

PLM systems are key enabling systems in the development of today's products. Introduction of a new PLM capability is an expensive and risky undertaking. Many implementation projects end in tears in the sense that they are frequently late or even cancelled. In this paper, a federated PLM architecture pattern – Genesis – is introduced and evaluated against prevalent PLM approaches. From an architecture perspective, Genesis with its two distinct integration tiers decrease the number of integration points and thus cost and complexity.

https://doi.org/10.1017/pds.2024.62

A MODEL TO DESCRIBE LOGISTICS SERVICE ARCHITECTURE BASED ON PRODUCT ARCHITECTURE

Erika Marie Strøm, Tine Meidahl Münsberg, Lars Hvam
Technical University of Denmark, Denmark

The growth in e-commerce has led to increased demand for logistics services. This puts a pressure on third-party logistics (3PL) providers who struggle with increasing operating costs and heightened competition. These providers could potentially exploit the advantages of modularisation, but few studies address the design of modular logistics services. This study explores modular design of logistics services and proposes a model to describe logistics service architecture based on product architecture. A case study shows that warehousing services can be described in three domains.

https://doi.org/10.1017/pds.2024.82

FUTURE-ROBUST PRODUCT DESIGN – VALIDATING INFLUENCING FACTORS ON UPGRADEABLE MECHATRONIC SYSTEMS

Maximilian Kuebler, Carolin Lange, Bastian Glasmacher, Tobias Düser, Albert Albers
Karlsruhe Institute of Technology, Germany

This paper examines upgradability through modular product design, aiming to extend lifecycles and promote cross-generational use. It builds up on a preceding work, a systematic literature- review identifying four fields of action in future-robust product design. The paper itself contains an in-depth interview study with 17 experts from industry and research to validate and expand the literature-based fields of action. The results provide insights into the application and employment of future-robust product design, with a focus on adaptable product architectures.

https://doi.org/10.1017/pds.2024.66

MANAGEMENT OF RULE-BASED PRODUCT-PORTFOLIOS WITH HIGH VARIANCE: A SYSTEMATIC LITERATURE REVIEW

Thorsten Schmidt, Frank Mantwill
Helmut Schmidt University Hamburg, Germany

This paper conducts a systematic literature review about the management of rule-based product-portfolios with high variance. This type of portfolio is particularly distinctive in the chosen use case of the German automotive industry since it satisfies the requirements of mass customization and modularization. However, the research field of variant- and complexity management is manifold and multidimensional. This paper systematically searches the databases Scopus and Web of Science using the PRISMA method and briefly summarizes the main contributions and comparing them by elaborated topics.

https://doi.org/10.1017/pds.2024.78

DESIGNING LAB-ON-A-CHIP SYSTEMS WITH ATTRIBUTE DEPENDENCY GRAPHS

Johannes Soika[1], Tobias Wanninger[1], Patrick Muschak[1], Sebastian Schwaminger[1,2], Sonja Berensmeier[1,3], Markus Zimmermann[1]
[1]Laboratory for Product Development and Lightweight Design, TUM School of Engineering and Design, Technical University of Munich, Germany; [2]Division of Medicinal Chemistry, Otto Loewi Research Center, Medical University of Graz, Austriacal University of Munich, Germany; [3]Munich Institute for Integrated Materials, Energy and Process Engineering, Technical University of Munich, Germany

Lab-on-a-Chip (LOC) products for point-of-care diagnostics have gained significant attention. However, there is a lack of systematic approaches for LOC product development. To address this, we introduce an Attribute Dependency Graph exemplary for a magnetophoretic LOC system for pathogen detection. This model organizes dependencies between the design variables and crucial quantities of interest, such as detectability, cost per test, and test duration. The obtained model helps to manage design complexity and can be adapted to other LOC approaches.

https://doi.org/10.1017/pds.2024.81

HUMAN-CENTRED ENGINEERING DESIGN: A CROSS-DISCIPLINARY PRODUCT INNOVATION PRACTICE

Sindre Wold Eikevåg[1,2], Jan Auernhammer[3], Christer W. Elverum[1], Henrikke Dybvik[1,2], Martin Steinert[1]
[1]Norwegian University of Science and Technology, Norway; [2]University of Bristol, United Kingdom; [3]Stanford University, United States of America

This article introduces a Human-centred Engineering Design (HcED) practice, which values human aspects. This practice engages deeply into (1) human geometry and motion for specific tasks, (2) product and manufacturing complexities through rapid prototyping, and (3) the broader human task context. This cross-disciplinary method combines ergonomics, AM, sensor applications, and multiple design practices. The framework provides concrete tasks to drive innovative designs in engineering. The study, grounded in design research case studies, led to five new Paralympic Rowing world records.

https://doi.org/10.1017/pds.2024.28

DRIVERS AND BARRIERS FOR DESIGN AND DESIGNERS IN INTERDISCIPLINARY PRODUCT DEVELOPMENT – A LITERATURE-BASED CONCEPTUAL MODEL

Bernd Stoehr, Christian Koldewey, Roman Dumitrescu
Heinz Nixdorf Institute, Paderborn University, Germany

Design is associated with many benefits for businesses, ranging from successful products and brands to greater economic success. However, companies still have difficulties in unlocking the potential of design. This publication develops a literature-based conceptual model that outlines necessary organizational factors and their interrelation to create an environment for design and designers to thrive. At the same time, it explains why companies are having difficulties in leveraging the benefits of design. Further research directions are derived to strengthen the role of design and designers.

https://doi.org/10.1017/pds.2024.38

HUMAN IN THE LOOP: REVOLUTIONIZING INDUSTRY 5.0 WITH DESIGN THINKING AND SYSTEMS THINKING

Mohammad Hossein Dehbozorgi[1], James Postell[1], David Ward[2], Carlo Leardi[3], Brendan P. Sullivan[1], Monica Rossi[1]
[1]Politecnico di Milano, Italy; [2]TMC Italia, Italy; [3]Tetra Pak Packaging Solutions, Italy

This study delves into Industry 5.0's Human Centric Manufacturing and Systems (HCM and HCS), emphasizing worker welfare and sustainability. Industry 5.0 advocates a human-centric approach, built upon three foundational pillars safety, inclusivity, and empowerment. The paper highlights the successful integration of Design and Systems Thinking in HCM and proposes a workshop at MADE COMPETENCE CENTRE proving the effectiveness in raising awareness and promoting Human-Centric principles throughout the system life cycle and in achieving Human-Centric Systems (HCS).

https://doi.org/10.1017/pds.2024.27

TOWARDS A METHOD FOR HUMAN-CENTRED ANALYSIS OF EXTERNAL VARIETY

Olga Sankowski, Dieter Krause
Hamburg University of Technology, Germany

Addressing VUCA challenges in product development, the Human-Centred Analysis of External Variety (HAV) method is introduced. Focusing on the early stages of new product development, HAV provides a structured approach, reducing uncertainty through quick market analysis, customer engagement, and goal setting. HAV is illustrated using a cargo bike product family case study and emphasizes its role in aligning human-centred methods with project goals. The first steps of the HAV method are presented, but also the need for further action towards a validated and elaborated method is discussed.

https://doi.org/10.1017/pds.2024.36

EXPLORING GESTURE GENERATION FOR SMARTWATCHES: IS USER ELICITATION ENOUGH?

Saugata Pramanik, Sahil Pabbathi, Shakuntala Acharya
Indian Institute of Technology Guwahati, India

Gestures are a preferred mode of interaction for smartwatches and these are commonly elicited either by expert/designers or by users. This paper aims to understand the most promising approach for generating and assessing gestures by employing two empirical studies to validate a set of expert/designer-generated gestures. It further gains insights into the users' mental models, their role as co-creators, and their considerations for one-handed gestures in smartwatches, and discusses the virtue of incorporating both approaches of gesture elicitation.

https://doi.org/10.1017/pds.2024.107

GAMIFICATION AS AN INNOVATIVE METHOD IN USER EXPERIENCE DESIGN

David Kessing, Tim Katzwinkel, Manuel Löwer
University of Wuppertal, Germany

The growing research field of gamification promises new insights and innovative methods for the active design of user experience. This article examines the extent to which gamification complements the established methods of user experience design in the context of product development. To this end, assessment criteria are proposed that can be used to evaluate human-centred design methods. A qualitative comparison is then used to determine the added value of the innovative field of gamification for future user experience design in consumer products.

https://doi.org/10.1017/pds.2024.31

DESIGN TO FAIL? THE REASONABLY FORESEEABLE FAILURE AND MISUSE

Harald Schaub[1], Petra Badke-Schaub[2]
[1]University of Bamberg, Germany; [2]Delft University of Technology, The Netherlands

This paper examines the critical concept of "reasonably foreseeable failures and misuse" in product design. The psychology of failures and the ethical/legal implications are highlighted. The approach aims to provide a comprehensive understanding of the challenges associated with integrating reasonably foreseeable user failure and misuse into the design process. By taking a proactive approach to failure and misuse, designers can not only increase product safety, but also stimulate innovation that takes into account a wide range of user behaviour, including in unexpected circumstances.

https://doi.org/10.1017/pds.2024.108

UNRAVELLING EXPERIENCES, BARRIERS, AND DESIGN STRATEGIES FOR ENCOURAGING REUSABLE TAKEAWAY CUP USAGE

Laure Herweyers, Els Du Bois, Ingrid Moons
University of Antwerp, Belgium

The increasing use of disposable takeaway cups negatively affects the environment due to their non-recyclability and waste. This study investigates the adoption and sustained use of reusable takeaway cups in Belgium, including routines and experience. We did structured interviews (n=58), a survey (n=300), diary studies (n=8) and interviews with baristas (n=8). The findings provide recommendations including clear communication, incentives, and user-friendly cup design. Future research should test interventions and consider regional and cultural variations in sustainable coffee consumption.

https://doi.org/10.1017/pds.2024.102

TOWARDS CYCLING ENGAGEMENT BY MAPPING DESIGN INTERVENTIONS TO OBSERVED BARRIERS: AN EXAMPLE FROM GLASGOW'S BIKE SHARE PROGRAMME

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The benefits of cycling are well-established, but how to engage people with bikes for active travel is far less understood. This study offers insights into the motivations, barriers, and design solutions associated with cycling. Interviews with 30 bike-share users in Glasgow, UK found a key motivation to be commuting time efficiency and the predominant barrier was shared space with vehicles. Alignment between the most mentioned design solution, dedicated cycling lanes, and the significant barrier of sharing space with vehicles underscores the importance of behavioural design interventions.

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EVALUATING DESIGN APPROACHES FOR ENCOURAGING BEHAVIOR CHANGE IN EDITORS: EXPLORING A DIGITAL NUDGING STRATEGY IN A NON-PERSONALIZED RECOMMENDER SYSTEM TO PROMOTE ADOPTION OF AUGMENTED ANALYTICS

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In the age of digitalization, navigating through vast amounts of data is a challenge. Augmented analytics, which often goes unnoticed by employees, has the potential to support effective decision-making. This study examines the impact of digital nudging on editors' cognitive load and behavioral change towards augmented analytics, providing insights into behavior change design. Combining theory with expert interviews and workshops, this study results in five nudging strategies. The findings reveal varied triggers influencing behavioral change, emphasizing stakeholder involvement in the process.

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WEAK TIE INTERACTIONS IN NETWORKING: FIVE TYPES OF INTERACTION STRUCTURES

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Weak ties contribute to an individual's happiness, health and career, yet networking events supporting weak ties are often considered ineffective and unenjoyable. More support is needed to aid the design of these experiences. This inductive qualitative study explores how weak tie interactions occurred in a 3-day event for a professional networking community. Data was collected from multiple behavioural settings through direct observation, semi-structured interviews and archival data. Results highlight five structures underpinning weak tie interactions and associated implications for design.

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DESIGN STRATEGIES TO FACILITATE SECOND-HAND CLOTHING ACQUISITION

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Extensive research found many barriers and drivers in second-hand clothing (SHC) acquisition. This study explores their relationships and the role of design in enhancing SHC experiences. 16 semi-structured interviews revealed insights into personal experiences and emotions. Customer journey mapping highlighted 5 design interventions: a. effective branding and marketing, b. appealing clothing presentation, c. facilitating garment search, d. aiding quality inspection, and e. optimizing price-quality balance. Future, quantitative, research is needed to confirm the findings for a wider public.

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CIRCULARITY IN PRODUCT ENGINEERING – TOWARDS A FORWARD-LOOKING APPROACH ACROSS PRODUCT GENERATIONS

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To enable a truly circular economy in product engineering, the development of products in generations must be considered. Thus, we strive to enable a forward-looking circularity approach, proposing the integration of system generation engineering (SGE) with circular economy principles. By analysing the qualitative interrelations among product generations driven by distinct value preservation strategies on various value creation tiers ("R-strategies"), we extend prior SGE research to advance model theory and support practical application of circular product engineering.

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NEW COMBINATION OF METHODS FOR SUPPORTING A SIMPLIFIED SET-BASED DESIGN APPROACH

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This work presents a Set-Based Design inspired approach for generation, evaluation and reduction of a solution space of alternative product concepts. Also, the aspect of how to implement the process in an industrial environment was investigated. The hypothesis, confirmed by case studies, is that it can be done using existing methods like Enhanced functional modelling, brainwriting, the Gallery method, Axiomatic Design, causal diagrams and Pugh matrices. The method can be successfully introduced in a timeframe of a few working days and support development engineers in the concept design phase.

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A NOVEL APPROACH TOWARDS UTILIZING GRAPH ANALYZING OBJECTS ARRANGEMENT – CASE STUDIES FROM AIRBNB HOMES IN NEW YORK AND BOSTON

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The spatial arrangement of objects in residential environments is a crucial indicator of occupant behavior, shedding light on the complex dynamics of their interaction with the interior. This study introduces an object-based graph method for decoding urban home interiors, examining the co-presence of objects to uncover domestic behavioral patterns through indoor imagery analysis. By integrating centrality metrics with objects in graphs, we gain deeper insights into household behaviors, which provide empirical evidence for future interior design.

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PROTOTYPING FUTURE SOCIETIES: GIGA-MAPPING AND NARRATIVES AS DESIGN MATERIAL

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In Norway, the housing challenges faced by migrant workers highlight increasing inequality. Designers striving to create more equitable and sustainable futures must adopt system-oriented tools and human-centered approaches. Utilizing giga-mapping and narratives as prototypes helps reframe issues, enhance communication, and simplify complexity into actionable steps. However, successful outcomes demand refined application and careful attention to communication, necessitating significant investment of time, skills, and effort.

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VIRTUAL DESIGN HACKATHONS: A DATA COLLECTION FRAMEWORK

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Design hackathons offer a unique research opportunity to study time-pressured collaborative design. At the same time, research on design hackathons faces unique methodological challenges, prompting the exploration of new research approaches. This paper proposes a new data-collection framework that leverages a virtual format of hackathon events and enables a deeper insight into hackathon dynamics. The framework applicability is presented through a case study of the IDEA challenge hackathon, in which different intrusive and non-intrusive data collection approaches were used.

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A NEW APPROACH TO DERIVE VARIATION SHARES BY COMBINING THE C&C² APPROACH AND THE PGE MODEL

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This paper introduces a method to derive variation shares in engineering design, merging the Contact & Channel Approach (C&C²) with the model of PGE - Product Generation Engineering. It focuses on one-piece parts, enhancing precision in identifying component variations. The integration allows for detailed qualitative modeling and subcomponent analysis, improving design efficiency and innovation, illustrated with bottle examples. This research advances engineering design by enabling more accurate categorization of system variations.

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ADDRESSING CULTURAL INERTIAS FOR CO-DESIGN: EXPLORING CHINESE PARTICIPANTS' PERCEPTIONS OF DESIGN GAMES

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Innovation-driven firms must adopt an open design strategy for competitiveness. Co-design games are recommended to foster an open, equal, and collaborative culture. However, most studies focus on the West. East-Asian countries, notably China, face unique challenges due to cultural disparities and inertia. This paper explores design games in the Chinese context through a case study with traditional workshops, revealing participants' perspectives and the potential impact on cultural inertia.

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ANALYZING THE DIMENSIONAL ASPECTS OF 3D VOLUMETRIC SPACES: A PRODUCT-ORIENTED PERSPECTIVE

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The concept of volumetric spaces has evolved in the Architecture, Engineering, and Construction (AEC) sector, ranging from traditional onsite built spaces to modern modular houses and portable architecture. Despite this diversity, there lacks a comprehensive framework to analyze volumetric space products across dimensions. This paper presents a conceptual framework based on abductive reasoning and qualitative analysis, aiming to explore interdependencies among dimensions. It hypothesizes that volumetric space dimensions are perceived differently and demonstrate interdependencies.

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THE BALANCE BETWEEN A USABLE AND EMOTIONAL PRODUCT DESIGN – A COMPARISON OF DIFFERENT METHODS FOR PRIORITISING RELEVANT INFLUENCING FACTORS

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Designing an equally usable and emotionally appealing product remains a challenge for product developers, not least due to conflicting goals. Product developers need to constantly map the affective user requirements to the product, whereby the requirements for the emotional and usable product design often cannot be equally addressed. The systematic approach presented can help product developers in conflicting decision-making situations to represent these affective user requirements by selecting and prioritising context-relevant influencing factors using multi-criteria decision-making methods.

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NURTURE EMPLOYEES' CREATIVE BEHAVIORS: UNVEILING THE IMPACT OF DESIGN THINKING ON HUMAN ORGANIZATIONAL BEHAVIOR

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This research explores the impact of Design Thinking (DT) on Organizational Behaviour, explicitly focusing on individual employees, the micro-level of the organization. The research runs a single-case study within an Italian bank adopting DT through its HR department. The study proposes a model illustrating how DT adoption influences specific individual behavioral constructs: motivations, attitudes, capabilities, and creative behaviors. The study finds that fostering confidence in the creative process enhances human engagement and proactivity.

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DEMYSTIFYING THE DESIGN PROCESS OF DEMONSTRATORS: CONTEXTUAL INQUIRY OF TWO CASES

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Over years of practice, industrial designers have developed three steps that always lead to a design solution: inspiration, ideation, and implementation. Usually, the result is a product, but sometimes it is a demonstrator, a versatile concept, combining design, engineering, and art. However, designers usually are not aware of this notion. But if the result is different, how does it affect the design process? The analysis of the contextual inquiry study of two demonstrators shows that the transformation should happen during the ideation phase, where abstract concept becomes a story.

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INNOVATION OF MEANING: DESIGN-DRIVEN STUDY BASED ON THE INTERPRETIVE THEORY OF NEW MEANING

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This study conducts design-driven meaning innovation research based on an interpretation of new meaning through qualitative and quantitative research rooted in design practice and builds design-driven theories, methodology, and highly replicable methods. It presents a new design approach to design thinking called 'design methodology and method of meaningful products'. The design process and framework integrate words, visuals, and functions to interpret and create new meanings. It highlights the importance of design semiotics in overcoming the limitations of traditional approaches.

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THE DIGITAL THREAD FOR SYSTEM LIFECYCLE MANAGEMENT WITH A NATIVE GRAPH DATABASE IN A POLYGLOT ARCHITECTURE

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The Digital Thread is a system that connects different phases of the product lifecycle and the related data across one or more companies in the supply chain. This work aims to develop a graph data model of the Digital Thread, in the context of the vision of polyglot persistence, that interconnects the different phases of the lifecycle and their corresponding data models, processes, and IT systems. This work proposes a Digital Thread Graph that integrates a Digital Model and a derived Digital Twin, using object and relation attributes for view creation and filtering while minimizing redundancy.

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TOWARDS THE DIGITAL FACTORY TWIN – DESIGN GUIDE FOR CREATING A 3D FACTORY MODEL

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Shorter product lifecycles are also leading to even shorter planning times for the development of production systems. In most companies, the restructuring is carried out within a few weeks during the annual holidays. Digital tools such as simulations or the digital twin are used to avoid delaying the restructuring during this time. However, the introduction of a 3D model of the factory is often the first point of failure for many companies. This article proposes a six-step process model that enables the transition from 2D to 3D design. The process model was evaluated in a research project.

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SELF-OPTIMIZING DIGITAL FACTORY TWIN: AN INDUSTRIAL USE CASE

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Digital Twins (DTs) are intended to be utilized for a wide range of applications, promising benefits like visualization, monitoring, simulation and control of a physical system. Not only the development of a DT for a production facility is a time-consuming task, but also to keep the virtual counterpart up to date in the use phase. In this work, the implementation of an industrial-scale DT of an automotive supplier production site based on a Discrete-Event Simulation (DES) model with self-optimization capabilities for easier maintainability and increased simulation accuracy is presented.

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DIGITAL TWINS TO INCREASE SUSTAINABILITY THROUGHOUT THE SYSTEM LIFE CYCLE: A SYSTEMATIC LITERATURE REVIEW

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Sustainability is not a new trend, but a mandatory measure for responsible and environmentally conscious use of resources. The digital transformation offers new potential in engineering and competitive advantages for companies through innovative technologies like the digital twin. Based on digital twins, products can be optimized, and new business models can be developed. Long-term added value is generated for manufacturing companies and customers. This paper explores the benefits of digital twins in the context of sustainability. Current challenges and use cases of digital twins are analysed.

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A SURVEY ON THE INDUSTRY'S PERCEPTION OF DIGITAL TWINS – A FOLLOW-UP TO THE DIGITAL TWIN WORKSHOP AT THE DESIGN CONFERENCE 2022

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Digital Twins are perceived differently between and within industry and academia regarding applications and potentials. For this reason, a round table was formed based on the Digital Twin Workshop of the Design Conference 2022. One of the results of this round table is this contribution, which deals with a survey within the industry. The survey captured the understanding of the different roles in the creation and use of Digital Twins, the requirements and hurdles as well as the perception of methodological support. In addition, factors that influence the perception were identified.

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ALIGNMENT OF THE FUNCTIONAL STRUCTURE WITH SUSTAINABILITY ASPECTS IN PRODUCT DEVELOPMENT – COMBINING THE STRENGTHS OF THE FUNCTIONAL STRUCTURE WITH THE MECO MATRIX

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Many of the methods and tools proposed in the literature for validating product concepts are matrix-based, but they do not allow the results to be communicated easily and comprehensibly. This is a major obstacle to the integration of such methods. The poor communication of the results of a method therefore represents great potential for better integration of sustainability aspects in product development. In this article, an approach is proposed on how the results of the MECO matrix can be converted into a clear visualization of the reduced environmental assessments.

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SELECTING SUSTAINABILITY INDICATORS FOR SMART PRODUCT DESIGN BASED ON INDUSTRY 4.0/5.0 TECHNOLOGIES: ANALYSIS AND PROPOSAL OF A METHODOLOGICAL FRAMEWORK

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Industry 4.0 deals with a digital revolution, integrating technologies like Virtual Reality, Augmented Reality, Digital Twin, and Robotics. This transformation unlocks opportunities in engineering, addressing sustainability challenges. Stakeholders use I4.0 technologies, including Industry 5.0, to measure sustainability indicators. This paper reviews I4.0 technologies for assessing sustainability, offering an SI framework in manufacturing and smart product design. Decision-makers can optimize environmental, social, and economic impacts in smart product design using this framework.

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WHAT'S THE CATCH? TRADE-OFF CHALLENGES IN EARLY DESIGN FOR SUSTAINABILITY

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Trade-offs involving multiple criteria that cannot be satisfied at the same time are ubiquitous in engineering design activities. Navigating trade-off decisions can be challenging, especially when it comes to sustainability-related decisions in early-stage projects. Through a systematic literature review, we unravel the challenges related to sustainability trade-offs in technology development, concept design, and other front-end of innovation activities. The challenges, which were evaluated by experts from industry and academia, range from technical and organisational to psychological aspects.

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DESIGN MEASURES TO ADDRESS CARBON EMISSIONS IN PRODUCTS' LIFECYCLE: AN EMPIRICAL ANALYSIS

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Companies need to implement low-carbon operations, including product-related innovation initiatives. The literature on low-carbon product design has grown, but existing studies are primarily theoretical. This empirical study identifies design measures adopted by companies committed to GHG emission reduction. A qualitative analysis of the climate change reports from a sample of companies reporting to the CDP was conducted. Design measures were identified and classified. The findings shed light on design measures contributing to emission reduction in different product lifecycle phases.

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NAVIGATING COMPLEXITY: VISUALISING SUSTAINABLE PRODUCT DEVELOPMENT KNOWLEDGE THROUGH DYNAMIC HEATMAPS

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The paper presents a novel approach to visualize the impacts of design heuristics in sustainable product development. Focusing on the integration of ecological sustainability, our research introduces a multivariate visual approach, combining Sunburst Charts and Radial Heat Maps. The methodology, based on a description standard for design heuristics, enhances knowledge sharing and provides an intuitive tool for designers. A dynamic three-series radial heatmap facilitates comparisons across different product properties, fostering informed decision-making in product development.

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OPTIMIZATION-BASED DESIGN SUPPORT FOR ENGINEER-TO-ORDER PRODUCT QUOTATION

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Quotation of engineer-to-order products provides substantial challenges in effectively managing engineering resources. This paper describes an approach that rationalizes this process by integrating multi-disciplinary design analysis and optimization with a new open-source library for managing engineering knowledge before and after optimization. The approach is applied and evaluated on mechanical rock excavation machines. Adapting the approach and considering the user feedback gathered can lead to an enhanced design space overview during quotation and thus more competitive product offerings.

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ARE GENERATIVE DESIGN TOOLS CREATIVE? A CHARACTERISATION OF TOOLS THROUGHOUT THE DESIGN PROCESS

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Generative design is now a core capability of today's CAD systems enabling broader exploration of the design space. This paper presents a desktop review of 15 tools with the aim of characterising where the tools are used in the design process and to what extent they can be considered creative.The results showed that, despite their increasing capabilities, GD tools are unable to exhibit all phases of creativity and cannot be applied in all stages of the design process. This highlights the criticality of the human in design providing opportunities for GD to augment designer creativity.

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ENHANCING DESIGN AUTOMATION FOR COMPONENTS OF ELECTRIC MACHINES: A SYSTEMATIC APPROACH

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This paper presents a systematic approach to multidisciplinary design automation in electric motor engineering, focusing on component design. Existing work in this field is often limited to a single level and lacks portability and reusability. The approach aims to enable simultaneous component and system design, with comprehensive models capturing specifications and architecture. Feasibility is demonstrated through the automated design of additive manufactured hairpin windings.

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DEVELOPING A METHOD TO IMPROVE UNKNOWN IDENTIFICATION AND DESIGN EFFORTS FOR ENVIRONMENTAL TRANSITION: A CASE STUDY IN THE PACKAGING INDUSTRY

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Most manufacturing companies have tested and adopted sustainable design methods to navigate their product's environmental transition. While successful at first in enhancing their environmental performance, these companies later struggle to pursue their environmental transition. This entails mastering two critical competencies: identifying transition unknowns, and fostering adequate design efforts. This action research with an innovative design intermediary - which has completed four sustainable packaging missions - reveals the specific design barriers encountered for environmental transition.

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APPROACHES FOR EXPLORATION, ANALYSIS, AND VISUALIZATION OF TRADESPACE FOR ENGINEERING DECISION-MAKING

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This paper discusses approaches for tradespace analysis, exploration, and visualization to address multi-objective decision-making. Next, computational tools for early-stage tradespace analysis to enhance programmatic decision-making are introduced via a vehicle design example to demonstrate the effectiveness and capability of the method. Using a smaller sample of technologies in this problem a synthetic tradespace spans the space of potential and available solutions and provides an opportunity for design engineers to develop an insight into possible technologies and solutions within the tradespace.

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CHRONOBIOLOGY OF PUPIL DILATION IN DESIGN STUDENTS DURING IDEA GENERATION

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Chronobiology studies physiological variations due to the time of day, an unexplored factor in design research. This paper explores the effect of time of day on designers' physiological responses in idea generation. Convergent (CT) and divergent (DT) thinking, as building blocks of designing, are explored using pupil dilation as a proxy for cognitive load. Time of day and educational background are explored for engineering and industrial designers. Results show a larger pupil diameter in the afternoon than in the morning, especially for DT, with higher values for industrial designers.

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THE EMOTIONPROBE: AN EXPLORATION OF DESIGN STUDENTS' EMOTIONS WHEN DESIGNING

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The emotional experiences significantly impact students' design processes. This research presents the EmotionProbe, a design probe tool for capturing design students' emotions while designing. The tool allows simple data collection, offering important insights into the students' design experiences, introducing the spectrum of emotions that design students go through, and showcasing various analysis approaches, allowing for a richer understanding of the design's emotional dimension. The research highlights the need for an emotional tool supporting students' emotional well-being while designing.

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EXPLORING DESIGNERS' COGNITIVE ABILITIES IN THE CONCEPT PRODUCT DESIGN PHASE THROUGH TRADITIONAL AND DIGITALLY-MEDIATED DESIGN ENVIRONMENTS

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This study explores design strategies that designers adapt in different design environments and assesses cognitive load associated with acquiring, comprehending, and implementing strategies in concept product design phase. The findings from qualitative and quantitative analyses show that the traditional design environment exhibits a greater intrinsic load, thereby fostering a greater diversity of ideas, design strategies, and solutions. The digitally-mediated design environment demonstrates extraneous load, resulting in a tendency towards similarity in ideas, design strategies, and solutions.

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AN EEG STUDY TO UNDERSTAND SEMANTIC AND EPISODIC MEMORY RETRIEVAL IN CREATIVE PROCESSES

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This study aimed to identify and compare the EEG activities associated with semantic and episodic memory retrieval during creative processes. Episodic and semantic memory induction studies were conducted and EEG was used to collect data. The results showed that (i) Episodic and semantic memory retrieval are related to the frontal lobe area; (ii) Semantic memory retrieval is evoked more swiftly compared with episodic memory retrieval (ii) Prior to episodic memory retrieval, semantic memory retrieval is evoked first.

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INVESTIGATING DIFFERENCES IN BRAIN ACTIVITY BETWEEN PHYSICAL AND DIGITAL PROTOTYPING IN OPEN AND CONSTRAINED DESIGN TASKS

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This article presents an fNIRS experiment investigating cognitive differences between physical and digital prototyping methods in designers (N=25) engaged in open and constrained design tasks. Initial results suggest that physical prototyping yields increased hemodynamic response (i.e., brain activity) compared to digital design, and that constrained design yields increased hemodynamic response compared to open design, in the prefrontal cortex. Further work will seek to triangulate results by investigating potential correlations to design processes and design outputs.

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A KNOWLEDGE-DRIVEN, INTEGRATED DESIGN SUPPORT TOOL FOR ADDITIVE MANUFACTURING

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Increasing adoption of additive manufacturing (AM) makes software support for design for additive manufacturing (DfAM) more relevant. This paper presents a novel, knowledge-driven design support tool for AM that leverages a central knowledge base to provide extensible and powerful DfAM support early in the development process. The approach was implemented using Python for the knowledge base and as a plugin for Siemens NX. It offers automated design checks, optimizations, and further information through an integrated Wiki. Evaluation confirms the feasibility and benefits of the approach.

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INVESTIGATING DESIGNERS' PREFERRED LEARNING MEDIA TO DESIGN FOR ADDITIVE MANUFACTURING

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In this exploratory study, designers' preferred learning media in learning to design for Additive Manufacturing was explored. Furthermore, by deploying an online survey questionnaire, factors such as years of experience, and the categories of products designed were explored to understand how they influence designers' learning media with a response from 201 respondents. The results show that designers have learned how to design for AM through experimentation and present the first step towards developing an appropriate Design for Additive Manufacturing knowledge dissemination approach.

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A PROPOSAL FOR GUIDING THE SELECTION OF SUITABLE DFAM SUPPORT BASED ON EXPERIENTIAL KNOWLEDGE

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Unlocking additive manufacturing's (AM) potential requires designer expertise. Design for additive manufacturing (DfAM) addresses this need but faces barriers, such as uncertainty in scope of integration, design support selection, result validation or time investment for incorporating design support. This paper proposes a framework aligning SCRUM (agile framework) to aid designers in overcoming those barriers. The goal is to pave the way for a better exchange between academia and industry and fostering iterative development of DfAM support tailored to designer needs.

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A BAYESIAN EXPERT SYSTEM FOR ADDITIVE MANUFACTURING DESIGN ASSESSMENT

Benedict Alexander Rogers, Neill Campbell, Mandeep Dhanda, Alexander James George Lunt, Elise Catherine Pegg, Vimal Dhokia
University of Bath, United Kingdom

Tools for analysing additive manufacturability often employ complex models that lack transparency; this impedes user understanding and has detrimental effects on the implementation of results. An expert system tool that transparently learns features for successful printing has been created. The tool uses accessible data from STL models and printer configurations to create explainable parameters and identify risks. Testing has shown good agreement to print behaviour and easy adaptability. The tool reduces the learning curves designers face in understanding design for additive manufacturing.

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PROVIDING A KNOWLEDGE-BASED DESIGN CATALOG AS AN APPROACH TO SUPPORT THE DEVELOPMENT OF DESIGN FOR ADDITIVE MANUFACTURING SKILLS

Gregory-Jamie Tüzün, Daniel Roth, Matthias Kreimeyer
University of Stuttgart, Germany

Proficiency in design for additive manufacturing (DfAM) requires training and a lot of trial and error. To support the development of DfAM skills, we redesigned 47 design artifacts from case studies and derived tacit knowledge from successful and unsuccessful redesigns. All knowledge about these artifacts was then collected in a design catalog. In a workshop with a total of 48 graduates and students, 45 participants deemed the design catalog supportive. After evaluating their designs, we concluded that the use of a knowledge-based design catalog can develop and improve individual DfAM skills.

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ENGINEERING DESIGNERS' CAD PERFORMANCE WHEN MODELLING FROM ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS

Fanika Lukačević[1,2], *Niccolò Becattini*[2], *Stanko Škec*[1]
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The presented study investigates differences in engineering designers' CAD performance when modelling from two types of projections in technical drawings – isometric and orthographic. The results revealed significant differences in the percentage of correctly replicated components' size and shape, indicating better CAD outcomes when generating CAD models from the orthographic projection. In addition, a comparison of duration, as well as the number and type of sketch entities, sketch relations, and CAD features, showed that CAD modelling processes were similar in both conditions.

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Session D426

Congress Hall Šipun

10:45 12:30

AUTOMATIC EVALUATION OF THE MISPLACEMENT RISK DURING MANUAL ASSEMBLY BASED ON A CAD DESIGN

Alexander De Cock, Ncamisile Khanyile, Bieke Decraemer
Flanders Make, Belgium

In HMLV manufacturing, assembly mistakes by operators are common due to the ever increasing product variability and complexity. If mistakes can be detected early-on in the design process, product designers can reduce the possibility for mistakes. We present an algorithm to automatically detect and evaluate potential misplacements of parts that need to be fastened. Evaluation starts from a product CAD and returns the risk of misplacement as well as visual feedback on possible misplacements. An implementation with FreeCAD of our algorithm is illustrated on different use cases.

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ASSESSING YACHT DESIGN PROCESSES: A COMPARISON OF TRADITIONAL AND INTEGRATED METHODOLOGIES

Ludovico Ruggiero, Massimo Piccioni, Arianna Bionda
Politecnico di Milano, Design Department, Italy

Yacht design process currently faces challenges as slow data sharing, lack of flexibility in modelling and inefficient optimisation of shapes. This paper assesses the potential of an integrated approach over the traditional one, using a hypothetical industry scenario. The key aspects of data sharing/project management, modelling system, and shape optimization are compared, and new collaborative tools and technologies are introduced. The research reveals significant benefits of the integrated approach over the traditional one highlighting its potential to foster innovation within the industry.

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DATA-DRIVEN SUPPORT FOR CAD PARTS MODELLING BASED ON AUTOMATED ESTIMATED PRODUCTION PLANNING – APPROACH AND USER RESEARCH

Martin Erler[1], Sebastian Langula[1], Christian Wölfel[1], Julia Schneider[1], Christiane Kunath[1], Michael Königs[2]
[1]Technische Universität Dresden, Germany; [2]FVP Aachen, Germany

We present a data-driven approach to support decision-making in CAD modelling and to improve design for manufacturing. Based on automated estimated production planning, information is provided on possible design actions and their impact. A study was conducted on perspectives on and visualizations in CAD modelling. Requirements for a user interface of the described support system were identified. The results serve as basis for further research and development on the interaction of engineering designers with data-driven decision-making support in CAD modelling.

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A COMPARATIVE STUDY OF VR CAD MODELLING TOOLS FOR DESIGN

Aman Kukreja, Christopher Michael Jason Cox, James Gopsill, Chris Snider
University of Bristol, United Kingdom

With recent advancements in Virtual reality (VR), 3D design in VR has gained significant interest from both academia and industries. However, the development of these VR CAD tools is either skewed towards the creative industry or simply mimicking conventional CAD. This paper presents three different tools, analyzes them, and compares their capabilities over various performance parameters. The paper finally suggests where these tools can be used in the design process and some critical pathways for developing VR-based CAD modeling software for practical use in the engineering design industry.

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DESIGN FOR ADDITIVE MANUFACTURING: IMPLICATIONS FOR SUSTAINABILITY

Dr. David W. Rosen
Professor Emeritus, Georgia Institute of Technology, College of Engineering, George W. Woodruff School of Mechanical Engineering

Additive manufacturing (AM) is a key digital manufacturing technology leading to Industry 4.0 processes. Its digital input enables great flexibility and adaptability to changing markets, lot-size-of-1 and mass customization, and little if any lead-time since no hard tooling is needed. Its shape complexity capabilities enable part consolidation where several (or many) conventionally manufactured parts can be combined into one part with complex geometry. These characteristics can have major benefits for life-cycle costs and sustainability impacts of products containing AM parts. However, the AM processes themselves are not necessarily more efficient or environmentally friendly than conventional manufacturing (CM) processes. This talk explores opportunities for radically redesigning parts and products to take advantage of the unique capabilities of AM. After a consideration of the sustainability characteristics of AM processes, an analysis is offered of implications for product design. Results of life-cycle analyses (LCA) are highly dependent on the system extent being analysed. Some alternative system extents are proposed to illustrate their effects. A design strategy is proposed for incorporating sustainability considerations into products and AM processes. Examples are used to illustrate the application of the design strategy. Throughout the talk, the emphasis is on exploring research issues rather than providing quantitative results.

BIOGRAPHICAL SKETCH

David Rosen is a Principal Research Scientist at the Institute for High Performance Computing and the Singapore Institute for Manufacturing Technology, both A*STAR institutes in Singapore. He was a Professor in the School of Mechanical Engineering at the Georgia Institute of Technology for many years. Additionally, he held faculty and research positions at the Singapore University of Technology & Design. He received his Ph.D. at the University of Massachusetts in mechanical engineering. His research interests include computer-aided design, additive manufacturing (AM), and design methodology, with a specific interest in design for additive manufacturing. He is a Fellow of ASME. Also, he is the recipient of the 2013 Solid Freeform Fabrication Symposium, International Freeform and Additive Manufacturing Excellence (FAME) Award and is a co-author of a leading textbook on AM. In the standards community, he chairs the ASTM F42 subcommittee on design for additive manufacturing and was awarded the ASTM Award of Merit and promoted to Fellow of ASTM.

GENERATIVE LARGE LANGUAGE MODELS IN ENGINEERING DESIGN: OPPORTUNITIES AND CHALLENGES

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Despite the rapid advancement of generative Large Language Models (LLMs), there is still limited understanding of their potential impacts on engineering design (ED). This study fills this gap by collecting the tasks LLMs can perform within ED, using a Natural Language Processing analysis of 15,355 ED research papers. The results lead to a framework of LLM tasks in design, classifying them for different functions of LLMs and ED phases. Our findings illuminate the opportunities and risks of using LLMs for design, offering a foundation for future research and application in this domain.

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INSPIRATION OR INDICATION? EVALUATING THE QUALITIES OF DESIGN INSPIRATION BOARDS CREATED USING TEXT TO IMAGE GENERATIVE AI

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This study explores the application of image generative AI to support design process by creating inspiration boards. Through an evaluative study, we compare the diversity, quantity, fidelity, and ambiguity of boards generated by image generative AI and traditional methods. The results highlight how generative AI produces a quantity of images, it exhibits limited diversity compared to traditional methods. This suggests a tendency for supporting interpolation rather than extrapolation of ideas, in turn providing insights on best practice and into the optimal stage for its application.

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INTEGRATING LARGE LANGUAGE MODELS FOR IMPROVED FAILURE MODE AND EFFECTS ANALYSIS (FMEA): A FRAMEWORK AND CASE STUDY

Ibtissam El Hassani[1,2], Tawfik Masrour[1,2], Nouhan Kourouma[1], Damien Motte[3], Jože Tavčar[3]
[1]Moulay Ismail University, Morocco; [2]University of Quebec at Rimouski, Canada; [3]Lund University, Sweden

The manual execution of failure mode and effects analysis (FMEA) is time-consuming and error-prone. This article presents an approach in which large language models (LLMs) are integrated into FMEA. LLMs improve and accelerate FMEA with human in the loop. The discussion looks at software tools for FMEA and emphasizes that the tools must be tailored to the needs of the company. Our framework combines data collection, pre-processing and reliability assessment to automate FMEA. A case study validates this framework and demonstrates its efficiency and accuracy compared to manual FMEA.

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TOWARDS AN AUTOMATIC CONTRADICTION DETECTION IN REQUIREMENTS ENGINEERING

Alexander Elenga Gärtner, Dietmar Göhlich
Technische Universität Berlin, Germany

This paper presents a novel method for automatic contradiction detection in requirements engineering using a hybrid approach combining formal logic with Large Language Models (LLMs), specifically GPT-3. Our three-phase process detects contradictions by identifying conditionals and pseudo-grammatical elements, and employing LLMs for nuanced contradiction detection. Tested extensively, including on a real-world electric bus project, our method achieved 99% accuracy and 60% recall. This approach significantly reduces manual effort, enhances quality, and is scalable for future advancements.

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SKETCH2PROTOTYPE: RAPID CONCEPTUAL DESIGN EXPLORATION AND PROTOTYPING WITH GENERATIVE AI

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Sketch2Prototype is an AI-based framework that transforms a hand-drawn sketch into a diverse set of 2D images and 3D prototypes through sketch-to-text, text-to-image, and image-to-3D stages. This framework, shown across various sketches, rapidly generates text, image, and 3D modalities for enhanced early-stage design exploration. We show that using text as an intermediate modality outperforms direct sketch-to-3D baselines for generating diverse and manufacturable 3D models. We find limitations in current image-to-3D techniques, while noting the value of the text modality for user-feedback.

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TOWARDS THE EXTRACTION OF SEMANTIC RELATIONS IN DESIGN WITH NATURAL LANGUAGE PROCESSING

Vito Giordano[1,2], Marco Consoloni[1,2], Filippo Chiarello[1,2], Gualtiero Fantoni[1,2]
[1]University of Pisa, Italy; [2]Business Engineering for Data Science Lab (B4DS), Italy

Natural Language Processing (NLP) has been extensively applied in design, particularly for analyzing technical documents like patents and scientific papers to identify entities such as functions, technical feature, and problems. However, there has been less focus on understanding semantic relations within literature, and a comprehensive definition of what constitutes a relation is still lacking. In this paper, we define relation in the context of design and the fundamental concepts linked to it. Subsequently, we introduce a framework for employing NLP to extract relations relevant to design.

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BRIDGING THE GREEN TALENT GAP: A CASE STUDY OF PRODUCT DESIGN EDUCATION

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[1]Luleå University of Technology, Sweden; [2]Creaternity Aerospace Lab, Sweden; [3]Creaternity Space Lab, United States of America

This research examines how sustainable product design education can address the deficit in green talent. It presents a framework for a structured curriculum in product design, with hands-on activities, industry-specific case studies, and best practices in alternative design development. The impact of technologies like additive manufacturing on design is considered. Findings demonstrate that knowledge of technological capabilities, industry specific understanding, and proficiency in analytical tools such as Life Cycle Assessments contribute to sustainable designs mitigating a green talent gap.

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DESCRIPTIVE STUDY OF THE INTEGRATION OF SUSTAINABILITY THROUGH THE DOUGHNUT IN AN ENGINEERING TRAINING MATERIAL

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[1]UR InSyTE, Université de Technologie de Troyes, France; [2]Univ. Grenoble Alpes, CNRS, Grenoble INP, G-SCOP, France; [3]Assystem, France; [4]Arts et Métiers ParisTech, France; [5]École de l'air et de l'espace, France

We need to integrate socioecological issues into our activities. Engineers and designers need to develop competencies in sustainability, but it exists a lack of support in an academic context and for the training of professionals. The aim of this article is to demonstrate that the Doughnut is a support for developing sustainability competencies. In the literature, these competencies are identified and pedagogical experiences on their integration in engineering curricula are reported. We use the doughnut in a workshop as an element of understanding and developing competencies for sustainability.

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PROPOSING AN SDGS EDUCATION MODEL: INTEGRATING DESIGN THINKING AND BEHAVIORAL SCIENCE "NUDGES" FOR HIGH SCHOOL STUDENTS

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This study focuses on the development of a creative model of SDGs education that promotes behavior change in upper secondary schools using an approach that combines design thinking and behavioral science nudge methods. The SDGs education for high school students, which utilized design thinking, was used as a case study. Questionnaire surveys of high school students and teachers who participated in the project were conducted. Based on the survey results, a new education model was proposed that can effectively improve SDGs education at the high school level and support educators in this field.

https://doi.org/10.1017/pds.2024.302

A GENERATIVE TOOLKIT TO HELP RAISE INDUSTRIAL DESIGN STUDENTS' AWARENESS OF LOW METAL RECYCLING RATES

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[1]University of Wuppertal, Germany; [2]Division Sustainable Production and Consumption, Wuppertal Institute for Climate, Environment and Energy, Germany

Education for Sustainable Development requires raising individuals' awareness of problems relevant to the environment. We designed a Generative Toolkit that supports industrial design students carrying out a Speculative Design task and through this process initiates greater problem awareness of low metal recycling rates. In this paper we give insights into the Toolkit's theoretical derivation and the design process. Findings from testing suggest that there are several opportunities for improvement, such as considering further content-related competencies in the Toolkit's design.

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THE SUSTAINABILITY AND SOCIAL ENTREPRENEURSHIP FELLOWSHIP: TRANSDISCIPLINARY AND MULTICULTURAL PROBLEM-BASED ENGINEERING EDUCATION

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[1]Harvey Mudd College, United States of America; [2]University of Waterloo, Canada

The nine-week Sustainability and Social Entrepreneurship Fellowship at the University of Waterloo addressed urban habitation sustainability in London, Ontario, via a multicultural, trans-disciplinary approach. Undergraduate engineering students addressed housing and transportation environmental and social sustainability, guided by expert lectures and fieldwork. The program highlights the importance of diversity in engineering education and the need for structured cultural and educational management. Students proposed engineering solutions to sustainably improve the housing development process.

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CHALLENGES IN PRODUCT VARIANT COSTING – A CASE STUDY

Morten Nørgaard, Jakob Meinertz Grønvald, Carsten Keinicke Fjord Christensen, Niels Henrik Mortensen
Technical University of Denmark, Denmark

This study explores challenges in decision-making for product design due to insufficient cost transparency because of product variety across the value chain. Utilizing a literature review and a case study on a company, it delves into issues such as value chain consideration, product family assessment, linking effects to specific product levels, and converting measured effects. Highlighting the critical need to address these challenges for decision-making. Future research should focus on a comprehensive costing framework, explore effect interdependencies, and expand the value chain analysis.

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COMPUTING SOLUTION SPACES FOR GEAR BOX DESIGN

Klara Ziegler[1], Kutay Demir[1], Thomas Luft[2], Thomas Mucks[3], Marius Fürst[1], Michael Otto[1], Karsten Stahl[1], Birgit Vogel-Heuser[1], Markus Zimmermann[1]
[1]Technical University of Munich, Germany; [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany; [3]J.M. Voith SE & Co. KG | VTA, Germany

The design of gear boxes is a complex challenge characterized by conflicting requirements and seemingly circular dependencies. Existing tools support engineers but focus on a single predefined design, often leading to costly iterative processes and non-optimal solutions. Solution Space Engineering (SSE) alleviates this by generating multiple designs represented by solution spaces. For this, a particular model structure is needed, and thus restructuring existing models, e.g., from industry standards. The application of solution spaces to a two-stage gear box is presented.

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A REVIEW OF HYDRAULIC ENERGY HARVESTER DESIGNS – CURRENT PRACTICE AND FUTURE IMPROVEMENTS

Lorenzo Giunta, James Roscow, Jingqi Liu
University of Bath, United Kingdom

This paper addresses the underexplored domain of hydraulic energy harvesters (HEH). Through a literature review, existing designs are identified, aiding in the categorisation of energy conversion technologies and fluid-mechanical interfaces. Recognizing a lack of standardized approaches to testing HEH, the paper proposes a re-configurable test platform. The platform, accommodating diverse configurations, operates at high pressures, aligns with existing hydraulic setups, and functions in static or dynamic modes. This tool aims to assist researchers further explore the implementation of HEHs.

https://doi.org/10.1017/pds.2024.303

APPROACHES TO REDUCING GEAR MASS AND THEIR EFFECTS ON GEARING STRESSES AND DEFORMATIONS

Dorian Vlašićek, Daniel Miler, Robert Mašović, Dragan Žeželj
University of Zagreb Faculty of Mechanical Engineering and Naval Architecture, Croatia

This study compares empirical and topology optimization methods for reducing gear body mass. Specimens produced via empirical guidelines and topology optimization were compared to referent full-disc gear, focusing on stresses and deformations. Values were determined numerically (Ansys was used) and the calculation method was verified using ISO 6336. The empirical approach exhibited substantial increases in stress and deformation while topology optimization method had promising outcomes. While decreasing mass, it also diminished tooth root stress on the tensile side by 17.1%.

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OPTIMIZATION OF THE POTTING DESIGN USING AN APPROACH FOR LOAD PATH OPTIMIZED DESIGNS OF SANDWICH STRUCTURES

Johann Schellhorn, Lukas Schwan, Dieter Krause
Hamburg University of Technology, Germany

In sandwich structures, mass can be reduced or mechanical properties increased if the challenging local load distribution can be improved. Through numerical optimizations, novel designs can be determined and investigated in physical and virtual tests. This paper presents an approach for load path-optimized design of sandwich structures and novel design concepts. The approach is applied to the design concept of honeycombs filled with potting compound. Due to the shown transferability to higher structural levels, it can be used as a basis for the design optimization of any sandwich structure.

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DESIGN DELUSIONS AND PROTOTYPING: ELICITING THE LINK BETWEEN PROTOTYPES AND PRODUCT PERFORMANCE

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This study investigates the relationship between the number and type of prototypes developed in rapid prototyping contexts, a team's performance self-estimations, and final actual performance. Findings suggest a strong correlation between each of these elements, with the converse also found to be true, motivating the introduction of the concept of Design Delusion - a type of cognitive dissonance due to differences between perceived and actual states. The paper suggests that early prototyping helps identify and mitigate design delusion, improving design decisions and preventing technical debt.

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MEDIATORS OF THE RELATIONSHIP BETWEEN PHYSICAL INDOOR SPACES AND INDIVIDUAL CREATIVITY

Chris McTeague, Katja Thoring
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Workspaces can enhance the creativity of the designers that occupy them. Here, we review experimental studies of creative spaces to identify constructs that mediate (explain) the relationship between physical spaces and creative performance. Through a literature review of 8 journal articles comprising 13 experiments, we identify 14 constructs involving cognitive, affective and physiological components. Knowledge of these mediators can help researchers to formulate hypotheses, select control variables, and develop conceptual models and theories of creative spaces in design.

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CHARACTERISTICS OF PARALINGUISTIC COMMUNICATION INDICATING PRE-RESONANCE DURING CO-CREATIVE DESIGN GRASPED BY DECISION TREE ANALYSIS

Karen Shichijo, Akane Matsumae
Kyushu University, Japan

The study aims to grasp the dynamic characteristics of paralinguistic communication during co-creation and has developed an analysis methodology by clustering the conversational patterns and determining the criteria more often observed in pre-resonance. The results suggest that pre-resonance is characterized by less silence, a rapid transition in exchanging ideas under one's initiative, and a conversation with equal amounts of utterances between both in a pair. This study reveals implications for better communication that lead to resonance, an essential phenomenon in collaborative design.

https://doi.org/10.1017/pds.2024.110

ASSESSMENT OF STRUCTUREDNESS OF PROBLEMS IN DESIGN

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Design problems are wicked in nature. Wicked problems are difficult to understand, formulate and solve. The literature focuses mainly on the characteristics of wicked problems, very little is available to how wicked problems (synonymous to ill-structured) should be formulated to make them well structured. Assessment of wickedness can help designers formulate problems into well-structured. This work proposes a metric for (lack of) structuredness as a measure for the degree to which a design problem is ill-structured. A Delphi-based method as benchmark for validating the metric is also proposed.

https://doi.org/10.1017/pds.2024.111

GENDER DIFFERENCES IN DESIGN CREATIVITY

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Gender is a crucial factor for creativity in design. Although the participation and recognition of successful and prominent women in the field of design seems to be increasing, many more men are still recognised and regarded as creative. This paper analyses the gender differences in design creativity. First, a summary of studies on gender differences in creativity in general is presented. It then discusses three critical aspects of gender differences in design creativity. Finally, some ways in which women's creativity can be encouraged and supported are outlined.

https://doi.org/10.1017/pds.2024.115

THE IMPERATIVE OF ASSESSING NEGATIVE CREATIVITY IN DESIGN: A MULTI-DIMENSIONAL APPROACH

Petra Badke-Schaub[1], Katja Thoring[2], Harald Schaub[3], Roland M. Mueller[4]
[1]Delft University of Technology, The Netherlands; [2]Technical University of Munich, Germany; [3]IABG Ottobrunn, Germany; [4]Berlin School of Economics and Law, Germany

The paper emphasizes the need to consider negative aspects of creativity, especially in design, where it can have significant societal impacts. It calls for a more comprehensive view of creativity that includes both positive and negative effects and proposes a research approach to assess the potential negative consequences of creative work.

https://doi.org/10.1017/pds.2024.90

FACTORS THAT DETERMINE DESIGN SIMILARITY

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In recent years, the importance of design has been pointed out as a source of competitive advantage. However, creating a great design also increases the risk of copy products being created. In this study, we used an approach based on visual information and conducted an international comparative judgment survey of elements considered to be similar within products.

https://doi.org/10.1017/pds.2024.76

HOW TO FACILITATE COMPARABILITY AMONG PRODUCT MODELS: APPLYING A STANDARDIZING DESCRIPTION APPROACH

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IPEK - Institute of Product Engineering at Karlsruhe Institute of Technology, Germany

During a design process, designers are supported by several purposive product models. To enable designers to switch between them, researchers need to consider the linking of product models during their development. To assist researchers in doing so, the capabilities of a standardizing description approach, stances towards product models, was investigated. The results show that the description approach was able to identify indicators of linking possibilities by facilitating comparability. This is a step towards assisting researchers in considering the linking of product models systematically.

https://doi.org/10.1017/pds.2024.47

ENHANCING DESIGN REPRESENTATIONS OF INFORMATION AND KNOWLEDGE OF COMPLEX AND LONG-LIVING ASSETS BY APPLYING SYSTEM MODELLING TECHNIQUES

Fabian Niklas Laukotka, Markus Christian Berschik, Dieter Krause
Hamburg University of Technology, Germany

Managing general domain knowledge and asset-specific information in the form of digital representations is especially important and challenging when focusing on long-living and complex assets. Implicit knowledge and existing structures need to be captured and digitalised, ideally without introducing unnecessary complexity through unfamiliar wording or new structures. To achieve this, a methodical approach that utilises ontologies as well as system modelling techniques and focuses on early-stage model instantiation is presented and applied to the cabin retrofit of aircraft.

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SUPPORTING THE DIGITAL THREAD THROUGH THE PRINCIPLES OF COMPLEMENTARITY

Yana Brovar, Saina Sadeghzadeh, Clement Fortin
Skolkovo Institute of Science and Technology, Russia

To establish a coherent Digital Thread, encompassing diverse information obtained during the design process, it is imperative to ensure the traceability of information particularly between engineering and manufacturing teams. A challenge lies in maintaining links between data, particularly in the context of configuration management. Through the principles of complementarity, we explore links between the Engineering and the Manufacturing definitions through a major structural element. We forsee the principles of complementarity as a support for Digital Thread throughout the product lifecycle.

https://doi.org/10.1017/pds.2024.40

INTRODUCING A MULTIPLIABLE BOM-BASED AUTOMATIC DEFINITION OF INFORMATION RETRIEVAL IN PLANT ENGINEERING

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[1]*Siemens Energy Global GmbH & Co.KG, Germany;* [2]*Technische Universität Dresden, Germany*

The complexity of process plants and the growing demand for digitalization require efficient and accurate information retrieval throughout the lifecycle phases of a process plant. This paper discusses the concept of instantiation and introduces a method for identifying and multiplying required information in plant engineering using scalable so-called Instantiation Blocks linked to the Bill of Material. Core functionality, an ontology graph and a user interface based on Python and React are developed to demonstrate the implementation of the framework and validate its effectiveness in practice.

https://doi.org/10.1017/pds.2024.44

AUTOMATIC KNOWLEDGE GRAPH CREATION FROM ENGINEERING STANDARDS USING THE EXAMPLE OF FORMULAS

Janosch Luttmer, Mostafa Kandel, Dominik Ehring, Arun Nagarajah
University of Duisburg-Essen, Germany

Engineering standards are an important source of knowledge in product development. Despite the increasing digitalisation, the provision and usage of standards is characterised by lots of manual steps.This research paper aims at applying automatic knowledge graph creation in the domain of engineering standards to enable machine-actionable standards. For this, a formula knowledge graph ontology as well as suitable information extraction techniques are developed. The concept is validated using the example of DIN ISO 281, showing the overall capability of automatic knowledge graph creation.

https://doi.org/10.1017/pds.2024.45

ENHANCING THE IFM FRAMEWORK BASED ON A META-ANALYSIS OF OTHER DESIGN METHODS

Merlin Krüger, Kilian Gericke, Stefan Zorn
University of Rostock, Germany

The use of design methods across multiple design phases of the product development process often leads to inconsistency, the loss of transparency, and the rejection of design methods by practitioners. The authors of this work intend to develop a central modelling approach that supports consistency, based on the integrated function modelling (IFM) framework. Therefore, various design methods from the literature were examined for their techniques and content to identify indicators for supporting consistency. The results led to an enhancement of the IFM framework.

https://doi.org/10.1017/pds.2024.65

THE CONNECTION BETWEEN IMPRESSIONS, USER EXPERIENCE AND DESIGN SPECIFICATIONS IN TECHNOLOGY-DRIVEN PRODUCTS

Fatma Nur Gokdeniz Zeynali[1], Ekrem Cem Alppay[2]
[1]Ondokuz Mayıs University, Turkey; [2]Istanbul Technical University, Turkey

In this study, the relationship between user experience, product appearance and emotional impressions generated by the user are examined through electric concept cars introduced by automotive companies in motor shows. The focus of the research is on the measurement of the emotional experiences that the interior design of the electric concept cars awakens in the user. The main purpose of the study is to open a discussion on the relation between the emotional impressions and product appearance.

https://doi.org/10.1017/pds.2024.239

USER INVOLVEMENT IN THE DESIGN OF COMPLEX DIGITAL TOOLS FOR EMPLOYEES IN A LARGE ORGANISATION

Anya Petyaeva, Joy Goodman-Deane, P. John Clarkson
University of Cambridge, United Kingdom

Large organisations are designing complex technology-based tools for their staff to use. In busy workplace environments, it can be difficult to get user input about a design. This paper describes the designer and user interactions in one such organisation, gaining insights that could be useful in other similar settings. The findings are based on a set of interviews with designers and researchers within the organisation. The paper identifies the current practices and constraints involved in understanding and capturing users' needs and discusses potential solutions.

https://doi.org/10.1017/pds.2024.245

AN INTEGRATED SURVEY-SIMULATION APPROACH FOR EXOSKELETON PERFORMANCE ESTIMATION

Niccolò Becattini, Luca Patriarca, Diego Scaccabarozzi, Paolo Parenti, Andrea Dal Prete, Marta Gandolla
Politecnico di Milano, Italy

The paper presents a hybrid user-centred/simulation approach to populate the design specification. It presents an application in the field of exoskeleton design, with the final goal to support workers to carry out their professional tasks. More than 100 professionals (mostly health workers) participated in the survey. The qualitative requirements were extracted are then tested in simulation environments. The approach proved to generate meaningful results for product concept generation. Beyond the expectations, the simulation also showed more adequate product architectures.

https://doi.org/10.1017/pds.2024.235

TERRITORIAL DESIGN: ETHOLOGICAL DESIGN OR POLITICAL DESIGN OR BOTH?

Stéphanie Hémon, Annie Gentès
CY ecole de design, France

Based on 4 codesign cases and 15 designer interviews, this article presents how territorial design serves as a catalyst for shared values in community living. Examining user experience and design goals, it reveals how ethological and political values shape territories and the design process. Participants explore new work methodologies, redefine collective activities and navigate in tensions, power issues and political dimensions. The codesign space transforms political interactions, shifting from controversy to conception, offering a new experience and perspective on territorial discussions.

https://doi.org/10.1017/pds.2024.241

DATA-INFORMED DESIGN IN THE AUTOMOTIVE INDUSTRY: CUSTOMER ACCEPTANCE STUDY IN SWEDEN AND CHINA ON RADICAL CAR DESIGN

Kostas Stylidis[1], Bastian Quattelbaum[2], Florian Konrad[3], Joe Simpson[4], Samuel Lorin[5], Rikard Söderberg[1]
[1]Chalmers University of Technology, Sweden; [2]Hochschule Niederrhein University of Applied Sciences, Germany; [3]Geely Design Global, Sweden; [4]Volvo Cars Corporation, Sweden; [5]Fraunhofer-Chalmers Centre, Sweden

This study explores the alignment between automotive design innovation and consumer acceptance, particularly in the context of two significant trends: electrification and digitalization. We probed the acceptance of replacing rear window with wide-angle camera We surveyed 1,546 potential customers from China and Sweden to assess their openness to such a radical design. Findings suggest a consensus on its futuristic appeal but diverge in adoption willingness. The study offers insights to bridge the design preference gap, positioning customer acceptance as key for car design strategy.

https://doi.org/10.1017/pds.2024.83

POSSESSION AND DISPOSSESSION: A DUAL PHENOMENON IN DIGITAL ARTEFACTS

Pranati Kompella, Neelakantan Keshavan
Indian Institute of Technology Hyderabad, India

A modern user's interactions with digital artefacts are a subject of interest to numerous fields of study, including human-computer interaction (HCI). Innovations in HCI necessitate an understanding of users' attachment to these artefacts. This paper characterises user attachment as a dual phenomenon of possession and dispossession. The findings give deeper insight into the influences of this phenomenon and how they might distinguish its manifestation in physical and virtual environments. Avenues for design interventions were then interpreted from these findings.

https://doi.org/10.1017/pds.2024.103

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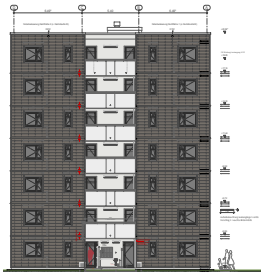

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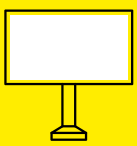
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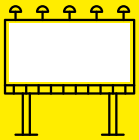
Jumbo plakati


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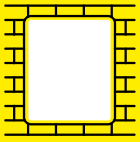
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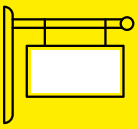
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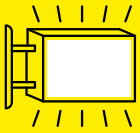
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Naljepnice


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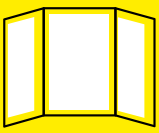
Roll up


SEG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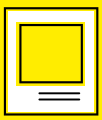
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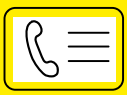
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