ICED 2015

DESIGN FOR life

The 20th International Conference on
Engineering Design

27-30th July 2015
Politecnico di Milano
Milan, Italy

Hosted by
Department of Mechanical Engineering,
Politecnico di Milano

Organised by
Politecnico di Milano, Politecnico di Torino
and the Design Society

Organizing Secretariat
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PROGRAMME & ABSTRACTS BOOK

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the Design Society
a worldwide community

POLITECNICO MILANO 1863

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CONFERENCE AT A GLANCE

	MONDAY 27th JULY	TUESDAY 28th JULY	WEDNESDAY 29th JULY	THURSDAY 30th JULY	FRIDAY 31st JULY
8:00 am - 9:30 am	*Registration*	*Registration*	*Registration*		
8:30 am - 10:15 am	**WORKSHOP SESSIONS 1.1 - 1.6** 9:30 am - 12:30 pm	**PODIUM SESSIONS 1.1 - 1.8**	**PODIUM SESSIONS 2.1 - 2.8**	**PODIUM SESSIONS 3.1 - 3.8**	
10:15 am - 11:00 am		*BREAK*	*BREAK*	*BREAK*	
11:00 am - 12:30 pm		**KEYNOTE 2**	**KEYNOTE 4**	**PODIUM SESSIONS 4.1 -4.8**	
		KEYNOTE 3	**KEYNOTE 5**		
12:30 pm - 2:00 pm	*LUNCH BREAK & MEETINGS*				
2:00 pm - 3:00 pm	**PHD FORUM** / **DESIGN THEORY SIG SYMPOSIUM** / **WORKSHOP SESSIONS 2.1 - 2.7**	**DISCUSSION SESSIONS 1.1 - 1.9**	**DISCUSSION SESSIONS 5.1 - 5.9**	**DISCUSSION SESSIONS 7.1 - 7.9**	
3:15 pm - 4:15 pm		**DISCUSSION SESSIONS 2.1 - 2.9**	**DISCUSSION SESSIONS 6.1 - 6.9**	**DISCUSSION SESSIONS 8.1 - 8.9**	*VISIT TO EXPO*
4:15 pm - 4:45 pm		*BREAK*	*BREAK*	*BREAK*	
4:45 pm - 5:45 pm	**OPENING SESSION** 5:15-6:00 pm	**DISCUSSION SESSIONS 3.1 - 3.9**	**DESIGN SOCIETY GENERAL MEETING** 4:30 - 5:30 pm	**KEYNOTE 6** 5:00 - 5:45 pm	
6:00 pm - 7:00 pm	**KEYNOTE 1**	**DISCUSSION SESSIONS 4.1 - 4.9**		**CLOSING SESSION**	
	WELCOME APERITIVO 7:00 pm	*YOUNG MEMBERS' EVENT* 7:00 - 9:30 pm	*GALA DINNER* 8:30 pm	*FAREWELL APERITIVO* 6:30 pm	

PREFACE BY PROGRAMME CHAIRS

We welcome you to the proceeding of the 20th International Conference on Engineering Design 2015 (ICED15) held at the Bovisa campus of Politecnico di Milano, Milan, Italy. The theme of the Conference is "DESIGN FOR LIFE", inspired by EXPO 2015 in Milan. These proceedings of ICED15 contain 427 double-blind peer-reviewed and accepted papers. The proceedings are published in different forms: a book of abstracts and a soft-copy of all contributions on a USB-based memory device for conference delegates plus printed books (11 volumes), which are available to the public via a print-on-demand service. All these different forms of proceedings are numbered against both Design Society and ISSN/ISBN referencing to allow wider access, better referencing and improved citation in the near and distant future. Additionally, all papers contain a citation proposal for a reproducible citation. The 11 volumes of the books are structured according to the conference topics and the sequence of the sessions. All papers in the proceedings have successfully fulfilled the criteria for acceptance in ICED15.

Continuing on from the changes introduced for ICED13, the papers in the proceedings were produced by combining an automatically generated cover page, based on the contribution details in the Conference Management System (ConfTool), with the paper as submitted by the authors, starting with the introduction section. This procedure supports consistent data for the papers, the conference programme, the Book of Abstracts, etc.

ICED15 and its proceedings are the result of the dedicated efforts of many people:
- the authors who submitted excellent papers (both in content and form),
- the reviewers who provided timely comments and positive feedback that helped to optimise the quality of papers,
- the chairs, assistant chairs and members of the Programme and Organising Committee and the Design Society Administration who had to deal with details galore in getting the conference and the proceedings planned, structured, organised and ready to go (it was also fun, though!).

Thank you all very much!

On behalf of the Programme Committee we hope that you enjoy the programme and participate fully in what is arguably the Premier engineering design research conference in the world. We also hope that you find time to discover Milan and EXPO 2015, that you meet old friends and make some new ones, and that – besides work – you also have as much fun as we had when preparing the conference!

Christian Weber
Programme Chair

Stephan Husung
Assistant Programme Chair

PREFACE BY CONFERENCE CHAIRS

Having reached its 20th edition, ICED15 confirms to be a well-established conference in the scientific design community and we are very pleased and honoured to host this edition, which has received a very significant attention from researchers and practitioners throughout the world. ICED15 is being organized at the same time and in the same location as the Universal EXPO. The EXPO has also inspired the theme of our conference - Design for Life - which has been further formulated as Design for a Healthy, a Sustainable and a Contented Life. While the submissions were arriving and the conference program was taking shape, we were very pleased to observe that this conference theme has indeed been picked up by many authors and has permeated their contributions. As an outcome of this emerging synergy between ICED and EXPO, we expect participants to return to their countries not only with the usual benefits that come from the ICED experience, but also with a stronger capability and determination to make positive and effective contributions to humankind through design research, education and practice.

If one looks at the program of previous ICED conferences, it is quite apparent that the field of design is continuously evolving, and that the Design Society community that is at the heart of ICED is also at the forefront of this continual evolution and adaptation to emerging opportunities and challenges. Specifically, ICED15 welcomes a growing number of contributions in fields pertaining to the human and social aspects of design, looking at humans both as actors and as recipients of the design activity. We all know that these advancements do not only take place in the formal presentation sessions, but also through other gatherings, including business meetings, information events, workshops and – of course –social events. The conference program has therefore been designed with the objective of providing ICED participants with a variety of opportunities for meeting and exchanging views.

All this will occur within the setting of a country such as Italy that – since ancient times, going through the Renaissance and until today – has been uniquely able to blend its technical know-how with an amazing quality of life. We therefore hope that you will make a memorable experience of ICED15, the EXPO and of the ideal of Designing for Life.

Gaetano Cascini
Conference Chair

Marco Cantamessa
Conference Chair

PREFACE BY DESIGN SOCIETY PRESIDENT

ICED15, the 20th edition of the International Conference on Engineering Design (ICED) is coming back to Italy, the country where the idea of a design conference first took shape. The first ICED took place in Rome in March 1981. The aims were, as its initiator Vladimir Hubka wrote in December 1980, set towards: "... determining the latest state of knowledge in areas of scientific design methods, and of gathering information about current results and future trends in research, to achieve a free co-ordination of scarce research resources." This year, we are not in Rome, but in Milan - and for a good reason. The city of Milan itself is a synonym for quality of design as a way of thinking and living, in activity or in outcome. The conference themes indicate the broadness of thinking about design in and around the host city and connect the conference with the Universal EXPO that is also taking place at the same time. ICED15 participants will have chance to experience the dynamics of a city that reflects all of the dichotomies that define design old and new, the art and technology, the research and practice, the chaotic and systematic. In the past thirty-five years the conference has become the event where all the richness of design research from all the continents is presented and all aspects of design explored.

ICED15 sessions are the results of continuous improvements in every aspect of conference organisation. The format of the conference is based on the previous events with a programme made up of plenary sessions, podium presentations, discussion sessions with a focused debate and workshops led by the Design Society's Special Interest Groups. In addition, the Young Members' Event and PhD Forum extend the networking opportunities of ICED15 for younger or first-time participants. The ICED15 programme will provide an exciting opportunity for researchers and practitioners to learn about the latest developments in design research and practice. The programme of ICED15 is the result of a joint effort from great teams that have been working together since the last ICED conference in Seoul. The Society extends its gratitude to all the authors who have submitted their papers and all the reviewers who have helped to select papers ensuring an outstanding conference experience for all participants. A special thank you goes to all the authors and Session Chairs who will make this experience possible.

Many things have changed through the last 19 conferences. The conference started in Rome by WDK (Workshop – Design – Konstruktion), has, since 2001, been organised by the Design Society. Design as a field has expanded tremendously and the conference programme has become more interactive and complex, opening new opportunities and challenges. Organising a conference with such a history takes an enormous amount of work and attention to detail. I would like to express sincere thanks of the Society to Gaetano Cascini and Marco Cantamessa and all colleagues from Politecnico di Milano and Politecnico di Torino who have made this conference happen. Special thanks also to Programme Chair Christian Weber and Assistant Programme Chair Stephan Husung and all the members of Programme Committee for ensuring that this conference presents a tremendous quality of content. Finally, thank you to all of the participants whose attendance and input are a constant sign that this conference and design as a field are going in the right direction.

Dorian Marjanović
Design Society President

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Zavbi, Roman - University of Ljubljana
Zeng, Yong - Concordia University
Zolghadri, Marc - Supmeca

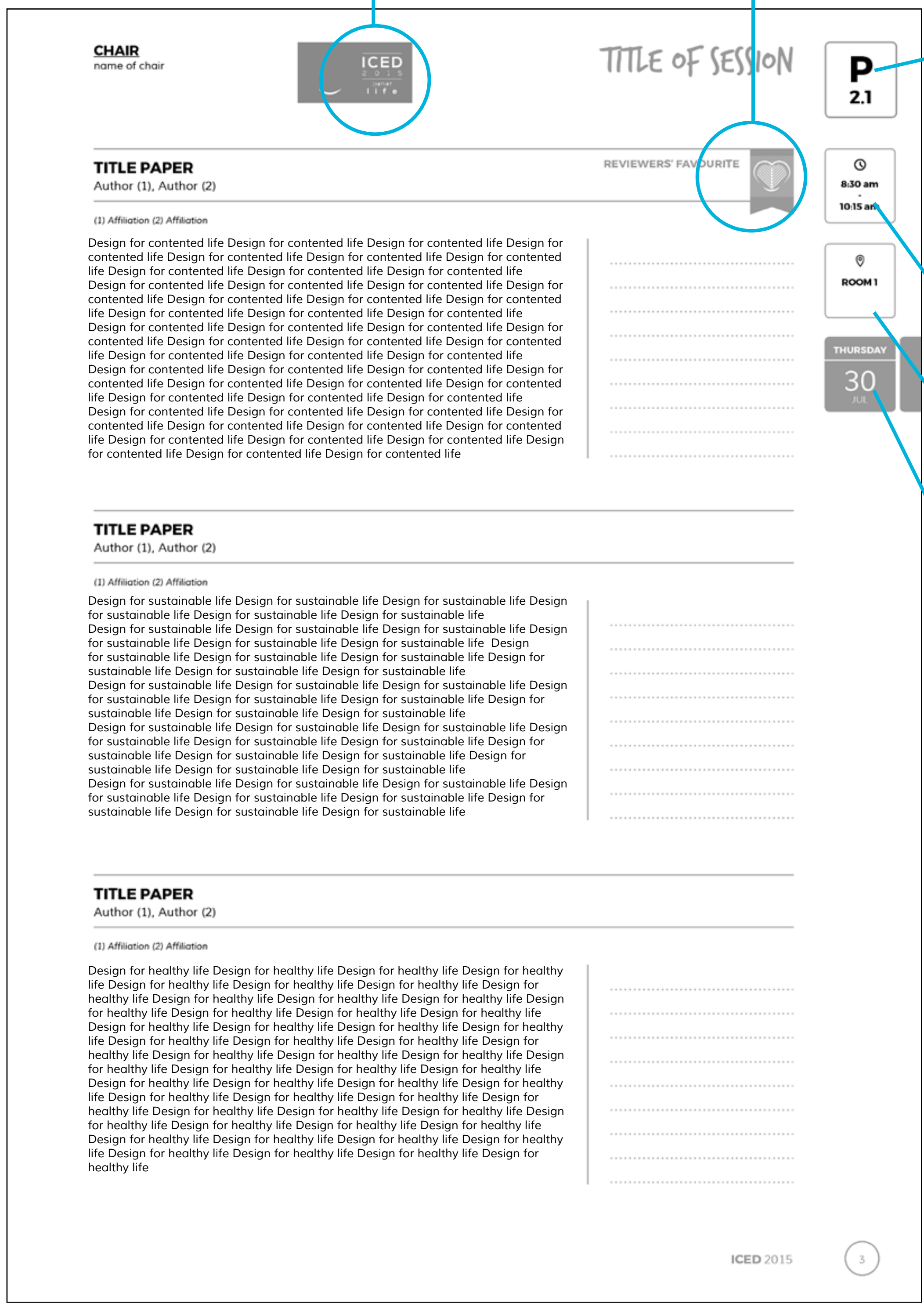
BOOK OF ABSTRACTS LAYOUT

ICED15 SPECIAL THEME

some sessions are specially focused on ICED15 themes. Check for the indicator!

REVIEWERS' FAVOURITE

you will find this indicator on the top 10% as resulted from review process



SESSION INDICATOR

P podium session
D discussion session
W workshop
K keynote

TIME

LOCATION

see p. 226 for indications

DAY

the indicator is scrolling down from day to day to allow an immediate exploration of the Book of Abstracts, by just looking at the side of the closed book

!!!

IMPORTANT REMINDER

Small, last-second changes to the Conference Programme can occur.

Please check the session you are interested on the Conference App!

The App is available at www.guidebook.com code: ICED15

ICED 2015 HEALTHY life

We all strive for a healthy life. All over the world, the concept is undergoing a deep and fundamental paradigm shift, based on the need to ensure health in the broadest sense possible, which includes wellbeing, wholesome lifestyles and prevention, to address the needs of an ageing population and to reduce the associated costs. Designers can have a huge impact within this paradigm shift, by designing innovative products, services and business models aimed at preserving human health, at ensuring more effective and less invasive therapies, and at fostering human wellness.

ICED 2015 SUSTAINABLE life

We know that the Earth is our home. The future of human life and economic and social progress on our planet depends on the concrete actions we will take on the path towards sustainability. This includes deploying new artifacts for energy production and transmission, reducing the environmental impact of human activity and reducing waste. Designers have a key role in the field of sustainability, by designing products and systems that are aimed to this goal, at the same time ensuring functionality and resources saving, performance and respect for future generations, also taking into account the economic and business perspective.

ICED 2015

CONTENTED life

Human beings pursue happiness and contentedness. When choosing activities to engage in, choosing goods to purchase and services to use, they do not only take functionality and performance into account, but also the satisfaction and the joy that can be derived by these choices. Whatever the goals – material, cultural or spiritual – human beings choose to pursue, this can be effectively supported by well-designed products and services, showing a link between the desires and needs of customers and users to the insight and ability of designers in interpreting them, thus covering both the fulfilment of the required functionalities and the affordance of user experience.

MONDAY 27TH

WELCOME APERITIVO

from 7:00 pm we will celebrate the beginning of the 20th ICED Conference in front of the Conference Marquee (in case of rain, it will be relocated at the Dining Area)

The word "Aperitivo" is the name for both the ritual of going out for a pre-dinner drink, as well as the sort of drink that you would probably have at such a ritual. "Aperitivo" comes from the Latin word meaning "to open" - a little something to encourage you to feel hungry, to get the juices flowing, so you can fully enjoy your upcoming meal.

The habit of taking an Aperitivo in the evening before a meal became an enormously popular and soon the classic cafes of the big Italian cities were serving up Aperitivo to their fashionable XIXth century clients. Today Aperitivo still plays an important role in Italian social life and is as much about the food and drink as it is about socialising.

WEDNESDAY 29TH

GALA DINNER
from 8:30 pm

Location:
Fondazione Palazzo delle Stelline
Corso Magenta, 61
+39 02 4546 2411

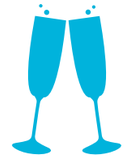
Public Transport:
Cadorna M1, M2, S-lines

The Palazzo delle Stelline, where the Foundation is located, is one of the most rooted historical places in Milanese history, opposite the church of Santa Maria delle Grazie where is placed "The Last Supper" of Leonardo da Vinci, and is one of the most striking features of Milan's urban fabric. It was once the whole complex of the suppressed monastery of St. Maria della Stella, then – in the 1600 - having become a public institution for housing and educating orphan girls (the "Stelline"), by the will of San Carlo Borromeo. Today the palace has undergone profound structural changes and uses, being restored to a design by the architect Jan Battistoni in the Seventies. The whole project was faithful to the original structure of the building and retains its original features, the stone staircases, the passages in the cloister and the magnolia in the centre, which has become its symbol. In 1986 the Lombardy Region and the City of Milan established the Stelline Foundation, in order to maintain and enhance the refurbished Palace, encourage the development of nationally and internationally social and economic, cultural enterprises, and from the last years in order to promote exhibitions devoted to contemporary and 20th century art.

THURSDAY 30TH

FAREWELL APERITIVO

from 6:30 pm we will gather for a last goodbye in front of the Conference Marquee (in case of rain, it will be relocated at the Dining Area)



HEALTHY AGEING | PATIENTS | NEW THERAPIES | SOLIDARITY & RESPECT | NEW MEDICAL TECHNOLOGIES | EFFICIENT HEALTHCARE | DETECTION, DIAGNOSIS & MONITORING | CLIMATE CHANGE | POLLUANT EMISSIONS | QUALITY OF LIFE | CONSUMER PROTECTION | KNOWLEDGE-BASED BIO-ECONOMY | RENEWABLE ENERGY SOURCES | ENVIROMENTAL CHALLENGES | CREATIVITY | EDUCATION & VALUES | NEW EXPRESSIVE PRACTICES | CULTURAL DIVERSITY AND HERITAGE | SOCIAL REVOLUTION | HAPPINESS | LIFE SATISFACTION | SELF ACTUALISATION | HABITS | LIFESTYLE | TRAINING PROTOCOLS | DESIGNING WELLNESS | PHYSICAL & PHYSIOLOGICAL WELLBEING | HEALTH TECHNOLOGY SOLUTIONS | BIOMECHANICS AND ERGONOMICS | BIODIVERSITY | HUMAN ACTIVITIES | CLEANER FUTURE | ENERGY USE OPTIMIZATION | INTEGRATED SOLUTIONS | SUSTAINABLE MANAGEMENT OF RESOURCES | ELECTRIC & HYBRID VEHICLES | CREATIVITY | EDUCATION & VALUES | KIDS' ENTERTAINMENT | CULTURAL DIVERSITY AND HERITAGE | INTERACTIVE MEDIA | RAINBOW | GAMES, TOYS & FUN

MONDAY 27 JUL

TUESDAY 28 JUL

WEDNESDAY 29 JUL

THURSDAY 30 JUL

ICED 2015
DESIGN FOR life

TABLE OF CONTENTS

MONDAY 27TH JULY 2015

	9:30 am - 12:30 pm	2:00 - 5:00 pm	5:15 - 6:00 pm	6:00 - 6:45 pm
MARQUEE			**OPENING SESSION** see p. 36	**Keynote 1** see p. 37
BL27.4		**SIG MEETING 1** Design Theory SIG Symposium *chair* *Akin Osman Kazakci* *Pascal Le Masson* *Eswaran Subrahmanian*		
BL27.5	**WS 1.1** 2025 - Grand Visions & challenges of Modelling & Management of Engineering Processes *chair* *Claudia Eckert* *Killian Gericke*	**WS 2.1** Eco-Innovation Methodologies and Application - A natural complement to ecodesign? - ECO Design (SIG) *chair* *Tim C. McAloone* *Daniela Pigosso*		
BL27.6	**WS 1.2** Bio-inspired design (BID) Design Creativity (SIG) *chair* *Gaetano Cascini* *Amaresh Chakrabarti* *Julie Linsey*	**WS 2.4** Decision making models as a basis for idecide - the new Decision Making App - Decision Making (SIG) *chair* *Julie Stal-Le Cardinal* *Sandro Wartzack*		
BL27.7	**WS 1.3** Set up of research studies in the field of Human Behaviour In Design - Human Behaviour In Design (SIG) *chair* *Petra Badke-Schaub* *Sven Matthiesen* *Mirko Meboldt* *Thomas Nelius*	**WS 2.5** Socio-technical framework for collaborative engineering design - Collaborative Design (SIG) *chair* *Avril Thomson* *Ian Whitfield*		
BL27.8	**WS 1.4** Robust embodiment design (SIG). How to design location schemes and part to part interfaces in a robust manner - Robust design SIG *chair* *Tobias Eifler* *Thomas J. Howard*	**WS 2.6** Assessing Creativity in Design Studio projects - Design Education and Design Creativity (SIG) *chair* *Erik Bohemia* *Yukari Nagai*		
BL27.13	**WS 1.5** Collaborative Design Methods and Training - Collaborative Design (SIG) *chair* *Avril Thomson* *Ian Whitfield*	**WS 2.7** Methodology for Design, Integration, Modeling and Simulation of Cyber Physical Systems - DesignCPS (SIG) *chair* *Benoit Eynard* *Peter Hehenberger*		
BL27.14	**WS 1.6** Core Readings in Design and Product Development Risk Management - Processes and Methods in Design (SIG) *chair* *Josef Oehmen*	**PhD Forum** *chair* *Philip Cash* *Killian Gericke*		
POLIfactory LAB		**WS 2.2** Emotional Engineering: Creating Life beyond Products (SIG) *chair* *Monica Bordegoni* *Shuichi Fukuda*		

LUNCH BREAK & MEETINGS see p.27

LUNCH BREAK & MEETINGS see page 27

LUNCH BREAK & MEETINGS see page 27

LUNCH BREAK & MEETINGS see page 27

WELCOME APERITIVO see page 17

WELCOME APERITIVO see page 17

CHAIR
Claudia Eckert
Killian Gericke

2025 – GRAND VISIONS & CHALLENGES OF MMEP

MONDAY 27 JUL

W 1.1

9:30 am - 12:30 pm

BL27.5

ABSTRACT

During this workshop experts from academia and practice will discuss how research in this area can contribute to solving industry's needs and what major challenges need to be addressed in this regard within a timeframe of 10 years. We aim to formulate grand visions for this joint endeavor. The workshop will be introduced by talks of experts and followed by a debate on grand visions, measures how these can be realized, and how we can assess a successful accomplishment. The intention is to ignite a fruitful dialogue and collaboration between different research groups and to involve industry experts in these activities.

Agenda

1. Presentation of activities in the SIG (15 min)
   > Brief summary of activities since workshop at ICED'13
   > Current activities and new initiatives
2. Impulse talks of invited speakers on grand visions (60 min)
   > Industry expert
   > Academic expert
   > Discussion
3. Grand visions, related research challenges and success criteria (100 min)
   > Breakout groups
   > Presentation of breakout group results
   > Discussion
4. SIG agenda planning (5 min)
   > Upcoming SIG events (MMEP'13 conference)
   > Further activities

PRESENTATION

THE LONG ROAD TO IMPROVEMENT IN MODELLING & MANAGING ENGINEERING PROCESSES (MMEP)

Killian Gericke[1], *Claudia Eckert*[2]

[1]*University of Luxembourg, Luxembourg*
[2]*The Open University, United Kingdom*

CHAIR
Gaetano Cascini
Amaresh Chakrabarti
Julie Linsey

BIO-INSPIRED DESIGN (BID)

ABSTRACT

Bio-inspired design (BID) seeks to exploit biology for several different kinds of design such as sustainable design, creative design, and complex system design. There are generally two approaches bio-inspired design: (1) solution-driven, where an interesting biological phenomenon inspires the search for potential applications and (2) problem-driven, where a given problem motivates the search for biological analogies that could help solve the problem.

Research on methods that support biomimetic design in general falls under the two high-level categories:

> Methods to support search, retrieval, and representation of biological phenomena for design

> Studies to better understand and therefore support the application of biological analogies to design

The two categories are related and affect each other.

In the last decade several BID approaches have been developed independently, by different entities, to support different users with sometimes different purposes. The differences in the theoretical approaches and levels of details achieved by BID approaches still confine their use for academic research and academic education without being widespread among professionals in the business sector where design innovation is a key priority, where basic research can become applied solutions and where multidisciplinary work, at the core of any BID approach, is more likely to happen.

The ICED15 event could allow to bring forward the discussion among and between researchers and practitioners about the challenges still to be solved in order to develop more coherent, user-friendly and robust BID approaches, try to assess pros and cons of what is currently available and look for synergies in order to improve it.

SCOPE OF THE WORKSHOP:

The workshop will be dedicated to BID approaches developers and practitioners and other experts in design approaches in order to:

* Identify main similarities and complementarities among BID approaches
* Discussing pros and cons of BID approaches and identify possible paths for improvement
* Identify barriers to the application of BID approaches outside the academic environment
* Exchange experiences in BID approaches and facilitate networking
* Promote BID approaches among people which are not familiar with them
* Leverage collaborations for projects

CHAIR
Gaetano Cascini
Amaresh Chakrabarti
Julie Linsey

DESIGN (REATIVITY (SIG)

MONDAY
27
JUL

W
1.2

9:30 am
-
12:30 pm

BL27.6

Agenda

1. PRESENTATIONS on different approaches of BID. In particular:

THE BIOMIMICRY THINKING APPROACH DEVELOPED BY THE BIOMIMICRY INSTITUTE (TBI).

While akin to a methodology, Biomimicry Thinking is a framework that is intended to help people practice biomimicry while designing anything. There are four areas in which biomimicry provides the greatest value to the design process (independent of the discipline in which it is integrated): scoping, discovering, creating, and evaluating. The Biomimicry Thinking approach considers both solution-driven and problem-driven paths (the methodology is in line with the framework of the AskNature database, also developed by the TBI)

THE DANE - DESIGN BY ANALOGY TO NATURE ENGINE

The DANE model was developed at the Design Intelligence Lab at the Georgia Institute of Technology. DANE was conceived of as a tool to facilitate particular kinds of analogical design activity, as well as to facilitate research into the cognitive underpinnings of analogical design.

THE SAPPhIRE MODEL

developed by A. Chakrabarti et al. uses constructs: State change, Action, Part, Phenomenon, Input, oRgan and Effect, to explain the causality of natural and engineered systems. It can describe functionality using its constructs action, state change and input together. The use of these constructs together and their links with functionality provides a richer description of behaviour.

THE WORDTREE METHOD

proposed by Julie Linsey, was developed to systematically re-represent a design problem, assisting the designer in identifying analogies and analogous domains. Key problem descriptors are identified from the design problem and used to create WordTrees that re-represent key functions, leading to more abstract and domain-specific terms resulting in analogies. Analogies and analogous domains are then identified for possible solutions to a design problem. Research of the analogies and a closer look into the identified analogous domains follows with newly created problem statements. Finally, idea and concept generation occurs.

2. FACILITATED DISCUSSIONS around the following questions:

* Which are the main barriers preventing widespread use of BID approaches? And how to overcome them?
* Can BID approaches be “unified” or synergize?
* How to develop a robust Biomimetics/Biomimicry ontology?
* How far should we frame a bio-inspired creative design process?

MONDAY
27
JUL

HUMAN BEHAVIOUR IN DESIGN (SIG)

CHAIR
Petra Badke-Schaub
Sven Matthiesen
Mirko Meboldt
Thomas Nelius

W
1.3

9:30 am
-
12:30 pm

BL27.7

SET UP OF RESEARCH STUDIES IN THE FIELD OF HBID

ABSTRACT
This workshop will assist researchers in the setup of design research experiments. A short introduction to research methodology and the design of experiments in design research will be given. The attendees are welcomed to share their research intentions, challenges in the setup of research studies and the interpretation of experiment results. The following discussion will provide approaches to solutions and the attendees will benefit from the exchange of knowledge.

Agenda

1. Presentation of activities in the SIG (10 min)
    > Brief summary of preceding activities
    > Current activities and new initiatives
2. Presentations about Research Methodology
    > Study Design (10 min)
    > Experiment (10 min)
3. Workshop (135 min)
    > Preparation time for the workshop participants (10 min)
    > Presentation of the attendees issue (5 min per person)
    > Discussion (15 min per person)
4. Presentation – Drawing Conclusions from an Experiment (15 min)
    > Validation
    > Reliability
    > Falsification

CHAIR
Tobias Eifler
Thomas J. Howard

ROBUST DESIGN (SIG)

MONDAY
27
JUL

W
1.4

9:30 am
-
12:30 pm

BL27.8

ROBUST EMBODIMENT DESIGN. HOW TO DESIGN LOCATION SCHEMES AND PART TO PART INTERFACES IN A ROBUST MANNER

ROBUST DESIGN METHODOLOGY & ROBUST DESIGN SIG
In spite of well-described product development processes and considerable effort for quality initiatives, many companies still experience immense challenges to efficiently account for variation of manufacturing/ assembly processes, material properties, loading conditions, ambient use conditions and time related changes such as creep and wear. Frequently, the result is a reduced efficiency of products/ processess due to overly specified tolerances, slow ramp-up times, late design changes , high scrap rates and a varying product quality.

Robust Design Methodology (RDM) provides methods and tools to be used at all stages of design, from the first design sketch to embodiment design, final detailing and the specification of tolerances, enabling engineers to design products, devices, and production equipment so that their performance and function is insensitive to variation. Available approaches link different perspectives on variation (Design, Production, Metrology) and consequently offer an enormous potential to smooth the way from design to production and use in terms of accelerated time-to-market, reduced ramp-up costs, improved product quality as well as customer satisfaction.

The Design Society's Robust Design SIG provides opportunities for Design society members and non-members to network, to collaborate and to share ideas, experience and knowledge within the field of Robust Design. The SIG offers an extremely important platform to identify actual as well as future challenges of Robust Design for Industry and Academia.

WORKSHOP ABSTRACT

How to design location schemes and part to part interfaces in a robust manner

While a variety of well described development processes is available, it is the organisers' impression that there is no well-accepted embodiment design approach how to systematically detail the layout, geometries, materials, etc. of conceptual solutions. In spite of numerous design rules, principles and guidelines provided by standard literature, a coherent process for an application in case of complex products and/or numerous trade-off decisions seems to be still missing. At the same time, the embodiment design phase is essential to achieve robustness of products and processes. Overconstraint design solutions, ambiguous interfaces between components, unfavourable material combinations, etc. are largely susceptible to variation and therefore frequently experience production/assembly issues, reduced performance, excessive and non-predictable wear-rates, etc.

Based on own research as well as a summary of existing approaches (e. g. Design Clarity, location schemes, etc.), the workshop raises the question of an Embodiment Design Process for Robustness. For this purposes, the participants will be provided with an actual use case of a consumer product including design files, drawings, samples, etc. which will be used to illustrate and evaluate the applicability/ suitability of existing approaches. In combination with presentations of robust design and embodiment design theory, guided tutorials as well as structured discussions, the workshop will provide a hands-on experience and a platform for ACADEMICS and PRACTITIONERS to discover the state of the art in robust design, to exchange knowledge on experiences as well as solutions and to discuss challenges faced.

The format and content of the workshop will be designed to suit the organisational roles of the participants, and their experience in the topic of Design Methodology and Robust Design.
We will therefore request that the participants fill out a short survey in advance.

COLLABORATIVE DESIGN (SIG)

CHAIR
Avril Thomson
Ian Whitfield

W
1.5

9:30 am
-
12:30 pm

BL27.13

COLLABORATIVE DESIGN METHODS AND TRAINING

ABSTRACT
The workshop will investigate and establish the training requirements for research within the different Collaborative Design research areas to provide a foundation for future knowledge creation. Existing globally available training provision will be mapped to these training requirements to form a complete picture of training availability which can be used by Collaborative Design researchers to support their development, establish international relationships, and strengthen the Collaborative Design network. The intention of this workshop is to form the basis for a complete map of research methods and training that are specific to collaborative design, and which can be used to tailor to the requirements of any collaborative Design research area.

W
1.6

9:30 am
-
12:30 pm

BL27.14

RISK MANAGEMENT PROCESSES AND METHODS IN DESIGN (SIG)

CHAIR
Josef Oehmen

CORE READINGS IN DESIGN AND PRODUCT DEVELOPMENT RISK MANAGEMENT

ABSTRACT
The objective of the workshop is to develop a shortlist (5-10 papers) that we consider core reading material for researchers in the field of product development and risk management. During the workshop, we will give an overview of the Risk SIGs collaborative online literature database that contains almost 200 papers. We will discuss criteria for selecting “core readings”, as well as what publications should be on a “recommended core publication” list of maybe 5-10 publications. This includes discussion of possible key reading material in adjacent fields, such as project management or decision making under uncertainty.
The objectives are:
> Publish a list of “recommended key reading” material on our website to get researchers started in the field
> Revise, if necessary, the structure of our online literature database

We will also discuss some relevant administrative items at the end of the workshop, including:
> SIG Website maintenance
> SIG mailing list maintenance
> Online meeting schedule and objectives 2015
> Preparation of DESIGN16 workshop

LUNCH BREAK

12:30 pm
-
2:00 pm

DINING AREA

1:00 pm - 2:00 pm

MEETING

Internation Journal of Design Creativity and Innovation (IJDCI) meeting

INVITED

BL27.11

LUNCH MENU*

STARTERS

Polpettone di fagiolini
Meatloaf with green beans

Polpo profumato al rosmarino, con pomodorini secchi, olive e pinoli tostati
Rosemary-flavoured octopus with dry tomatoes, olives and roasted pine nuts

Insalatina di stagione con carpaccio di manzo al rosa
Seasonal salad with pink-peppered beef carpaccio

accompagnato da
Formaggio del giorno, Torte di verdura assortite
Verdure cotte e crude di stagione

served with
A variety of Italian cheeses, Mixed savoury pies and raw/warm vegetables

***

1 FIRST COURSE TO CHOOSE FROM:

Lasagnette estive alle melanzane e pomodori a crudo
Summer-style Lasagna with eggplants and raw tomatoes

Cous cous mediterraneo
Mediterranean Cous cous

***

DESSERT

Fresh Fruit salad, Selection of cakes
and the traditional Italian ice-cream

Vegan, Gluten-free, and alergies-free options are available.
Please check with our Staff the best meal for you!
**changes can occur*

PHD FORUM

CHAIR
Philip Cash
Killian Gericke

W

2:00 pm
-
5:00 pm

BL27.14

ABSTRACT

Research within the Design Society community offers many possibilities of exchange and collaboration between fellow researchers. While these opportunities cover a broad scope from young researchers to senior members of the community with a range of research interests, we aim to support the specific needs of PhD students.

Aims

> To foster the exchange of ideas and research approaches between younger researchers
> To provide opportunities for discussing personal research topics, methodologies and potential problems with experts
> To enhance networking and collaboration

Format

The forum will be an opportunity for PhD students to discuss their research questions and ideas with their peers and experienced researchers in order to support their research. Small discussion groups will be organised in which individual research topics are presented to and discussed within the group. Discussion groups will consist of 5-6 PhD students and 1-2 experts.

Participating students will be asked to give an elevator pitch introducing their research in a speed-dating round prior to the main discussion (1 min):
> Research topic
> Research objectives / question(s) and relevance considering published research and industrial needs
> Research methodology applied
> Personal questions/problems or issues you want feedback on e.g.
> Research methodology
> Research methods
> Potential ideas for enhancing the approach

Participants

The PhD Forum is aimed at PhD students. To facilitate meaningful discussion it is essential that potential participants should already have defined their PhD research topic, undertaken an initial literature study and formulated aims and objectives.

CHAIR
Akin Osman Kazakci
Pascal Le Masson
Eswaran Subrahmanian

SIG MEETINGS (1): DESIGN THEORY SIG SYMPOSIUM

MONDAY
27
JUL

W

2:00 pm
-
5:00 pm

BL27.4

ABSTRACT

Design theory is a growing research field. In the last years a large variety of models and formalisms led to significant advances on the deep logic of generativity and unknownness that is central to design. Design theory deepens the foundations of engineering science; it bridges the gap with other design professions (like industrial design) and helps to address critical, contemporary innovation issues. Moreover, new fruitful relations between design research and design theory can be explored. Design theory paves the way to a design science that extends decision science and supports new views on growth and organization.

This symposium unfolds in two parts:
> in a first part we invite Armand Hatchuel, new fellow of the Design Society and founder of the Design Theory SIG, to present the « formal program » in design theory, its main results and perspectives.

> in a second part, some researchers will share their experience on how they use Design Theory to contribute to breakthrough in different fields. We expect presentations on:
> Design Theory and cognition,
> Design Theory and data science
> Design Theory and project Management
> Design Theory and Creativity
> Design Theory and conceptual design methods
> Design Theory and engineering science
> Design Theory and the design of scientific instruments.

MONDAY
27
JUL

ECO DESIGN (SIG)

CHAIR
Tim C. McAloone
Daniela Pigosso

W
2.1

2:00 pm
-
5:00 pm

BL27.5

ECO-INNOVATION METHODOLOGIES AND APPLICATION: A NATURAL COMPLEMENT TO DESIGN?

TOPIC & BACKGROUND

"Eco-innovation is the development and application of a business model, shaped by a new business strategy that incorporates sustainability throughout all business operations, based on life cycle thinking and in cooperation with partners across the value chain. It entails a coordinated set of modifications or novel solutions to products (goods / services), processes, market approach and organisational structure, which leads to a company's enhanced performance and competitiveness." [UNEP working definition, 2014] UNEP is currently leading an eco-innovation project, jointly funded by UNEP and the European Commission. The project aims to develop local resources and capacity for eco-innovation in emerging and developing economies. The project specifically targets service providers for Resource Efficiency and Cleaner Production (RECP) and other business intermediaries, in order for them to provide technical assistance to small and medium sized enterprises.

As a supplier to UNEP, the Technical University of Denmark is leading the creation of an eco-innovation methodology (and accompanying toolbox), which now exists in its first working version for pilot application. See: http://www.ecodesign.dtu.dk/Eco-innovation.

WORKSHOP CONTENTS

This workshop will present and run through the methodology and toolbox for eco-innovation. The methodology is currently under evaluation in a number of countries worldwide.

We will use this workshop to both present and trial parts of the methodology to our Ecodesign SIG members and followers, and also to gain feedback and evaluation about the methodology's contents and its usage. We will also discuss the characteristics and contents of eco-innovation, when compared to ecodesign. At the workshop we will also inform about updates and developments in the Ecodesign SIG, and will make a call for further supporters to the SIG's organisation and operation.

Jointly organised by the Ecodesign SIG and UNEP

CHAIR
Monica Bordegoni
Shuichi Fukuda

EMOTIONAL ENGINEERING (SIG)

MONDAY
27
JUL

W
2.2

2:00 pm
-
5:00 pm

POLIfactory LAB

CREATING LIFE BEYOND PRODUCTS

ABSTRACT

The attitude of designers has changed in recent years. They do not only design products that suit the customers, but they also give a new life to products and create a new lifestyle. Emotional Engineering is the enabler of this novel and innovative way of creating products: a novel product is inspired by emotions and elicits emotions. And emotions generate new lifestyle. Issues related to emotions are closely related to multisensory ways of experiencing products, which are attracting and affecting us as customers and as users as well.

The workshop will host presentations of Emotional Engineering methods applied to the ideation and creation of new products, where multisensory interaction, product experience and novel methods for product innovation are the focus of the design studies.

The presentations are aimed to stimulate discussion with the participants.

This year, the EE-SIG workshop will host demonstrations of "Emotional Engineering in practice".
We invite young researchers and PhD students to participate to the workshop and present and demonstrate their EE approach to product design through demonstrations and prototypes. Please send an email to Monica Bordegoni (monica.bordegoni@polimi.it) if you would like to join the workshop and show your prototype.

The workshop will be hosted at the POLIfactory Lab of Politecnico di Milano (www.polifactory.polimi.it)

To reach the POLIfactory, you can join the Meeting Point at the Registration Desk at 1:45 pm.

DECISION MAKING (SIG)

CHAIR
Julie Stal-Le Cardinal
Sandro Wartzack

W
2.4

2:00 pm
-
5:00 pm

BL27.6

DECISION MAKING MODELS AS A BASIS FOR IDECIDE – THE NEW DECISION MAKING APP

TOPIC & BACKGROUND

The Special Interest Group Decision Making (SIG DM) of the Design Society is planning a workshop at the ICED 2015 and would like to invite all interested researchers. The research activities of the SIG DM contribute to the field of engineering design research especially in the development of methodologies, models and tools in order to describe the decision making situation and to support the decision maker.

One important task of engineers is to select and prioritize new ideas during the early phases of the product development process. The selection of promising ideas represents a decision making process which can be characterized as complex, dynamic and multi-staged process which has multiple and often conflicting objectives as well as often involves different groups of decision makers. Due to the complexity of this innovation process, there is no single approach or model for making decisions or for all decision making situations.

Therefore, we would like to discuss with you about decision making models as a basis for idecide, the new Decision Making App, during our next workshop. For the preparation of the workshop, please give us your input and comments regarding the following questions and aspects:

Who will be or could be the users of idecide?
Examples of decisions which could / should be made with idecide
Needs and requirements regarding idecide
Collection of information about existing Decision Making (DM) process models
Collection of ideas regarding new DM processes
Key / crucial steps within the DM process
Expected outcome of this workshop will be an understanding of decision making models which are important for developing a new Decision Making App.

To stimulate an exchange of ideas and a discussion of the mentioned issues before and after the workshop, we invite you to join our Decision Making Group at LinkedIn. This gives you the opportunity to share knowledge with other scientists worldwide as well as to receive the latest news of the SIG DM.

We would be very glad to welcome you at the workshop at the ICED 2015 and as a new member of the LinkedIn group “Decision Making”.

CHAIR
Avril Thomson
Ian Whitfield

COLLABORATIVE DESIGN (SIG)

W
2.5

2:00 pm
-
5:00 pm

BL27.7

SOCIO-TECHNICAL FRAMEWORK FOR COLLOABORATIVE ENGINEERING DESIGN

ABSTRACT

Collaborative engineering design may be considered as a socio-technical activity. Research has tended to focus upon technical collaborative engineering design with relatively little consideration addressing the interrelated social aspect.

The workshop is targeted at experts and researchers within the domain of collaborative engineering design with a focus on identifying perspectives regarding the social and technical aspects of collaborative engineering design. The workshop will facilitate discussion and the exchange of ideas between collaborative engineering design experts and researchers from social and technical domains.

CHAIR
Erik Bohemia
Yukari Nagai

DESIGN EDUCATION AND DESIGN CREATIVITY (SIG)

W
2.6

2:00 pm
-
5:00 pm

BL27.8

ASSESSING CREATIVITY IN DESIGN STUDIO PROJECTS

ABSTRACT

Group design projects are practical activity commonly implemented in the educational schemes of all design fields. In recent years these commonly feature both academic and industrial participants. Team working and design studio projects are expected to offer an opportunity for interdisciplinary collaboration and produce highly creative outcomes.

Through series of short presentations, this workshop will first showcase the practice of creative outcomes achieved in group projects featured in different design disciplines. This will be followed by the forum chaired by the workshop facilitators which is expected to develop provoking discussion about assessing creativity in design studio projects. It is expected that the exchange of knowledge and experiences in educating design among SIG leaders and participants will be interesting and motivating for the audience.

DESIGN EDUCATION AND DESIGN CREATIVITY (SIG)

CHAIR
Erik Bohemia
Yukari Nagai

W
2.6

2:00 pm
-
5:00 pm

BL27.8

ASSESSING CREATIVITY IN DESIGN STUDIO PROJECTS

Agenda

(1) ASSESSING CREATIVITY IN DESIGN STUDIO PROJECTS
Yukari Nagai and Erik Bohemia

(2) PANELISTS' TALKS AND DISCUSSIONS:

Chris McMahon and Thea Monrgan
"Design as a resolution of paradoxes: the need for new approaches in creative design"
The presenters have been undertaking an ethnographic study of discourse in design teams, including the study of undergraduate engineering students working on group project work in the first and final years of their degree programmes. This study has found Dorst's ideas of design as a resolution of paradoxes to be very powerful in allowing the interpretation of the group discourse from both technical and stakeholder perspectives. The results show that a characteristic of successful design is the ability of the groups to identify and resolve paradoxes, and yet conventional approaches to design creativity are perhaps not very helpful in this regard. This presentation will suggest that new approaches are needed in design education to help design students to identify and creatively address paradoxes and then to assess their performance in that regard, and will make tentative suggestions for the direction that these approaches might take.

Mario Štorga and Neven Pavkovic
"Impact of CAI tools on creative problem solving in engineering design education"
Creativity fostering techniques and methods are recognised as being important to engineers. Creative problem-solving is valuable at any stage of the engineering design process, but it is of critical importance in the conceptual design stage. Even more important is in engineering design education for the students without extensive professional experience being challenged by engineering design tasks requested by the project that is part of the European Global Product Realisation (EGPR) course. Need to simulate the growing competitiveness of the commercial sector and the increasing complexity of the engineering systems, request student's response with innovative solutions, and hence a greater need for their creative performance. Introducing the CAI (Computer Aided Innovation) tools in education practice is influencing their ability to solve engineering problems creatively, in both positive and negative ways. While positive effects are easy to recognise and fairly self-evident, the negative effects are more hidden. This presentation builds on existing studies and discussing the influence of computer added innovation software to creative problem-solving in engineering design projects.

Andrew Wodehouse
"Understanding creativity through sketches in global design projects"
This talk reviews how sketching can support creative design teams in the early phases of concept design. When working with the limited communication channels of distributed teams in particular, it can be problematic for teams to achieve their creative potential. We will draw on the experiences of a global design class where students have to work collaboratively with colleagues in remote locations to produce innovative design solutions. Based on a review of the class and associated literature, we examine the different sketches during the concept phase in a distributed design environment, and how they can be used to understand the creative process.

Ricardo Sosa
"Assessing creative ideas in a Fluid Mechanics design project: experiences and open questions "
We revise current teaching and research practices related to the assessment of creativity based on a recent experience coordinating a semester-long design project in a Fluid Mechanics course. Open challenges are framed in relation to our broader experience teaching creativity and design in undergraduate engineering 'cornerstone' projects and MBA modules.

(3) GROUP DISCUSSION BY PROVIDING CASE OF INTERNATIONAL COLLABORATE ON EDUCATION PROJECTS (ERIK BOHEMIA)
SIG leaders facilitate discussions- Yukari Nagai, Ricardo Sosa, Erik Bohemia
The session concludes with a 30 min wrap-up.
Intended audience: Researchers, educators, industrial participants, students

CHAIR
Benoit Eynard
Peter Hehenberger

DESIGN CYBER PHYSICAL SYSTEMS (SIG)

MONDAY
27
JUL

W
2.7

2:00 pm
-
5:00 pm

BL27.13

METHODOLOGY FOR DESIGN, INTEGRATION, MODELING AND SIMULATION OF CPS

ABSTRACT

A cyber-physical system is a system of collaborating computational elements controlling physical entities. These systems can be found in areas such as aerospace, automotive, energy, healthcare, manufacturing, entertainment, and consumer appliances. Design of CPSs involves close examination and further development of design methods, design processes, models and tools.

The new DesignCPS-SIG (Methodology for Design, Integration, Modeling and Simulation of Cyber Physical Systems) aims to initiate a research roadmap for the development of methods, tools and methodologies for designing Cyber Physical Systems (CPS) through addressing e.g. Performance of CPSs, Model-based Systems Engineering for CPS, Information and knowledge flow during CPS-design processes for closing the gap between scientific approaches and industrial practice.

The first action item is Kick-off Workshop at ICED15 which should result in a common understanding of the objectives of the SIG, the founding members list and definition of further activities.
The Workshop starts with a presentation of the motivation and potential objectives of the "DesignCPS-SIG" given by the SIG-chairs. Afterwards invited speakers present examples for CPSs and their specific point of view on the SIG-topic. A discussion round and the definition of next steps summarize the SIG-activities.

CHAIR
Marco Cantamessa

5:15 pm
-
6:00 pm

MARQUEE

ICED15
Opening ceremony

Speakers

Opening Remarks
DONATELLA SCIUTO
Politecnico di Milano, Vice Rector

MARCO CANTAMESSA
Politecnico Torino, Chairman and CEO of I3P - Innovative Companies Incubator

Welcome on behalf of the Design Society
DORIAN MARJANOVIC
Design Society, President

Welcome speech
GAETANO CASCINI
Conference Chair

CHRISTIAN WEBER
Programme Chair

K
1

6:00 pm
-
6:45 pm

MARQUEE

Ferrari's design: the metalanguage of form

FLAVIO MANZONI

Design Director & Senior Vice President
Ferrari

ABSTRACT
I believe that design is creative sensitivity and knowledge of the design concept. It is a combination made up of intuition, creativity, capacity for abstraction from the present to the future, as well as capability to associate features and components, which appear to be very different from each other. The development of a new Ferrari is lived always as a special moment that is focused on the search for a shape able to make tangible the essence. It is a challenging matter of being visionary, with the head and the mind turned to future scenarios. It is also a collaborative and individual process that involves people both as individuals and teams in a sort of initial brainstorming where all the ideas grow and expand till the final concurrence. My team and I live a sort of magic moment that starts when we are all around a blank page and ends with the creation of the new Ferrari. This magic is renewed every time a new car becomes reality as a result of a process that starts from an initial sketch, which is then enriched and implemented according to our creativity. So, while sketching the concept that will become a real product, I wish to enable the idea behind the design concept to remain intact till the end of the development process. In this way, it is the idea itself that characterizes the final product through a language that does not need any further explanation. The wish is that the creation itself is self-explanatory, thus being able to convey the meaning behind its concept, as well as the philosophy, the values and the innovative distinctive features, which are intrinsic in its nature. While designing a new Ferrari, it is necessary to be daring, sensitive and visionary, in order to be able to understand and anticipate the natural evolution of things. And this is what we do every day when we design the Ferrari of tomorrow: we nurture the design culture with forward-thinking choices, which tie together the best from the past and what we expect from the future.

BIO
Architect and Designer, born in Sardinia (Italy), Ferrari's Senior Vice President of Design. A graduate in Architecture with a specialisation in Industrial Design, in 1993 he joined Lancia in charge of Interior Design. In 1999 he went to Barcelona as the head of SEAT Interior Design and developed the interiors of the Salsa Emoción and Tango concept cars, and of the Altea and León production cars. In 2001 he returned to Lancia as Design Director, where he worked on the relaunch of the brand through the research concepts Granturismo, Stilnovo and Fulvia 2003 and the production cars Ypsilon and Musa. In 2004 he took on the role of Fiat, Lancia and LCV Design Director, working on the Grande Punto, New 500, Fiorino and Cubo cars. In 2006 he was appointed Director of Creative Design, Volkswagen Group. Amongst the production cars, alongside Walter de Silva, he designed the recent generation of VW cars, (Scirocco, Golf VI, Golf VII, the new Polo, the new Beetle and the new Touareg). Since January 2010 he has been Senior Vice President of Ferrari Design with the task of creating a Ferrari Styling Centre. In 2011 Manzoni had been included into the Hall of Fame of car design at the National Automobile Museum in Turin, Italy. Awards: "AutoDesign Awards 2014–Design of the Year" for the LaFerrari, "Born Ultimate" for design,"ADI Compasso d'Oro Award" for the F12 Berlinetta, "Red Dot" for the LaFerrari and California T, "Red Dot: Best of the Best" for the Ferrari FXX K.

TUESDAY 28TH JULY 2015

	8:30 - 10:15 am	11am - 12:30 pm	2:00 - 3:00 pm	3:15 - 4:15 pm	4:45 - 5:45 pm	6:00 - 7:00 pm
MARQUEE		**Keynote 2 & 3** see pp. 55-56				
BL27.1	**Podium 1.1** Design for a sustainable life - Management & Decision Support					
BL27.2	**Podium 1.2** Design for a contented life					
BL27.3	**Podium 1.3** Design Methods and Tools Requirements Engineering		**Discussion 1.3** Inclusive Design (1)	**Discussion 2.3** Inclusive Design (2)	**Discussion 3.3** User Behaviour and Perception (1)	**Discussion 4.3** User Behaviour and Perception (2)
BL27.4	**Podium 1.4** Design Methods and Tools Evaluation/Analysis		**Discussion 1.4** Design for X, Design to X (1)	**Discussion 2.4** Design for X, Design to X (2)	**Discussion 3.4** Design for X, Design to X - Design for Manufacturing (1)	**Discussion 4.4** Design for X, Design to X - Design for Manufacturing (2)
BL27.5	**Podium 1.5** Design Processes Models and Modelling		**Discussion 1.5** Design Methods and Tools - Requirements Engineering	**Discussion 2.5** Design Methods and Tools - Early Phases (1)	**Discussion 3.5** Design Methods and Tools - Early Phases (2)	**Discussion 4.5** Design Methods and Tools - Early Phases (3)
BL27.6	**Podium 1.6** Product Modularisation in/for Industry		**Discussion 1.6** Design Processes Models and Modelling	**Discussion 2.6** Design Organisation and Management - Analysis and Optimis.	**Discussion 3.6** Design Organisation and Management - Project Management	**Discussion 4.6** Design Organisation and Management - Participatory Design
BL27.7	**Podium 1.7** Open Innovation		**Discussion 1.7** Product Modularisation Strategies	**Discussion 2.7** Product Modularisation - Case studies and Applications	**Discussion 3.7** Product Modularisation Methods and Tools (1)	**Discussion 4.7** Product Modularisation Methods and Tools (2)
BL27.8	**Podium 1.8** Design Education		**Discussion 1.8** Creativity and Idea Generation (1)	**Discussion 2.8** Creativity and Idea Generation (2)	**Discussion 3.8** Innovation Methods and Tools (1)	**Discussion 4.8** Innovation Methods and Tools (2)
BL27.12			**Discussion 1.9** Human Behaviour in Design - Investigation Methods	**Discussion 2.9** Human Behaviour in Design - Case studies	**Discussion 3.9** Design Information and Knowledge - Products Models and PLM	**Discussion 4.9** Design Information and Knowledge - Pattern Recognition Techniques
BL27.13			**Discussion 1.2** Design for a Contented Life	**Discussion 2.2** Design Theory and Methodology - Definition and use of Ontologies	**Discussion 3.2** Design Theory and Methodology - New Approaches (1)	**Discussion 4.2** Design Theory and Methodology - New Approaches (2)
BL27.14			**Discussion 1.1** Design for a Sustainable life - Methods and Tools (1)	**Discussion 2.1** Design for a Sustainable life Methods and Tools (2)	**Discussion 3.1** Design for a Sustainable life - Dimensions of Sustainability	**Discussion 4.1** Design for a Sustainable life - User Perspectives

COFFEE BREAK

LUNCH BREAK & MEETINGS see p.57

see page 57

COFFEE BREAK

YOUNG MEMBERS' EVENT see page 111

see page 111

CHAIR
Andy Dong

DESIGN FOR A SUSTAINABLE LIFE MANAGEMENT AND DECISION SUPPORT

P 1.1

TUESDAY 28 JUL

8:30 am - 10:15 am

BL27.1

DESIGN STRATEGIES FOR CIRCULAR ECONOMY

Suman Devadula, Amaresh Chakrabarti

Indian Institute of Science, India

A Circular Economy (CE) values material, technical or biological, as nutrient. CE thinking seeks to accelerate the conversion of technical nutrient cycles along the lines of biological nutrient cycles by re-designing systems till the scale of the economy. Though the notion of products being technical nutrient exists, its situation as an outcome of design intent is not contextually made. One objective of this article is to situate design and nutrient cycles of the earth system as and within natural cycles. This situation emphasizes the mechanism by which design affects nutrient availability to vital earth systems and draws attention to the functions that nutrients afford and serve by default before being embodied in products by human intent. The first principle of CE seeks to eliminate waste and re-purpose nutrients with minimal energy. Towards this, the historic trend of perceiving waste is drawn and Gestalts identified to arrive at the concept of tenancy and inform design. Tenancy is defined as the duration for which the nutrient embodied serves some purpose. Identifying the 6R scenarios as nutrient re-purposing functions, corresponding design strategies are stated.

MODEL BASED DECISION SUPPORT FOR VALUE AND SUSTAINABILITY IN PRODUCT DEVELOPMENT | Ola Isaksson (1), Marco Bertoni (2), Sophie Hallstedt (2), Niklas Lavesson (2)

(1) GKN Aerospace Sweden AB; (2) Blekinge Institute of Technology, Sweden

Decomposing and clarify "sustainability" implications in the same way as concrete targets on product functionality is challenging, mainly due to the problem of showing numbers and 'hard facts' related to the value generated by sustainability-oriented decisions. The answer lies in methods and tools that are able, already in a preliminary design stage, to highlight how a sustainable design choice can create value for customers and stakeholders, generating market success in the long term. The paper objective is to propose a framework where Sustainable Product Development (SPD) and Value Driven Design (VDD) can be integrated to realize a model-driven approach to support early stage design decisions. Also, the paper discusses how methods and tools for Model-Based Decision Support (MBDS) (e.g., response surface methodology) can be used to increase the computational efficiency of sustainability- and value-based analysis of design concepts. The paper proposes a range of activities to guide a model-based evaluation of sustainability consequences in design, showing also that capabilities already exist for combining research efforts into a multi disciplinary decision making environment.

IMPROVING THE MANAGEMENT OF ENVIRONMENTAL REQUIREMENTS IN CLIENTS/SUPPLIERS CO-DESIGN PROCESS

REVIEWERS' FAVOURITE

Fabien Michelin (1), Tatiana Reyes (2), Flore Vallet (1), Benoît Eynard (1), Viet-Long Duong (3)

(1) Sorbonne Universités, Université de Technologie de Compiègne, France;

(2) Université de Technologie de Troyes, France; (3) CETIM, France

The integration of the environmental criteria in clients/suppliers co-design process becomes an important issue owing to the growing influence of suppliers' design choices on the clients' products. This issue is currently poorly integrated in such a design context because of the limited ability for low mature suppliers to provide the basic environmental information to the clients; and of the difficulty for clients to properly size requirements in accordance with to the suppliers' expertise. The paper describes a proposed method called "Environmental specifications diagnosis method" which is being developed in order to improve the requirements management. This method aims firstly at increasing the companies' awareness toward environmental issues by positioning companies regarding the current sectorial practices. Secondly, the method provides a support for the clarification of better tuned requirements regarding the suppliers' expertise. The paper provides also results from a case study performed with an industrial of the French mechanical industry in order to test the method validity.

P
1.1

DESIGN FOR A SUSTAINABLE LIFE MANAGEMENT AND DECISION SUPPORT

CHAIR
Andy Dong

TUESDAY
28
JUL

8:30 am
-
10:15 am

BL27.1

THE BUSINESS MODEL, A TOOL FOR TRANSITION TO SUSTAINABLE INNOVATION

Justine Bisiaux (1), Thierry Gidel (1), Frédéric Huet (1), Dominique Millet (2)

(1) Sorbonne Universités, Université de Technologie de Compiègne, France; (2) SEATECH/SUPMECA-UTLN, France

To be consistent with sustainable innovation, production and consumption evolution, business model design needs to be reconsidered to jointly redefine the value proposition, the productive organization, the remuneration modalities and the customer relationship. This paper shows how business model design could help to manage the transition from intensive innovation toward sustainable innovation. First, we distinguish two visions of business model: a representative vision, and an interactionist vision in which the business model acts as an intermediary object. Then, we choose to adopt the interactionist vision diverting the representative canevas of business model as an intermediary object. This approach is supposed to support the co-evolution of business models and technologies leading to the design of sustainable innovation. We have tested this methodology with industrial partners in order to move toward PSS offers as sustainable innovation. Our results suggest that business model can become a privileged tool for facilitating this transition. This finding leads us to formalize a method supporting decision in order to help industrials to define their sustainable transition.

IMPLEMENTING ECODESIGN PRINCIPLES IN PRODUCT DESIGN: THE ROLE OF USABILITY

Ana M. Sousa (1), Alvaro M. Sampaio (2), Paulo Simoes (1),(3), Raquel Oliveira (2)

(1) Polytechnic Institute of Cávado and Ave, Portugal; (2) University of Minho, Portugal; (3) Superior Institute of Paços de Brandão, Portugal

The market growing saturation with products similar to the already existent ones or whose adaptation to a user revealed inefficiency, makes relevant the elaboration of projects that effectively bring competitive advantage and consequently contribute to the development and well-being of the society and the ecosystem. With this paper it is intended to elaborate a project methodology which encompasses the concepts inherent to sustainability in conjunction with user-centered design. The study of these areas - the combination of ecodesign and usability criteria - culminates in a methodology which was applied to the redesign of a vacuum cleaner, as illustrative form, divided into two relevant phases, which are: (i) recognition of the users real needs, as well as problems associated with the product, through research and usability testing (N=120), and (ii) the product environmental impact quantification, through the eco-indicator 99 method. Thus, the criteria to be incorporated into the product are defined with the aim of applying characteristics that point to improve the usability of the product, but also keeping them compatible with ecological solutions and therefore sustainable.

CHAIR
Jonathan C. Borg

DESIGN FOR A CONTENTED LIFE

P
1.2

TUESDAY
28
JUL

8:30 am
-
10:15 am

BL27.2

A FRAMEWORK FOR UNDERSTANDING, COMMUNICATING AND EVALUATING USER EXPERIENCE POTENTIALS | *Simon Kremer, Udo Lindemann*

Technische Universität München, Germany

Designing positive User Experiences with products enables the creation of unique selling propositions. Interdisciplinary design teams need feasible methods to deal with UX factors in design processes. But conventional design tools are not focused on analyzing the holistic influencing factors: User Experience goes beyond usability, considers time periods before, during and after the actual interaction, includes hedonic aspects and is dependent on intangible factors like subjective characteristics of the user. Existing UX approaches range from the emergence of emotions to the fulfillment of psychological needs, making it hard to understand and consequently design products that facilitate positive experiences. The UX framework is introduced to face these challenges by integrating the main theoretical models of User Experience Design in a pragmatic tool – enabling a common understanding, communication and evaluation of User Experience potentials. The paper defines the structure and elements of this framework and suggests a process for applying the framework in product development projects.

WHY PRODUCT DESIGN SUPPORT FOR IMPROVED WORKER CONTENTEDNESS ?

Lawrence Farrugia, Jonathan Borg

University of Malta, Malta

It is frequently unrealised that emotions elicited through human-product interactions are not limited to the use phase. Indeed human workers also interact with the evolving artefact throughout distinct life-cycle phases such as manufacturing, transport and disposal. This paper reports on the work carried out in researching the influence of product design on the emotions elicited from workers who interact with the artefact during the manufacturing phase. The research results indicate that product design has indeed a capacity to influence the emotions elicited from life-phase workers. In turn the elicited emotions have been demonstrated to impact the performance of life-phase workers. This may contribute to longer product development time and increased costs. The evidence presented in this paper therefore justifies the need for the development of a design means which puts product designers in a better position to foresee the influence of design commitments on the emotions and performance of life-phase workers. The paper contributes towards the development of this design support means by establishing a number high level requirements to be considered.

PERSONAL VALUES AS A CATALYST FOR MEANINGFUL INNOVATIONS: SUPPORTING YOUNG DESIGNERS IN COLLABORATIVE PRACTICE | *Lenny van Onselen, Rianne Valkenburg*

The Hague University of Applied Sciences, Netherlands

The overall aim of this research is to assist junior designers in using their personal values and those of others for creating meaningful innovations. Studying the use of values in design is new to the design research field and there is a lack of a validated approach to cope with conflicts of values. In this paper we outline the theoretical framework and the view from practice as a foundation for our research approach. From the literature review can be concluded that values have an influence on behavior, decision making (Trimingham 2008), collaboration (Bergema et al, 2011; Kets de Vries et al, 1997), creativity (Rothkegel 2012) and the design result (Trimingham 2008). The use of values in practice was explored through semi-structured interviews with four design professionals and one design student. Additionally a semi-structured interview with Dr den Ouden was conducted to better understand the value framework (Ouden, 2012). Analyzing the interviews made us realize that conflicts are not uncommon and can result in abandonment of the project or termination of the collaboration. At the end of the paper we propose two research questions and research methodology.

DESIGN FOR A CONTENTED LIFE

CHAIR
Jonathan C. Borg

RECONCEPTUALIZING DESIGN THINKING AND EQUIPPING DESIGNERS FOR THE NEXT WAVE OF DIGITAL INNOVATION | *Maaike Kleinsmann, Dirk Snelders*

TU Delft, The Netherlands

With the advent of a third wave of digitization designers are facing new challenges to create products and services. We believe that the far-reaching user involvement and the flexible functionalities of third-wave digital innovation is radically changing the work field of designers. The paper focuses on two main effects of third-wave digital innovation; convergence and generativity. We analyzed the consequence of these two effects on three process-oriented roles of the designer that make up an important part of Design Thinking: (1) the designer as integrator; (2) the designer as boundary creator; and (3) the designer as the user's advocate. Based on this analysis, we propose three new roles that better fit the third wave of digital innovation: (1) designers as function orchestrators; (2) designers as gatekeepers of initiatives; and (3) designers as advocates of human desire. To fulfill these new roles and to equip designers for the new wave of digital innovation, we belief that there is a need for reconceptualizing Design Thinking.

DESIGN FOR INFANTS IS NOT DESIGN FOR CHILDREN: ON THE QUEST OF TOOLS TO MODEL A METHOD TO DESIGN FOR INFANTS | *Juliana Monsalve, Jorge Maya Oliveira (2)*

EAFIT University, Colombia

Child Centred Design focuses on understanding children's contextual and experiential factors for design. However, the conventional user-designer interaction could not support the specific situation of designing for infants. This is due to infants are not verbal or self-reflective. Approaches addressing users largely dependent on caregivers could support the case of design for infants, considering the wide knowledge caretakers may hold about their care-receivers. This paper addresses a literature survey of tools for designing for children, aiming to provide theoretical support for the formalisation of a method for designing for infants. The study followed a systematic approach data abstraction and analysis. The study shows that the current CCD domain has a focus on co-design tools with intergenerational teams, addressing children older than 6 years old. There were no findings addressing the case of infants. However, it was found that frameworks intended to design for autistic children might support the case of design for infants, as they involve actively caretakers. Finally, this study proposes a selection of methods and tools that might be relevant when designing for infants.

CHAIR
Hansgeorg Binz

DESIGN METHODS AND TOOLS REQUIREMENTS ENGINEERING

A FRAMEWORK FOR QUANTITATIVE ANALYSIS OF GOVERNMENT POLICY INFLUENCE ON ELECTRIC VEHICLE MARKET | *Namwoo Kang (1), Manos Emmanoulopoulos (1), Yi Ren (2), Fred M. Feinberg (1), Panos Y. Papalambros (1)*

(1) University of Michigan, United States of America; (2) Arizona State University, United States of America

There is increased government intervention worldwide towards supporting growth of the global Electric Vehicle (EV) market motivated by public interest in greenhouse gas emission reduction and energy security. Previous studies have shown a positive relationship between government investment and the growth of EV market share within the overall vehicle market. This paper describes a quantitative framework for analyzing the effect of EV-related government policies on emissions reduction that includes modeling decision making of the manufacturer, charging service operator and consumer. Two interesting findings from applying this framework to specific urban use scenarios are reported. First, if the budget for the relevant government subsidies is increased, the focus should shift from direct support of battery EVs to building public infrastructure such as charging stations; second, government policies that affect the design of both charging services and EVs would allow the government more effective use of its investments.

A COMPARISON OF CONJOINT ANALYSIS AND INTERACTIVE GENETIC ALGORITHMS FOR THE STUDY OF PRODUCT SEMANTICS

REVIEWERS' FAVOURITE

Jean-François Petiot (1), Cervantes Chavez Francisco (1), Boivin Ludivine (2)

(1) Ecole Centrale de Nantes, France; (2) Technocentre RENAULT, France

An active research field in product design concerns the analysis of end-users' evaluations on virtual products, in order to understand the product semantics. This study compares two methods for eliciting user's perceptions of a product: a classical model-based method, based on conjoint analysis, and a more innovative non model-based test, using interactive genetic algorithms. The product proposed to illustrate the study is a digital instrument panel integrated in a car dashboard, and the semantic dimension considered is the "sportiness". After the definition of the variables of the instrument panel, the two users' assessment tests are conducted with a panel of 30 participants. For both tests, the most influent variables on the "sportiness" of the instrument panel are selected, and representative designs of the sportiness are defined (the most or the least sporty). A comparison of the results of the tests is proposed, by examining the differences and agreements between them. The results show that the agreement between the two tests is important and that interactive genetic algorithms can be an interesting alternative to classical rating tests to study product semantics.

STAKEHOLDERS' DIVERGING PERCEPTIONS OF PRODUCT REQUIREMENTS: IMPLICATIONS IN THE DESIGN PRACTICE | *Yuri Borgianni, Federico Rotini*

Università di Firenze, Italy

A relevant challenge of firms developing new products stands in the capability to fulfil the requirements customers expect, which can give rise to design conflicts. Many techniques consider the relevance assigned to requirements by consequently focusing on those characteristics to which customers attribute more importance. The matter is complicated by multiple kinds of subjects, often indicated as stakeholders, that interact with the product and can influence the success of new products. Stakeholders can manifest different preferences also about requirements which are not intrinsically conflicting. The application of Kano model has been proposed to lay bare the extent of said divergences. An illustrative experiment has been conducted in the footwear industry to reveal the perception of retailers and end users with respect to shoes requirements. It emerges that the consideration of the relevance attributed to a subset of requirements is significantly different. The paper further discusses the expected modifications of design processes followed by companies needing to pay attention to intricate networks of requirements and stakeholders.

P
1.3

DESIGN METHODS AND TOOLS
REQUIREMENTS ENGINEERING

CHAIR
Hansgeorg Binz

TUESDAY
28
JUL

8:30 am
-
10:15 am

BL27.3

THE MALICIOUS LABYRINTH OF REQUIREMENTS - THREE TYPES OF REQUIREMENTS FOR A SYSTEMATIC DETERMINATION OF PRODUCT PROPERTIES

Ilyas Mattmann, Sebastian Gramlich, Hermann Kloberdanz

Technische Universität Darmstadt, Germany

Product designers face the challenge of translating customer needs and expectations into requirements to define appropriate desired product properties that satisfy customers. Various conceptual requirement definitions are existing in literature. The definitions allow a great room for interpretation and are partially contradictory for which reason it lacks a differentiated conceptual understanding. Therefore, the paper presents the results of a systematic literature analysis of existing requirement definitions by analysing their causal dependencies. Often, the terminology refers to the purpose of requirements in development processes. The paper provides a critically reflected conceptual differentiation of existing requirement terms. Resulting from the differentiated conceptual understanding, three major types of requirements need to be distinguished. They support an effective transformation of requirements into desired product properties. Thus, a valuable base for methodological support of the requirement acquisition process is provided.

REQUIREMENTS CHECKLISTS: BENCHMARKING THE COMPREHENSIVENESS OF THE DESIGN SPECIFICATION | *Niccolò Becattini (1), Gaetano Cascini (1), Federico Rotini (2)*

(1) Politecnico di Milano, Italy; (2) Università degli Studi di Firenze, Italy

It is commonly recognized that the definition of product requirements is an essential step of any design process. Many techniques have been proposed for building a suitable design specification, i.e. for defining a set of requirements characterized by validity, completeness, operationality, non-redundancy, conciseness and practicability. Among them, several methods and tools primarily aim at populating the design specification: some of them focus on very specific objectives but are applicable in many different domains (e.g., Design for X). Others are domain specific, but try to cover the entire scope of the specification (e.g., checklists and standards). This paper describes an abstract-level checklist for requirements definition, suitable for any field of application, aiming at producing exhaustive lists of requirements. A previous experimental application with Mechanical Engineering students clearly showed that the proposed multi-purpose checklist allows populating design specifications more complete than those defined without any support. This paper follows up demonstrating the capability of the novel checklist against the checklist for conceptual design by Pahl and Beitz.

CHAIR
Christopher Alan McMahon

DESIGN METHODS AND TOOLS
EVALUATION/ANALYSIS

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1.4

TUESDAY
28
JUL

8:30 am
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10:15 am

BL27.4

AVOIDING RESONANT FREQUENCIES IN A PIPELINE APPLICATION BY UTILISING THE CONCEPT DESIGN ANALYSIS METHOD | *Alexander Khamuknin (1), Marco Bertoni (2), Murat Hakki Eres (3)*

(1) Tomsk Polytechnic University, Russian Federation; (2) Blekinge Institute of Technology, Sweden;
(3) University of Southampton, United Kingdom

Avoiding disasters due to the problems stemming from resonance is a major concern in any construction project. This becomes particularly important for oil and gas pipeline systems as some damages may lead to leakage of flammable fluids, explosions, fires, destruction and loss of life. The proximity to the natural frequencies of forced frequencies (frequency ratio) normally leads to intolerant resonant vibrations and catastrophic failures. A relevant case study on a partial pipeline design with an unacceptable level of frequency ratio is presented. In order to assess the overall design merit of the case study, the Concept Design Analysis (CODA) method is utilised to map captured Customer Needs (CNs) into Engineering Characteristics (ECs). As the frequency ratio is an important EC of the whole system, the improved CODA method for the pipeline design introduces an avoidance type merit function that allows excluding a range of relevant ECs. This improved CODA method is demonstrated in a model whereby certain frequency ratios are successfully avoided in the final design.

INTRODUCTION OF A COMPUTATIONAL APPROACH FOR THE DESIGN OF COMPOSITE STRUCTURES AT THE EARLY EMBODIMENT DESIGN STAGE | *Daniel Klein, Waldemar Malezki, Sandro Wartzack*

REVIEWERS' FAVOURITE

Friedrich-Alexander University Erlangen-Nürnberg, Germany

The imminent climate change, the increasing environmental pollution or the dwindling of resources - all these points have made lightweight design more and more relevant for many different industries. Whenever masses in motion can be reduced, the energy efficiency, and therefore, the sustainability of a product is increased. A common way to reduce the weight of technical products or systems is the use of lightweight materials like aluminium or titanium. However, over the last few years and decades a novel material class has become more and more popular in lightweight design - the so called composite materials where a weak matrix material is reinforced with fibres. The aim of this paper is to show the challenges in the design of composite structures and, for the first time, to give a complete overview of a novel computational design approach which was developed over the last few years. It should be pointed out here that the regarded composite parts in this article are thin-walled parts made of endless CFRP with an unidirectional fibre reinforcement.

ASSESSING THE DIFFERENCES BETWEEN NUMERICAL METHODS, CAD EVALUATIONS AND REAL EXPERIMENTS FOR THE ASSESSEMENT OF REACH ENVELOPES OF THE HUMAN BODY | *Mathieu Delangle, Jean-François Petiot, Emilie Poirson*

Ecole Centrale de Nantes, France

Numerical models and computer-aided modeling software are tools commonly used to assess the accessibility of an environment, based on static human body dimensions. In this paper, the limits of validity of these approaches are assessed by comparing the reach envelopes obtained by these methods to those obtained experimentally. First, the accessibility areas of forty adult subjects were evaluated by performing a task comprising 168 reach points. Second, anthropometric characteristics of participants were recorded and used to perform the reach assessment by a numerical method, and then by a CAD-based analysis. In spite of the simple nature of the presented design problem, the results show important differences between the three methods. The study shows that the CAD-based assessment provides more accurate results than the numerical model. Nevertheless, the shapes envelopes comparison indicates that the maximum reach envelopes obtained with the CAD analysis are not always consistent with those obtained experimentally, closely linked to the hand location. Results indicate that the CAD model used to obtain maximum reaches gave predictions that underestimate the reach ability.

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DESIGN METHODS AND TOOLS EVALUATION/ANALYSIS

CHAIR
Christopher Alan McMahon

TUESDAY
28
JUL

8:30 am
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EFFICIENT DESIGN EVALUATION THROUGH THE COMBINATION OF NUMERICAL AND PHYSICAL COMPUTATIONS | *André G. C. Foehr, Marius Stücheli, Mirko Meboldt*

ETH Zurich, Switzerland

Over the past decades, the finite element method (FEM) has helped to accelerate design processes. However, when a problem is highly nonlinear, e.g. systems with changing unilateral contacts, numerical methods often struggle or fail completely to solve the design problem. We propose the concept of physical computation (pC) as a tool to help circumvent these numerical problems and thereby accelerate the design process. pC denotes the process of using physical systems to compute the answer to a specific part of a problem, which is hard to solve using numerical or analytical methods. pC complements said methods. Additionally, the use of rapid prototyping (RP) allows to quickly manufacture the pC setups. The application of pC in a design process is shown on the case study of a highly progressive spring. The combination of pC and numerical methods is shown to be efficient in the case study. Based on the results of this case study we see considerable potential to reduce the effort needed for the design evaluation of diverse design problems through the application of the concept of pC.

DESIGN ROADMAPPING: CHALLENGES AND OPPORTUNITIES

REVIEWERS' FAVOURITE

Euiyoung Kim, Shun Yao, Alice Merner Agogino

UC Berkeley, United States of America

While product and technology roadmaps have been well-formalized in terms of their structures, methodologies, and frameworks, design roadmaps have not been explicitly explored nor studied from either an academic or industry practice standpoint. With increasing uncertainties, rapid changes, and complexities in market environments, companies are finding that they can no longer differentiate their products and services by relying on traditional roadmapping processes that focus on technologies and product features. Rather strategies that revolve around the holistic experience of products or services are more likely to be successful in today's market. In this paper thirty-five interviews of product managers, technology managers and designers from San Francisco Bay Area consumer product companies were analyzed and synthesized. We summarize challenges and opportunities for the design roadmapping process in order to formalize its structure, framework and elements. We illustrate with Sproutel's product, Jerry the Bear, (Sproutel.com, 2015) as an example of an integrated design roadmap model used in their product development and evolution.

CHAIR
Kristin Wood

DESIGN PROCESSES MODELS AND MODELLING

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TUESDAY
28
JUL

8:30 am
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ENHANCED ANALYTICAL MODEL FOR PLANNING THE VERIFICATION, VALIDATION & TESTING PROCESS

REVIEWERS' FAVOURITE

Shabi Yakov, Yoram Reich

Tel Aviv University, Israel

System VVT (verification, validation, and testing) are three tasks of System Engineering that focus on ensuring that systems are designed and delivered to meet customer and engineering requirements in the best way possible. Most organizations use sub-optimal VVT processes and methods. Moreover, in many projects, the project manager should anticipate unexpected outcomes during the VVT process, for example, Cost to complete, or Time to complete exceed Cost or Time predictions prior to commencement of the VVT process. The literature include very little research for associating VVT methods to VVT activities and does not offer an effective recovery procedure to suit unforeseen events. In this paper, we present enhanced analytical model that not only structures the decision process but also outputs the optimal VVT methods given Cost, Risk and Time constraints to suit unpredictable outcomes during the VVT process. The use of the enhanced model is demonstrated on a sample problem incorporating some unexpected outcomes during the VVT process.

INTEGRATED PRODUCT AND PROCESS MODELS: TOWARDS AN INTEGRATED FRAMEWORK AND REVIEW | *Claudia Eckert (1), Albert Albers (2), Nikola Bursac (2), Hilario Xin Chen (3), P. John Clarkson (3), Kilian Gericke (4), Bartosz Gladysz (2), Jakob F. Maier (3), Galina Rachenkova (2), Daniel Shapiro (3), David Wynn (5)*

(1) The Open University, United Kingdom; (2) KIT, Germany; (3) University of Cambridge, United Kingdom; (4) University of Luxenburg, Luxenburg; (5) McGill University, Canada

While product models and process models have a long standing transiting, there are few models that integrate the two type of models. Those that exist are research systems, which even if validated in industry do not have a broad uptake to date. This paper develops an integrated framework for product and process models based on the purpose the models are put it building on a model of Browning and Ramasesh. Selected integrated model are classified according to the framework. This revealed the no model to date gives equal weight to product and process models.

FBS MODELS: AN ATTEMPT AT RECONCILIATION TOWARDS A COMMON REPRESENTATION

Christian Spreafico (1), Gualtiero Fantoni (2), Davide Russo (1)

(1) University of Bergamo, Italy; (2) University of Pisa, Italy

FBS is one of the most followed and studied design theories, as evidenced by the numerous investigations and rework on the subject. It is often used to provide a better understanding on existing design methods and tools in order to make them more accurate or efficient. Nevertheless the resulting methods are often loose or too heterogeneous to be easily applied; what is lacking is a scheme of collection that supports design process from the beginning to the end, while considering all possible facets. This paper contains an attempt at reconciling many previous works on FBS, through a homogeneous and unique representation: all the elements (function, behaviour, structure, affordances, signals) have been reformulated according to the designer's and user's perspective, in terms of perception and interpretation; in this way they could be bound together in a common ontological reformulation of a more extensive scheme. In this article, we propose a bond between the various elements, using a logical-mathematical form.

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DESIGN PROCESSES MODELS AND MODELLING

CHAIR
Christopher Alan McMahon

TUESDAY
28
JUL

8:30 am
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MODELLING PRACTICES OVER TIME: A COMPARISON OF TWO SURVEYS TAKEN 20 YEARS APART |

Marie-Lise Moullec (1), Jakob Maier (1), Stephen Cassidy (2), Anita F. Sommer (1), P. John Clarkson (1)

(1) University of Cambridge, United Kingdom; (2) BT Research Labs, United Kingdom

Although modelling tools are intensively used within companies, the modelling process itself is still scarcely researched. The few related works focus on the steps encompassed when developing a model, without taking into consideration the context surrounding it. Nevertheless understanding this context is crucial since this influences the modelling process in terms of objectives, available data and tools. A survey conducted among expert modellers in 1994 provided insights into this context by establishing a profile of the modeller and highlighting the qualities needed to improve modelling practice. However software, technology and businesses have evolved over twenty years, which may have impacted the modelling practice. Twenty years later, we conduct a similar survey. Comparing the results enables studying the evolution of modelling practice over time. The findings are discussed in the light of potentially impacting technological progress and provide insight for future research concerned with improving the modelling process.

VALUE MODELLING IN AEROSPACE SUB-SYSTEM DESIGN: LINKING QUANTITATIVE AND QUALITATIVE ASSESSMENT |

Alessandro Bertoni (1), Henrik Amnell (2), Ola Isaksson (2)

(1) Blekinge Institute of Technology, Sweden; (2) GKN Aerospace Systems Sweden

The paper presents a prototype of a value model where engineering design teams can play with cost and value data in a semi-structured way. In particular, the value model serves to facilitate communication of multidimensional information during preliminary design analysis and to visualize such information in a unique environment. The model first automatically generates, from the output of a computer-based simulation, a quantitative assessment of manufacturer costs and customer cost savings of a set on different configurations of the same design concept. Second, it couples to the results a qualitative assessment of concept risks and product and process commonalities. Third, it allows an assessment of the concept impact on the customers' "ilities" (maintainability, survivability, scalability, flexibility). The model has been developed in collaboration with an aerospace sub-system manufacturer and it ultimately aims to enable the maturation of the knowledge about cost and value aspects among the design team since the preliminary stages of design.

CHAIR
Dieter Krause

PRODUCT MODULARISATION IN/FOR INDUSTRY

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TUESDAY
28
JUL

8:30 am
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BL27.6

ASSESSING MODULARISATION TRANSITION WITH METRICS

REVIEWERS' FAVOURITE

Markus Heilemann (1), Culley Steve (1), Schlueter Meike (2), Lindemer Vera (2)

(1) University of Bath, United Kingdom; (2) Bosch Group

Modularisation is a major area of interest within the field of engineering design. In order to support engineers in establishing modular product architectures, researchers have published a wide variety of modularisation metrics. However, no research has been found that surveyed the implementation of modularisation metrics in companies transitioning from single product development toward modular system development. For this reason, this paper seeks to close this gap by providing a set of six coherent metrics for modularisation transition. The metrics were developed in close collaboration with industry and tested and applied in a company transitioning toward modularisation. The metrics assess three different levels. First, the business level is assessed for senior managers that have a focus on the overall modular system. Second, result-oriented metrics provide support for engineering managers and senior engineers. Third, product architecture metrics support design engineers on detailed product level already during early design phase. Validation of the metrics in industry showed that the metrics are applicable in industry and support companies in modularisation transition.

COST PROGNOSIS OF MODULAR PRODUCT STRUCTURE CONCEPTS

Sebastian Ripperda, Dieter Krause

Hamburg University of Technology, Germany

Modular product structures are often used by companies dealing with a high variety in their product families to cope with that challenge. Due to the gradual properties of modularity, more than one modular product structure concept is developed. The cost prognosis shown in this paper supports the selection of concepts by making the monetary effects of changing product structures transparent. It is one unit of the complexity cost management approach, which is based on a systematic literature review. The correlation of the method unit with the integrated PKT-approach is shown and compared to methods from literature. The cost prognosis is described in detail using the example of a product family of floor cleaning robots and verified by applying it on a product family of elevators. The detailed analysis of cost effects of modular product structure concepts supports decision making and leads to cost advantage solutions.

TOWARDS PRODUCT PLATFORM INTRODUCTION: OPTIMISING COMMONALITY OF COMPONENTS |

Miguel Zapico (1),(2), Claudia Eckert (2), Iestyn Jowers (2), Christopher Earl (2)

(1) Engineering Concept Centre - NACCO Materials Handling Group, United Kingdom; (2) The Open University, United Kingdom

Companies that design and manufacture products for a wide range of related applications need to offer the right product for each use. A platform design strategy allows designing the product range based on product platforms, where some of the components and systems are common across the range whereas other components are individual for each product variant. This paper presents the problems that a company faces when trying to introduce a platform strategy and outlines a method to find suitable components to be made common. The method is shown with a simple case. The approach uses fuzzy logic to obtain a suitable criterion to assess the overall value of the product line and a genetic algorithm for finding the set of components to be made common.

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PRODUCT MODULARISATION IN/FOR INDUSTRY

CHAIR
Dieter Krause

TUESDAY
28
JUL

8:30 am
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STRUCTURING PERCEIVED QUALITY ATTRIBUTES FOR USE IN THE DESIGN PROCESS

Konstantinos Stylidis (1), Jonas Landahl (1), Casper Wickman (2), Hans Johannesson (1), Rikard Söderberg (1)

(1) Chalmers University of Technology, Department of Product and Production Development, 412 96, Göteborg, Sweden;
(2) Volvo Car Group, Craftsmanship & Ergonomics Centre, 91300 PVÖS35, 405 31, Göteborg, Sweden

Perceived quality has received much attention the last decade, mainly in the automotive industry. The focal drivers are the competitiveness within the premium segment, and customers' high demands. The existing definitions of perceived quality found in the literature are fuzzy. Methods for assessing perceived quality do exist, however the attributes need to be incorporated into existing design support systems to be efficiently used in the design process. This paper is a first attempt to merge a new terminology framework of perceived quality with an apparent problem, observed at an automotive company, of incorporating perceived quality in the product design process. A case study was conducted at an automotive company to depict the current state of managing information. It was uncovered that information is scattered across systems and that the way to package information is assorted. A new framework, introducing Value Based Perceived Quality and Technical Perceived Quality is presented. To better incorporate the attributes into the design process, a platform system model is proposed. In this way, perceived quality attributes can be reused for various design applications.

TOWARDS A DECISION SUPPORT FRAMEWORK FOR SYSTEM ARCHITECTURE DESIGN

Sonia Ben Hamida (1),(3),(4), Marija Jankovic (1),(3), Martine Callot (3),(5), Anne Monceaux (5), Claudia Eckert (2)

(1) Centrale Supelec, France; (2) The Open University, United Kingdom; (3) IRT SystemX, France;
(4) AIRBUS Defence and Space, France; (5) AIRBUS Group Innovations, France

Early phase design phases of more and more complex systems enhance the need for a more interdependent decision-making process across design disciplines and processes. No clear system architecture design process in industry identifies support tools for system architects' need. In this paper, we conducted interviews and workshop with system architects in a major aerospace company in order to understand what system architecture design process is and what decision support tools are needed in this process. The analysis of the collected data has underlined 10 different decision domains that we define and link to the needs expressed by the systems architects interviewed.

CHAIR
Udo Lindemann

OPEN INNOVATION

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TUESDAY
28
JUL

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RISK AND INNOVATION BALANCE IN CROWDFUNDING NEW PRODUCTS |

REVIEWERS' FAVOURITE

Chaoyang Song (1), Jianxi Luo (1), Katja Hölttä-Otto (1), Warren Seering (2), Kevin Otto (1)

(1) Singapore University of Technology and Design, Singapore; (2) Massachusetts Institute of Technology, United States of America

Many have considered that innovation through new and small companies is a vital driver for sustainable economic growth. Recent growth in Web 2.0 demands small companies to further incorporate risk management while developing innovative products. How to balance risk and innovation during new product development becomes a priority for small companies to survive the competition. Yet, the approach is not likely similar to that employed by incumbent firms. This paper explores innovation versus risk for small companies using crowdfunding products as a proxy for analysis. A database with 127 consumer electronics, namely 3D printers and smart watches, are collected from Kickstarter and Indiegogo. The metric of Real-Win-Worth is adapted to provide a well-rounded assessment of the product's innovation, risk and other related business and engineering aspects. Our result suggests a preliminary framework of innovation and risk balance for crowdfunding NPD success. A statistical model is developed to correlate the amount of crowdfunding raised with 64% predictability. These results may contribute to better understand and balance risk and innovation in crowdfunding and small company contexts.

OPEN DESIGN PLATFORMS FOR OPEN SOURCE PRODUCT DEVELOPMENT: CURRENT STATE AND REQUIREMENTS

REVIEWERS' FAVOURITE

Jérémy Bonvoisin (1), Jean-François Boujut (2)

(1) Technische Universität Berlin, Germany; (2) University Grenoble Alpes, France

The spread of ICT and cheap low-size production tools like 3D-printers led to the development of open design, i.e. community-based and open source development of physical products. This innovative organization of product development offers a great opportunity for continuous improvement of products as well as formidable a potential for product innovation and incubation of new businesses. However, because of a limited availability of supporting methods and tools, open design projects are still unable to compete with today's standards of industrial product design. The present article aims at providing a state of the art of existing online tools for open source product development and discusses their limitation regarding the challenges raised by what is identified as an emerging design paradigm. This is performed through the definition of an analysis grid through which existing tools have been scanned as well as a case study. It claims for further empirical research in order to describe the phenomenon from a design science perspective, to define appropriate categories and develop new specific online product data management tools.

HOW TO SEARCH FOR OPEN INNOVATION PARTNERS?

REVIEWERS' FAVOURITE

Matthias R. Guertler, Constantin von Saucken, Maria Schneider, Udo Lindemann

Technische Universität München, Germany

Open Innovation (OI) allows the utilisation of external expertise. This can increase the customer integration, reduce the time to market and reduce products' flop rates. However, companies still face challenges when planning and conducting OI. A major issue is the identification and selection of suitable partners (so called OI-actors). Besides OI-actors with specific technical capabilities for solving the primary issue/task of the OI-project, also relevant OI-actors in terms of power and influence need to be involved. In the context of Situative Open Innovation (a methodical procedure model for planning OI-projects), we developed a methodology for identifying suitable OI-actors. Starting with an analysis of existing stakeholders, in the following different search methods are proposed - including a decision support for selecting specific search methods. Identified potential OI-actors are assessed and ranked from a technical and a strategic perspective, and generic cooperation strategies derived for selected OI-actors. By the use case of an industrial project we demonstrate the methodology's applicability and benefit but also show points for further improvements.

OPEN INNOVATION

CHAIR
Udo Lindemann

OPEN INNOVATION ECOSYSTEM: TOWARDS COLLABORATIVE INNOVATION

Annette Isabel Böhmer, Udo Lindemann

Technische Universität München, Germany

Innovation is a precondition for the success of companies in today's markets to differentiate from their competitors. Particularly disruptive innovations are addressed in numerous research contributions, product contests and advertisements. They carry a high risk of failure and often require a high investment in research and development. (Watty, 2013) Corporate groups are often very successful in specialized market segments and with incremental innovations adapted to the needs of their customers. Regarding disruptive innovations, startups and small businesses have better capabilities capturing a new market in a minimum of time (Christensen, 2013). This paper addresses the research question how an Open Innovation Ecosystem can boost the innovation capability of its community. It describes the context of an (open) innovation system from an engineering perspective and foucses on challenges and opportunities of today's businesses. In conclusion, an exemplary case of an Open Innovation Ecosystem referred to as TechShop@UnternehmerTUM is introduced. Outlining an approach, in order to gather information about companies' way to systematically implement an open innovation space.

USING CROWDS IN ENGINEERING DESIGN - TOWARDS A HOLISTIC FRAMEWORK | *Jitesh H. Panchal*

REVIEWERS' FAVOURITE

Purdue University, United States of America

Product development organizations are increasingly using crowdsourcing for design-related activities such as idea generation and evaluation, and solving difficult problems. In order to effectively use crowdsourcing within engineering systems design, it is important to systematically design these initiatives by considering conflicting goals such as maximizing participation and the quality of outcomes within cost constraints. There is currently a lack of holistic frameworks that help design engineers in designing crowd-based initiatives, specifically, framing problems, choosing the right type of crowdsourcing mechanisms, and designing incentives. This paper is an attempt towards such a holistic framework which consists of three phases. The first phase involves selecting from the four classes of crowdsourcing initiatives. The second phase involves making structural, problem-related and evaluation decisions about the crowdsourcing initiative. The third phase involves designing appropriate reward structures. An analytical modeling framework based on the theory of contests is presented, followed by a discussion of specific issues related to engineering systems design.

CHAIR
Joshua David Summers

DESIGN EDUCATION

ACADEMIC DESIGN

Ilpo Koskinen (1), Kees Dorst (2)

(1) The Hong Kong Polytechnic University, Hong Kong S.A.R. (China); (2) University of Technology Sydney, Australia

This paper proposes to reshape the discussion design schools about the relationship of design practice to research. Many universities now have very successful design departments that educate high-level design practitioners. But the rapid growth of these departments, popular as they are with students, has meant that there has been very little time to step back and reflect on the nature and development of academic design in its new environment. Consequently, the formation of an academic design practice that can take its rightful place among other academic fields has been slow. In this paper we will propose a model of academic design and critically assess its qualities, as well as the challenges that lie ahead for this new species of academic design practitioner. The model builds on recent work dealing with forms of abduction in design, and on a few papers that describe the development of research programs at Aalto University.

GUIDELINES FOR COMPETENCE ASSESSMENT IN ENGINEERING EDUCATION AN IMPLEMENTATION IN PROJECT NUSAL

REVIEWERS' FAVOURITE

Albert Albers, Viktoriia Butenko, Jan Breitschuh, Benjamin Walter, Sandra Drechsler, Norbert Burkardt

Karlsruhe Institute of Technology (KIT), Germany

Methods of competence modelling and assessment used in psychological research hold high potential for gaining insight into requirements to engineers in product design. The contribution describes methods for competence modelling, task and test development and test analysis and optimization. The methods describes are exemplarily implemented in a federal funded project about Standardization in Higher Education in Germany and the imtermediate results in this ongoing work are discussed.

A CASE STUDY EXPLORING THE USE OF JOURNALS TO SUPPORT STUDENT ENGAGEMENT | *Werner Christian Born, Linda Catherine Schmidt*

University of Maryland, United States of America

This paper presents research related to improving student assessment and monitoring team engagement in capstone design courses through the use of design journals. It is proposed that design journals can be used to obtain a more detailed understanding of the progress of individual students in design learning that graded assignments, reports, and peer evaluations cannot provide. Several metrics have been developed and are discussed to better analyze journal content. Results are presented for one team of five students and include a look at individual cognitive activities, concept referencing, and concept propagation. Patterns pertaining to less-engaged students are witnessed and discussed. By utilizing design journals, instructors can become better equipped to make a dynamic examination of a student's understanding and engagement of design principles.

CHAIR
Joshua David Summers

NEW APPROACHES TO TEACHING DESIGN FOR ADDITIVE MANUFACTURING | *Stefan Junk, Rebecca Matt*

University of Applied Sciences Offenburg, Germany

Additive Manufacturing and Reverse Engineering have increasingly been gaining in importance over the past years. This paper investigates the current status of the implementation of these new technologies in design education and also identifies current shortcomings. Then it develops two new approaches for the teaching of the necessary expertise for the design of 3D-printed components and illustrates these with case studies. First, a workshop is presented in which students gain a broad understanding for the functionalities of additive manufacturing and the creative possibilities and limits of this process, through the assembly and installation of a 3D-printer. A second new approach is the combination of reverse engineering and 3D-printing. Thereby, students learn how to deal with this complex process chain. The result of these new approaches can e.g. be seen in the design guidelines for Additive Manufacturing, which were developed by the students themselves. At the same time, the students are able to estimate opportunities and limits of both technologies. Finally, the success of the new course contents and form is reviewed by an evaluation by the students.

DO HIGH SCHOOL STUDENTS BENEFIT FROM PRE-ENGINEERING DESIGN EDUCATION? | *Udo Kannengiesser (1), John Gero (2), John Wells (3), Matthew Lammi (4)*

REVIEWERS' FAVOURITE

(1) Metasonic GmbH, Germany; (2) UNCC & GMU, USA; (3) VPI, USA; (4) NC-State, USA

This paper tests the hypothesis that the design cognition of high school students who have taken pre-engineering courses will be different to those who have not. The test is based on analysing and comparing two sets of design protocol studies for the respective groups of students. All design protocols are coded uniformly using the Function-Behaviour-Structure (FBS) ontology. The analysis in this paper focuses on three aspects: design issue distributions, cumulative design issues and cumulative design processes. The results show that there is no statistical support for the hypothesis that differences exist between the pre-engineering and non-engineering student groups. These unexpected results potentially have profound implications for high school pre-engineering education.

COFFEE BREAK
10:15 - 11:00 am
Dining area

CHAIR
Christian Weber

Engineering Design: Unlocking the Potential of Additive Manufacturing

CAROLYN CONNER SEEPERSAD

Associate Professor of Mechanical Engineering and General Dynamics Faculty Fellow
University of Texas at Austin

ABSTRACT

Additive manufacturing (AM) is having a profound impact on the way engineers realize custom parts, and it is democratizing product design and manufacturing in unprecedented ways. Also known as 3D printing, AM is the use of additive technologies to fabricate objects, layer by layer. It enables a host of design opportunities including fabrication of customized and form-fitting parts directly from three-dimensional computer-aided design (CAD) models or imaging data; economical production of small lots of products; consolidation of parts into lightweight, complex assemblies; fabrication of complex lattice structures, internal channels, and multimaterial and functionally graded structures with different properties in different locations. In this talk, these design opportunities will be explored, along with the corresponding design challenges posed by AM. CAD/CAE tools need to support models with thousands or even millions of features with hierarchical size ranges from microns to meters. At the same time, these tools need to provide real-time feedback on the constraints and process-structure-property relationships relevant to specific AM technologies, as the parts are being designed. Furthermore, the democratization of AM relies on the development of user-friendly tools for creating and customizing digital 3D models.
With AM, we can imagine a future in which customers design their own products on their own computers, rather than being forced to simply select an option from a catalog. Meanwhile, engineers can tailor products with seemingly endless complexity. With the help of the engineering design community, AM is poised to unleash a wave of innovation with profound implications for the way we design and build our engineered world

BIO

Carolyn Conner Seepersad is an. She received a PhD in Mechanical Engineering from Georgia Tech in 2004, an MA/BA in Philosophy, Politics and Economics from Oxford University in 1998 as a Rhodes Scholar, and a BS in Mechanical Engineering from West Virginia University in 1996. Dr. Seepersad's research involves the development of methods and computational tools for engineering design and additive manufacturing. Her research interests include simulation-based design of complex systems and materials, design for additive manufacturing, innovation, and environmentally conscious design of products and energy systems. In 2010, she received the ASME Design Automation Committee's Outstanding Young Investigator Award and The University of Texas Regents' Award for Outstanding Teaching by an Assistant Professor, the highest teaching award for faculty in The University of Texas System. In 2013, she received ASEE's Outstanding New Mechanical Engineering Educator award. Dr. Seepersad is the recipient of a Best Paper Award for the 2009 ASME Design Theory and Methodology Conference and two best paper awards for the 2010 ASEE Annual Conference and Exposition. She is also the author of more than 80 peer-reviewed conference and journal publications and one book. She teaches courses on product design, additive manufacturing, and design of complex engineered systems.

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KEYNOTE

CHAIR
Christian Weber

TUESDAY
28
JUL

11:45am
-
12:30 pm

MARQUEE

The cancer challenge

ALBERTO BARDELLI

Associate Professor
University of Torino, Dept. of Oncology
Director
Laboratory of Molecular Oncology at the Candiolo Cancer Institute-IRCCS, Candiolo (Torino, Italy)

BIO
Prof. Bardelli received a PhD in Biochemistry and Molecular Biology at UCL (London, UK) in 1996. As a post doc at the Howard Hughes Medical Institute at the Johns Hopkins University (Baltimore, USA), in the group led by Bert Vogelstein, he has developed the first comprehensive mutational profile of kinases in CRCs.

As an independent investigator Prof. Bardelli has then translated these findings into clinical practice by discovering that K-RAS (B-RAF) mutations impart resistance to EGFR-targeted agents. These findings were later confirmed by independent laboratories with such compelling evidence that they were rapidly translated into clinically applicable predictive biomarkers (genomic signatures) currently used to select patients for anti EGFR therapy.

Recently, Prof. Bardelli's work has defined mechanisms of acquired resistance to anti EGFR therapies in colorectal cancer patients thus providing insights into new therapies aimed at overcoming resistance. These studies involve an innovative methodology - named liquid biopsy - which allows the use of circulating tumor DNA to monitor patient's response using a blood draw.

In 2014 he has been listed in the Thomson Reuters List of Highly Cited Researchers (HYPERLINK "http://highlycited.com/" http://highlycited.com/). His H factor is 62.

12:30 pm
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2:00 pm

TUESDAY
28
JUL

DINING AREA

LUNCH BREAK

1:00 pm - 2:00 pm

MEETING

Design Science Journal
editorial board meeting

INVITED

BL27.11

LUNCH MENU*

STARTERS

Margottino di erbette e patate dolci
Flan with herbs and sweet potatoes

Insalata di seppie con agrodolce di Verdure e Noci
Cuttlefish salad with bittersweet of vegetables and walnuts

Insalata di pollo con sedano e bacon affumicato
Chicken salad with salad and smoked bacon

accompagnato da
Formaggio del giorno, Torte di verdura assortite
Verdure cotte e crude di stagione

served with
A variety of Italian cheeses, Mixed savoury pies and raw/warm vegetables

***

1 FIRST COURSE TO CHOOSE FROM:

Insalata di riso venere con primizie dell'orto
Dark rice salad with first fruits from the garden

Rollè di magro con crema di latte e basilico
Fresh vegetarian roulade with milk & basil cream

***

DESSERT

Fresh Fruit salad, Selection of cakes
and the traditional Italian ice-cream

Vegan, Gluten-free, and alergies-free options are available.
Please check with our Staff the best meal for you!
**changes can occur*

D
1.1

DESIGN FOR A SUSTAINABLE LIFE METHODS AND TOOLS T

CHAIR
Pascal Le Masson

TUESDAY
28
JUL

2:00 pm
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3:00 pm

BL27.14

DEVELOPMENT OF A SYSTEM FOR PRODUCTION ENERGY PROGNOSIS

Ralf Stetter (1), Piotr Witczak (1), Marcin Witczak (2), Florian Kauf (1), Benjamin Staiger (3), Claudius Spindler (1)

(1) University of Applied Sciences Ravensburg-Weingarten, Germany; (2) University of Zielona Góra, Poland; (3) Kirchner Konstruktionen GmbH, Germany

This paper, based on a current research project, describes the development of a system that addresses the issue of the prognosis of energy efficiency. The energy consumption in production is determined very early in the product development process by designers and engineers, for example through selection of raw materials, explicit and implicit requirements concerning the manufacturing and assembly processes, or through decisions concerning the product architecture. Today, developers and engineers have at their disposal manifold design and simulation tools which can help to predict the energy consumption during operation relatively accurately. In contrast, tools with the objective to predict the energy consumption in production and disposal are not available. This paper presents the development and realization of a system which is integrated in a commercial CAD system and supports an early evaluation of the energy spent during the production of a product.

IDENTIFYING NEEDS FOR NEW ECODESIGN TOOLS WITH THE DSM VALUE BUCKET TOOL AN EXAMPLE IN THE CONSTRUCTION INDUSTRY | *Guillaume Lamé (1), Yann Leroy (1), Sébastien Lasvaux (2)*

(1) Ecole Centrale Paris, France; (2) Centre Scientifique et Technique du Bâtiment, France

Although a large number of ecodesign tools is available to designers, adoption of these tools still seems limited. This is in part due to an inadequacy between ecodesign tools and designer's expectations. To develop relevant tools, more attention must be paid to designers' needs and usages. In order to do this, a methodology adapted from innovation management is applied to the specific case of building ecodesign. To apply this methodology, data is gathered from interviews and case studies. Three dimensions are mapped with the DSM Value Bucket tool: problems encountered by designers, usage situations and existing solutions. As a result, value buckets are identified as major issues happening in important usage situations where current solutions offer little help. These value buckets are opportunities for new ecodesign tool development for the construction sector. Results obtained are compared to those of previous studies and give original insights on needs of building designers concerning ecodesign tools.

SUPPORTING ENVIRONMENTALLY-BENIGN DESIGN - ELUCIDATING ENVIRONMENTAL IMPACT PROPAGATION IN CONCEPTUAL DESIGN PHASE BY SAPPHIRE MODEL OF CAUSALITY | *Shakuntala Acharya, Amaresh Chakrabarti*

Indian Institute of Science, India

Conceptual Design Phase is the most critical for design decisions and their impact on the Environment. It is also a phase of many 'unknowns' making it flexible and allowing exploration of many solutions. Thus, it is a challenge to determine the most Environmentally-benign Solution or Concept to be translated in to a 'good' product. The SAPPhIRE Model captures the various levels of abstractions present in Conceptual Design by Outcomes and defines a Solution-variant as a set of verifiable and quantifiable Outcomes. The Causality explains the propagation of Environmental Impact across Outcomes at varying levels of abstraction, suggesting that the Environmental Impact of an Outcome at a certain level can be represented as a collation of Environmental Impact information of all the Outcomes at each of its subsequent lower levels of abstraction. Thus a ball-park impact value can be associated with the higher-levels of abstraction, thereby supporting design decisions taken earlier on in Conceptual Design directing towards Environmentally-benign Design.

CHAIR
Pascal Le Masson

DESIGN FOR A SUSTAINABLE LIFE METHODS AND TOOLS (1)

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TUESDAY
28
JUL

2:00 pm
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BL27.14

ENVIRONMENTAL EVALUATION OF IDEAS IN EARLY PHASES: A CHALLENGING ISSUE FOR DESIGN TEAMS | *Yann Leroy (1), Benjamin Tyl (2), Flore Vallet (3), François Cluzel (1)*

(1) Ecole Centrale Paris, France; (2) APESA, France; (3) Université de Technologie de Compiègne, France

In early eco-innovation phases, design teams need to assess the environmental relevance of ideas, and consequently, the evaluation stage becomes even more critical, subjective and uncertain than in traditional design. This paper tackles the following question "How to turn elementary ideas into concepts with a high environmental potential in a design team?" Based on eco-innovation literature, we propose to test two methods involving mapping, selection, combination and environmental evaluation of ideas (namely Combineval and Geneval) plus additional free method. Starting with 14 to 15 elementary ideas, three groups of mixed academics and industrials are asked to generate 3 to 5 environmentally relevant concepts on two different test cases. Main results show that there is a large inter-group variability in the evaluation of environmental potential of ideas. Our contribution deals with the systematisation of the environmental evaluation of ideas in early phases thanks to adapted methods and tools. Should the format of ideas be highlighting environmental or a sustainable consideration is one of the emerging issues of the paper.

CHAIR
Tim C. McAloone

DESIGN FOR A CONTENTED LIFE

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1.2

DESIGNING WITH CRIME PREVENTION – CREATING COMMUNITY WELLBEING THROUGH DESIGN | *Rodger Watson, Lucy Kaldor*

2:00 pm
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3:00 pm

BL27.13

University of Technology, Sydney, Australia

This research examines a group of professional practitioners engaged in a reframing exercise on complex social problems. The research is part of a broader research question which is examining problem solving practices and the role of design in complex social problems. This paper reports on a workshop involving seven practitioners who were facilitated through the Frame Creation workshop methodology by the (anonymized) research team with the process documented for analysis. The findings illustrate the shifting of frames from a starting point of security or protection, to frames that are more open and able to address the broader issues surrounding the problems. The findings highlight the significantly different solutions that can be created by using a design process that focuses on human needs.

DESIGN FOR A CONTENTED LIFE

CHAIR
Tim C. McAloone

DEVELOPMENT OF A NATIONAL SURVEY ON AGING AND THE DOMESTIC BATHROOM: THE LIVABLE BATHROOMS SURVEY |

Alicia Mintzes, Catherine Bridge, Oya Demirbilek

University of New South Wales, Australia

A national survey on older Australians and their domestic bathrooms has been designed and implemented to collect a large-scale dataset on older Australians relating to their needs and abilities within bathroom environments. This survey is the first of it's kind, in terms of it's focus and it's scale. It was mailed out to a stratified random sample of 16,524 people over the age of 60, using the Australian Electoral Roll. This survey has developed a core set of items to measure the suitability of older people's bathrooms in order to provide useful information and insight to design better bathrooms for ageing in place. Older people participated in the survey development to provide insight and advice using their personal experience and expertise. This paper describes the strategies and processes used to develop the content of the survey, in order to overcome existing data limitations. Survey development was carried out in three phases: development, testing and finalising. The data gathered has since been used to develop new bathroom products and underpins better policy and design standards to support population ageing and the domestic bathroom of the future that better enables 'ageing in place'.

DESIGN FOR CONTENTED LIFE: A PROPOSED FRAMEWORK

Ayman Fathy Ashour

University of Sharjah, United Arab Emirates

This paper addresses design contribution to the happiness of individuals leading to a contented life. A framework for design for contented life is introduced. It includes four main components: engaging, pleasure, personal fulfilment and belongingness. Each represents an ingredient of design for happiness. We suggest that design that includes these ingredients is design that promotes contented life. The intention to support human life is the explicit, central design objective of design for contented life. The need for contemporary design for contented life approach arises. Some research challenges are presented to indicate directions for more research. In light of the framework, these research directions should serve as inspiration for designers and design researchers in their work towards design for contented life.

INCLUSIVE DESIGN (1)

CHAIR
Monica Bordegoni

EMPATHIC-DESIGN ASSISTED BY THE KANO METHOD – A HUMAN-CENTERED DESIGN METHOD FOR MEDICAL DEVICES CONSIDERING PATIENTS |

Martin Ahrens, Peter Hehenberger

Johannes Kepler University Linz, Austria

Every day we are confronted with new products and innovations. These may be based on known consumer demands or on industry innovations that give rise to new consumer demands. Usually, customers have little or no involvement in the product development process, which often results –as many well-known examples have shown –products that fail on the market. First of all human-centered design requires studying the customers. Further, all the other influencers must be considered. All of these groups wish to be part of realizing the potential success of the product. In addition to investigating the importance of integrating the customer, we also provide an assessment of existing methods for customer integration. Empathic design supported by the Kano method aims to be sufficiently intimate that latent customer requirements that have not previously been voiced can be identified in a structured form. The method was applied in a case-study in which an insulin pump was to be improved. Particular attention was paid to the requirements of diabetics who depend on insulin pumps for their whole lives. We present conclusions drawn from this case study and further aspects worth investigating.

NAVIGATION SYSTEM BASED ON HUMANE ENGINEERING FOR WHEELCHAIR USERS

Yukari Nagai, Hironori Kihara

Japan Advanced Institute of Science and Technology, Japan

This paper discusses a social design by humane engineering, from multiple viewpoints of design domains, which consists engineering design, information design, product design, and community design. Focusing on the fun in experience, we designed a personal navigation system in order to encourage the users' fun-exploring at the zoo. In this study, we consider two types of users' mobility: walk and wheelchair. We conduct an experiment to evaluate the distance to be travelled and time required to explore a zoo by both mobility methods—walking and wheelchair—using our proposed system and comparing it with other navigation systems. The data obtained from all sessions of the experiment—time and distance of a scroll and number of operations on a device—were analyzed to compare the two navigation systems. Moreover, the timing of the automatic display of the information in the zoo was highly evaluated as positive among the participants.The results of the experiment suggest that the proposed system successfully encouraged the users to fun-explore the zoo not only by walking but also if the user is on a wheelchair.

REVIEWERS' FAVOURITE

A CAPABILITY APPROACH BASED STAKEHOLDER ANALYSIS FOR THE BASE OF THE PYRAMID: A CASE STUDY OF THE FIREWOOD BASED COOK-STOVES |

Pramod Ratnakar Khadilkar, Monto Mani

Indian Institute of Science, Bangalore, India

People living under $2 income per day, referred as Base of the Pyramid (BoP), face undesired situations like lack of nutrition, health, education etc. Design as a process of changing current undesired situation to a desired situation has failed. A crucial reason behind these failures is lack of normative basis to identify and understand the absent or unsatisfied stakeholder. Currently stakeholder analysis in the design is heuristic. This paper uses a normative framework of Capability Approach (CA) for the stakeholder analysis. A brief discussion on stakeholder theory and analysis is used to identify gaps in the literature. The constructs of the CA are discussed for its suitability to the purpose. Along with methodological details, data generated from the stakeholder interviews, focus groups in a case study of dissemination of improved cook-stoves is used to interlink the theory with the practice. The scope of this work is in identifying and investigating the motives of the stakeholders in the involvement in the product. Though a lot of insights to discern and manage crucial stakeholders is inbuilt in the methodology, this work does not claim explicit coverage of these aspects.

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TUESDAY
28
JUL

2:00 pm
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INCLUSIVE DESIGN (1)

CHAIR
Monica Bordegoni

USER INVOLVEMENT IN PRODUCT DESIGN PRACTICES: A CASE STUDY ON TECHNOLOGIES FOR OLDER ADULTS | *Chaiwoo Lee, Joseph F. Coughlin*

MIT AgeLab, United States of America

Recent efforts to address challenges brought by the aging of the population have looked at technology as a possible solution. In order to effectively deliver value and benefits, it has been suggested that the design of technology for older adults need to be based on proper understanding of the population's needs and expectations with user-centered approaches. This study examines two examples of hardware and software technologies developed to address older adults' needs to stay healthy, independent and socially connected. Based on findings from in-depth interviews, documents and observation of physical artifacts, this paper presents detailed descriptions of the two cases. The case descriptions include design activities, managerial decisions and user involvement practices carried out throughout the process from planning and development to distribution. Implications for design of products targeted at older adults, as well as insights for development of interactive systems in general, are discussed.

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DESIGN FOR X, DESIGN TO X (1)

CHAIR
Georges M. Fadel

DESIGN FOR RECOVERY - APPLYING MULTIVARIATE STATISTICS TO DEFINE GROUPINGS OF FRENCH WEEE PRE-TREATMENT OPERATORS | *Natalia Alonso Movilla, Peggy Zwolinski*

University Grenoble Alpes, France

Electronic appliances can follow different pre-treatment processes once they reach their end-of-use phase. To ensure their best recovery, their design has to meet the needs of the operators that are going to treat them. Design for Recovery methods have been largely developed in scientific literature for the last two decades. However, they are not properly adapted to the requirements of the different operators since they do not take into account the diversity of pre-treatment practices nor the reasons that lead to carrying them out. This paper first presents a qualitative analysis which allowed us to create a model containing the parameters that influence the functioning of French WEEE (Waste Electrical and Electronic Equipment) pre-treatment centres. Then multivariate statistical analysis has been used to define groupings of pre-treatment operators. Further work will focus on building the bridge between the identified groupings and ecodesign methodologies.

DESIGN FOR RETROFITTING

Jenny Coenen (1), Valentina Ruiz (2), Jose Manuel Fernandez Hernando (3), Koos Frouws (1)

(1) Technical University Delft, The Netherlands; (2) VICUS DESARROLLOS TECNOLOGICOS S.L., Spain; (3) ACCIONA, Spain

This paper explorers the possibilities to design a ship for a future 'sea change' like a major retrofit of the engine room. In order to assess the potential future beneficial impact of such design measures, a demonstrator method has been developed that scores a concept design for its 'Retrofit-penalty', thus allowing for comparison of design alternatives and what-if analyses in a very early stage. The conclusion is that such an approach is feasible, but in order to get more meaningful results further research on scaling of parameters is required.

CHAIR
Georges M. Fadel

DESIGN FOR X, DESIGN TO X (1)

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TUESDAY
28
JUL

2:00 pm
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THE REALIZATION OF AN ENGINEERING ASSISTANCE SYSTEM FOR THE DEVELOPMENT OF NOISE-REDUCED ROTATING MACHINES | *Christof Küstner, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany

Today, product developer face the challenge taking not only the requirements for mechanical properties of a product into account, but also other requirements like the acoustical properties, for instance. If undesired acoustical product properties are identified product developer ask experts for counter-measures. They usually can find solutions for these acoustical issues by detailed analysis of data like sound emission measurements, noise and vibration measurements or validated multi-body simulation results. By aid of an engineering assistance system the knowledge of the expert can be provided to product developer in order to reapply these findings for new products or product variants already in early design phases of the product development process. This will help the product developer to guarantee the specified acoustical product properties already in the earlier phases. This contribution will give an insight in the realization of the engineering assistance system ALARM for the development of noise-reduced machines.

DEVELOPMENT OF PORTABILITY DESIGN HEURISTICS

Dongwook Hwang, Woojin Park

Seoul National University, Korea, Republic of South Korea

Product portability is defined as a product's ability to be easily and safely carried and be used in a variety of situations without increasing the user's effort and workload. Product portability can greatly enhance human experience during product use, and, thus, is set to be a design goal in many design pro projects. Despite the importance, however, systematic methods that guide realizing portability during the product concept design stage do not seem available at this time. To address the lack of design tools, this study presents a set of ready-to-use design heuristics for realizing product portability and a new brainstorming-based design method that utilizes the design heuristics. An example design problem and solution alternatives developed on the basis of the design heuristics and the design method are presented for the illustration purpose. The portability design heuristics are expected to greatly facilitate creating various portable systems.

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DESIGN METHODS AND TOOLS
REQUIREMENTS ENGINEERING

CHAIR
Mike Van der Loos

TUESDAY
28
JUL

2:00 pm
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3:00 pm

BL27.5

UNDERSTAND THE DESIGN REQUIREMENT IN COMPANIES

Xuemeng Li, Saeema Ahmed-Kristensen

Technical University of Denmark, Denmark

Design requirement identification is often the initial step in the product development process, for market-pull cases. Understanding the nature of design requirements and the sources, from where they can or should be captured, is critical to minimise this risk of generating poorly defined requirements. However, a clear view of the sources for eliciting design requirements is still lacking in academic studies, especially in the engineering design field. Hence, the aim of this paper is to better understand design requirement type and design requirement source, and to explore the interconnections between them through empirical studies. The research consisted of primary case studies in three Danish manufacturing companies and secondary data from a survey with 93 valid answers from the industry. The research findings enriched the understanding of where and how design requirements can be identified. This knowledge can be used to support companies to focus their efforts on the right sources according to the specific context. The development of a design requirement source-type model together with supportive toolboxes is suggested as the next step for further research.

A PRODUCT PLANNING OF E-SPORTS HEADPHONE BY BLENDING REPLICATION ZMET WITH QFD | *Hung-Hsiang Wang*

National Taipei University of Technology, Taiwan, Republic of China

In the drastic competition in the e-sports games marketplaces, many manufacturers make efforts on the visual qualities of products in its use context as a differentiation strategy. Industrial designers need useful visualization tools to listen to the Voice of the Consumer (VOC), and to capture the product's visual features. Several tools are available, but isolated. This article introduces a case study that blended two methods for product planning of e-sports headphone. The first method was a modified Zaltman Metaphor Elicitation Technique (called Replication ZMET) for "seeing" VOC, and the second one was House of Quality (HOQ) for identifying verbal and visual design specification. Results included a set of visual metaphors and verbal consensus constructs about the e-sports headphones, which then were transformed into priorities of a set of verbal and visual design features. Major advantage of the integrated approach is not only to expand Replication ZMET to product planning, but also to complement the non-visual preconception of QFD. This visualized approach helps industrial designers see the VOC and the design features at earlier stages of product planning.

QUALITY FUNCTION DEPLOYMENT USING MULTISPACE DESIGN MODEL AND ITS APPLICATION | *Takeo Kato (1), Shigehiro Horiuchi (2), Toshiharu Miwa (3), Yoshiyuki Matsuoka (4)*

(1) Tokai University, Japan; (2) Lenovo Japan, Ltd., Japan; (3) Hitachi, Ltd., Japan; (4) Keio University, Japan

Due to the rapid growth of the information and communication technology, most system developments are required not only the high functionality but also the flexibility to collaborate with the other one through the network. For the successful implementation of the difficult development, the conceptual design process in which the various stakeholders' requirements and their bottlenecks are discussed, has become important. This paper introduces the multispace quality function deployment (M-QFD) and its analytical methods and illustrates their application to a lithography system design. M-QFD is comprised of four deployment charts which includes the four types of design elements: value, meaning, state, and attribute. M-QFD enables designers to extract the design elements based on diverse requirements (requirements of the customer, company, society, etc.) and the circumstance of the design objects (user physique, ambient temperature, etc.). In addition, the analytical methods for M-QFD (correspondence analysis, interpretive structural modeling, design structure matrix, and multi domain matrix) enable them to easily understand the design element relationships.

CHAIR
Mike Van der Loos

DESIGN METHODS AND TOOLS
REQUIREMENTS ENGINEERING

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TUESDAY
28
JUL

2:00 pm
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BL27.5

CONSIDERING USER'S IMPACT IN VALIDATION ACTIVITIES – AN APPROACH FOR THE DETERMINATION OF REQUIREMENTS | *Tobias Pinner, Franz Jost, Daniel Schmid, Albert Albers*

Karlsruhe Institute of Technology (KIT), Germany

Validation activities use virtual and physical validation models within a validation setup. In practice, a human user influences the product's functions and the overall user experience. Certain validation setups consider this user-evoked influence. Therefore, a suitable user model is required, as well as an interface system that supplies the model based user input to the systems under validation. This paper presents an approach to support the designer in the definition of requirements for interface systems that transform virtual user models into physical actions. A system's analysis approach supports the designer in identifying the relevant user input to a technical system on the test bench. A descriptive model for interface systems supports a common understanding of these systems and helps to raise their modularity and adaptability. The manual gear-shifting process is the application example within this paper. A generic gear-shifting model is presented. This model is part of a shifting robot that transforms a virtual model input into the physical shifting action.

CHAIR
Mario Štorga

DESIGN PROCESSES
MODELS AND MODELLING

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BL27.6

PROCESS TYPES AND VALUE CONFIGURATION IN MODELLING PRACTICE – AN EMPIRICAL STUDY OF MODELLING IN DESIGN AND SERVICE | *Anita Friis Sommer (1), Jakob Maier (1), Jonathan Mak (1), Marie-Lise Moullec (1), Stephen Cassidy (2), P. John Clarkson (1)*

(1) University of Cambridge, United Kingdom; (2) BT Research Labs, United Kingdom

The development of models, especially simulation models of both products and processes, has increased in industry and now offer substantial competitive advantages in decision support across many fields. Even so, little is known about the structures of applied modelling processes as the focus so far has primarily been on improving modelling tools and software, methodologies, and modelling outcomes. In this paper, we gain insights into the value creation activities in modelling practice through the analysis of activity structures from 12 different modelling processes across two large UK companies. The results show that modelling process structures can be divided into three distinct process types; ad-hoc modelling for decision support, new model development, and model change management. Existing research mainly considers new model development and therefore it is suggested that the other two types are also part of modelling practice, and therefore should be included in modelling process management. The process types are categorized from a modelling management perspective and a tentative modelling process management toolbox is suggested for further research.

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DESIGN PROCESSES MODELS AND MODELLING

CHAIR
Mario Štorga

TUESDAY
28
JUL

2:00 pm
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BL27.6

TOWARDS THE NEXT GENERATION OF DESIGN PROCESS MODELS: A GAP ANALYSIS OF EXISTING MODELS |

Daniel Guzzo Costa (1), Victor Cussiol Macul (1), Janaina Mascarenhas Hornos Costa (1), Konrad Exner (2), Anne Pförtner (2), Rainer Stark (2), Henrique Rozenfeld (1)

(1) University of São Paulo, Brazil; (2) Technical University of Berlin, Germany

Companies that follow a reference process are usually more successful. Over the last decades many different reference process models have been developed primarily in academia. Nevertheless, many approaches have not been adopted in practice. The paper analyses the most known reference models according to discipline, knowledge area, considered design stages, scope, included design approaches, provided meta information, flexibility and guidance for implementation. The results of this research show that the analysed reference models are unable to cover the whole breadth of the proposed classification scheme. There is also a lack in guidelines and support for implementation. Meta information is missing in all reference process models to facilitate a flexible and straightforward implementation into a company specific reference process. Specific research questions are derived from the analysis regarding the development for the next generation of design reference models concluding in expectations for future solutions.

AN INVESTIGATION OF DESIGN PROCESS CHANGES

Daniel Shapiro, Anita Friis Sommer, Peter John Clarkson

University of Cambridge, United Kingdom

Research on changes in design has focused on engineering changes, i.e. changes in the product domain, which is the manifestation of the design process. This article takes a different perspective and investigates changes in the process domain, which is characterised by the coordinated execution of design activities with complex interdependencies. Design process changes (DPCs) comprise various types of perturbations, e.g., delays in activities, changes in customer requirements on design parameters or the addition of new activities to the process plan. This article derives a definition for DPCs, investigates their characteristics, including reasons, types and consequences, and examines existing methods to model and manage DPCs. The research is based on a systematic literature review, which is supported through an on-going industrial case study. Given both the frequent occurrence and potentially severe impacts of DPCs on process performance a set of substantial research gaps are identified and promising directions for future research on DPCs are derived.

STRUCTURE-BASED SYSTEM DYNAMICS ANALYSIS- A CASE STUDY OF BENCHMARKING PROCESS OPTIMIZATION |

Daniel Kasperek, Sandra Berger, Sebastian Maisenbacher, Udo Lindemann, Maik Maurer

Technische Universität München, Germany

In this paper, we present a case study in collaboration with MAN Truck & Bus AG which shows the application of the concept of structure-based System Dynamics analysis. The structure-based System Dynamics analysis approach uses structural Multiple-Domain Matrix models as a basis to derive System Dynamics models which are able depict the behavior of the examined processes. The implications from the behavioral models can be used to analyze the structure of the underlying process. For this case study the partner was interested in a process comparison of its own product benchmarking processes with benchmarking processes of other automotive OEMs. The tools and methods of the other OEMs were identified and analyzed. Based on a simulation-based comparison with the own tools and methods, potentials for further process improvements by integrating specific tools and methods of the other companies were identified. The results of the simulation were used as a decision basis for the industry partner to decide whether it is beneficial for the industry partner to incorporate particular tools and methods or not. Consequently benefits, challenges and further areas of research are identified.

CHAIR
Kevin Otto

PRODUCT MODULARISATION STRATEGIES

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TUESDAY
28
JUL

2:00 pm
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3:00 pm

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FRAMEWORK FOR DIAGNOSING STANDARDIZATION POTENTIAL IN CURRENT PRODUCT RANGE |

Sushil Chandra

Hero Motocorp Limited, India

Standardization and innovation are two contradictory but essential requirements of modern design. Standardization improves operational efficiency and innovation which essentially results in differentiation of a product improves the marketability. The challenge to share the parts across a range of products without compromising the distinctiveness needs to be resolved by the designer at many levels- at the top level design while defining the architecture of the product and at level of detailing. This becomes more difficult in a situation where a range of products already exist without a clear definition of platforms. This paper successfully attempts to develop a basis for identifying platforms and formulate a tool to identify the focus areas for standardization both from microscopic and macroscopic perspectives accounting for financial considerations. At the macro level, the paper is able to identify the areas with substantial standardization potential by scanning an automobile industry for example.

CONCEIVING MODULAR SOLUTIONS IN EARLY CONCEPTUAL DESIGN ACTIVITIES

Lorenzo Fiorineschi, Federico Rotini, Paolo Rissone

Università di Firenze, Italy

Literature acknowledges modular architectures to give rise to a series of positive effects, and advantages given by considering modularity early in the design process have also been inferred. As a matter of the fact, many attempts have been made to develop modularization methods and tools. However such methods mainly support redesign tasks focused on modifying the architecture of an existing solution, i.e. operate only after, at least, a preliminary conceptual design process. Anyway, it is well acknowledged that product success is strongly influenced by the quality of the underlying concept. Such an observation leaded the authors of this paper towards a research activity aimed at the development of new design tools, for supporting the designer in facing modularity issues during the conceptual design phase. In particular, the present paper shows some preliminary results concerning the development of a new design approach capable of taking into account modularity issues since early concept generation activities.

PLATFORM CONCEPT DEVELOPMENT WITHIN THE INTEGRATED PKT-APPROACH

Moritz Kruse, Sebastian Ripperda, Dieter Krause

Hamburg University of Technology, Germany

The development of modular product structures and platforms for product families is used more and more in companies to cope with the increasing complexity. Both approaches, modules and platforms, contain the definition of a certain degree of reusable elements which leads to a reduction of the internal variety, e.g. a reduced number of parts. The integrated PKT-approach is a method toolkit including different combinable method units supporting the development of modular product structures with reduced internal variety. The aim of this paper is to include the specific development of product platform concepts and the evaluation of different concepts regarding complexity costs into the integrated PKT-approach on an exemplary product family.

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JUL

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PRODUCT MODULARISATION STRATEGIES

CHAIR
Kevin Otto

A REVISION OF PRODUCT ARCHITECTURE DESIGN FOR MULTI-MODAL PRODUCTS

Cong Liu (1),(2), Hans Petter Hildre (2), Houxiang Zhang (2), Terje Rølvåg (1)

(1) Norwegian University of Science and Technology, Norway; (2) Aalesund University College, Norway

Integrating a number of products into an all-in-one artefact is a common form of innovation. The integrated products can finally meet diverse customers' needs, adapt to changes in the task or environment, or improve performance. Very often, the expansion of functionality achieved by the integrated products is accomplished with multiple modes, which enable the product to operate in various configuration states. This paper investigates the phenomena and significance of having multiple modes in regard to product family design and platform-based product development. As a revision of product architecture, the authors claim that modes indicate different clusters of functions and modules at different times. More intrinsically, the modes are seen as a product or system divided by time. Multi-modal products promote innovative and efficient design by actively reallocating system resources. As an example, the design of a dual-mode swimming climbing underwater robot is examined to verify the assertions.

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CREATIVITY AND IDEA GENERATION (1)

CHAIR
Francesca Montagna

SUPPORTING IDEA GENERATION THROUGH FUNCTIONAL DECOMPOSITION: AN ALTERNATIVE FRAMING FOR DESIGN HEURISTICS | *Colin M. Gray (1), Seda Yilmaz (1), Shanna Daly (2), Colleen M. Seifert (2), Richard Gonzalez (2)*

(1) Iowa State University, United States of America; (2) University of Michigan, United States of America

This study explored how guided ideation can support concept initiation and development. We conducted a set of in-class activities in a junior-level industrial design studio at a large Midwestern US university with 20 students. Participants generated concepts individually while working on a previously defined problem. They performed a functional decomposition of existing concepts, then used a self-selected function to rapidly generate ideas in three stages over 45 minutes, supported by Design Heuristics cards. Through analysis of eight cases, we found that generated concepts were consistent with the originally defined function. The students' ability to create a range of solutions increased over time, and concepts became more divergent through each of the three stages. Use of Design Heuristics changed, beginning as a tool for divergent concept generation (ideation), moving to a more mechanical transformation of existing concepts (iteration), and concluding with a broader, more evaluative synthetic framing (recomposition). Based on these results, we offer implications for the integration of idea generation methods across multiple stages in design and engineering contexts.

CHAIR
Francesca Montagna

CREATIVITY AND IDEA GENERATION (1)

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A CROSS-FUNCTIONAL APPROACH FOR THE FUZZY FRONT END: HIGHLIGHTS FROM A CONCEPTUAL PROJECT | *João Filipe Figueiredo (1), Nuno C. Correia (1), Inês Secca Ruivo (2), Jorge Lino Alves (1)*

(1) University of Porto, Portugal; (2) University of Évora, Portugal

Ideation is regarded as a critical element in the innovation process; besides, it is transversal to the different design models. Notwithstanding its fundamental characteristics for the innovation process, ideation is the least-studied phase and an ambiguous nature is sometimes assigned to it. Consequently, the Fuzzy Front End (FFE) designation was born to describe this early phase and the interest over its study has recently increased. By means of an extensive literature review, ideation is highlighted from the design process and diverging models for the FFE are comparatively analyzed. The importance of a cross-functional approach for the FFE is underpinned with an analysis of a multidisciplinary and mainly conceptual project over the transportation sector. The innovative character and the perceived value of this project is precisely grounded in its integrated and cross-functional approach, which combines the technological possibilities with the passenger focus.

STRATEGIES TO EMPLOY SOCIAL NETWORKS IN EARLY DESIGN PHASES (IDEA GENERATION) | *Ma-Lorena Escandon-Quintanilla, Luz-Maria Jimenez-Narvaez, Mickael Gardoni*

École de technologie supérieure, Canada

For companies to be innovative, they need to look outside their boundaries and exchange knowledge, with crowdsourcing being an increasingly interesting idea given the potential of participation that can be reached. In this article, we summarize the arguments in favor and against the use of social networks for early design phases (idea generation), as well as the recommendations documented so far. We explored the use of Facebook and Twitter in idea generation sessions, and documented the issues observed with the platforms and with the process followed by participants. We list the needs to consider in the next solutions, and finally provide some suggestions to be able to employ social networks within the process of an idea generation session. The inclusion of crowds in the idea generation process can have a positive impact. The key to their successful application is to clearly define the objective beforehand, to select the right social network, and to use an adequate process.

MODULATION OF AMBIGUITY, A COGNITIVE FUNCTION OF REPRESENTATIONS DURING IDEA GENERATION | *Olga Kasatkina, Erica de Vries, Cédric Masclet, Jean-François Boujut*

Univ. Grenoble Alpes, Frances

The role of the representations that are developed in creativity sessions is often overlooked as a potential factor, which can influence the progression and the results of those sessions. Through the qualitative analysis of a case, observed in an open innovation center called Ideas Lab, we will explain the use, the nature and the functions of representations developed during a creativity session. We aim at articulating Duval's representational cognitive functions and the mode of attribution of meaning, polysemic versus monosemic, in creativity sessions as specific situations. In addition to the classical cognitive functions of Duval's framework, we propose a new cognitive function of representation that we call the modulation of ambiguity specific to the creative process. The representation allows the adjustment of the ambiguity level to give way to a variety of interpretations. This potential of the modulation of polysemy supports the idea generation activity by introducing or preserving a variety of interpretations, and prepares the idea evaluation phase by reducing polysemy and supporting the construction of a common understanding.

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HUMAN BEHAVIOUR IN DESIGN INVESTIGATION METHODS

CHAIR
Francesco Ferrise

TUESDAY
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DYNAMICALLY CAPTURING ENGINEERING TEAM INTERACTIONS WITH WEARABLE TECHNOLOGY | *Heikki Sjöman (1), Martin Steinert (1), Greg Kress (2), Matteo Vignoli (3)*

(1) NTNU, Norway; (2) Stanford University, USA; (3) Università di Modena e Reggio Emilia, Italy

This paper addresses the need of matching the product architecture and the interactions in design teams. A new method for this of how to build agile design teams was first introduced in 2013. We conducted a method-confirming study during spring 2014 where the same study-setup was tested. An idea of gathering interaction data of this study dynamically with a device occurred and led to prototyping with different technologies and concepts. We built a wearable device that is able to detect proximity of other similar devices in front of it nearby and this acts as a proxy for interaction. The device is based on an open source Arduino platform and a radio frequency transceiver chip. User testing of the proof of concept prototype shew promising results of acceptance and robustness. In future research we should be able to to see in real-time how system components and organizational interactions are in interplay with each other, where are the resources used, and thus learn from it how to build better design teams and manage their allocation and interfaces more effectively throughout the various phases of the product and systems development process.

DESIGN QUESTIONS FOR LIFE: CONNECTING ENGINEERING DESIGN, APPRECIATIVE INQUIRY, AND OTHER QUESTION-BASED MODELS

REVIEWERS' FAVOURITE

Johan Lilja (1), David Hansen (2), Daniel Richardsson (3)

(1) Mid Sweden University, Sweden; (2) Resonans A/S, Denmark; (3) Styrkebaserad.org, Sweden

The “Design for Life” philosophy is an invitation to create new products,services, processes, and experiences that enhance human life. Research further suggests that a good life is qualitatively different than simply not having a bad life, and implies that the inquiry process during design is important.However, current engineering design approaches are not particularly clear as to which specific design questions should be used in the design process, and even less as to the role various design questions might play. Some of the current approaches even seem to use questions that inhibit Design for Life due to their strong emphasis on only solving deficiencies. This paper aims to highlight the unexplored potential of a more deliberate choice of design questions in the engineering design process. By mapping out four question-based design models and analyzing their differences in relation to the traditional engineering design process, an overview of design question types and their various sequences is produced. The analysis further highlights practical implications and potential gains when it comes to choosing design questions more deliberately in the engineering design process.

THE INFLUENCE OF DIFFERENT MEDIA INSTRUCTIONS ON SOLVING A PROCEDURAL TASK | *Koteshwar Chirumalla (1), Yvonne Eriksson (1), Pelle Eriksson (2),(1)*

(1) Mälardalen University, Sweden; (2) Dalarna University, Sweden

This study investigates the influence of different forms of media instructions on the process and outcomes of completing a specific procedural task. The experiment was conducted with four student groups having an education in the area of Information Design. In the experiment four media instructions – text only, text plus drawings, a series of pictures and video with narration – were considered. The findings show that the type of media has an influence on the ability to solve a procedural task and on group interaction and the way groups solve a task. Compared with the other instructions, video instruction triggered a different interaction and behavioural pattern during assembly. Participants considered both video and picture instructions as more usable in terms of facilitating the ability to understand, select and apply possible solutions to a given task. However, the video medium showed little influence on dialogue in the group during assembly. The instructions, such as text plus drawings, pictures and video had a similar influence on task performance times, whereas text instructions took three times longer to implement than other instructions.

CHAIR
Pascal Le Masson

DESIGN FOR A SUSTAINABLE LIFE METHODS AND TOOLS (2)

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TUESDAY
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COLLABORATIVE PROCESS BETWEEN FUNCTIONAL ANALYSIS ET LIFE CYCLE ASSESMENT: INTEGRATING ENVIRONMENTAL CONSIDÉRATIONS INTO EARLY STAGES OF DESIGN PROCESS | *Paulina Rodriguez Moreno (1), Serge Rohmer (1), Hwong-Wen Ma (2)*

(1) Troyes University of Technology, France; (2) National Taiwan University, Taiwan

Is in the early stages of design process where decisions can have most influence on the definition of product environmental performance. Nevertheless, is difficult to integrate environmental considerations into a phase where designers have a reduced knowledge about the product. In fact, functional requirements present in conceptual phase are qualitatively subjective to allow the prediction of environmental impacts in the future product. Anyway, some authors suggest that establishing environmental performance in a functional structure can influence a more effective eco-design practice for products. This paper present the construction of a collaborative process where functional analysis will be related with environmental considerations with the aim to help designer to propose products that have less environmental impact from the early stages. The chosen methods to carry out this proposal are Functional Analysis, based in Value Analysis and Life Cycle Assessment method.

TASK-BASED LCA FOR ENVIRONMENTAL IMPACT ASSESSMENT OF MULTIPLE HETEROGENOUS SYSTEMS | *Ning Quan (1), Harrison Kim (1), Erica Knight (2), Jeffrey Nelson (2), Peter Finamore (2)*

(1) University of Illinois at Urbana-Champaign, United States of America; (2) Deere and Company

Life Cycle Impact Assessment (LCIA) is the framework for assessing the environmental impact of a product over its entire lifecycle. There have been numerous LCIA studies in the past conducted on stand-alone heavy-duty machines, but the usefulness of the methods in these studies is limited when the goal is to compare the environmental impact of two cotton stripper designs. Cotton strippers do not operate in isolation — they always operate in unison with supporting machinery such as tractors, or tractor-powered machinery, which means any meaningful comparison of cotton stripper designs must also account for the close coupling between cotton strippers and their supporting machinery. This paper proposes a new framework for comparing the environmental impact generated by two cotton harvesting systems. The proposed framework is task-based in the sense that a series of common tasks defined on a given field serve as a standard unit of work in a fair comparison of the two cotton harvesting systems. A simulation model is used in the proposed framework to simulate the movements and interactions of the machines on the field.

HEURISTIC GUIDELINES IN ECODESIGN

Julian Sarnes, Hermann Kloberdanz

Technische Universität Darmstadt, Germany

Guidelines, in the form of rules and instructions, are a commonly used support for analysis and synthesis in the field of ecodesign. This paper considers the heuristic nature of ecodesign-guidelines and argues for the necessity to gain a deeper understanding on this subject-matter and the potential of a method to support the formulation of new heuristics by ecodesign experts. Based on the theory of heuristics and literature concerning guidelines a new approach for a formalized guideline-documentation is proposed, which uses additional information to increase the usability and effectiveness of ecodesign guidelines.

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DESIGN THEORY AND METHODOLOGY
DEFINITION AND USE OF ONTOLOGIES

CHAIR
Tim C. McAloone

TUESDAY
28
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COMPUTATIONAL SUPPORT OF DESIGN CONCEPT GENERATION THROUGH INTERACTION OF SKETCHING, ONTOLOGY-BASED CLASSIFICATION AND FINDING VOIDS

Yutaka Nomaguchi, Taku Nakagiri, Kikuo Fujita

Osaka University, Japan

Drawing a sketch takes an important role for generating new design concepts. Although there are some tools that can support the drawing activity, designer's thinking process behind it has rarely been supported, because its process is implicit, and therefore, it is difficult to explicitly formalize it. This research focuses on the concept generation process through interaction of sketching and classifying concepts, and proposes a computational support methodology that helps a designer systematically find new concepts which cannot be noticed intuitively. This methodology consists of three steps, i.e., representing design concepts with sketching, classifying concepts with the function ontology, and finding new design concepts with the void theory that sees design concept generation as a process to resolve defects of the classification. A prototype support tool is implemented based on the proposed methodology. This paper demonstrates a concept generation example performed with the prototype support tool to show that more design solution candidates can be created with the proposed methodology.

ONTOLOGY IN DESIGN ENGINEERING: STATUS AND CHALLENGES

Soon Chong Johnson Lim (1), Ying Liu (2), Yong Chen (3)

(1) Universiti Tun Hussein Onn Malaysia, Malaysia; (2) Cardiff University, United Kingdom; (3) Shanghai Jiao Tong University, China

Nowadays, the wide adoption of affordable ICT hardware and software solutions has fundamentally changed how product design information is being created, shared, stored and retrieved. Due to numerous issues related to heterogeneous system implementation and design information retrieval, ontology has been identified as a feasible modeling solution for rich design information and knowledge representation. From the literature, ontology has been widely applied in various areas of design engineering, both in the academia and industry applications. In line with the latest development in both fields, this paper attempt to provide the status quo on ontology applications for design information and knowledge management. We report our reviews and findings in a number of perspectives, that includes ontology engineering, major applications of ontology in design engineering and the state of ontology adoption in the industry. Based on these outcomes, a number of challenges, research issues and potential directions of research concerning the application of ontology in design engineering have been discussed and suggested.

DESIGNING WITH PRIORITIES AND THRESHOLDS FOR HEALTH CARE HETEROGENEITY: THE APPROACH OF CONSTRUCTING PARAMETRIC ONTOLOGY | *Shahryar Eivazzadeh, Peter Anderberg, Johan Berglund, Tobias Larsson*

Blekinge Institute of Technology, Sweden

Designing for complex health care environments needs to address heterogeneous, competing, or even contradicting requirements expressed in different wordings and levels of abstraction by various actors of the health care complex environment, i.e. health care consumers, health care professionals, regulatory bodies, production lines, and marketing departments. The method introduced in this paper, utilizes ontological structures to unify heterogeneous requirements in different levels of abstraction. A weighting mechanism, which utilizes the ontology structure, allows to prioritize the requirements, while a threshold mechanism enforces minimum required qualities in a clear and integrated way. The application of the method is not limited to designing for health care, and it might be applied in design processes for similar environments or can be used to communicate standard requirements and regulations in clear ontology structures.

CHAIR
Tim C. McAloone

DESIGN THEORY AND METHODOLOGY
DEFINITION AND USE OF ONTOLOGIES

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TUESDAY
28
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DESIGN TALKING: AN ONTOLOGY OF DESIGN METHODS TO SUPPORT A COMMON LANGUAGE OF DESIGN

REVIEWERS' FAVOURITE

Celeste Roschuni, Julia Kramer, Qian Zhang, Lauren Zakskorn, Alice Agogino

University of California, Berkeley, United States of America

While many design firms have created and use their own collections of design methods, there is no standard language of design that spans across disciplines. With over 300 distinct design thinking methods and more developed every year, there is a need to clearly categorize and organize these methods and develop a standard way of communicating about them. To build a common lexicon of design methods applicable to designers across a range of disciplines and domains, this paper introduces an ontology of design thinking methods developed through an extensive literature review and a series of workshops with industry practitioners. The resulting ontology will be integrated into the online database at theDesignExchange.org to make it widely accessible and support practitioners in "design talking".

CHAIR
Monica Bordegoni

INCLUSIVE DESIGN (2)

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INCLUSIVE DESIGN; FROM PHYSICAL TO PSYCHOSOCIAL - A LITERATURE ANALYSIS TOWARD A DEFINITION OF PSYCHOSOCIAL DIMENSIONS IN DESIGN

Yonghun Lim, Farnaz Dr. Nickpour

Brunel University, United Kingdom

With the dual demographics of an aging population and more people living with disabilities, inclusive design has been recognised as a driving force for accessibility and social equality in design of products, services and environments. However, it is yet to be thoroughly and effectively applied. The limited understanding and knowledge of inclusive design principles among the various stakeholders and public is one contributing factor. Secondly, the conventional application and interpretation of inclusive design has mainly focused on physical inclusion, usefulness and usability aspects rather than the psychological or social dimensions of inclusion or exclusion. The psychological and social dimensions will be called "psychosocial inclusion" in this paper. The psychosocial perspective could have potential roles in next stage of facilitation and practice of inclusive design. In the existing design literature, however, the concept of psychosocial inclusion is limited. Therefore, existing definitions of the psychosocial aspects in non-design fields, alongside design were researched and analysed in order to establish an initial definition and framework of psychosocial inclusion in design.

DESCRIPTION OF A COMPETENCE ORIENTED APPROACH FOR DESIGNING TECHNICAL ASSISTANCE SYSTEMS | *Johanna Walter, Kristin Paetzold, Verena Nitsch*

Universität der Bundeswehr München, Germany

Technology can be tremendously helpful in assisting the elderly to lead an independent lifestyle. However, using a deficit-oriented approach to characterizing these user groups can stigmatize them and adversely affect their ability to conserve their competencies. Hence, this article advocates an alternative approach to characterizing elderly user groups, which emphasizes their competencies and takes their general life situation as well as context-specific performance motivation into account. It is embedded in a support hierarchy, which reflects medical and cognitive-psychological research findings and allows for the derivation of specific development guidelines. The approach is illustrated with a modular concept of mobility support.

INCLUSIVE DESIGN (2)

CHAIR
Monica Bordegoni

DESIGN TOWARDS BETTER LIFE EXPERIENCE: CLOSING THE GAP BETWEEN PHARMACEUTICAL PACKAGING DESIGN AND ELDERLY PEOPLE

Giana Carli Lorenzini, Annika Olsson

Lund University, Sweden

The aging of the population is a worldwide trend, especially in Western countries. The increased number of people living past 65 years is also a trend for polypharmacy (the multiple use of medication) among elderly people. In terms of market orientation, the pharmaceutical industry is well-developed, but the same cannot be said in terms of design orientation. Previous studies indicate that packaging is one of the biggest issues in the use of medications by elderly people, with a lack of inclusivity of older patients. Since interest in pharmaceutical packaging is growing, an explorative review of design approaches for inclusion of senior citizens by the industry is needed. This paper reviews how design research and current design practices have been conducted in pharmaceutical packaging design. It mainly concerns the choices of methods to understand and to integrate the needs of elderly people. The paper also presents four propositions for future empirical studies in the field.

DESIGN FOR ASSISTIVE TECHNOLOGY APPLICATIONS: USEFULNESS OF RE-USE?

Edwin Peter Walsh, Walter Daems, Jan Steckel, Herbert Peremans, Christiaan Baelus

University of Antwerp, Belgium

Due to an increased need for Assistive Technology (AT) applications, governmental interest into reducing the total cost of providing AT applications is growing. A commonly reported high rate of AT abandonment indicates a potential for recovering unused AT and re-introducing it into the pool of available AT applications. In this paper we perform a literature review of waste management concepts from the 'Waste Hierarchy' process, and translate these concepts into concepts applicable for AT, with the intention of investigating the potential of re-use (including constraints and conditions) as an attempt to battle the increased health care cost of AT due to an aging population. The key problems and issues, when translating these concepts to the specific needs of the AT market, are highlighted. Re-use concepts that strictly fall outside of the definition of re-use are addressed.

DESIGN FOR X, DESIGN TO X (2)

DEALING WITH NON-TRADE-OFFS FOR FRUGAL DESIGN

Chloé Lecomte, Eric Blanco

Grenoble INP, France

The frugal innovation approach takes place in developing countries to develop simple but essential products for low-income population. This approach asks for careful trade-offs to target a just-enough between cost reduction and essential value of the product. In this paper, we aim at understanding how the essential value of a product is defined during early design phases, and how it guides the "just-enough" between affordability and performance. Our study of five frugal products in India shows three strategies that define differently the essential values and their associated just-enough: design by aggregation, design by extension, and design by focalization. Design by focalization seems to answer frugal design issues, as it isolates the essential value in order to reduce drastically the overall cost. The introduction of the concept of Non-Trade-Offs (NTO), meaning the non-negotiable elements that guide design choices, helps understanding how to separate this essential value from additional functionalities. Our study gives new directions for both practionners and researchers towards a design for essential value, in developing countries but also in westerns countries.

EXPLORING BENEFITS OF USING AUGMENTED REALITY FOR USABILITY TESTING

Young Mi Choi, Sanchit Mittal

Georgia Institute of Technology, United States of America

This study explores the use of augmented reality (AR) in product usability testing compared to traditional methods. AR is being used in various fields, but this technology's use for usability testing has been very limited. This study specifically explored if it could be used for product usability testing. For this study, a product that is already in the market was used. First, the usability of the product was tested using traditional methods. Then the same product was modeled for augmented reality environment and subsequently a different set of users were asked to accomplish same tasks in AR environment. Same questionnaire was provided to all users for feedback. The feedback received using the two methods was compared. It was hypothesized that similar usability feedback could be obtained through AR as compared to traditional usability testing. The results showed that the feedback gathered using the two methods were the same, showing that evaluation of the AR representation of the product's usability is comparable to usability evaluation of the actual product.

DEVELOPMENT OF AN INTERFACE ANALYSIS TEMPLATE FOR SYSTEM DESIGN ANALYSIS

Amad Uddin, Felician Campean, Mohammed Khurshid Khan

University of Bradford, United Kingdom

Interface definition is an essential and integral part of systems engineering. In current practice, interface requirements or control documents are generally used to define systems or subsystems interfaces. One of the challenges with the use of such documents in product development process is the diversity in their types, methodology, contents coverage, and structure across various design levels and across multidisciplinary teams, which often impedes the design process. It is important that interface information is described with appropriate detail and minimal or no ambiguity at each design level. The purpose of this paper is to present an interface analysis template (IAT) as a structured tool and coherent methodology, built upon a critical review of existing literature concepts, with the aim of using and implementing the same template for capturing interface requirements at various levels of design starting from stakeholders' level down to component level analysis. The proposed IAT is illustrated through a desktop case study of an electric pencil sharpener, and two examples of application to automotive systems.

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DESIGN FOR X, DESIGN TO X (2)

CHAIR
Georges M. Fadel

TUESDAY
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JUL

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THE APPLICATION OF CROWDSOURCING FOR 3D INTERIOR LAYOUT DESIGN

Hao Wu, Jonathan Corney, Michael Grant

University of Strathclyde, Glasgow, United Kingdom

Since the activity was first defined in 2005, the use of crowdsourcing has been investigated by researchers in various domains (i.e., open innovation, linguistic study, commercial collaboration, etc.). However, less is known about the use of the crowdsourcing as a tool for collaborative design. Although the crowdsourcing has been used to carry out generative design, there are still many gaps in knowledge about the capability and limitations of the technology. For example although researchers have reported the use of the "crowd" to combine and evaluate designs, the application have been limited to hand sketches or 2D layouts. This paper assesses how well crowds can combine and evaluate 3D designs. An experiment, described in terms of the Crowdsourced Design framework, is presented for the collaborative creation and iterative improvement of a 3D layout. The results of the experiment make two contributions; firstly it demonstrates that 3D design can be carried out as effectively as 2D using open, could-based tools; secondly, the cDesign framework can be mapped on to the activities required to support 3D crowdsourced design tasks on the commercial crowdsourcing platform.

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DESIGN METHODS AND TOOLS EARLY PHASES (1)

CHAIR
Mike Van der Loos

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ON THE DEVELOPMENT OF VISUALISATION CONCEPTS AS TOOLS IN PRODUCT DESIGN

Nicolas Gebhardt, Dieter Krause

Hamburg University of Technology, Germany

Visualisations as tools for product design are very useful in supporting engineers in their tasks. Product design is a complex task and features interdisciplinarity and communication across departments. Visualisations can help to increase product design performance under these challenges. The integrated PKT-approach for developing modular product families, Radikal Forenkling via Design or Complexity Management by DSMs and Node-Link-Graphs are just a few examples of methods for product design that utilize visualisations as important tools for design support. Much research has been done in order to develop such visualisation concepts and on how these can be used in engineering design. In this paper however the focus lies on how design researchers proceed when developing a visualisation concept meant as a tool for engineering design, what problems they encountered and what need for support they have for the development of the visualisations. Fourteen cases of PhD projects at three universities have been analysed by document study and interviews. The results build a foundation for a future support that can help to develop effective visualisation concepts as tools in product design.

CHAIR
Mike Van der Loos

DESIGN METHODS AND TOOLS EARLY PHASES (1)

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TUESDAY
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BUILDING BRANDS THROUGH DESIGN: A SYSTEMATIC BIBLIOGRAPHICAL REVIEW

Gustavo Michelini, Daniel Capaldo Amaral

University of Sao Paulo, Brazil

There is a set of significant researches about branding and a consensus that design product is an important tool to create and maintain it. A set of authors demonstrated that functions and characteristics of products can influence during the branding process, but these practices were not collected or systematized. How does brands could be created through design? What are the most important decisions? Who are the actors on this process? The objective of this paper was to collect all practices cited on journals and summarized them inside a conceptual model to support designers into the comprehension of this topic and act during the design management. The paper concludes with a framework about "how designers can contribute to the brand creation" and offers some implications for design theory and directions for future research.

DETERMINING THE SIMILARITY OF PRODUCTS USING PAIRWISE COMPARISONS AND EYE TRACKING

Duncan R Boa (1), Charlie Ranscombe (2), Ben Hicks (1)

(1) University of Bristol, United Kingdom; (2) Swinburne University of Technology, Australia

Styling is an important aspect of the design process in which the overall appearance of a product is developed and the visual appeal is achieved. However, styling decisions are often subjective and can be difficult to satisfy the needs for all stakeholders. In this paper an exploratory study is discussed that aims to address the subjectivity of styling rationale by quantifying aspects of product appearance through the use of eye tracking. Two research questions are addressed that relate closely to typical styling issues; how are products compared when determining similarity? And, what patterns of feature engagement exist in pairwise comparisons? Preliminary findings show a weak effect between feature engagement and the similarity ratings of product pairs. Recommendations are made in the paper on the practical implementation of eye-tracking to support styling decisions as well as experimental refinements to elucidate behavioural patterns during pairwise comparisons.

ECO-EVALUATION OF TECHNICAL SYSTEMS IN THE CONCEPTUAL PHASE

Ida Midži, Mario Štorga, Dorian Marjanović

University of Zagreb, Croatia

In conceptual design phase, description of the final product solution is abstract, and there is the lack of information on product's environmental performance throughout its life cycle. Quantitative environmental assessment methods are used in the lesser extent during conceptual design due to lack of knowledge about future life cycle of the product and embodiment design. Qualitative approach to eco-evaluation is needed in early design phases and support for original design concepts. Novel eco-evaluation approach is proposed for comparison of environmental friendliness of technical system's conceptual solutions. The approach is demonstrated by establishing effects and technical processes of laundry cleaning concept variants. Proposed eco-evaluation criteria are based on adopted concepts of energy transformation quality and waste management hierarchy.

MATCHING PRODUCT ARCHITECTURE AND SUPPLY NETWORK - SYSTEMATIC REVIEW AND FUTURE RESEARCH | *Florian G. H. Behncke, Liza Kayser, Udo Lindemann*

Technische Universität München, Germany

Manufacturing firms concentrate on their core competences to prevail in fierce competition. This concentration lead manufacturing firms to shift large shares of their value creation to their suppliers. As a result, the supply network drives the economic performance of manufacturing firms through three measures; individual performance of suppliers (1), their arrangement and the structure of the supply network (2), as well as the matching between the supply network and the product architecture (3). As literature provides numerous approaches to support (1) and (2), the paper at hand focuses on the matching between product architecture and supply network on the level of architectural attributes. This paper provides a systematic review on approaches for the matching between the product architecture and the supply network within product development. The elaborated overview allows a distinct classification of approaches and the elaboration of future research.

UNDERSTANDING ENGINEERING PROJECTS: AN INTEGRATED VEHICLE HEALTH MANAGEMENT APPROACH TO ENGINEERING PROJECT MONITORING | *Chris Snider (1), James A. Gopsill (1), Simon Jones (2), Lei Shi (2), Ben Hicks (1)*

(1) University of Bristol, United Kingdom; (2) University of Bath, United Kingdom

Due to heterogeneity in engineering projects and the contexts in which they occur, it is challenging to develop generic methods for monitoring and management. Particularly in large projects, high complexity, scale, and distribution creates difficulty in identifying what performance metrics should even be applied, aside from how to assess. To address this issue this paper presents a new approach to project monitoring based on Integrated Vehicle Health Management (IVHM), a widely used monitoring method for machine maintenance. By focusing on wide capture of low-level data, in this case digital files produced during everyday work, an IVHM approach uses many analysis techniques simultaneously, automatically creating a high-level description of the state of the project which a manager can use for assessment and intervention. To allow IVHM to be applied to engineering projects this paper presents 70 features captured from interview, each present in all engineering projects, whose state influence performance. Feasibility of the IVHM approach in engineering management is shown through three data examples, in which higher level project understanding is inferred directly from low level data.

IMPLEMENTATION OF R&D MANAGEMENT MODELS IN GLOBAL ORGANISATIONS

Gleen Johansson (1),(2), Kristina Säfsten (1), Ann-Cathrine Adolfsson (1)

(1) Jönköping University, Sweden; (2) Mälardalen University, Sweden

This paper addresses implementation of R&D management models in global product development organisations. The study rests upon empirical material originating from five industrial companies that was collected via workshops and interviews. A number of enablers for and barriers to implementation of R&D management models have been identified. The study adds to the current theory on how companies with global organisations can ensure that the R&D management model is implemented throughout the entire organisation. In addition, the practical value refers to that the identified enablers and barriers support companies in their strive towards better adherence to the R&D management models in product development projects.

CHAIR
Mario Štorga

DESIGN ORGANISATION AND MANAGEMENT
ANALYSIS AND OPTIMISATION

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2.6

TUESDAY
28
JUL

3:15 pm
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BL27.6

AN AGENT-BASED APPROACH TO SUPPORT PLANNING FOR CHANGE DURING EARLY DESIGN | *João Fernandes, Elsa Henriques, Arlindo Silva, César Pimentel*

Instituto Superior Técnico, Portugal

Early design is the most dynamic and unpredictable stage of complex design processes, since it involves a great deal of uncertainty, collaborative iteration and adaptive organizational behaviour. This paper argues that current activity-based modelling approaches have limited ability to capture the dynamics of early design and explores novel modelling approaches to support planning during this stage. The development of an Agent Model for Planning and rEsearch of eaRly dEsign (AMPERE) aiming to support early design planning is described. The initial results from agent-based simulations are presented reporting an investigation to the likely effects of requirements change in global design process performance.

CHAIR
Kevin Otto

PRODUCT MODULARISATION
CASE STUDIES AND APPLICATIONS

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2.7

3:15 pm
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BL27.7

THE IMPACT OF CRITERIA IN SYSTEM ARCHITECTURE SELECTION: OBSERVATION FROM INDUSTRIAL EXPERIMENT | *Marie-Lise Moullec (1), Marija Jankovic (2), Claudia Eckert (3)*

(1) University of Cambridge, United Kingdom; (2) Ecole Centrale Paris, France; (3) The Open University, United Kingdom

Decisions related to system architecture are difficult, because of fuzziness and lack of information combined with often conflicting objectives. We organised an industrial workshop with the objective to choose 5 out of 800 architectures. The first step, the identification of selection criteria, proved to be the greatest challenge. As a result, designers selected system architectures that did not satisfy them without being able to explain what went wrong in their selection process. The objective of this study is to investigate the impact of criteria in system architecture selection. The recordings of the workshop were transcribed and analysed in order to identify the difficulties related to the definition and the use of criteria. The analysis highlights two issues: the interdisciplinarity of system architecture makes criteria interdependent and the lack of information is making it impossible to define an exhaustive set of criteria. This questions the applicability of most of design selection methods that assume that criteria are well defined by designers. Finally, this study provides insights and recommendations for future selection support tools dedicated to system architecture design.

PORTFOLIO MANAGEMENT FOR ELECTRIC DRIVES IN POWERTOOLSAT HILTI: CHALLENGES AND SOLUTION APPROACHES | *Josef Ponn*

Hilti Entwicklungsgesellschaft, Germany

The Hilti product portfolio contains a wide spectrum of electric powertools for construction professionals. The electric drive is an important subsystem within the powertools and a decisive driver for differentiation, but also a source of growing complexity due to its mechatronical character. At the interface between tool and drive development, this leads to increased technical and organizational challenges. This contribution presents an approach towards portfolio and complexity management at the Hilti Electronics & Drives development based on product platforms. The first aspect includes a recently introduced platform process as a means for an efficient organization of the platform development. A second aspect deals with creating more transparency in the portfolio, based on a structured visualization of the system architecture. Finally a concept is presented towards more conscious decision making in portfolio management, including a classification of decision situations and a guideline for the decision making process. The methodology is applied at Hilti since roughly one year, the feedback and effects are rather positive and the methodology is continuously expanded.

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PRODUCT MODULARISATION CASE STUDIES AND APPLICATIONS

CHAIR
Kevin Otto

TUESDAY
28
JUL

3:15 pm
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BL27.7

AN ENGINEERING DESIGN APPROACH TO LITHIUM-ION CELLS - MODULAR KIT CONFIGURATION FOR AN INNOVATIVE TECHNOLOGY APPLICATION

Matthias Tschech, Thomas Vietor

TU Braunschweig, Germany

Introducing a significant fleet share of electric or plug-in hybrid electric vehicles seems indispensable for vehicle manufacturers to fulfil CO2-emission regulations. The cost situation for lithium-ion batteries is one of the key limitations for the market potential of electric vehicles. This work introduces a value based engineering approach for the application in this specific technology. General quantitative relations between cost and function are determined by using a detailed lithium-ion cell model, which links material properties, design parameters and costs to the key functions storable energy and available power. The optimal cost situation is identified when the power to energy ratio of the cell directly matches the power and energy requirement of the vehicle. For a multiple project portfolio this implies a specific cell for each vehicle project. The potentially large number of cell types seems unfavorable for OEMs especially due to onetime expenses in development and validation. Therefore a genetic algorithm optimization is applied to determine the cost optimal electrode designs and number of cell versions to address an exemplary vehicle portfolio case.

DEVELOPING AN OBJECTIVE FORMULATION FOR MOTORCYCLE ARCHITECTURE

Sushil Chandra

Hero Motocorp Limited, India

Though an objective formulation is available for building and IT architecture, no such formulation is available for architecture of automobiles, which characterizes the relationship between various elements of the design of a vehicle. This paper attempts to provide a mathematical formulation for engineering and visual architecture of motorcycles, define and quantify the complexity of architectural change to help the designer form the architecture strategy. This has been done by applying domain modeling concept to design data of motorcycles, scanning through the history of motorcycles in terms of architecture and applying the formulation to see how it helps the designers to understand the complexities of design changes. It concludes that major evolutions in motorcycles result in a drastic shift in architecture, visual architecture is a reflection of technological shifts and designers need to evolve architecture strategies for innovation.

CHAIR
Francesca Montagna

CREATIVITY AND IDEA GENERATION (2)

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2.8

TUESDAY
28
JUL

3:15 pm
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BL27.8

USING IDEA MATERIALIZATION TO ENHANCE DESIGN CREATIVITY

Georgi V. Georgiev, Toshiharu Taura

Kobe University, Japan

In this paper, we focused on the advantages of 3D printers to build new creative designs and to make it possible to enhance physical interactions with the design idea that may be able to expand the feelings of the designers and users of the designs. We proposed a general method focused on intentional theoretical expansion of concept space and materialization of design ideas. In an exploratory example, we investigated generation of design ideas and materialization of creative ideas for shapes. Interaction with the materialized ideas, and expansion of concept space results in the generation of new features, uses, functions, or contexts of the design idea and these can be reflected into a new idea. This suggests that interaction with materialized idea and expansion of concept space, and further rapid iterations of this cycle, can contribute to the expansion of human feelings evoked by the design, through this, contributing to design creativity.

CREATIVITY TOOL SELECTION FOR DESIGN ENGINEERS IN IDEA GENERATION

Yanliuxing Yan, Peter R N Childs

Imperial College London, United Kingdom

The aim of this study is to investigate the utility of a framework of selecting suitable creativity tools for designers according to personality attributes and design application. Five intuitive feeling (NF) design engineers who share similar if not identical personality type, were observed while using lateral thinking, which is suggested as one of the suitable creativity tools based on this framework, to produce ideas for a design task. The aim of this study is to understand the creative process that designers go through when using lateral thinking, and the perceived utility of this creativity tool in ideation by this personality group. The analysis of the ideation process revealed creative thinking is an intuitive and associative process where intuition and imagination are frequently employed by the intuitive feeling designers to construct the problem, trigger ideas or illustrate ideas. The subjects' positive evaluations towards the use of lateral thinking in ideation supported its utility, but factors such as ease of use and previous experience in using creativity tools should be taken into account when applying the framework.

INSPIRATIONAL DESIGN BRIEFING PERFORMANCE

Søren Ingomar Petersen, Jaewoo Joo, Shelley Takahashi

Ingomar & Ingomar - Consulting, United States of America

Design briefs provide the legal as well as inspirational basis for a design project's direction, design and development. The content of briefs has adapted to changing management practices, however, until now, no concerted effort has been made to make a brief that improves design team performance. We introduce the Inspirational Design Brief, by first describing the development of the approach, reviewing not only academic papers but also a wide variety of professional design briefs from industry and industry-sponsored projects. Next, we clarify the Inspirational Design Brief's role in bridging business and design; demonstrating with empirical evidence that the Inspirational Design Briefing outperforms current practices and discusses how Inspirational Design Briefings can align with the conventional design process in theory and practice. Finally, we offer suggestions as to how design briefs can be utilized in other business domains, such as the artistic fields and startups.

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2.8

CREATIVITY AND IDEA GENERATION (2)

CHAIR
Francesca Montagna

TUESDAY
28
JUL

3:15 pm
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4:15 pm

BL27.8

EVALUATION METHOD WHICH PROMOTE CREATIVITY: CASE STUDY ABOUT ERGONOMIC DESIGN IN POINTING DEVICES | *Mohammad Hossein Namayandegi*

Tehran University of Art, Islamic Republic of Iran

Findings from multiple studies demonstrated large effects of using computer mouse and also some other types of pointing devices on developing Cumulative Trauma Disorders (CTD). The main cause of these injuries considered being user's non-ergonomic posture. In fact, using most pointing devices involves pressure on nerves at entrapment points, increased neural tension and use of muscles while contracted. Accordingly, wide range of pointing devices are developed regarding to ergonomic design issues and to modify user's body posture but the classic mouse still remains the most popular device. This paper tried to evaluate available pointing devices in the market regarding to users favorites and ergonomic design factors through an analytical process which promote creativity, and then explore the limitations and possibilities for developing new design solutions. This hypothesis also examined that the most of computer users resist any big modification in their posture; therefore they tend to use pointing devices which are more consistent with their previous daily experiences and looks more natural from their perspective.

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2.9

HUMAN BEHAVIOUR IN DESIGN CASE STUDIES

CHAIR
Francesco Ferrise

3:15 pm
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BL27.12

A SENSOR DESIGN AND DATA ANALYSIS FOR AUTOMATIC DRUM BEATER WINDING

Yuchen Zhao (1), Teegan Johson (2), Yee Mey Goh (1)

(1) Loughborough University, United Kingdom; (2) Cranfield University, United Kingdom

In the percussion music industry, drum beater manufacturing requires a skilled operator to manually wind the beater with acrylic yarn. Tacit skill is used to control and adapt tension during the winding process of beater construction, which cannot be easily articulated. Consequently the operator has been unable to successfully pass the skill on. In order to overcome this problem, an investigation into automating the drum beater winding process has been initiated. An in-depth human task analysis was performed to identify the skill-, rule-, and knowledge-based tasks during the winding process. In this paper, the two key parameters, yarn tension and patting force reported by the human task analysis during the manual process are further studied. The patting force has been measured and analysed for the low-level control unit. A tension measurement sensor has been designed and substrate has been simulated. This sensor will be used to measure yarn tension during the manual winding process and further work will be carried out to analyse the results for tension control mechanism.

CHAIR
Francesco Ferrise

HUMAN BEHAVIOUR IN DESIGN CASE STUDIES

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2.9

TUESDAY
28
JUL

3:15 pm
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BL27.12

BARRIERS TO HINDER COLLABORATION WITHIN PRODUCT DEVELOPMENT TEAMS FROM DESIGNERS' PERSPECTIVE AND THE DEVELOPMENT OF A METHOD TO FACILITATE THE COLLABORATION | *Yeonghun Kim (1), Chajoong Kim (2), Kwangmin Cho (2), Kwanmyung Kim (2)*

(1) Korea Institute of Design Promotion, South Korea; (2) UNIST, South Korea

To be successful in the market, industries have kept trying to increase users' satisfaction with their new products. Under this circumstance, firms have realized the importance of collaborative environment in which different team members closely work together, to meet rising expectations of the users. Although multi-disciplinary teams have been developed with such great optimism, inevitable conflicts are frequently occurred between different team members. However, it has been hardly studied how well the collaboration within a product development team is being done. Therefore, this study aims to reveal barriers to hinder collaborative environment. To figure out the causes of conflicts within the teams, we interviewed design practitioners in multi-disciplinary product development teams. Through the interview five common causes of conflicts and newly emerging conflicts were identified. The findings led to the development of a collaborative toolkit to facilitate the collaboration within a multi-disciplinary team. The usability of the toolkit was evaluated through an expert interview and a focus group interview. The implications and a further study are discussed as well.

A COMPARATIVE STUDY ON THE ROLE OF MODELS AND PROTOTYPES IN HUMAN-CENTERED DESIGN VERSUS DESIGN-DRIVEN INNOVATION APPROACHES

Siti Salwa Isa, Andre Liem

Department of Product Design, Norwegian University of Science and Technology, Norway

In search for meaningful and radical innovations, many authors comply with the understanding that User-Centered Design lead to incremental innovation. However, opposing views are prevalent among design researchers, when discussing and comparing the innovation impact between Human-Centered Design and Design-Driven Innovation approaches. Some researchers claim that Human-Centred Design methods contain a significant facilitative value for achieving radical innovation, because of their participatory and design led characteristics. However, this is contested by another group of researchers, who are convinced that to realise breakthrough innovation, user involvement, whether participative or not, is not sufficient. The aim of this article is to discuss on how models and prototypes can be applied in Design-Driven Innovation, as well as how they can facilitate a more explorative and creative approach towards idea and concept generation in a Human-Centered Design. Results indicate that active engagement through models and prototypes enables designers, stakeholders and interpreters to gain first-hand experience with existing or future design contexts.

DESIGN AS THE RESOLUTION OF PARADOXES: AN EXPLORATORY STUDY

Thea Morgan, Chris McMahon

University of Bristol, United Kingdom

This paper presents an ethnomethodological case study of a student engineering design team during their final year design project. The results were analysed with reference to a theoretical framework, based on Dorst's (2006) model, in which "a 'design problem' is taken as a paradox, made up out of the clash of conflicting discourses" and "the nature of creative design is the forging of connections between these discourses". Three key discourses emerged from the data, that of the 'commercial sponsor', the 'university', and the 'student group'. It is suggested that the 'commercial sponsor' and 'university' discourses were in conflict, forming the 'central paradox' at the heart of the design problem. The student group failed to resolve this paradox, and went on to significantly underachieve in their design project.The aim of this research was to explore and describe the complex ways in which design emerges in practice, using Dorst's model of design problems as a theoretical framework. The framework has proved a useful and insightful way of considering how design occurs naturally in interactions between people.

CHAIR
James T. Allison

INVESTIGATING THE SUSTAINABILITY OF PRODUCT SUPPLY CHAINS

Michele Germani, Marco Mandolini, Marco Marconi, Eugenia Marilungo, Alessandra Papetti

Università Politecnica delle Marche, Italy

According to the growing pressure on Sustainability issues from governances, manufacturing industries must pay their attention to optimize their processes. Anyway, it is necessary go behind this preliminary approach, extending the boundaries from the single company to the other actors that operate in the same supply chain. In this context, the paper proposes a methodology to increase the sustainability and to guarantee the traceability along the whole product supply chain. The methodology allows to model any supply chain, through the data collection from all the actors involved, and to measure the environmental sustainability, through the implementation of a distributed software system. The experimental case study, which involved a leather shoe supply chain, allowed to demonstrate the effectiveness of the approach in the selection of suppliers and in the optimization of the supply chain, taking into account the environmental aspects together with the other constraints such as design, costs and quality.

DEGREES OF CUSTOMIZATION AND SALES SUPPORT SYSTEMS - ENABLERS TO SUSTAINIBILITY IN MASS CUSTOMIZATION | *Paul Christoph Gembarski, Roland Lachmayer*

Leibniz Universität Hannover, Germany

For more than 20 years, mass customization proofed as valuable business strategy to manufacture goods tailored to a customer's needs with nearly mass production efficiency. After pointing out key characteristics of the MC business model using the product-process change matrix we discuss modular product architectures and process stability with regard to sustainability. As tools for translating customer needs into technical specifications a classification of sales support systems is presented where catalogues, query forms, sales configurators and choice navigation systems are characterized. After this we define as different degrees of customization 'tuning', 'cosmetic', 'set-up', 'composition', 'aesthetic co-design' and 'function co-design' and compare them by their impact on the value chain. Depending on market needs and the over-all business strategy both issues can be addressed as enablers for sustainability in the mass customization business model.

INTERACTION DESIGN FOR SUSTAINABLE MOBILITY SYSTEM

Andrea Gaiardo, Andrea Di Salvo

Politecnico di Torino, Italy

This paper presents the results and the methodology carried out by the research group of the Department of Design and Architecture at the Polytechnic University of Turin the field of Interaction Design for sustainable mobility. These two apparently dissociated disciplines found the contact point in a three-year research project between the university and a car company R&D department of the Italian territory: Centro Ricerche Fiat. The cooperation has produced an innovative approach to sustainable mobility and different concepts in the field of Human Machine Interaction (HMI).

CHAIR
James T. Allison

DESIGN FOR A SUSTAINABLE LIFE
DIMENSIONS OF SUSTAINABILITY

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TUESDAY
28
JUL

4:45 pm
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BL27.14

MEETING SUSTAINABILITY CHALLENGES: SOFT SYSTEMS THINKING AS AN ENABLER FOR CHANGE | *Åsa Ericson, Johan Holmqvist*

Luleå University of Technology, Sweden

There are three dimensions of sustainability: environmental, economic, and social. One important task is to integrate them so as to identify how more sustainable paths can be identified, assessed, and decided upon. Previous research has identified systems thinking as a key to achieving this. The purpose of the paper is to build on these ideas and to propose an initial framework that demonstrates the potential of incorporating soft systems methodology and a theory of modalities, introducing aspects in addition to environmental, economic, and social ones. Moreover, theoretical exploration shows that understanding different predispositions, or worldviews, are vital to creating shared and purposeful actions. This paper expresses the intentions of a pre-study, and the ideas are far from mature; however, the importance of collaboration in shared and more sustainable actions is the basis for an industry-wide initiative called the Construction Climate Challenge (CCC).

CHAIR
Kilian Gericke

DESIGN THEORY AND METHODOLOGY
NEW APPROACHES (1)

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3.2

4:45 pm
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BL27.13

AN APPROACH FOR INDUSTRIAL APPLICATION OF AXIOMATIC DESIGN

Jakob Weber (1), Johannes Kößler (2), Kristin Paetzold (2)

(1) Daimler AG, Germany; (2) Universität der Bundeswehr München, Germany

This paper presents an Axiomatic Design based approach which aims to simplify the application of this methodology in everyday working life of engineers. As a basis Axiomatic Design Theory is chosen because of its clear representation of dependencies of functional requirements. This provides a good control for designers if their design maintains functional independence and therewith the principles of good design. Based on the original methodology a new shortened procedure has been developed. The focus of this procedure has been set on applying Suh's independence axiom on the most abstract levels during decomposition of the design task. The presented procedure is meant either as first steps into a complex design methodology or as a kind of approximation in early design phases. This approximation can be detailed to a full Axiomatic Design approach during the following design steps. The effects of using this shortened approach have been evaluated by carrying out a common design task. Finally the results of this evaluation have been discussed critically.

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DESIGN THEORY AND METHODOLOGY NEW APPROACHES (1)

CHAIR
Kilian Gericke

TUESDAY
28
JUL

4:45 pm
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BL27.13

HOW MUCH DESIGN DOES RESEARCH NEED: AN INQUIRY OF THE SYNERGETIC POTENTIAL OF METHODS OF SOCIAL AND DESIGN RESEARCH

Sandra Dittenberger, Andrea Koscher

New Design University, Austria

This paper presents the findings of a study with end-user involvement with the ultimate goal to test the synergetic potential of methods of two different research realms: on the one hand methods of qualitative social research and on the other hand methods of design research. The case for the appliance of this new mixed methods approach is the end-user requirements engineering phase 1 for the research project RelaxedCare, organized and co-funded within the Ambient Assisted Living (AAL) Joint Programme of the European Commission. The purpose of the project is to develop solutions and products to connect elderly persons (assisted persons) and their relatives/friends (informal caregivers) in order to create a more relaxed care situation. AAL projects use in general quantitative and qualitative methods of social research for accessing user requirements. For the phase 1 of the end-user requirements engineering methods of both areas are chosen to find out if a trans-disciplinary research approach would reveal more significant findings concerning their translation in a holistic product development process and aim at creating a “best of both” research methodology.

A SEARCH AND OPTIMIZATION PERSPECTIVE ON CONCEPTUAL DESIGN

Ehud Kroll, Gil Weisbrod

Technion, Israel

Conceptual design using the method of Parameter Analysis is related in this paper to the tree structure formed in C-space of C–K Theory. This, in turn, leads to an analogy to the search tree in branch-and-bound optimization. We show that the classical branch-and-bound method can be generalized to include a dynamic and expanding state space, operators as design moves that are not pre-defined, and a cost function that consists of learning-based evaluation of the artifact. The generalized branch-and-bound modeling can be used as a well-understood notional framework to study and compare human design methods and to develop computerized design assistants.

ATTRIBUTES IN INTEGRATED DESIGN ENGINEERING - A NEW WAY TO DESCRIBE BOTH PERFORMANCE CAPABILITY AND BEHAVIOUR OF A PRODUCT | *Sandor J. Vajna*

Otto-von-Guericke University Magdeburg, Germany

Integrated Design Engineering (IDE) is a human-centred and multidisciplinary development approach that integrates products and their lifecycle phases, processes, organisations, knowledge, and information. One of the features of IDE is to describe both performance capability and performance behaviour of a product with different but equivalent and equally important attributes. These are structured into product attributes, performance attributes, and economic attributes. Due to this diversity, IDE attributes offer significantly more and better ways to describe and to develop a product exactly according to various requirements, which are based on the needs and desires of customers, on the different environments in which the product is to be used, and on the respective conditions to which the product must comply. This paper gives an introduction to the IDE attributes and describes how to work with them.

CHAIR
Serena Graziosi

USER BEHAVIOUR AND PERCEPTION (1)

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TUESDAY
28
JUL

4:45 pm
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BL27.3

DYNAMIC PRODUCTS: AN INSTRUMENT FOR SAVING RESOURCES. IMPROVE USER'S AWARENESS THROUGH DESIGNING PRODUCT EXPERIENCES | *Sara Bergamaschi*

Politecnico di Milano, Italy

Nowadays, householders hear about the need to reduce their resources consumption, but they are still not really conscious about the amount of their daily usage.Studies proved that giving to householders clearly feedback can help them to be more aware about their consumptions and they can positively motivate users to not waste resources.In this context the role of the industrial designer seems to be marginal, but thanks to new materials and technologies, designers can create artifacts more attractive and fascinating for engaging users, such as designing Dynamic Products. The aim of this research is to investigate Dynamic Products as a medium for transmitting information about resources’ consumptions. In the first step of this study, a literature research has been performed in order to identify the characteristics of the information that have to be conveyed; in the second step those findings have been compared to previous researches on Dynamic Products for exploring advantages and limitations in this field. In this study an important role of industrial designers has been emerged, who can help users to be more aware about their consumption creating new engaging product experiences.

A STUDY ON CONSUMER TREND AND SERVICE INNOVATION IN KOREAN MARKET

Kyungmi Ahn, Kee-Ok Kim, Hyunjin Sung

Sungkyunkwan University, Korea, Republic of South Korea

In the economic condition of the day, it is very difficult to meet customer’s demand as it has diversified. Therefore a new idea should be created based on a profound research on the consumers rather than on a simple marketing strategy and product development as up to now. As a result, a new field, service design, has been developed, and many businesses have tried to identify customer’s inner demand and sentiment. In recent, South Korean shows the most rapid increase in the supply and usage of the internet in the world. Korean Ministry of Trade, Industry and Energy stress that business should attempt to understand how technology affects people’s lives and come up with creative products in reponse to changes in consumer need. Beside of other design research, studying consumer trend can be a basic foundation to understand the consumer needs. In this study, the domestic consumption patterns that have been shown of late are analyzed. New and interesting service innovation cases were also introduced in accordance with the consumer trend and lifestyle change.

BEHAVIOUR-ATTENTIVE PROTOTYPING OF A DESIGN AND SIMULATION SYSTEM FOR IC CHAMBERS | *Yuemin Hou (1),(2), Imre Horvath (3), Zoltan Rusak (3), Linhong Ji (1), Yunchun Sun (1), Jia Lin (1)*

(1) Tsinghua University, China; (2) Beijing Information Science & Technology, China;

(3) Delft University of Technology, The Netherthands

This paper proposes a method of behaviour-attentive prototyping (BAP). BAP differentiates an approach of prototyping that provides a comprehensive description of the main features of the evolving system based on the conjoint behaviours of users, computers, and the designed system. The goal of BAP is to produce a rough working model of the designed system. The method has been developed with a view to and is intended to be used primarily, but not exclusively, in the early development of design systems of processing chambers of integrated circuit (IC) equipment. The method uses a behaviours tracking strategy. It involves five steps: (1) construction of behaviour space; (2) reasoning with the sequence of behaviours; (3) behaviour decomposition; (4) behaviour prototyping; (5) validation on computer. The BAP approach is interested not only in how the system is configured and manifest, but also in what it operates and how it behaves.

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3.3

USER BEHAVIOUR AND PERCEPTION (1)

CHAIR
Serena Graziosi

TUESDAY
28
JUL

4:45 pm
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BL27.3

IDENTIFYING THE FACTORS TO INFLUENCE PRODUCT ATTACHMENT THROUGH PRODUCT FANDOM PHENOMENON | *Jieun Bae, Chajoong Kim*

UNIST, South Korea

Users become attached to particular products or services since they convey a personal meaning. According to literature study, four factors play a role in product attachment. However, it has not been known how those factors influence product attachment because product attachment varies between products as well as between users. Therefore, this study aims to investigate 1) the relationship between the four attachment determinants and product fandom, and 2) what product features play a role in product attachment, focusing on product fandom that represents an ultimate level of product attachment. Two online product fandom communities were chosen: one for capsule coffee machine (single functional product) and the other for iPhone (multi-functional product). An on-line questionnaire survey was conducted with the communities and a total of 88 respondents participated in the survey. The results of the study indicate that 'pleasure' among the factors of product attachment was the major reason attached to the products. It turned out product features and multi-functionality of product are also involved in product attachment. The implications to the industry are discussed as well.

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3.4

DESIGN FOR X, DESIGN TO X DESIGN FOR MANUFACTURING (1)

CHAIR
Stephan Husung

4:45 pm
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BL27.4

METHODICAL SUPPORT FOR CONCURRENT ENGINEERING ACROSS PRODUCT AND PRODUCTION (SYSTEM) DEVELOPMENT | *Pascal Stoffels, Michael Vielhaber*

Saarland University, Germany

Today, the implementation of concurrent engineering is further progressed on a strategic level than on operative level. Methods connecting both domains, product and production (system) development, are not yet advanced in order to fully exploit the potentials for cross-domain targets, e.g. minimization of the lifecycle energy consumption. This contribution describes a scientific formalization how product characteristics and production system characteristics depend on each other. Furthermore, a method that enables the multidimensional evaluation of product solutions with production system solutions is introduced in order to support decision making process in early product and production (system) development phases. The result of the method provides a combination of optimized solutions for product and production system.

CHAIR
Stephan Husung

DESIGN FOR X, DESIGN TO X DESIGN FOR MANUFACTURING (1)

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3.4

TUESDAY
28
JUL

4:45 pm
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ASSESSING TIME-VARYING ADVANTAGES OF REMANUFACTURING: A MODEL FOR PRODUCTS WITH PHYSICAL AND TECHNOLOGICAL OBSOLESCENCE

Minjung Kwak (2), Harrison Kim (1)

(1) University of Illinois at Urbana-Champaign, United States of America; (2) Soongsil University, South Korea

For a successful remanufacturing, it is important to ensure in advance that a product is suitable for remanufacturing and that a remanufactured product will provide greater economic and environmental value than a brand-new product. This paper provides an approach to estimate the economic and environmental advantages of remanufacturing. Focusing on the fact that advantages are greatly influenced by the nature of a product, i.e., its design and lifetime characteristics, as well as the timing of remanufacturing, this paper proposes a model for assessing the time-varying advantages of remanufacturing. The model provides an objective, quantitative method to compare a remanufactured product with an equivalent brand-new version from three perspectives: unit production cost, environmental impact, and net profit. It also defines a set of conditions under which a remanufactured product will be more profitable than a brand-new product. The model is expected to help remanufacturers make informed and effective decisions concerning product design and remanufacturing strategies. To illustrate, the developed model is demonstrated with an example of a desktop computer.

PRODUCT DEVELOPMENT IN LOW-VOLUME MANUFACTURING INDUSTRIES: CHARACTERISTICS AND INFLUENCING FACTORS | *Siavash Javadi, Jessica Bruch, Monica Bellgran*

Mälardalen University, Sweden

Product development process has a considerable effect on factors such as time to market and quality of product which are vital for manufacturing companies to remain competitive. Therefore, study of the factors which influence the product development process such as characteristics of products and production systems is necessary to support and improve the product development process. Since most of the studies have been conducted in the context of high-volume manufacturing industries, the influences of characteristics of low-volume products and production systems on the product development process in such industries have not been considered sufficiently. In this paper, characteristics of low-volume products and production systems, their inter-relations and their influences on the product development process have been studied through a multiple case study. A general map of characteristics of low-volume products and production systems and their inter-relations was presented in this paper. Moreover, the influences of these characteristics on product development process including the reduced complexity of the process and lack of opportunities for test and refinement were discussed.

MODELING FACTORY SYSTEMS USING GRAPHS - ONTOLOGY-BASED DESIGN OF A DOMAIN SPECIFIC MODELING APPROACH | *Christian Plehn, Florian Stein, Gunther Reinhart*

Technische Universität München, Germany

Changeable factory systems are a viable strategy for manufacturing companies to cope with dynamic and uncertain environments, characterized by frequent engineering changes, product and technology innovations, and continuous improvement initiatives often resulting in changes of factory systems. Flexibility and changeability are considered beneficial properties helping to be prepared for the various possibilities of an uncertain future. To support the analysis of these system properties, suitable modelling techniques are required covering both structural and element properties. Hence, the objective of this paper is to provide a graph-based domain specific modelling approach for factory systems. Metamodels for nodes and edges are suggested based on metamodel and ontology design theory and an extensive review of factory planning literature. The approach is demonstrated by modelling a simple compressor shaft workshop production. Finally, promising application perspectives of the graph-based modelling approach are outlined.

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3.5

DESIGN METHODS AND TOOLS EARLY PHASES (2)

CHAIR
Peter Törlind

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.5

THE VALUE OF PROTOTYPES IN THE EARLY DESIGN AND DEVELOPMENT PROCESS

Siti Salwa Isa (1), Andre Liem (1), Martin Steinert (2)

(1) Department of Product Design, Norwegian University of Science and Technology, Norway;

(2) Department of Engineering Design and Materials, Norwegian University of Science and Technology, Norway

Prototypes are considered to be efficient tools in engineering design as they help to reveal flaws in ideas and concepts, highlighting problems to be solved. Limited research has been conducted in detail about prototyping activities that have contributed to the increase of designers' ideas in the design process. This study explores the use of prototypes to generate more ideas compared to the designers that were not involve with prototypes in design process. It also investigates how prototypes enhance designers' idea by involving 45 participants in three separate groups in early ideation and concept development process. The aim of this paper is to explore the ability of prototyping to produce creative and innovative ideas in the conceptual phase of design process. Results indicated that the group of participants who were involved with prototypes in their design process produced more amount of ideas compared to the group who did not use it. It also shows prototypes helps designers to generate more creative and innovative ideas.

AN AUTOMATED FUNCTION DECOMPOSITION METHOD BASED ON A FORMAL REPRESENTATION OF SOLID MATERIAL'S SHAPE | *Lin Yuan (1), Zhinan Zhang (2), Yusheng Liu (1)*

(1) Zhejiang University, People's Republic of China; (2) Shanghai Jiao Tong University, People's Republic of China

The objective of this work is to develop a formal representation of the material flow's shape in the conceptual design stage, specifically to meet the needs of function modelling in order to support the function decomposition of working machines. A hierarchical shape graph (HSG) is used to abstract the structure of shape elements for a material flow's shape. Based on the semantic information contained in the input/output material flow's HSG model, the global shape change of a material flow is decomposed to several local relation changes between shape elements. Moreover, a planning algorithm is proposed to support finding a feasible sub-function execution sequence for achieving the shape change function. Finally, a knowledge representation scheme is developed for action, which is the principle solution to bridge the result of system level function decomposition and the design of mechanism motions. The representation and automated decomposition process have been implemented based on IBM Rhapsody platform.

A BAYESIAN NETWORK APPROACH TO IMPROVE CHANGE PROPAGATION ANALYSIS

Jihwan Lee, Yoo S. Hong

Seoul National University, Republic of South Korea

Predicting and analysis of change propagation is one of the important issues in engineering change management. In this paper, we illustrate how the Bayesian network (BN), which is emerging tool for a wide range of risk management, can be used in change propagation analysis. The paper compares BN with most popular tool for change propagation analysis, namely CPM. Firstly, we show that CPM can be directly converted into an equivalent BN. In addition to this, we also show that BN has significant advantages over CPM at both modeling and analysis level. In the model-ing level, various assumption over CPM can be relaxed and various kinds of modeling exten-sion can be accommodated with BN. At the analysis level, BN's ability to performing probabilistic inference provides a user with another interesting measures, which cannot be obtained with CPM. Moreover, BN provides robust framework for learning change propagation probabilities from empirical data. Our method can enhance the capability of engineering change management throughout entire product life-cycle.

CHAIR
Peter Törlind

DESIGN METHODS AND TOOLS EARLY PHASES (2)

D
3.5

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.5

DIGITAL INTERMEDIARY OBJECTS: THE (CURRENTLY) UNIQUE ADVANTAGE OF COMPUTER-SUPPORTED DESIGN TOOLS | *Andrea Luigi Guerra (1),(2), Thierry Gidel (2), Enrico Vezzetti (1)*

(1) Politecnico di Torino, Italy; (2) Université de Technologie de Compiègne, France

The TATIN and TATIN-PIC projects lies at the crossroads of preliminary design and Computer Supported Cooperative Work in Design (CSCWD) tools. Those projects studied the impact of multi-touch, multi-users tabletop groupware for co-located teamwork. The projects aim was to observe an improvement of the effectiveness of the preliminary design process when mediated by a CSCWD tool. Along 4 years several design observations have been conducted on specific design methods; each result have been presented independently during past Design Society conferences. This paper regroups and synthesizes all those results to draw a holistic conclusion. Digital intermediary objects represent the (currently) unique advantage of such CSCWD tools, as well as their greatest potential. Digital boosts their traditional role of inter-mediator improving teamwork's perceived productivity and confidence in the results, and open a wide range of possibilities like the interaction with AI systems.

CHAIR
Bernard Yannou

DESIGN ORGANISATION AND MANAGEMENT PROJECT MANAGEMENT

D
3.6

4:45 pm
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5:45 pm

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ENVISIONING PRODUCTS TO SUPPORT THE AGILE MANAGEMENT OF INNOVATIVE DESIGN | *Fábio Henrique Trovon de Carvalho, Janaína Hornos Mascarenhas da Costa, Daniel Capaldo Amaral*

University of Sao Paulo, Brazil

Create a Product Vision is a challenge recognized for innovative design and it is a mandatory practice in the agile project management approach. The Product Vision Management Method (PVMM) was conceived to support this activity but it was tested with undergraduate students only. The aim of this paper is to present the results of two applications of the PVMM in a large worldwide company of consumer products. The aim of the analysis was to evaluate if the PVMM's deliverables fit the theoretical requirements of product vision, the compliance with the agility principles, or agility essence, and the designer satisfaction. The results reinforce some of the agile characteristics as guidance for innovation, collaboration, creativity, requirements progressive elaboration, iteration and value adding to customers. Among the conclusions are the identification of improvement opportunities to the method and new perspectives about how to create a product vision in innovative product design.

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3.6

DESIGN ORGANISATION AND MANAGEMENT PROJECT MANAGEMENT

CHAIR
Bernard Yannou

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.6

EXPLORING TENSIONS BETWEEN CREATIVITY AND CONTROL IN PRODUCT DEVELOPMENT PROJECTS | *Catarina Bojesson, Tomas Backström, Erik Bjurström*

Mälardalen University, Sweden

To sustain organizational performance in dynamic contexts, organizations must be able to change through innovation while still continuing to perform in the short term. Central to successful innovation is to understand and manage tensions, paradoxes, contradictions, and dilemmas. This paper will present empirical data from a single case study discussed in relation to institutional theory in connection to organizational tensions and conflicts. Results show examples of a strong focus on proactive approaches with attempts to control and manage product development projects in a strict manner, even though the organization is acting in a context characterized by uncertainty with a need for creativity and a reactive approach. This shows a lacking understanding of what is required of the project process in this context and the tensions created between the strict process control and the dynamic environment. Conclusions point at the need for both creativity and control in the management of product development projects. However, there is a risk of strong institutions preventing organizations from recognizing the need for change.

CONSTANT DRIPPING WEARS AWAY THE STONE: LINKING DESIGN THINKING AND EFFECTUAL ACTION IN DESIGNING NEW VENTURES

Anja Niedworok (1), Stephan Schloegl (1), Peter J. Mirski (1), Rudolf Greger (2), Marcus Ambrosch (3)

(1) MCI Management Center Innsbruck, Austria; (2) GP Design Partners, Austria; (3)Ambrosch, Austria

In this paper we explore how to intertwine designers' work and problem solving approaches with effectuation. At a first glance, establishing effectuation as the overlap between an entrepreneurial spirit and a certain design mindset seems to be rather obvious. Taking a closer look, however, it calls for further research, in particular to clarify the applicability of such a concept. The goal of our research is therefore to explore how designers' work approaches and design thinking tools may support companies in designing their business in the early start-up phase. As playground for these investigations we use a third-party project, which strives for initiating, fostering and integrating design orientation and effectual action into the strategy process. Our project partners developed a series of workshops in which the participants get to know the underlying concepts and methods. As evaluation methodology we use semi-structured interviews. Our current results indicate that while a sustainable integration of this concept requires a clear presentation of the effectuation principles, ongoing exposure demonstrates the potential to change the future entrepreneurial behavior.

CONSTRUCTING A MULTI-DIMENSIONAL MODEL TO UNDERSTAND TEAM DESIGN THROUGH LANGUAGE | *Jiang Xu, Feng Guo, Xiang Gan, Xiuyue Wang*

Southeast University and Monash University joint graduate school, People's Republic of China

As the support for creative design of complex products, multi-disciplinary team design has always been the focus of researches on design. By taking language as the data resource in design, a multi-dimensional model called linkage which represents the design process in dimensions of the time, the math and the space is proposed. On the basis of traditional research, the process of team design has been transformed into the forms of linkograph, colored-linkograph, matrix and network. Defining the colored-linkograph, the code vector and the link matrix, and introducing the clustering of network, the multi-dimensional representation of the whole design process can be realized. This model disruptively reconstructed the representation of design cognition space and realized the data-driven reasoning and visualization.

CHAIR
Filippo Arnaldo Salustri

PRODUCT MODULARISATION METHODS AND TOOLS (1)

D
3.7

TUESDAY
28
JUL

4:45 pm
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5:45 pm

BL27.7

BROWNFIELD PROCESS FOR THE RATIONALISATION OF EXISTING PRODUCT VARIETY TOWARDS A MODULAR PRODUCT FAMILY | *Jarkko Pakkanen, Tero Juuti, Timo Lehtonen*

Tampere University of Technology, Finland

Modularisation, product platforms, product families and product configuration are efficient product structuring tactics for providing of product variants for customers. This paper studies how the design information related to designing of modular product family that supports product configuration can be structured and how to support defining of this kind of design information in a design situation in which existing product assortment should be rationalised towards a modular product family that supports product configuration. Research approach bases on literature review and empirical findings. Categorisation to five design information elements including partitioning logic, set of modules, interfaces, architecture and configuration knowledge is suggested. Existing methods consider partly or as different combinations these elements but considering of all of them is rare although all of them have been recognised as important. Thus a design method known as the Brownfield Process is introduced. Steps of the method are tested in industrial cases. As a conclusion we state that the method can be applied also to other cases in which rationalisation of existing product assortment is sought.

INDEX-BASED METRICS FOR THE EVALUATION OF EFFECTS OF CUSTOM PARTS ON THE STANDARDIZATION OF MECHANICAL SYSTEMS | *Pavlos Christoforos Sinigalias, Argyris Dentsoras*

University of Patras, Greece

The number and the attributes of custom parts affect significantly the standardization level of mechanical systems and determine their functional characteristics and their value. In the present study, a part classification scheme and a calculation procedure are introduced that enable systematic adaptation and standardization of custom parts during in-enterprise design and manufacturing processes. The level of standardization of the mechanical system under consideration is evaluated via metrics represented by a composite standardization index derived from the combination of two (2) partial indices, namely an index that represents the absolute attribute-based standardization of each part of the system and a second index that represents the degree of commonality for different parts and/or assemblies for the same system. The proposed approach leads to a more reliable evaluation of standardization levels by taking into account all in- and out-of-enterprise available standard resources and provides a framework that promotes design-for standardization processes. Additionally, it contributes towards more efficient and functional products and decreases design and manufacturing costs.

DESIGN FOR EMBODIMENT THROUGH SMART ARCHIVES

Francesco Rosa, Roberto Viganò, Edoardo Rovida

Politecnico di Milano, Italy

The design of a new product begins with functional analysis, and then continues with conceptual solution. Only in final and somehow separate stages, the designer has to embody and then to design in detail any part of the product. Even if the great majority of the recent developments in design methods and tools are devoted to the first two and more abstract steps of the product development process, as shown above, the last two steps are the among the more common activities of a design office, and are also the more time and resource consuming steps. These considerations apply not only to the design of a new product, but also to the very common re-design activity, where the past experience plays an important role in "suggesting" how to avoid "trouble". In order to overcome these limitations, the structure of an archive is presented, discussed and applied to a practical case study. This catalogue is the result of a tailoring process of an amalgamation of the Systematic Design catalogues with the aim of easing and anticipating the issues typically relegated to embodiment and detail design, in order to recognize as soon as possible practically unfeasible concepts.

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3.7

PRODUCT MODULARISATION METHODS AND TOOLS (1)

CHAIR
Filippo Arnaldo Salustri

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.7

EXPLORATORY RESEARCH ABOUT THE CUSTOMIZATION OR PERSONALIZATION OF ASSISTIVE PRODUCTS FOR WALKING | *Marcel Gois (1),(2), Guillaume Thomann (1),(2), Jeremiah Autreau (1)*

(1) Univ. Grenoble Alpes, France; (2) CNRS, France

This paper presents an exploratory study performed in the context of the assistive products for walking. The aim was to verify the applicability of design strategies to increase the users' perceived value via the offer of controlled levels customization. For that, lean principle of standardization and the taxonomy of customization levels from the mass customization approaches guided this study. These concepts focused the research into design patterns identification, allowing the use of combinatorial modularization. The efforts consisted in a technologic research made in Abledata and Assisdata AT databases, which resulted in a selection of 200 walking aids and accessories. After, their features were analyzed, with special attention to the products architecture. The investigation concluded that assistive products for walking are able to incorporate high levels of product customization. This may be implemented by the design of a flexible modular product body configurable in different ways. Thus, the product differentiation between canes, crutches and walking frames, for example, will be done by an adaptable body and the respective accessories to complete the product structure.

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3.8

INNOVATION METHODS AND TOOLS (1)

CHAIR
Anja Martina Maier

4:45 pm
-
5:45 pm

BL27.8

DESIGN DRIVEN INNOVATION – MINIMUM VIABLE PRODUCTS FOR LOCAL ENTREPRENEURSHIP IN NEPAL | *Martina Maria Keitsch*

Norwegian University of Science and Technology, Norway

Well-designed products and services link to the ability of designers of interpreting needs, but they often struggle getting valuable contributions from users when developing innovative products and services. Minimum Viable Products (MVPs) address this problem through a practice of connected leaning and development. MVPs are useful to test the utility of a product before making efforts to improve its usability and desirability. In this article, the value of the MVPs for a product development process is appraised within a case study on a local entrepreneurship project in Jharkot, Lower Mustang, Nepal. The case study shows that MVPs are not only interesting for mass-production or high-end design, but comprise a valuable tool for Micro- Small and Medium Enterprises (MSME) and frugal Innovation too. Among others, MVPs emphasize the importance of testing different prototypes, which is an interesting onset for future research on collaborative knowledge generation and co-operative decision-making between stakeholders.

CHAIR
Anja Martina Maier

INNOVATION METHODS AND TOOLS (1)

D
3.8

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.8

A WATER SAVING SOLUTION WITH A TRIZ BASED METHOD

Davide Russo (1), Christian Spreafico (1), Nicola Mores (2)

(1) University of Bergamo, Italy; (2) University of Pavia, Italy

The number and breadth of eco-improvement methods has been steadily rising over the past decades. However a lot of eco-friendly product are struggling to find their collocation on the market. This deficit is generally due to the high costs of the proposed solutions. TRIZ methodology offers a structured way to simplify a technical system, exploiting all resources within it and overcoming internal contradictions that could prevent his evolution. Unfortunately a complete TRIZ activity could be time-consuming and requires people skilled in the art. In the present paper, we propose a simplified scheme, conceived to facilitate the use of the resources, totally based on TRIZ. Not to substitute, but to get along and systematize eco-design. A case study is proposed to save water from the tap opening until hot water starts to flow, which is usually wasted. Starting from an Italian application (www.bluewatersaving.it) obtained through patent research, the method can make this solution cheaper and more robust. Considering that for a big house (120 m2, 4 people) the water saving is up to 120k litres per year, the benefit consequential to its adoption on the planet would be considerable.

PRODUCTION INNOVATION IN MANUFACTURING FIRMS: THE CASE OF SWEDISH SMES

Brenda Viveros-Eulogio (1), Anna Öhrwall Rönnbäck (1), Andres Ramirez-Portilla (2),(3)

(1) Lulea University of Technology, Sweden; (2) KTH Royal Institute of Technology, Sweden; (3) Politecnico di Milano, Italy

In this paper we explore how to intertwine designers' work and problem solving approaches with effectuation. At a first glance, establishing effectuation as the overlap between an entrepreneurial spirit and a certain design mindset seems to be rather obvious. Taking a closer look, however, it calls for further research, in particular to clarify the applicability of such a concept. The goal of our research is therefore to explore how designers' work approaches and design thinking tools may support companies in designing their business in the early start-up phase. As playground for these investigations we use a third-party project, which strives for initiating, fostering and integrating design orientation and effectual action into the strategy process. Our project partners developed a series of workshops in which the participants get to know the underlying concepts and methods. As evaluation methodology we use semi-structured interviews. Our current results indicate that while a sustainable integration of this concept requires a clear presentation of the effectuation principles, ongoing exposure demonstrates the potential to change the future entrepreneurial behavior.

INVESTIGATION AND SUPPORT OF EVOLUTIONARY DESIGN

Ralf Stetter (1), Stefan Möhringer (2), Joachim Günther (3), Udo Pulm (4)

(1) University of Applied Sciences Ravensburg-Weingarten, Germany; (2) Simon Möhringer Anlagenbau GmbH, Germany;
(3) University of Applied Sciences Munich, Germany; (4) BMW AG, Germany

Current research proposes a distinction between evolutionary and revolutionary approaches aimed at supporting design. Earlier investigations showed that in design of one-off products but also serial production products evolutionary processes can frequently be identified. However, one important insight of the presented research was also the identification of a lack of research into evolutionary design processes. This paper aims to address this discrepancy by means of an analysis of different sources of insight concerning evolutionary design. This sources range from a literature review of analyses of single designers and design teams over observations of design teams in design education to three kinds of design in industrial practice: design of one-off products and of serial products (hand-held construction tools and automotive components).

CHAIR
Saeema Ahmed-Kristensen

PLM IMPLEMENTATION: CASE STUDY

Nenad Bojcetic, Damir Salopek, Dorian Marjanović

University of Zagreb, Croatia

Nowadays modern company that strives to excel in an ever growing competitive market has to embrace new technologies. One available technology that can distinguish a company from others and bring about advantages is the Product Lifecycle Management (PLM). The Product lifecycle Management is the management of all product related information and processes. The PLM system through database technology and intranet or internet network manages the production process in all product-related information and processes. This article brings a case study of the ongoing implementation of the PLM system in a company that produces power transformers engineered to order. The process and the experience gained in the implementation of PLM software are presented.

STUDY OF THE EFFICIENCY OF PRODUCT DEVELOPMENT TEAMS THROUGH COMBINED VIRTUAL COMMUNITIES OF PRACTICE, PLM AND SOCIAL MEDIA TECHNOLOGIES

Nancy Doumit (1), Clément Fortin (2), Gregory Huet (3)

(1) Ecole Polytechnique de Montréal, Canada; (2) Skolkovo Institute of Science and Technology, Russia; (3) PTC Inc.

With globalization and increasing product complexity, manufacturing industries are experiencing increased user demands to incorporate informal exchange mechanisms especially when it comes to international groups and multifunctional products where collaboration is much more difficult. The article looks at industrial case studies within a global manufacturing company involving established communities of practices and Enterprise Social Media (ESM) technologies to see how these could possibly be combined eventually with PLM tools to improve the productivity of large product development teams. The results of surveys based on geodistant product development teams are presented. Then, a Social Network Analysis (SNA) tool is evaluated to represent the product development team dynamics and a brief overview of Social PLM functionalities is presented. The study indicates that the role of communities of practice and their moderators supported by ESM technologies can effectively complement the formal product development process commonly supported by PLM systems based on 3D mock-ups and other Data Management Systems.

PLM-MES INTEGRATION TO SUPPORT COLLABORATIVE DESIGN

Gianluca D'Antonio, Joel Sauza Bedolla, Paolo Chiabert, Franco Lombardi

Politecnico di Torino, Italy

In order to deal with global competition, manufacturers have to develop innovative, sustainable, high added-value, high quality products. Cooperation among companies is necessary to share product development capabilities, costs and potential risks. Information systems such as PLM, ERP and MES must be deployed and reciprocally integrated to improve the efficacy of this collaboration. In this paper, we focus on PLM-MES cooperation: the former system manages relevant product information to meet client specifications; the latter analyzes real-time data collected at the shop-floor (e.g. through a set of sensors installed on the machines) and extracts useful data concerning the "as-is" state of the process or product. The information generated by MES can be used as a feedback to redesign or revise manufacturing operations, in order to enhance the quality of the product and the performance of the production process. This experience-driven knowledge must be integrated in the PLM, to be available for future production, even in different places or for cooperating companies. In this paper, we show an application in the field of aeronautics, in which produced parts must meet very high quality.

CHAIR
Saeema Ahmed-Kristensen

DESIGN INFORMATION AND KNOWLEDGE PRODUCT MODELS AND PLM

D
3.9

TUESDAY
28
JUL

4:45 pm
-
5:45 pm

BL27.12

A SUSTAINABLE PRODUCT MODEL

Kiyan Vadoudi, Nadège Troussier

University of Technology of Troyes, France

There are major challenges for the designer to include Sustainable Development aspects into product design activities; particularly related to the social and wider environmental aspects. One way of giving a more accurate meaning to sustainability is the territorial understanding of the term. A territorial interpretation can make sustainability a more articulate, current, and pragmatic theory. Literature review shows that the existing product design approaches are mostly general at global level and very little attention has been paid to integrate territorial characteristics into product information-modeling. Despite, in recent years, some agriculture products having been designed and developed based on territorial specifications, but this approach is needs to be expanded with other types of products. Therefore, in this paper we describe a general product information-modeling framework that we believe can help designers to optimize product performance in the design phase by taking into account territorial conditions and requirements. The framework is based on the Core Product Model (CPM) which is extended with geographical and environmental data models.

CHAIR
James T. Allison

DESIGN FOR A SUSTAINABLE LIFE USER PERSPECTIVES

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4.1

6:00 pm
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7:00 pm

BL27.14

BRINGING A FULLER SOCIO-TECHNICAL PERSPECTIVE TO DESIGN DECISIONS

Vasilije Kokotovich

University of Technology Sydney, Australia

More often than not Designers and Design Engineers, tend to focus on Techno-physical aspects as they move through their design process. It is argued even the smallest and seemingly benign design decision, during the design process, may have a large and significant impact upon issues outside of the techno-physical focus [i.e. sustainability]. The paper will draw upon the idea within the technological change literature that it is not merely technologies advancing at and exponential rate but non-technical issues are increasing as well. There is a strong relationship between technology, society, and the environment. This paper will frame and discuss our need to educate future Designers/Design engineers to consider technical issues in parallel with larger issues generally considered to be outside the domain of Design / Design engineering. If we are able to find methods that assist both our present and future designers to become "Active Players" in seriously considering how we impact larger socio-cultural issues, which include notions of sustainability, we may embed a full/rich Socio-Technical Perspective within every aspect of our design decisions, and the outcomes we generate.

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DESIGN FOR A SUSTAINABLE LIFE USER PERSPECTIVES

CHAIR
James T. Allison

TUESDAY
28
JUL

6:00 pm
-
7:00 pm

BL27.14

FIRING UP SUSTAINABLE BEHAVIOUR

Johannes Daae (1), Casper Boks (1), Franziska Goile (2), Morten Seljeskog (2)

(1) Norwegian University of Science and Technology, Norway; (2) SINTEF Energy AS, Norway

For many products there is a substantial potential for reducing environmental impacts by altering the way people interact with them. The current work investigates the potential for improving the way people interact with woodstoves, thereby reducing the environmental impact resulting from burning firewood, by adjusting the design of the woodstove. The paper describes a complete user centred Design for Sustainable Behaviour process, from initial ethnographic studies, through the design process, to a comparative testing of a prototype and a regular woodstove monitoring emissions and user behaviour. The test indicates that the prototype is used much more in line with the recommendations and emitted 35% less particles than the conventional stove, and thus indicates the successfulness of the applied approach.

DESIGN FOR SUSTAINABILITY – TRADE-OFF DILEMMAS FROM THE CONSUMER PERSPECTIVE | *Eric Shiu*

University of Birmingham, United Kingdom

Product designers always look at the functionality and aesthetics aspects when deciding on the features and appearance of a new product. More recently, as the environmental issue becomes increasingly a concern for an increasing number of consumers, sustainability is rapidly becoming another important aspect that product designers should also consider. To date, there is no published research in any English-written international journals that assess the trade-offs of all these three aspects in the product design process from any perspective including the consumer perspective. Considering that consumers have the final say in the market performance of any new product, this study attempts to fill the above research gap by assessing the trade-offs amongst functionality, sustainability and aesthetics from the consumer perspective.

DESIGNING CHILD-SIZED HOSPITAL ARCHITECTURE: BEYOND PREFERENCES FOR COLOURS AND THEMES | *Laure Verschoren (1),(2), Margo Annemans (1),(3), Iris Van Steenwinkel (1), Ann Heylighen (1)*

(1) University of Leuven (KU Leuven); (2) A33 architecten; (3) osar architects

Hospitals tend to be associated with being ill and suffering from pain. Especially for children a hospital stay can be a poignant experience. On top of not feeling well, they have to exchange their familiar environment for the structured hospital system. Our study explored the role of architecture in making hospital stays more pleasant for children. More precisely, we investigated what child-friendly hospital architecture means from the perspective of young patients, and what role architecture plays therein. To this end, we combined observations in a child oncology ward with interviews with young patients, their parents, and hospital staff. The insights gained in this way shed a new light on findings available in literature on designing child-friendly hospital architecture. Moreover, while the literature often advances generalizing concepts, this study shows how children's experience of hospital architecture can be highly personal. As such, our study suggests that designing child-friendly hospital architecture is a matter, not so much of preferences for specific colours or themes, but of more complex design principles like flexibility and customizability.

CHAIR
Kilian Gericke

DESIGN THEORY AND METHODOLOGY NEW APPROACHES (2)

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4.2

TUESDAY
28
JUL

6:00 pm
-
7:00 pm

BL27.13

DESIGNING PSI: AN INTRODUCTION TO THE PSI FRAMEWORK

Yoram Reich (1), Eswaran Subrahmanian (2),(3)

(1) Tel Aviv University, Israel; (2) Carnegie Melon University, United States of America; (3) NIST, United States of America

The PSI spaces are a framework for studying designing as practiced in the real world: framing and solving technical, social or organizational goals embedded in the existing socio-economic and institutional cultures and practices. Given the interconnected nature of the design product, knowledge and activities, we should anticipate that understanding designing is at least as complex as designing itself. Consequently, understanding designing involves mobilizing multiple knowledge sources, with different perspectives and diversity of participants orchestrated to achieve an effective outcome. We call the study of the PSI spaces the PSI framework. We introduce the PSI spaces, and their language resting on diverse disciplines such as psychology, engineering, economics, and sociology. We introduce some of its methodological tools; how the PSI spaces might be used to explain design challenges through misalignments of the spaces and how these misalignments could be resolved. The PSI framework has significant implication to the development of design science; it demands that design science be a trans-disciplinary endeavor, in need of a flexible community that will study it.

IMPROVING DESIGN METHODOLOGY: SYSTEMATIC EVALUATION OF PRINCIPLE SYNTHESIS | *Tim Katzwinkel, Jan Erik Heller, Alexander Schmid, Walter Schmidt, Manuel Löwer, Jörg Feldhusen*

RWTH Aachen, Germany

Developing new products based on a systematic approach is essential for the entrepreneurial success of technology companies. Through functional analysis and successive synthesis of a product reformative solutions can be generated. The paper in hand reviews existing methods and illustrates the occurring hurdles and advantages. Commonly used, the morphological box with its inevitable and hardly manageable large number of theoretical solutions resulting from combinatorial explosion is investigated. To overcome those drawbacks, a new software-based method for stepped synthesis is presented which integrates existing knowledge about physical principles and an evaluation algorithm. The applicability of this new method is evaluated in a student survey using a software prototype.

TOWARDS GENETIC MODELING OF MACHINES FOR ENGINEERING DESIGN SYNTHESIS

Jami Shah

Arizona State University, United States of America

A novel physics based model of engineered artifacts is described analogical to molecular biology which tells us function and behavior are encoded in organisms. Each gene encodes what particular protein is to be made, and the protein performs the same function as part of a cell or organism. In our model a gene is equivalent to a working principle. Combinations of genes appear in chromosomes which makes them equivalent to working structures. Since proteins are the physical function carriers, they can be considered equivalent to physical embodiment of a design, and cells/organs are analogous to machine parts or sub-systems. The amino acids and their arrangement in proteins determines the behavior of the protein. In an abstract sense, this is equivalent to a the behavior of the working structure of a machine component. Each individual organism has unique DNA, so also each designed artifact has a unique working structure (although identical designed and manufactured parts could nominally be considered clones). Each class of designed artifacts can be defined by its genome.

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4.2

DESIGN THEORY AND METHODOLOGY NEW APPROACHES (2)

CHAIR
Kilian Gericke

TUESDAY
28
JUL

6:00 pm
-
7:00 pm

BL27.13

CHALLENGES IN DEVELOPING AN ONTOLOGY FOR PROBLEM FORMULATION IN DESIGN

Mahmoud Dinar, Yong-Seok Park, Jami J Shah

Arizona State University, United States of America

The need for capturing and documenting problem formulation data exists for early stages of conceptual design. In this paper, we review two versions of our Problem Map ontological framework which we have used for expressing problem formulation data of different designers with the intent of understanding differences among them. We discuss some of the challenges that we have faced in developing and using the ontology for the annotation of problem formulation data for both introspective and reflective annotators. They include unclear boundaries of definitions for a few entities; difficulty in striking the right balance between a light, structured, easy to express ontology, and a fluid ontology with many entities that increases the chance of expressing data fragments but lowers accuracy among annotators; and making the ontology easier to learn for users, both introspective and reflective annotators. We give examples of how the ontology represents problem formulation data fragments, and examples of challenges from collected data.

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4.3

USER BEHAVIOUR AND PERCEPTION (2)

CHAIR
Serena Graziosi

6:00 pm
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7:00 pm

BL27.3

EXPERIMENTAL SETUP FOR VISUAL AND TACTILE EVALUATION OF MATERIALS AND PRODUCTS THROUGH NAPPING® PROCEDURE | *Jenny Faucheu (1), Antonio Caroli (2), Barbara Del Curto (2), David Delafosse (1)*

(1) Ecole Nationale Supérieure des Mines de Saint-Etienne, France; (2) Politecnico di Milano, Italy

Selection and definition of materials surfaces in product design can be driven by the sensory effect conceived. Certain characteristics that can be perceived through the sense of vision can also be perceived through the sense of touch. As a consequence, the sense of touch also plays an important role in functional user-product interactions. In this paper, a specific setup dedicated to Napping® evaluation with a focus on visual and tactile modalities is presented, using untrained subjects. This procedure allows highlighting the main perceptions the subjects have about the materials. It enables to rank the sample attributes that are perceived by the subjects when different sensory modalities are used. In particular visual-tactual incongruity can be highlighted, which can be of interest in product design. For instance, with our set of materials, in tactile perception, the primary axis clearly opposes slick and scratchy perceptions. In the visual test, the samples exhibiting large features are clearly set apart from samples exhibiting no features (slick). The other samples are gathered in between. In the visuo-tactile test, a hybrid perception is observed.

CHAIR
Serena Graziosi

USER BEHAVIOUR AND PERCEPTION (2)

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4.3

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.3

HOW DOES EXPECTATION CHANGE PERCEPTION? : A SIMULATION MODEL OF EXPECTATION EFFECT | *Hideyoshi Yanagisawa, Natsu Mikami*

University of Tokyo, Japan

Prior expectation affects posterior perception of physical variables, such as weight of a product. This psychological effect is called expectation effect. Two different patterns of expectation effect, contrast and assimilation, were observed. In this paper, we propose a simulation model of the expectation effect that explains the conditions of contrast and assimilation. We assume that perceived variable is estimated using a Bayes' inference of prior prediction and likelihood based on sensory stimuli. We formalize the expectation effect as a function of three factors: expectation error, prediction uncertainty, and external noise. We conducted computer simulations with the model and obtained a hypothesis of the conditions of assimilation and contrast. To validate the hypothesis, we conducted an experiment with participants using the size-weight illusion as a case of the expectation effect. Both the results of the simulation and the experiment revealed that 1) the pattern of expectation effect shifted from assimilation to contrast as the prediction error increased, 2) uncertainty decreased the extent of the expectation effect, 3) and external noise increased the assimilation.

TOWARDS IMPROVEMENT OF INTERACTION AESTHETICS OF MOBILE MUSIC LISTENING JOURNEYS | *Güzin Sen (1), Bahar Sener (1),(2)*

(1) University of Liverpool, United Kingdom; (2) Middle East Technical University, Turkey

Mobile music listening can be traced back to the introduction of Sony Walkman that upgraded music players both with privacy and portability. With the mobile listening media, our daily journeys in public environment have become more privatized, aestheticized and contented. It is a challenge to perform such a private activity in public environment with many people and audio-visual stimuli around. The journeys with music become additionally challenging with the music players' interfaces confined into tiny buttons and screens that heavily rely on visual modality. This paper discusses if the aesthetic experience of mobile listening can be enhanced through the way users control mobile listening media. It presents the analysis of a tri-partite fieldwork to demonstrate how the use of physicality in interaction can contribute to the beauty of our interactions with mobile listening media while dealing with the challenges in the (use) context. This study points out that context comprises inspiration as well as challenge. The results indicate that controlling mobile listening media becomes sensorially enriched and meaningful when physical context is interpreted as a means of interaction.

PRODUCT DESIGN OF NOVEL TECHNOLOGY-BASED PRODUCTS THE IMPORTANCE OF USERS | *Álvaro M. Sampaio, António J. Pontes*

University of Minho, Portugal

Terms such as product design, engineering design, and others, have been used to represent specific ways to look at Product Design and Development (PDD). Each of them features specific methods and techniques and, despite the evolution of PDD, most processes remain unchanged. Moreover, as products incorporate more technology, with emphasis on microelectronics, it becomes obvious that improvements of the traditional PDD processes are required. Incorporating microelectronics in products, without the user being able to perceive them, while simultaneously ensuring their functionality, is not a trivial task. Therefore, improving a user-centered design (UCD) approach is paramount. In this framework, 6 design processes proposed by different authors and the UCD standard were analysed by comparing the phases of each process, and their methods, techniques, and tools were explored. Finally, a case-study is described, which enables studying how the different processes can be applied and, how the user could be linked to the process. This opens the path for the optimization of PDD to meet the needs of novel products by improving the importance of users' direct participation in the process.

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DESIGN FOR X, DESIGN TO X
DESIGN FOR MANUFACTURING (2)

CHAIR
Stephan Husung

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.4

TASKS AND CHALLENGES IN PROTOTYPE DEVELOPMENT WITH NOVEL TECHNOLOGY AN EMPIRICAL STUDY | *Poul Martin Ravn, Tómas Vignir Guðlaugsson, Niels Henrik Mortensen*

Technical University of Denmark, Denmark

This paper presents a thematic analysis of 138 monthly reports from a joint industrial and academic project where multiple prototypes were developed based on the same technology. The analysis was based on tasks and challenges described in the reports by project managers over a period of three years. 17 task themes and 9 challenge themes were identified. It was found that test, implementation, and project management were prominent tasks. Familiarization with the technology was found to a very little degree, which was in opposition to literature. The main challenge was found to be system development. It was found that the predominant tasks and challenges are distributed over long periods of time, rather than in chunks linked to a specific development phase.

DESIGN-FOR-MANUFACTURE OF SHEET-BULK METAL FORMED PARTS
Thilo Breitsprecher, Christopher Sauer, Christian Sperber, Sandro Wartzack

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany

Sheet-bulk metal forming (SBMF) is an emerging and sustainable manufacturing technology that offers potential both for shortening process chains and for designing new geometry features that enable functional integration. In order to make use of the latter one the design engineers need design-relevant and manufacturing related knowledge that has to be acquired at early stages of the process development process. This objective is pursued by our self-learning engineering assistance system (SLASSY) that supports the knowledge-based analysis of sheet-bulk metal formed parts. It does so by means of metamodels that have been derived from manufacturing data via our KDD-based selflearning process. In this paper we present the foundations for a knowledge-based synthesis of such parts. That is, SLASSY will be enabled to automatically propose a design-for-manufacture geometry. We discuss the idea of design-for-manufacture from the SBMF point of view and show why our objective calls for multi-objective optimization and which algorithms meet our requests. Finally, a use case shows the utilization of evolutionary algorithms.

DIGITAL AESTHETIC OF NEW PRODUCTS OBTAINED BY SELECTIVE LASER MELTING PROCESS | *Giorgia Galimberti, Mario Guagliano, Barbara Previtali, Lucia Rampino*

Politecnico di Milano, Italy

Additive Manufacturing processes are rapidly evolving in order to enable their increasing diffusion in all those industrial contexts where a flexible, customized and low volume production is needed. The research is focused on processes that use metal powders. Such manufacturing techniques allow achieving illusory shapes free from any geometrical and productive constraints, thus fostering a new conception of production based on the digital aesthetic. This revolution is expressed by the digitalization of manufacturing processes which opens the way to a direct production from 3D model to the real object and therefore to a new way of thinking, designing and producing objects. This new production requires also new rules and guidelines for a product design. The purpose of work is to illustrate the state of the art of selective laser melting techniques based on metal deposition, highlighting the critical issues such technical limitations and the designing rules for a mass production. It is necessary to point out sensible future industrial applications, the social impact that this technology can have.

CHAIR
Peter Törlind

DESIGN METHODS AND TOOLS EARLY PHASES (3)

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4.5

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.5

AN APPROACH TO THE PROPERTY-BASED PLANNING OF SIMULATIONS
Jochen Reitmeier, Abdo Chahin, Kristin Paetzold

Universität der Bundeswehr München, Germany

The requirements related to technical systems are very diverse. This ultimately leads to an increase in complexity in products and in development processes. Due to time and cost pressure, effective methods are necessary to focus on activities with real added value in terms of lean product development. Continuous validation of product functionality must be ensured throughout the development process, this is done by means of simulations as far as possible. Simulation methods are well known and a variety of powerful tools is available. However, it is still an open issue, which simulations can be executed at what point in time to really support development processes. In addition, the coupling of the quality of input data and the quality of analytical results is not considered enough. For this reason, a situation-specific and generally applicable approach to a property-oriented simulation planning is presented to detail and support steps of analysis. These will be essentially triggered or rejected based on the quality of required input data. Moreover, maturity estimations and decisions based thereon with respect to product modification and course of the process are also supported.

DESIGNING OF HYBRID JOINTS AT THE EARLY EMBODIMENT DESIGN STAGE
Markus Kellermeyer (1),(2), Daniel Klein (2), Sandro Wartzack (2)

(1) CADFEM GmbH, Germany; (2) Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

Increasing costs for fuel and an increasing ecological awareness of the companies have lead to a higher importance of lightweight constructions in the automotive industry. A possibility to make components more energy-efficient is to use aluminum/CFRP (carbon-fiber-reinforced plastics) hybrid structures. In today's state of technology the design of reliable and safe hybrid joints is a big challenge that can be solved using simulation programs in the early embodiment design stage. This paper shows the development of a new method to simulate and estimate the behavior of hybrid aluminum/CFRP hybrid joints in an effective and realistic way. In a first step the joints are explored in an experimental characterization. In a second step, detailed simulation models are created and uncertain parameters are adapted to the experiments using parameter identification methods. After that, the simulation models are used to create meta-models containing the behavior of the joints which in a last step are implemented in simplified abstraction models. This enables product developers to predict the realistic behavior of hybrid structures much faster than before.

APPLYING MATRIX-BASED METHODS FOR IMPROVING USER EXPERIENCE OF A DRIVER ADVISORY SYSTEM | *Ioanna Michailidou, Lorenz Diergarten, Udo Lindemann*

Technische Universität München, Germany

Users need tools to accomplish complex tasks in dynamic use situations; but meanwhile want the experience of product interaction to be intuitive and enjoyable. To achieve the goal of handling technologies and motives and mapping functions from the users' perspective, matrix-based method can be applied by designers. But those positive effects can only be achieved, if the method is viable and usable. In this work, a matrix-based method is applied in the case study of a rail driver advisory system (DAS) with a twofold purpose: (1) to adjust the method in order fit the specific and limited in term of resources frame of the project, and (2) to create new concepts for the complex interface of DAS in order to improve the drivers' experience and acceptance. The methodological proceeding with useful insights and best practices are presented in the paper. Furthermore, new dynamic DAS interface concepts are proposed as result of use case-based (i.e. functions most likely to be needed in a use case are clustered in one interface) approach.

D
4.5

TUESDAY
28
JUL

6:00 pm
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BL27.5

DESIGN METHODS AND TOOLS EARLY PHASES (3)

CHAIR
Peter Törlind

EVALUATION OF CLAY MODELLING AND SURFACING CYCLES FROM DESIGNERS PERSPECTIVE | *Sushil Chandra*

Hero Motocorp Limited, India

A good example of the manual vs. digital divide in design process is the studio modelling process. On one hand, the manual clay modelling offers the much needed tangibility and adds a touch-and-feel quality, whereas the digital clay offers flexibility and accuracy. This paper attempts to (a) analyze various options covering the manual to digital spectrum (b) devise a scientific criterion to evaluate them and (c) conclude the best option. After calculating weighted quality level for each function the results showed that overall value addition is best in digital route due to the head-start it gets in the first step, where 3D sketching provides the best advantage in terms of detection and quantification. In subsequent stages, the manual-digital route adds best values, due to the mix of qualities of digital and forward routes. This results in a hybrid option (3D sketch to virtual reality to hard clay) which offers the best value addition. A dispassionate evaluation of all options is needed to get the best mix of new and traditional and this study has attempted to objectively explore the best mix of digital and tangible processes to optimally exploit the advantages of all processes.

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6:00 pm
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DESIGN ORGANISATION AND MANAGEMENT PARTICIPATORY DESIGN

CHAIR
Bernard Yannou

THE USE AND VALUE OF DIFFERENT CO-CREATION AND TOOLS IN THE DESIGN PROCESS

Abu Ali, Andre Liem

Norwegian University of Science and Technology (NTNU), Norway

When company representatives, academics, and design consultants engage in research and practice involving co-creation, it is usually conducted in a business context, driven by consumerism, and centered on innovation and creativity. However, the question here is the “creation of what”. Since it cannot based on the assumption that all participants in the co-creation process have high technical and visualization capabilities. The results tend to be rather abstract highlighting merely the potential for new experiences or product service systems (PSS). Many participatory toolkits were developed for creating holistic spatial design solutions through arrangements, which somehow limit the designer´s creative space in developing monolithic stand-alone objects. Moreover, there are no other specific methods and tools, which downstream translate co-created experiences into tangible designed objects. With respect to the development of industrial designed products and involvement of different stakeholders, this article is intended to investigate, methods and tools, which can use in co-creation processes towards the form giving three-dimensional products.

CHAIR
Bernard Yannou

DESIGN ORGANISATION AND MANAGEMENT PARTICIPATORY DESIGN

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4.6

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.6

PHYSICAL INTERACTION MAPPINGS: UTILIZING COGNITIVE LOAD THEORY IN ORDER TO ENHANCE PHYSICAL PRODUCT INTERACTION | *Bryan Gough Young, Andrew Wodehouse, Marion Sheridan*

University of Strathclyde, United Kingdom

Learning to physically operate traditional products can be viewed as a learning process akin to any other. As such, many of today’s products, such as cars, boats, and planes, which have traditional controls that predate modern user-centered design techniques may be imposing irrelevant or unrelated cognitive loads on their operators. The availability of working memory has long been identified as a critical aspect of an instructional design. Many conventional instructional procedures impose irrelevant or unrelated cognitive loads on the learner due to the fact that they were created without contemplation, or understanding, of cognitive work load. The goal of the research was to investigate the fundamental relationships between physical inputs, resulting actions, and learnability. The results showed that individuals can quickly adapt to input/output reversals across dimensions, however, individuals struggle to cope with the input/output when the dimensions are rotated due to the resulting increase in cognitive load.

AN EXPLORATORY STUDY OF THE SPECIFICATIONS PROCESS IN A CUSTOMER-SUPPLIER COLLABORATIVE NEW PRODUCT DEVELOPMENT | *Matthieu Yager (1), Marie-Anne Le Dain (1), Valéry Merminod (2)*

(1) Université Grenoble Alpes, France; (2) Université Pierre Mendes France, France

In this paper we focus on the collaborative process of definition of specifications of a complex product. The aim of the paper is to improve the understanding of the specifications elaboration process and particularly the interactions between customer and supplier project teams. A case study has been analyzed to precise the collaborative definition of specifications through respective contributions of the client and the supplier team members. We have described the interactions between customer and supplier project teams by combining a collaborative concept development process with the formalism of the blueprint method in order to highlight the roles of each company. Our conclusions pointed out three patterns, (1) the degree of interactions between customer and supplier project teams vary in the upstream phases of the New Product Development process, (2) the use of narrow-based definition of specifications enables to increase the trust from the customer towards the supplier, and (3) the collaborative specifications definition process is seen as a co-evolution approach, where needs, specifications and architecture evolve in parallel.

CORRELATIONS BETWEEN SUCCESSFUL CONSUMER GOODS IN THE MARKET AND CREATIVITY IN FORM AND FUNCTION ATTRIBUTES | *Cristina Morandi Sehn, Mauricio Moreira, Silva Bernardes, Jocelise Jacques de Jacques*

UFRGS - Federal University of Rio Grande do Sul, Brazil

This article sought to correlate creativity in form and function attributes with successful products of consumer goods companies. For this purpose, it analyzed 20 products from a Brazilian company. The products were chosen at random from a list of products that were in the market between three to seven years. This period was reported by the company as indicative of market success for the products it develops. The measure of success was appointed directly by the marketing department of the study company. Then, a group of 15 judges evaluated creativity in form and function attributes through a Likert scale for the 20 selected products. The results obtained by means of data collection showed evidence of correlation between creativity and form and function attributes with earnings success.

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4.7

PRODUCT MODULARISATION METHODS AND TOOLS (2)

CHAIR
Filippo Arnaldo Salustri

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.7

PRODUCT ARCHITECTURE DESIGN METHODOLOGY FOR DEVELOPING STANDARDIZED MODULES | *Benjamin Roland Thumm, Dietmar Göhlich*

Technische Universität Berlin, Germany

This paper provides a new approach based on "Product Architecture Drivers" (PA Drivers) as well as an overview of product variety and its relevance to product standardization. The target products for the approach are capital goods which are typically produced in low quantities. Those products are in general highly customized which leads to high product complexity. A profound literature review of different types of variety, development processes and projects and a new definition for standardized product architectures is given. Most approaches consider modularization based on green field development. In this paper we investigate an approach applicable for brownfield product development. For implementing new standardized modules into an existing product portfolio a suitable architecture has to be developed. A mapping between the future common product architecture, standardized modules and the product lines is given.

SUSTAINABILITY OF MODULAR PRODUCT FAMILIES

Tammo Bahns, Gregor Beckmann, Nicolas Gebhardt, Dieter Krause

Hamburg University of Technology (TUHH), Germany

A global customer base demanding highly individual products often forces companies to offer a wide range of products. Commonality within modular product families allows great product variety through lower internal variety of components and processes. Companies then struggle with sustainability of modular product families, that is, managing commonality across the product family lifecycle when modular product families are changed to react to new customer demands. Based on a literature review, the current support from academia for handling the sustainability of modular product families is presented. The findings are consolidated into a conceptual schema. The subsequent successful use of the conceptual schema in the process planning of a medium-sized enterprise, developing and producing elevators, identified further factors that influence the sustainability of modular product families. These factors will be addressed in the future, with support from academia.

HIGHER ORDER INTERACTIONS: PRODUCT AND CONFIGURATION STUDY ON DSM SATURATION | Keith Phelan, Joshua David Summers, Brian Pearce, Mary E. Kurz

Clemson University, United States of America

Research has shown that higher order interactions are important in evaluating change propagation within a system. This paper presents a systematic approach to evaluate how component interactions beyond the first order affect the interconnectivity of the product/system. A correlation between the higher order component interactions and the betweenness of the components is identified. This information is then used to identify relationships between different products and make inferences about additional systems that exhibit similar patterns. The methods are also applied to subsets of product configuration rules to understand whether or not the same relationship trends occur within product configuration as in product architecture.

CHAIR
Filippo Arnaldo Salustri

PRODUCT MODULARISATION METHODS AND TOOLS (2)

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4.7

TUESDAY
28
JUL

6:00 pm
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BL27.7

HARNESSING SOCIAL MEDIA AND CLOUD-COMPUTING TECHNOLOGIES FOR CO-DESIGN IN OPEN COLLABORATIVE INNOVATION: THE CASE OF 24 HOURS OF INNOVATION

Luz-Maria Jimenez-Narvaez (1), Kimiz Dalkir (2), Valerie Gelinas (1), Mickael Gardoni (1),(3)

(1) École de technologie superieure, Canada; (2) McGill University, Canada; (3) INSA de Strasbourg, France

Designers and industry both agree that new uses of media and cloud computing technologies have had a major impact on the way designers receive and share information and knowledge. Our research team was interested in examining whether these technologies also directly affect the social dynamics in co-design meetings. In this paper, we describe the dynamics observed during an annual international competition, "24 Hours of Innovation", and at two co-design sessions held at the École de technologie supérieure's INGO Innovation Center in Montreal. Our aim was to develop a Knowledge Management System that supports the co-design experiences present in an open collaborative innovation process. We analyzed the use of media by participants during four periods of the event: announcement, information, contributions, and polling of projects. We followed 135 teams from more than 20 universities, from 5 continents, which participated in the 5th edition of 24 hours of Innovation in Montreal. This competition also included 14 remote teams that participated in the 6th edition at ESTIA France.

CHAIR
Anja Martina Maier

INNOVATION METHODS AND TOOLS (2)

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4.8

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BL27.8

A MODEL OF IDEA EVALUATION AND SELECTION FOR PRODUCT INNOVATION

Milan Stevanovic (1), Dorian Marjanović (2), Mario Štorga (2)

(1) Markot.tel, Croatia; (2) University of Zagreb, Croatia

Product innovation is one of key strategic guidelines for sustainable business and competitive advantage. The process of innovation takes significant resources, and it is extremely important during the front-end of innovation to choose a concept with high innovation potential. There is a consensus among researchers that the evaluation and selection of ideas is critical to innovation success. Current research indicates that companies carry out the selection of ideas ad hoc or intuitively, and that only a small number has defined methods and/or the methodology. In this paper, we propose a rational and effective model of evaluation and prioritization of ideas, on the basis of which it is possible to make a choice of ideas. The model emphasizes a set of criteria for evaluating the efficacy of innovation, and defines the attributes for determining the value of each of the criteria. The proposed model represents a level in the methodology and can be applied separately or as part of the methodology. The development model is based on extensive research of the literature, empirical research and practical work. The application of the model was presented by the analysis of one practical case.

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INNOVATION METHODS AND TOOLS (2)

CHAIR
Anja Martina Maier

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.8

A METHOD MODEL FOR DISTINGUISHING AND SELECTING OPEN INNOVATION METHODS

Constantin von Saucken, Matthias Gürtler, Maria Schneider, Udo Lindemann

Technische Universität München, Germany

In this paper, we present a method model specifically for Open Innovation (OI) methods. In an iterative process, we took three steps to define suitable and usable method attributes: we started with a literature review in OI, refined the resulting attributes by applying them in an academic case study and finally ran two workshops with OI experts. The resulting method model is embedded in an industrial project with the aim to enable inexperienced designers in small and medium-sized enterprises (SME) to apply OI. Based on their OI-situation (represented by OI-situation attributes) the user selects suitable OI-actors (or stakeholders, represented by OI-actor attributes) and finally gets suggestions for OI-methods. These suggestions get automatically calculated from the dependencies between the OI-situation, OI-actors and the OI-methods. For this purpose, we developed the OI-method model with attributes fulfilling requirements regarding a clear distinction of methods in an understandable and usable way. As a further result, we illustrated a set of 11 OI-methods as OnePagers (all meta-information of the method on one sheet) based on the method model.

THE IMPLEMENTATION OF INNOVATION METRICS: A CASE STUDY

Andre Benaim (1),(2), Jenny Elfsberg (3), Tobias C. Larsson (1), Andreas Larsson (2)

(1) Blekinge Institute of Technology, Sweden; (2) Lund University, Sweden; (3)Volvo Construction Equipment

The paper explores the implementation process of an innovation measuring system prototype to support a heavy machinery multinational company to secure their innovative capability. In general,companies recognize the importance of becoming innovative to become, or remain, competitive on a global market. The case company decided to pilot a metric system that corresponds to the crucial factors to secure innovative capability and work with the stepwise improvement based on the assessment results. The methods are based on design-research approach and participatory action research. Interviews, surveys and observation were used, as well as, workshops were conducted to develop and follow up the implementation innovation measuring system. The findings explore topics and open questions related to metric selection, purpose and use of the selected indicators, as well as challenges related to the implementation of the metric system. Some of the conclusions question the viability of measuring project teams, as well as, it suggests the need for further research to clarify whether team metrics need to be develop in parallel to organizational ones.

INNOVATION AMBIDEXTERITY IN MEDIUM SIZE ENTERPRISES

Pierre Lavayssière (1),(2), Eric Blanco (1),(2), Marie-Anne Le Dain (1),(2), Pierre Chévrier (1),(2)

(1) Univ. Grenoble Alpes, France; (2) CNRS, France

The ability to explore new horizons while exploiting current capabilities is necessary for enterprises to attain long-term success. The theory of organizational ambidexterity studies the paradoxical relation between exploration and exploitation. At its current level, this theory identifies several antecedents of ambidexterity but do not provide a way to identify the optimal combination for a given organization. In this paper, we analyse the emphasis on exploration and exploitation of two complex approaches to product development: Lean Development and Design Thinking. This analysis and the comparison of the two approaches provides us two models of ambidextrous organizations. The fit between these models and the specificities of intermediate size enterprises span the formulation of several propositions regarding the barriers and opportunities of these enterprises. This paper opens the way for a greater understanding of ambidexterity among medium-sized enterprises.

CHAIR
Saeema Ahmed-Kristensen

DESIGN INFORMATION AND KNOWLEDGE PATTERN RECOGNITION TECHNIQUES

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TUESDAY
28
JUL

6:00 pm
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BL27.12

IDENTIFYING FLEXIBLE DESIGN OPPORTUNITIES: GETTING FROM A PROCEDURAL TO AN EXECUTION MODEL |

David Allaverdi, Arne Herberg, Udo Lindemann

Technical University Munich, Germany

An offshore drilling rig faces continuous need for upgrades especially due to significant uncertainty in all phases of the lifecycle. As in other application fields, rigid design usually prevails, thus leading to value losses that could have been avoided by flexible design. This research focuses on supporting system suppliers to identify and offer customer relevant and effective flexible design concepts. Based on a procedural model for identifying Flexible Design Opportunities (FDOs), it suggests how to use and embed industry specific knowledge in an execution model for application in tender projects. This paper describes the different types of models required for supporting the identification of FDOs. It provides details on the interview procedure for data acquisition and suggests a mapping and processing of the elicited data in a dedicated model. This model supports generating classes of objects which facilitate the set-up, management and maintenance of the execution model. The paper indicates which parts of the procedure are generally applicable in related industries, and which require the integration of industry specific data.

CROWDSOURCING FOR SEARCH OF DISASTER VICTIMS: A PRELIMINARY STUDY FOR SEARCH SYSTEM DESIGN |

Alex Burnap (1), Charlie Barto (1), Matthew Johnson-Roberson (1), Max Yi Ren (2), Richard Gonzalez (1), Panos Y. Papalambros (1)

(1) University of Michigan, United States of America; (2) Arizona State University, United States of America

Teams of unmanned aerial vehicles (UAV) have been suggested as sensor platforms for disaster victim search systems used shortly after natural disasters such as an earthquake or tsunami. Previous efforts have used UAVs equipped with video cameras for the disaster information gathering stage, with the information processing stage performed by either a single human searcher or a victim detection computer vision algorithm. We propose extending these efforts by investigating how a large and distributed "crowd" of volunteers may augment the information processing stage by helping search video feeds for disaster victims. An experiment is conducted comparing the victim detection accuracy between a single human searcher, a crowd of searchers, and a victim detection algorithm. Our preliminary results show that while victim search accuracy is sensitive to both UAV altitude and crowd size per video feed, crowdsourcing the search process can be more accurate than a single human or victim detection algorithm alone. These findings are a first step towards optimizing search system design with respect to both information collection and information processing augmented with crowdsourcing.

STRENGTH MAPPING ALGORITHM (SMA) FOR BIOMECHANICAL HUMAN MODELLING USING EMPIRICAL POPULATION DATA |

Jörg Miehling, Sandro Wartzack

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Despite the increasing level of detail in biomechanical simulation, human models are not yet valid to represent specific individuals or populations. Therefore, the generic models need adaptation to depict the varying competencies of the respective person or user group aimed to investigate. There have been achievements in scaling single modelling domains (e.g. anthropometry). However, a comprehensive approach is still lacking. This paper extends available methods by introducing a Strength Mapping Algorithm (SMA) for the adaption of individual maximum isometric forces to match empirical strength data. This procedure involves static optimization simulation of predefined body postures to reveal the dependencies between muscle forces and joint torques of a generic model specifying the skeletal and muscular geometry. Based on this information, we determine a set of muscle scaling factors for a given age, gender and strength percentile. As a result, the SMA enables the quick generation of a large number of individuals in order to implement a design for populations paradigm. This leads one step closer to gain deeper insight on how health relevant products and processes are to be developed.

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4.9

DESIGN INFORMATION AND KNOWLEDGE PATTERN RECOGNITION TECHNIQUES

CHAIR
Saeema Ahmed-Kristensen

TUESDAY
28
JUL

6:00 pm
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7:00 pm

BL27.12

SYSTEMATIC ONLINE LEAD USER IDENTIFICATION - CASE STUDY FOR ELECTRICAL INSTALLATIONS | *Sanjin Pajo, Dennis Vandevenne, Joost R. Duflou*

KU Leuven, Belgium

Identification of emerging needs and partial solutions is crucial for industries to stay competitive in a fast evolving marketplace. A small subgroup of customers, called lead users have been shown to experience needs before the rest of the marketplace and propensity to find solutions to address those needs. Involvement of lead users in the new product development process leads to attractive and successful new products. In this paper, the authors present a fast lead user identification approach that makes use of data mining, network analysis and machine learning techniques. An implementation of the approach for the micro-blogging site Twitter is described and the results of the effectiveness analysis case in the domain of electrical installations are reported. The implemented methodology points to opportunities in systematic and fast identification of lead users online with additional studies for different domains required to validate the approach.

CHAIR
Kristina Shea

YOUNG MEMBERS' EVENTS

TUESDAY
28
JUL

TUESDAY 28TH

7:00 pm - 9:30 pm

Location: MARQUEE

ABSTRACT
The aim of the event is to:
> Set new visions or challenge established views of design within the community!
> Share opinions and exchange ideas on vital design community topics!
> Meet international young people working in design research and practice!
Selected young researchers will give short, dynamic, talks on a variety of timely topics that describe their vision for how design research can impact: Contented Life / Healthy Life / Sustainable Life.

PRESENTATIONS
Etienne Boisseau:
"Open-Design", Arts et Métiers, France

Alex Burnap:
"Data-Driven Design", University of Michigan, USA

Edoardo Filippo Colombo:
"Open Innovation Meets Customizability: New Opportunities In Cyber-Physical Platforms", Politecnico di Milano, Italy

Kosa Goucher-Lambert:
"Inside The Mind: Using Neuroimaging To Understand Open Engineering Design Research Questions", Carnegie Mellon University, USA

Elke Lelegems:
"Positive And Elegent Architecture For All!", Universiteit Hasselt, Belgium

Ivar Marthinusen:
"Automation For A Contended Life", Norwegian University Of Science And Technology, Norway

Chris Mccomb:
"The Cyborg Designer", Carnegie Mellon University, USA

Anna Meroni:
"Design for Social Innovation", Politecnico di Milano, Italy

Konstantinos Stylidis:
"Perceived Quality And The Future Cars: A Paradigm Shift", Chalmers University Of Technology, Sweden

Carlo Arnaldo Vezzoli:
"Designing system discontinuity for sustainability", Politecnico di Milano, Italy

All ICED15 participants, young and formerly young, are welcome to join the event,
Join us at the end of the presentations for a toast with our Young Members!

WEDNESDAY 29TH JULY 2015

	8:30 - 10:15 am	11:00 - 12:30 pm	2:00 - 3:00 pm	3:15 - 4:15 pm	4:30 - 5:30 pm	8:30 pm
MARQUEE		**Keynote 4 & 5** *see pp. 129-130*				
BL27.1	**Podium 2.1** Design for a sustainable life - Methods, Tools and Case Studies				**Design Society General Meeting**	
BL27.2	**Podium 2.2** Design Research Applications and Case Studies					
BL27.3	**Podium 2.3** Design Methods and Tools Concept Generation		**Discussion 5.3** User Centred Design (1)	**Discussion 6.3** User Centred Design (2)		
BL27.4	**Podium 2.4** Design Methods and Tools Optimisation		**Discussion 5.4** Design for X, Design to X - Additive Manufacturing	**Discussion 6.4** Design Methods and Tools - Robust Design		
BL27.5	**Podium 2.5** Design Organisation and Management - Analysis and Optimisation		**Discussion 5.5** Design Methods and Tools - Simulation (1)	**Discussion 6.5** Design Methods and Tools - Simulation (2)		
BL27.6	**Podium 2.6** Design for X, Design to X		**Discussion 5.6** Design Organisation and Management - Collaboration in Design (1)	**Discussion 6.6** Design Organisation and Management - Collaboration in Design (2)		
BL27.7	**Podium 2.7** Innovation Strategies		**Discussion 5.7** Product Service Systems (PSS)	**Discussion 6.7** Systems Engineering		
BL27.8	**Podium 2.8** Human Behaviour in Design - Interaction between Products and Users		**Discussion 5.8** Innovation Methods and Tools (3)	**Discussion 6.8** Innovation Methods and Tools (4)		
BL27.12			**Discussion 5.9** Design Information and Knowledge - Visualization techniques	**Discussion 6.9** Design Information and Knowledge - Structuring knowledge		
BL27.13			**Discussion 5.2** Design Theory and Methodology - Bio-Inspired Design (1)	**Discussion 6.2** Design Theory and Methodology - Bio-Inspired Design (2)		
BL27.14			**Discussion 5.1** Design for a Sustainable life - Case studies & examples (1)	**Discussion 6.1** Design for a Sustainable life - Case studies & examples (2)		

COFFEE BREAK

LUNCH BREAK & MEETINGS see p.131

LUNCH BREAK & MEETINGS see page 131

LUNCH BREAK & MEETINGS

LUNCH BREAK & MEETINGS see page 131

GALA DINNER

8:30 pm

@ Fondazione Palazzo delle Stelline

see p.17 for info

CHAIR
Albert Albers

DESIGN FOR A SUSTAINABLE LIFE METHODS, TOOLS AND CASE STUDIES

P 2.1

8:30 am - 10:15 am

WEDNESDAY 29 JUL

BL27.1

QUANTIFICATION OF INDOOR ENVIRONMENTAL QUALITY IN SUSTAINABLE BUILDING DESIGNS USING STRUCTURAL EQUATION MODELING |

Joseph R Piacenza (1), John J Fields (2), Christopher Hoyle (2), Irem Y Tumer (2)

(1) California State University Fullerton, United States of America; (2) Oregon State University, United States of America

This paper presents an experimental design framework for quantifying Indoor Environmental Quality in sustainable buildings, by estimating causal relations between design attributes, and both the stated and revealed post occupancy user preferences. In this research, a combination of statistical data and qualitative assumptions are used to formulate a structural equation model (SEM) to determine a subsequent latent construct between variables. The SEM is comprised of fixed attributes, observed variables, and latent variables, and is designed to evaluate postulated significant correlations between each. Results show that quantifying relationships among user preferences and built environment attributes will allow designers to consider and incorporate characteristics in early design that support these correlations.

ARCHAEONICS – HOW TO USE ARCHAEOLOGICAL SOLUTIONS FOR MODERN PRODUCT DEVELOPMENT |

Matthias R. Guertler (1), Simon Schaefer (1), Johannes Lipps (2), Stephan Stahl (3), Udo Lindemann (1)

(1) Technische Universität München, Germany; (2) Eberhard Karls University Tübingen, Germany; (3) Engineers without Borders

This paper addresses the fact that product development often tends to “reinvent the wheel”. By inventing the Archaeonics methodology / Archaeology-inspired-design (AID), we present a systematic approach to identify suitable archaeological solutions and make them useable for modern engineering issues. For this, we use problem abstractions and analogy search methods from TRIZ and biology-inspired design. The archaeology-inspired design approach was successfully evaluated in the context of a water cistern building project in Tanzania which is coordinated by the German chapter of “Engineers Without Borders”.

COMPARISON AND CLASSIFICATION OF ECO IMPROVEMENT METHODS

Davide Russo, Marco Serafini, Caterina Rizzi, Stefano Duci

University of Bergamo, Italy

The number and breadth of eco-improvement methods has been steadily rising over the past decades to include design for X methods and more problem-solving oriented software, based on the Russian TRIZ methodology, and the integration of CAE software and optimization techniques. With such heterogeneous approaches, there is a need of a quantitative classification scheme to help the designer in choosing the best method for each environmental scenario. In the present paper, we propose a comparison and classification, based on the number of eco-guidelines and their distribution on standard impact categories, of 17 of the most known Eco-improvement methods. Furthermore, we propose an interactive selection software that gives the user the ability to exclude or give priority to some life cycle phases and impact categories; empowering him to select the most fitting eco-improvement method or to create a list of the relevant eco-guidelines across all the analysed methods.

P
2.1

DESIGN FOR A SUSTAINABLE LIFE METHODS, TOOLS AND CASE STUDIES

CHAIR
Albert Albers

8:30 am
-
10:15 am

WEDNESDAY
29
JUL

BL27.1

INTRODUCTION OF THE IDEALITY TOOL FOR SUSTAINABLE DESIGN

Yael Helfman Cohen, Yoram Reich

Tel Aviv University, Israel

Sustainability strategies in nature are studied, translated to design principles and used as a base for bio-inspired sustainability tools such as the life principles and the ideality design tools. While the life principles tool reflects a holistic view, the ideality tool is derived from a technical view that might be more inherent and applicable for engineers, observing biological systems as if they were technical systems. In this paper we demonstrate how to use the ideality tool by two case studies. The first one demonstrates the tool in a sustainable design context and the second one demonstrates the tool in a biomimetic design context. In addition, we describe an experiment that compares the ideality tool and the life principles tool. Both tools have a major value as sustainability tools and there is no difference between them in terms of users' perceptions regarding the tool. However, the ideality tool has an advantage in terms of the tool validity. Students who used the life principle tool significantly missed more sustainability criteria identified by experts compared to students who used the ideality tool.

ECODESIGN MATURITY MODEL AS A FRAMEWORK TO SUPPORT THE TRANSITION TOWARDS ISO 14.001:2015 CERTIFICATION

REVIEWERS' FAVOURITE

Daniela C. A. Pigosso, Tim C. McAloone

Technical University of Denmark, Denmark

Currently, the certification standard for Environmental Management Systems (EMS) ISO 14.001:2011 is under a major revision process, regarding its structure and requirements. The current draft entails major changes related to the integration of the product life cycle perspective into business processes, such as product development and value chain. The standard is expected to be launched in late 2015 with a 3-year transition period. This paper explores the application of the Ecodesign Maturity Model (EcoM2) as a framework to support the planning and implementation of ISO 14.001:2015, based on a case study carried out in a large manufacturing company. The EcoM2 supports the identification of the gaps to be fulfilled based on the diagnosis of the current maturity profile, the definition of the activities to be carried out in a strategic roadmap deployment, and the systematic measurement of the achievements obtained over time, towards the fulfillment of requirements and improved maturity profiles.

CHAIR
Lucienne Blessing

DESIGN RESEARCH APPLICATIONS AND CASE STUDIES

P
2.2

8:30 am
-
10:15 am

WEDNESDAY
29
JUL

BL27.2

CASE STUDY: INDIVIDUALIZATION OF A FULLY AUTOMATED COFFEE MACHINE

Maike Kosiol, Annette Isabel Böhmer, Udo Lindemann

Technische Universität München, Germany

People aspire to individuality and look for products that correspond to their needs as much as possible. In the InnoCyFer project the complete process of individualization - starting with the personalization by the customer and ending with the individual manufacturing - is implemented on the basis of a fully automatic coffee machine. This paper focused on the individualization of an existing product based on the given product architecture and developed a system of criteria to evaluate the existing product with reference to possibilities for individualizations. Approaches to develop customized products are shown. Both modular and customized product development, as well as the product creation process of customized products, are discussed. An analysis of the fully automatic coffee machine is outlined and a possibility to evaluate standardized and customized components. Further options for individualization, like add-on modules or the restructuring of the product architecture of the fully automatic coffee machine are discussed.

DESIGN OF MEDICAL DEVICES FOR PRESSURE ULCER PREVENTION

Alejandro Velasquez, Ana Maria Almonacid, Lisa Maria Jaramillo, Mauricio Aramburo, David Velasquez, Camilo Iza, Luis Miguel Zapata

Universidad EAFIT, Colombia

This paper presents a stage-gate design methodology implemented during the design of two mechatronic medical devices for the prevention of ulcers in skin. Each product required the integration of different disciplines such as mechanics, electronics and software, and went through three stages on which technical tests were performed on each stage. Afterwards a feedback was introduced into the next stage and improvements were implemented on the design. At the end both products were tested by health-care staff members, and patent applications were issued for.

BIOINSPIRED DESIGN: A CASE STUDY OF RECONFIGURABLE CRAWLING-ROLLING ROBOT

Aditya Kapilavai, Rajesh Elara Mohan, Ning Tan

Singapore University of Technology and Design, Singapore

Mobile robots capable of traversing rough terrains are highly desired for numerous applications including search, reconnaissance and surveillance missions. To this end, nature offers numerous highly effective, efficient and optimal biological precedence as a result of evolution process. Developing a bio-inspired robot poses numerous challenges and requires systematic design process to mimic biological counterparts. This paper presents our efforts in developing a bio-inspired self reconfigurable miniature robot capable of producing crawling and rolling locomotion gaits to traverse in highly complex terrains. Also, the article provides a descriptive account on the use of Problem-Based Biological Design (PB-BID) process in solving a robotics problem and summarizes our key observations. Furthermore, the paper details experimental validation of the developed robotic prototype that mimics Cebrennus Rechenberg, a class of huntsman spider.

P
2.2

DESIGN RESEARCH APPLICATIONS AND CASE STUDIES

CHAIR
Lucienne Blessing

8:30 am
-
10:15 am

WEDNESDAY
29
JUL

BL27.2

COMPUTATIONAL DESIGN-TO-FABRICATION USING SPATIAL GRAMMARS: AUTOMATICALLY GENERATING PRINTABLE CAR WHEEL DESIGN VARIANTS

Tian Chen, Kristina Shea

Swiss Federal Institute of Technology in Zurich, Switzerland

Additive Manufacturing (AM) technologies offer new possibilities for engineers to fabricate designs that may not otherwise be possible or cost-effective with conventional methods. However, each process has constraints that must be adhered to and designers faced with such freedom do not readily explore the new search space offered. Computational design-to-fabrication, introduced in this paper, utilizes new AM opportunities by encoding the constraints of AM processes as well as considerations such as style and performance, into generative design systems that automatically generate designs that are directly printable. This paper presents the specific example of generating car wheel spoke variants using a set of 12 spatial grammar rules that conform to the DfAM constraints for the Fused Deposition Modeling printer UPrint SE Plus and FEM meshing and analysis requirements. From a set of 72,500 valid designs, 100 were generated automatically, 12 of which are fabricated. The results demonstrate the spatial grammar's capability to automatically generate valid designs, both known and new to spark creativity, that can also be directly analyzed with FEM and fabricated using 3D printing.

VIRTUAL VALIDATION OF FUNCTIONAL AUTOMOTIVE DOOR ASSEMBLY PROPERTIES BY MEANS OF SUPERPOSED CAT AND FEM ANALYSIS

Matthias Ehlert (1), Björn Heling (1), Sandro Wartzack (2)

(1) BMW AG, Germany; (2) Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

As with all industrially manufactured goods, it is generally necessary to ensure costumer requirements are met. Therefore, it is important to ensure that functional as well as optical specifications of a product are fulfilled for large quantities in series production. The following piece of work demonstrates the effect that the elasticity of an assembly has on specific functional criteria in order to meet the aim of a robust design. For this purpose an automotive door assembly is examined, where tightness is one of the most relevant attributes from the customer's perspective. In the present case, the effect of the elastic sealing system on the development of the limiting positions of the observed assembly that result from a corresponding tolerance analysis will be examined in greater detail which, in turn, has an impact on tightness. The term 'limiting position' generally describes the largest deviation from the nominal dimension that can occur with a high level of statistical probability. To that end, a simulation-based integrated process is introduced that covers CAT as well as FEM methods and in this way respects the elasticity of the system with its corresponding deformation.

CHAIR
Armand Hatchuel

DESIGN METHODS AND TOOLS CONCEPT GENERATION

P
2.3

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.3

THE POTENTIAL OF DESIGN-BY-ANALOGY METHODS TO SUPPORT PRODUCT, SERVICE AND PRODUCT SERVICE SYSTEMS IDEA GENERATION | *Diana Paola Moreno Grandas (1), Luciënne Blessing (1), Maria Yang (2), Kristin Wood (3)*

(1) University of Luxembourg, Luxembourg; (2) MIT, USA; (3) SUTD, Singapore

Design-by-Analogy (DbA) is the process of developing solutions for design problems through the mapping of attributes, relations and purposes that a source problem or situation may share (or at least partially share) with an existing target solution or situation. There is a range of available DbA methods that have been developed to assist designers during the ideation stage to identify potentially useful analogies to solve design problems. However, generally these methods have been developed and applied in the product domain rather than in the service and product service systems domains. The purpose of this article is to identify the characteristics and nature of products, services and product service systems; to provide an overview of existing DbA methods and their drivers to evaluate the potential transferability of DbA across domains.

A QUALITATIVE INVESTIGATION OF IDEATION PRACTICES IN ENGINEERING AND PRODUCT DESIGN | *Rebecca Currano, Emily Henriksson*

Stanford University, United States of America

We use semi-structured interviews to examine ideation practices from a more comprehensive perspective, with the objectives: 1) to further explore the variety of activities that serve as catalysts for creative ideation in engineering design projects, 2) to examine the qualities and attributes of these activities and the context in which they take place, and 3) to discern principles which may underlie the usefulness of various activities for creative ideation. This study builds upon our previous work, increasing the number of interview participants from 7 to 20, and extending the pool of participants to include design instructors and industry practitioners as well as students. We identified 190 activities described by participants as reflective practices for ideation, and eleven characteristic traits, or attributes, frequently associated with these activities. Some notable trends emerged, such as the frequent mention of activities allowing mental disengagement, activities involving social interaction, and activities involving physical exercise. This paper presents the results of this extended study, and suggests principles underlying successful ideation strategies employed by many designers.

SYNTHESIS OF CONCEPTUAL DESIGNS FOR SENSORS USING SAPPHIRE-LITE

Biplab Sarkar, Amaresh Chakrabarti, G.K Ananthasuresh

Indian Institute of Science, India

The demand for variety of products and the shorter time to market is encouraging designers to adopt computer aided concept generation techniques. One such technique is being explored here. The present work makes an attempt towards synthesis of concepts for sensors using physical laws and effects as building blocks.A database of building blocks based upon the SAPPhIRE-lite model of causality is maintained. It uses composition to explore the solution space. The algorithm has been implemented in a web based tool. The tool generates two types of sensor designs: direct sensing designs and feedback sensing designs. According to the literature, synthesis using building blocks often lead to vague solutions principles. The current work tries to avoid uninteresting solutions by using some heuristics. A particularly novel outcome of the work described here is the generation of feedback based solutions, something not generated automatically before. A number of patent violations were observed with the set of generated concepts; thus emphasizing some amount of novelty in the designs.

P
2.3

DESIGN METHODS AND TOOLS CONCEPT GENERATION

CHAIR
Armand Hatchuel

8:30 am
-
10:15 am

WEDNESDAY
29
JUL

BL27.3

WHEN COSTS FROM BEING A CONSTRAINT BECOME A DRIVER FOR CONCEPT GENERATION | *Stefania Altavilla, Francesca Montagna*

Polytechnic of Turin, Italy

The ability of addressing global competitive environments is highly determined by quality, costs and time to market. Moreover, focusing on customer is becoming so important that companies have to take into account even the costs that a customer sustain during the product usage, being them extremely important in his purchasing decision. Therefore, manufacturers more and more are forced to reduce not only the costs that directly determine the price of the product, but they must evaluate also those costs that affect the entire lifecycle. Despite the recognized importance of product lifecycle into literature, none of the present cost estimation methods proposes actual proper solutions. The paper hence suggests a methodology that aim to fill this gap in literature by integrating qualitative information usually available since the beginning of the process with quantitative data derived from lifecycle operations. The proposed method was developed and validated within an automotive company that produce instrumentation for engine development.

FORM FOLLOWS DATA: A METHOD TO SUPPORT CONCEPT GENERATION COUPLING EXPERIENCE DESIGN WITH MOTION CAPTURE | *Serena Camere (1), Giandomenico Caruso (1), Monica Bordegoni (1), Carmelo Di Bartolo (2), Duccio Mauri (2), Enrico Pisino (3)*

(1) Politecnico di Milano, Italy; (2) Design Innovation; (3) FCA Group

Human movements express non-verbal communication: the way humans move, live and act within a space influences and reflects the experience with a product. The study of postures and gestures can bring meaningful information to the design process. This paper explores the possibility to adopt Motion Capture technologies to inform the design process and stimulate concept generation with an Experience Design perspective. Motion data could enable designers to tackle Experience-driven design process and come up with innovative designs. However, due to their computational nature, these data are largely inaccessible for designers. This study presents a method to process the raw data coming from the Motion Capture system, with the final goal of reaching a comprehensible visualization of human movements in a modelling environment. The method was implemented and applied to a case study focused on User Experience within the car space. Furthermore, the paper presents a discussion about the conceptualization of human movement, as a way to inform and facilitate Experience-driven design process, and includes some propositions of applicable design domains.

CHAIR
Sandor J. Vajna

DESIGN METHODS AND TOOLS OPTIMISATION

P
2.4

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.4

GRAPHICAL SUPPORT ADAPTED TO DESIGNERS FOR THE SELECTION OF AN OPTIMAL SOLUTION IN DESIGN BY SHOPPING | *Audrey Abi Akle (1),(2), Stéphanie Minel (1), Bernard Yannou (2)*

(1) ESTIA, France; (2) Ecole Centrale Paris, France

Design space exploration, that is an embodiment of a paradigm Design by Shopping, refers to the systematic activity of discovery and evaluation of the elements in the design space in order to identify optimal solution by reducing the design space toward an area of performance. This activity is composed of three main phases: the discovery, the optimization and the selection. There are existing tools for the design space exploration with different graphs (ScatterPlot matrix, 2D and 3D scatter plot, parallel coordinates plot, etc.). These graphs are useful for the representation of multidimensional set of data with an unlimited number of alternatives (design points). Obviously, during the selection phase, designers face to a reduced design space with a limited number of design points (in a performance area). Thus, in our work, we try to identify which graph is the most adapted to the selection phase. It emerges, from literature, three graphs useful for the representation of multidimensional set of data (>3 variables) and with a limited number of alternatives (<50). Thus we have designed experimentation composed of 3 scenarios (with 13 design parameters and 5 variables of performance) performed by 30 participants. It results one graph more suited to the selection phase in the Design by Shopping: the Parallel Coordinates Plot.

HETEROGENEOUS SIMULATED ANNEALING TEAMS: AN OPTIMIZING SEARCH ALGORITHM INSPIRED BY ENGINEERING DESIGN TEAMS | *Christopher McComb, Jonathan Cagan, Kenneth Kotovsky*

REVIEWERS' FAVOURITE

Carnegie Mellon University, United States of America

Although insights uncovered by design cognition are often utilized to develop the methods used by human designers, using such insights to inform computational methodologies also has the potential to improve the performance of design algorithms. This paper uses insights from research on design cognition and design teams to inform a better simulated annealing search algorithm. Simulated annealing has already been established as a model of individual problem solving. This paper introduces the Heterogeneous Simulated Annealing Team (HSAT) algorithm, a multi-agent simulated annealing algorithm. Each agent controls an adaptive annealing schedule, allowing the team develop heterogeneous search strategies. Such diversity is a natural part of engineering design, and boosts performance in other multi-agent algorithms. Further, interaction between agents in HSAT is structured to mimic interaction between members of a design team. Performance is compared to several other simulated annealing algorithms, a random search algorithm, and a gradient-based algorithm. Compared to other algorithms, the team-based HSAT algorithm returns better average results with lower variance.

FEATURE BASED INTERPRETATION AND RECONSTRUCTION OF STRUCTURAL TOPOLOGY OPTIMIZATION RESULTS | *Thomas Stangl, Sandro Wartzack*

REVIEWERS' FAVOURITE

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

The application of structural topology optimization is a common computer aided method to define the ideal design of a mechanical part. However, the problem remains, that the optimized component in its triangulated surface form cannot directly be used as model in the CAD based product development process. Due to different design aspects (even when using additive layer manufacturing technologies) the result needs to be interpreted and converted into a parametric feature based CAD model. After all, the current standard method is a time consuming, long-winded manual reconstruction. To put this right, this paper presents a semi-automatic approach to support the design engineer. The tool provides a way to interpret and reconstruct three dimensional topology optimization results as a parametric feature based CAD model. This approach automates the manual proceeding in order to generate a high quality solid CAD part. The functionality is demonstrated in a case study by an optimized and reconstructed motorcycle swing arm.

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2.4

DESIGN METHODS AND TOOLS OPTIMISATION

CHAIR
Sandor J. Vajna

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.4

FROM SIMULATION TO INVENTION, BEYOND THE PARETO-FRONTIER

Sebastien Dubois (1), Lei Lin (1), Roland De Guio (1), Ivana Rasovska (2)

(1) INSA de Strasbourg, France; (2) Université de Strasbourg, France

In this article, the authors will present a general approach to build a continuum between optimization and dialectic based invention (problem solving) methods. The building of this continuum is mainly based on the consideration of the Pareto-frontier as a link between both approaches. The authors considered TRIZ contradiction models as the entry point of the inventive methods. As this Pareto-frontier is recognized as the limits of the optimal solutions for the optimization approaches, a link between this frontier and the contradiction model is described in this article. Then the general approach is described, and illustrated through the resolution of a supply chain problem.

DESIGN FOR SCALABILITY AND STRENGTH OPTIMISATION FOR COMPONENTS CREATED THROUGH FDM PROCESS | *A.J. Qureshi, Shahrain Mahmood, W.L.E. Wong, Didier Talamona*

Newcastle University, United Kingdom

Design scalability is a technique used in routine design and manufacturing to adapt existing design knowledge to varying requirements. Guidelines exist for design scalability for subtractive manufacturing but there is much less support for components produced through additive manufacturing process. Due to particularities of additive manufacturing many process parameters related to additive manufacturing need to be taken into account while designing the parts with an expected functional requirement. The objective of the investigation described in this paper is to evaluate the effect of using design scalability technique for the 3D printed components with a focus on mechanical properties of the design. This is done through identifying and aggregating a list of comprehensive process parameters from research and available 3D printing machines, and then developing a standard based Taguchi's design of experiment to analyse the effect of these parameters, including scalability on the mechanical properties of an ISO compliant test sample for ultimate tensile stress and Elastic Modulus. A list of optimised parameters is also presented for achieving high tensile properties in 3D printed components.

CHAIR
Erik Bohemia

DESIGN ORGANISATION AND MANAGEMENT ANALYSIS AND OPTIMISATION

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2.5

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.5

THE EVOLUTION OF TERMINOLOGY WITHIN A LARGE DISTRIBUTED ENGINEERING PROJECT | *James Anthony Gopsill (1), Simon Jones (2), Chris Snider (1), Lei Shi (2), Ben James Hicks (1)*

(1) University of Bristol, United Kingdom; (2) University of Bath, United Kingdom

Communication features in many engineering activities within an engineering project. It is the main form by which information & knowledge is shared, and facilitates the generation of a shared understanding between engineers. While there exists a significant body of literature relating to communication, much of the research has been through qualitative studies using techniques such as surveys, interviews and observation. Given the prevalence of computer-mediated communication and the development of techniques to analyse such datasets, there is now the opportunity to provide quantitative metrics that can characterise communication. Therefore, this paper examines this opportunity through the co-word analysis of the subject line terms of an engineering project e-mail corpus comprising of 10,628 e-mails, featuring 1,045 individuals and spanning over a 4 year period. More specifically, the analysis has focused on the evolution, use/re-use and centrality of terms across the various project stages. The results provide interesting insights in the evolution of engineering terminology, which leads onto a discussion on how these metrics may provide indicators of project 'normality'.

DIFFERENT LEVELS OF PRODUCT MODEL GRANULARITY IN DESIGN PROCESS SIMULATION| *Jakob F. Maier (1), Claudia M. Eckert (2), P. John Clarkson (1)*

(1) Cambridge University, United Kingdom; (2) The Open University, United Kingdom

The design of many products is incremental, based on a prior architecture and may be thought of as a series of changes to an existing design. Nonetheless, design changes and their propagation complicate design process planning. They are a major source of rework and lead to frequent rescheduling and re-prioritisation of design tasks. Few methods exist to estimate the impact of such planning decisions with regard to both the design process and the product. Process simulation may provide support in this context when it is based on an appropriate description of the product. However, it can be hard to determine a suitable level of description, or granularity, for the product model. This article explores, by reference to a diesel engine, the implications of product model granularity for simulating design change propagation, and design process planning.

MODULARIZATION MANAGEMENT AND NETWORK CONFIGURATION

Poul Kyvsgaard Hansen, Louise Møller Nielsen

Aalborg University, Denmark

A given product structure will have a crucial effect on the performance of the operations network. The product structure will impact the potential configuration of the product according to the customer needs, and, furthermore, impact the cost, quality and speed of delivery. It is generally recognized that a modular product structure will have an improved effect on all of these performance parameters, but empirical studies prove that many companies are challenged in realizing the full benefits of modular product structures. This paradox indicates that the cause-effect relationships between modularization and realized benefits are complex and comprehensive. Though a large number of research works have contributed to the study of efficient and effective modularization management it is far from being clear. Based on case based empirical studies the paper will present two frameworks to support the heuristic and iterative process of planning and realizing modularization benefits. This is to be seen as the critical elements in efficient network configurations.

P
2.5

DESIGN ORGANISATION AND MANAGEMENT ANALYSIS AND OPTIMISATION

CHAIR
Erik Bohemia

8:30 am
-
10:15 am

WEDNESDAY
29
JUL

BL27.5

INFLUENCE OF DESIGN-FOR-X GUIDELINES ON THE MATCHING BETWEEN THE PRODUCT ARCHITECTURE AND SUPPLY NETWORK | *Florian G. H. Behncke, Paula Thimet, Benjamin Barton, Udo Lindemann*

Technische Universität München, Germany

Emerging global markets and fierce competition lead manufacturing firms to a transfer a large share of their value creation in development and production to suppliers that are arranged in a supply network. To prevail in this competitive situation manufacturing firms have to depend on the performance of their supply network, which is ideal for a matching between the product and its supply network. Besides manufacturing firms apply certain design guidelines to improve time-to-market and production cost as well as ensure product quality. Those guidelines (Design-for-X) focus on specific characteristics (e.g. manufacturing, assembly, procurement ...) of the design and have a significant influence on the matching between product architecture and supply network. To unveil the effects of design guidelines on the matching, this paper presents an overview of relevant Design-for-X guidelines and elaborates their influence on either the product architecture or the supply network. In essence, these guidelines employ four technqiues (modularization, standardization, simplification and partnership), which are applied to an academic case study to evaluate their internal validity and operability.

A STUDY TO IDENTIFY ENGINEERING DESIGN RESOURCES IN COMPLEX PRODUCT DEVELOPMENT PROJECTS | *Hilario Lorenzo Xin Chen, Peter John Clarkson, Anita Friis Sommer*

University of Cambridge, United Kingdom

The planning and scheduling of appropriate resources is essential in engineering design for delivering quality products on time, within cost and at acceptable risk. In order to achieve this, it is necessary to identify and understand the different resources required. This paper attempts to do so through insights drawn from interviews in an aerospace company. Firstly, it investigates what elements have been considered design resources by current modelling approaches and how the approaches have managed resources. Secondly, interviews identified that key design resources does not only include designers but also computational, testing and prototyping resources. Thirdly, the paper introduces resource attributes that can impact on resource availability and their effectiveness on process performance. Fourthly, it proposes a set of requirements to distinguish design resources from company resources. Finally, it advocates for having allocation flexibility to balance all these resources within the process, requiring new approaches for planning and scheduling that can model resources along with their attributes.

CHAIR
Yasushi Umeda

DESIGN FOR X, DESIGN TO X

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2.6

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.6

APPROACH TO CONSIDER RAPID MANUFACTURING IN THE EARLY PHASES OF PRODUCT DEVELOPMENT | *Florian Weiss, Hansgeorg Binz, Daniel Roth*

University of Stuttgart, Germany

Additive Manufacturing technologies are becoming more and more economical. In some cases – due to the possible complexity of geometry – they can be competitive to conventional manufacturing. But nowadays, Rapid Manufacturing is mostly not included in the decision for the manufacturing technology because of a lack of knowledge on the part of designers. In order to consider Rapid Manufacturing as an alternative, a step-by-step decision-making process with evolving parameters is proposed in this approach. Here, the consideration of Rapid Manufacturing, as well as Conventional Manufacturing technologies, can be included in the assessment. The proposed step-by-step procedure with hierarchically structured characteristics for the product and the manufacturing processes should ensure that decisions are supported in the early phases of product development as well as in the later phases. By using the suggested procedure, it is possible to take full advantage of the potential of Rapid Manufacturing in the early phases of the product development process. In this stage, the potential can be classified as the highest, because of the high level of design freedom.

RESULT VISUALIZATION AND DOCUMENTATION OF TOLERANCE SIMULATIONS OF MECHANISMS | *Michael Simon Josef Walter, Michael Pribek, Tobias Constantin Spruegel, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Imprecise manufacturing processes lead to products which differ in their dimensions and shape. As a consequence, the product developer has to specify appropriate tolerances to limit these deviations and thus to ensure the adequate functional and aesthetic quality of the final products. These tolerances, however, affect several departments of a company, such as manufacturing, technical procurement, metrology or quality control. Hence, insights gained during tolerance analysis and tolerance synthesis must be documented and visualized in a clear and comprehensive manner toward all departments involved. This paper presents an academic recommendation on a comprehensive visualization and documentation of the results of statistical tolerance simulations, focusing on systems in motion which underlie different kinds of deviations. These so-called mechanisms demand a more detailed result visualization than common static (non-moving) systems. The implemented academic tool called “Tol/Mech–insight” provides a comprehensive result visualization and documentation for tolerance simulations of mechanisms and may serve as a sufficient basis for decision-making among experts in various departments.

THE DESIGN AND MANUFACTURE OF INDIVIDUALISED PERFECT-FIT PACKAGING SOLUTIONS | *Vimal Dhokia, Stephen Thomas Newman*

REVIEWERS' FAVOURITE

University of Bath, United Kingdom

With continuing growth in the personalised high value product manufacturing sector, there is a need to provide new ways to store and transport high value parts economically in small batches/batches of one without damage and contamination, providing complete environment buffering. Current methods have an inability to design and generate on demand-individualised packaging as individual unique moulds are required. This paper provides a new approach to packaging individualised components and artefacts through combining a scanning methodology, and computational design methods to generate cryogenically machined packaging solutions using a computer aided design and manufacturing system. A prototype is used to demonstrate the proposed method and is validated by two example case studies consisting of a high value component and a representative artefact example.

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DESIGN FOR X, DESIGN TO X

CHAIR
Yasushi Umeda

8:30 am
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10:15 am

WEDNESDAY
29
JUL

BL27.6

ASSEMBLY SEQUENCE PLANNING WITH THE PRINCIPLES OF DESIGN FOR ASSEMBLY

Michal Sasiadek

University of Zielona Góra, Poland

The article characterises the EASYASSEMBLE method, which is meant to set an optimal assembly sequence for mechanical products, basing on an evaluation including requirements of design for assembly. The use of the computer implementation of the method - computer program EASYASSEMBLE - is presented on a real live example. The program is dedicated to constructors, technologists and planners (especially of the assembly process). It should serve as a help in designing products and adjusting their construction to easy and cheap assembly process.

HANDLING PRODUCT VARIETY IN A MIXED-PRODUCT ASSEMBLY LINE: A CASE STUDY

Narges Asadi, Mats Jackson, Anders Fundin

Mälardalen University, Sweden

In today's fast-changing global market, using mixed-product assembly lines (MPALs) and mixed-model assembly lines (MMALs) allows manufacturing companies to be flexible and to maintain their competitive edge through product variety. Balancing and sequencing issues have been recognized as the main challenges of MPALs and MMALs, but other practical needs of MPALs remain unclear. Recognizing the practical needs of MPALs helps in identifying related requirements for product design, leading to products that closely align with the MPAL concept. The objective of this paper is to offer an industrial perspective on the needs of MPALs and to identify its requirements vis-à-vis product design. To achieve this objective, a single real-time case study in a heavy-vehicle-manufacturing company has been performed. The results from this industrial case study suggest that in order to handle product variety in MPALs and to reduce the related complexity, certain dimensions of flexibility need to be created in the assembly system, and requirements related to product design should be considered simultaneously in order to support assembly processes.

CHAIR
Kees Dorst

INNOVATION STRATEGIES

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WEDNESDAY
29
JUL

BL27.7

SUPPORTING NEED SEEKER INNOVATION: THE RADICAL INNOVATION DESIGN METHODOLOGY | *Bernard Yannou*

Ecole Centrale Paris, France

Driven by a utilitarian perspective, the question of useful innovation and creating essential values is set. Such innovation should lead to cover or alleviate significant pains which are not satisfactorily covered by existing solutions. Radical Innovation Design (RID) is a structured methodology for exploring the front end of useful innovation in need seeker mode. In this paper, the fundaments of RID are presented for the first time and illustrated on the search for radical innovations for a handitennis wheelchair of a champion. The most original part of RID stands in the problem setting stage which starts with re-expressing the ideal need to set the issue playground - for usefully thinking in the box - in which two worlds are populated: the world of problems or pain points and the world of usage scenarios. The determination of value buckets has been automated by matrix representations of dependencies between problems, usage scenarios and existing solutions. A subset of opportunistic value buckets are further addressed in the problem solving stage for focused ideation, to ensure performing "blue ocean" innovations, i.e. in not yet explored usage and problem situations.

DESIGN INNOVATION FOR SOCIETAL AND BUSINESS CHANGE

REVIEWERS' FAVOURITE

Clementine Thurgood (1), Kees Dorst (1),(2), Sam Bucolo (1), Mieke van der Bijl-Brouwer (1), Pieter Vermaas (3)

(1) University of Technology Sydney, Australia; (2) Eindhoven University of Technology, The Netherlands;
(3) Delft University of Technology, The Netherlands

We present two approaches for addressing complex societal and business problems: frame creation and design led innovation. Both methods combine a broad systems approach to problem solving together with the reframing of problems based on uncovering deep underlying human values and needs. While the practical usefulness and viability of our methods has been established through a series of projects, design methods need evaluative criteria to enable a more formal discussion and assessment of projects. This is particularly important for enabling comparisons across studies, and/or when attempting to communicate the value of design to non-design audience. For this purpose, we suggest articulating the steps of design methods using S.M.A.R.T. criteria from the management literature. We describe the aims, means, and evaluative criteria of each step of our methods, which can be likened to the specific (S) and measurable (M) indices of S.M.A.R.T. Thus, S.M.AR.T. descriptions enable management of projects by means of their own design methods and contribute to establishing sound design innovation methodologies that can eventually be scaled up for large research programs and educational purposes.

SOCIO-TECHNICAL DESIGN FOR RESILIENCE: A CASE STUDY OF DESIGNING COLLABORATIVE SERVICES FOR COMMUNITY RESILIENCE | *Joon Sang Baek*

UNIST, Korea, Republic of South Korea

This paper presents selected findings from a doctoral study on how design could be used to construct a resilient community. It describes a framework for diagnosing the resilience of people's social networks and developing strategies for a resilient community based on the network theory. It goes on to outline the methodology and findings of a case study exploring the application of this framework in designing services around a farmers' market in Milan. Based on the analysis of the producers' collaborative networks, the paper explores the perceived feasibility of this framework as a preliminary stage to develop collaborative services. It concludes by commenting on the wider implications of the framework for the field of design for sustainability.

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INNOVATION STRATEGIES

CHAIR
Kees Dorst

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WEDNESDAY
29
JUL

BL27.7

THE ROLE OF AMBIGUITY AND DISCREPANCY IN EARLY PHASES OF INNOVATION | *Linda Nhu Laursen, Christian Tollestrup*

REVIEWERS' FAVOURITE

Aalborg University, Denmark

Innovation literature mainly focuses on eliminating ambiguity and discrepancy from the early phases of innovation. This study questions this implicit assumption, as it may provide an oversimplified view on, how to attain proficiency. Instead of narrowly focusing on reducing ambiguity and discrepancy, we seek to understand if it might be there for a reason. Through a laboratory experiment, we propose ambiguity and discrepancy actually have a function in concept development. Accordingly the paper contributes with a better understanding of, the role ambiguity and discrepancy as triggers of sense making in conceptualisation in the early phases of innovation.

INNOVATIVE AND SUSTAINABLE DESIGN: PERCEPTIONS OF EXPERTS

Cassandra Telenko (1), Kristin Wood (2)

(1) Georgia Institute of Technology, United States of America; (2) Singapore University of Technology and Design, Singapore

Innovation and creativity research assists and enables designers to break the mold of everyday, expected designs and discover the delightful, but unexpected, meaning-rich, and radical through novel approaches to engineering problems and opportunities. Sustainability is one "wicked problem" that requires innovative design thinking to change the interface between nature, society, economy and artifact. We surveyed perspectives on the innovation process from 59 design experts internationally through two separate workshops. In the first workshop, 38 experts in innovation provided perspectives on the cognitive underpinnings and design processes relevant to innovation. In the second, 21 experts provided their perspectives on the same topics in light of sustainable design objectives. These findings show the two areas of research to be linked alternatives, and that future research into analogies, creativity, open-mindedness and the application of constraints can help bridge the gap between techniques in engineering design innovation and the applications of sustainable engineering design.

CHAIR
Stefano Filippi

HUMAN BEHAVIOUR IN DESIGN INTERACTION BETWEEN PRODUCTS AND USERS

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WEDNESDAY
29
JUL

BL27.8

DESIGN FOR BEHAVIOR CHANGE: AN ELABORATION-BASED APPROACH TO PERSUASION IN PRODUCT DESIGN | *Soodeh Montazeri (1), Papalambros Panos (2), Gonzales Rich (2)*

(1) Fors Marsh Group, United States of America; (2) University of Michigan, United States of America

This paper investigates the premise that products can be designed in a principled persuasive way to induce behavior change; specifically it explores how designers can adopt behavior change theories from psychology to design products that make people behave more environmentally responsible. Studies were conducted in two parts; Part I entails a retrospective study of persuasive products with behavior change intent. Adopting the Elaboration Likelihood Model of persuasion from Psychology, these products were studied with respect to the elaboration of the persuasive message. Part II presents 2 empirical studies of behavior change based on the ELM to test the effectiveness of these strategies in product design. The studies showed that the aesthetics of a product can influence how it is used and can prompt users to change their behavior. This work shows that if designers identify the right information-processing route, the visual appearance of a product can cue desirable behavioral responses. This is an example of an evidence-based approach to understand the link between perceived formal and meaningful properties of design and how these properties influence behavioral responses.

THE USE OF MULTISENSORY FEEDBACK TO MAKE USERS BEHAVE IN A SUSTAINABLE WAY | *Serena Graziosi, Francesco Ferrise, Alessandro Achille Maria Costanzi, Monica Bordegoni*

REVIEWERS' FAVOURITE

Politecnico di Milano, Italy

The paper proposes an alternative approach to well-known feedback solutions, such as visual displays or warning sound messages, to make users perceptually aware of the energy consumption occurring when using a product. The approach is grounded on the use of multisensory feedback interfaces that are designed to make the user experience the consumption process directly during the interaction with the product. Such multisensory feedback should be intended as indications, rather then alarms, so as to naturally guide users towards a more sustainable behaviour. The daily task of opening the fridge door has been used as case study. All the steps followed to ideate and test the effectiveness of the designed multisensory interfaces are discussed. The results demonstrate how even simple stimuli, such as a gradual colour change of the fridge cavity from a cold to a warm one, may be able to reduce the time users keep the fridge door open.

SUPPORT OF THE SYSTEM INTEGRATION WITH AUTOMATICALLY GENERATED BEHAVIOUR MODELS | *Johannes Kößler, Kristin Paetzold*

Universität der Bundeswehr München, Germany

The development of technical systems is faced with an increasing complexity. A reason for this is the growing number of domains working together for a final product. Thereby the system integration is getting more important for companies while the development of single components is often outsourced to other companies. This leads to the need of detailed interfaces descriptions between these components to support the product development process and the data and information flows. In this paper the initial steps to automatically generated behavioural simulation models are presented. The fundament for the generation of these models is model-based system engineering (MBSE). The available diagrams of MBSE are used to generate the main structure of a behaviour model. In addition partial models have been developed describing the behaviour of machine elements. Combining the MBSE models with the partial behaviour models allows the generation of a behaviour model of a complete system. A first validation of the concept of automatically generated models is presented. Based on simple MBSE and CAD models of a gear unit, different behaviour models are generated for the use with Matlab/Simulink.

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WEDNESDAY
29
JUL

BL27.8

HUMAN BEHAVIOUR IN DESIGN INTERACTION BETWEEN PRODUCTS AND USERS

CHAIR
Stefano Filippi

TECHNOLOGY-SUPPORTED DESIGN RESEARCH

REVIEWERS' FAVOURITE

Katja Thoring (1),(2), Roland M. Mueller (3), Petra Badke-Schaub (1)

(1) Delft University of Technology, The Netherlands; (2) Anhalt University of Applied Sciences, Germany; (3) Berlin School of Economics and Law, Germany

This survey paper explores the opportunities and challenges of new technologies and social media for design research and design ethnography in particular, and summarizes the results in a framework. Understanding users' needs and observing their behavioral patterns becomes more and more important when designing innovative products or services. Traditional design ethnography mainly consists of in-depth interviews and field observations of individuals or groups in the social context to be investigated. Digital technologies might enable new possibilities in collecting, analyzing, and visualizing research data. Advanced hard- and software, the ubiquitous presence of smartphones, global accessibility of data, and new technological and social concepts, such as social media or crowdsourcing, allow for new approaches in design research. We suggest that technology nowadays is able to not only collect large numbers of data but also improve data quality by providing access to new approaches in design research as well as facilitating and assisting the researcher with coding and interpreting the collected data.

MOVING TARGETS: HOW CONSUMERS CHANGE VALUE SYSTEMS THROUGH INTERACTION WITH DESIGNED PRODUCTS AND OTHER CONSUMERS | *Russell C. Thomas (1), John S. Gero (1),(2)*

(1) George Mason University, United States of America; (2) University of North Carolina at Charlotte, United States of America

Designers need to understand the role of social influence between consumers as an endogenous process of shaping value systems, and within the larger framework of indirect mutual influence on value systems of both consumers and designers. This paper presents the results of computational experiments on the effects of social influence on individual and systemic behaviour of modelling consumers as situated cognitive agents in a product-consumer environment. Paired experiments were performed with identical initial conditions to compare the behaviour of social agents with non-social agents. Experiment results show that social agents are more productive in consuming available products, both in terms of aggregate unit consumption and aggregate utility. But this comes at a cost of individual average utility per unit consumed. In effect, social interaction achieved higher productivity by 'lowering the standards' of individual consumers. While still at an early stage of development, such an agent-based model laboratory is shown to be an effective research tool to investigate rich collective behaviour in the context of demanding cognitive tasks such as design innovation.

CHAIR
Panos Y. Papalambros

KEYNOTE

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4

11:00 am
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11:45 am

WEDNESDAY
29
JUL

MARQUEE

Engineering Talent and Skill for Innovation

ANDREA PONTREMOLI

CEO & General Manager
Dallara Automobili

BIO

Andrea Pontremoli joined IBM in 1980 in as Customer Engineer and grew up in the professional career until in 1999 he left Milan and moved to Paris as Vice President of Global Services Operations for IBM Europe, Middle East and Africa and later he became General Manager of Integrated Technology Services for the same Area managing more than 25.000 people.In 2001 he came back to Italy and was appointed IBM Global Services General Manager for South Europe, a position he kept until 2004 when he was appointed President and CEO of IBM Italy.

In October 2007 Andrea Pontremoli left the position of President and CEO IBM Italy to face a new challenge joining Gian Paolo Dallara to manage Dallara Automobili, a glorious historic company at Varano de' Melegari in Valceno (Parma). Andrea Pontremoli joined the company as Partner of the founder Gian Paolo Dallara and he was appointed CEO and General Manager, with the aim of devising new and innovative strategies for the development of the company.

He has several positions besides Dallara: In May 2000 he has been appointed as President of Centro Studi Valceno 'Antonio Samore', a no-profit company. In November 2007 he has been appointed as Scientific Director for the "Executive Master in Technology and Innovation Management" at the Bologna Business School, University of Bologna. Since April 2008 Andrea Pontremoli is a member of Barilla S.p.A.'s Boards of Directors and Executive Committee. Since May 2012 Andrea is the Lead Indipendent Director in the Board of Directors of Brunello Cucinelli S.p.A, where he has also the responsibility of the Risk Committee and member of the Compensation Committee.

In 2004 Università degli Studi of Parma awarded him a honorary degree in Computer Science Engineering for his expertise developed during the many years of his managerial activity and for the constant commitment for the technological development of territorial areas. Pontremoli has been for a long time a member of Boards at Confindustria, Assolombarda and Assonime, moreover he is a member of Aspen Institute Italia.

On 27 of December 2005 he was awarded the honour of Cavaliere di Gran Croce al Merito della Repubblica Italiana from Italian Republic President Mr. Carlo Azeglio Ciampi, the highest honorary degree in the Italian Republic.

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KEYNOTE

CHAIR
Panos Y. Papalambros

11:45am
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12:30 pm

WEDNESDAY
29
JUL

MARQUEE

Design Theory: the foundations of a new paradigm for science and Engineering



PASCAL LE MASSON[1], YORAM REICH[2], ESWARAN SUBRAHMANIAN[3]

[1]*MINES ParisTech*
[2]*Tel Aviv University*
[3]*Carnegie Mellon University*

ABSTRACT

In recent years, the works on Design Theory (and particularly the works of the Design Theory SIG of the Design Society) have contributed to reconstruct a basic science, Design Theory, comparable in its structure, foundations and impact to Decision Theory, Optimisation or Game Theory in their time. These works have reconstructed historical roots and the evolution of design theory, unified the field at a high level of generality and uncovered theoretical foundations, in particular the logic of generativity, the "design-oriented" structures of knowledge and the logic of design spaces that goes beyond the problem space complexity. These results give the academic field of engineering design a new consistent ecology of scientific objects and models, which allows for advanced courses and education. They have contributed to a paradigm shift in the organization of R&D departments, supporting the development of new methods and processes in innovation centres. Emerging from the field of engineering design, design theory development has now a growing impact in many disciplines and academic communities. The Design Society may play significant role in addressing contemporary challenges if it brings the insights and applicability of Design theory to open new ways of thinking in the developing and developed world.

12:30 pm
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2:00 pm

DINING AREA

WEDNESDAY
29
JUL

LUNCH BREAK

1:00 pm - 2:00 pm

MEETING

Design Science Journal authors & editors meeting

BL27.1

1:00 pm - 2:00 pm

SIG MEETING

Digital Human Modelling for the Use of Product Development

BL27.11

1:00 pm - 2:00 pm

SIG MEETING

Design for Additive Manufacturing Launch - Inaugural meeting

BL27.2

LUNCH MENU*

STARTERS

Tortino di carote e mascarpone
Savoury pie with carrots and mascarpone

La nizzarda con tosso rosso
Nicoise salad with bluefin tuna

Il vitello al cubo con salsa di acciughe estive
Beef cube with summer anchovies sauce

accompagnato da
Formaggio del giorno, Torte di verdura assortite
Verdure cotte e crude di stagione
served with
A variety of Italian cheeses, Mixed savoury pies and raw/warm vegetables

***

1 FIRST COURSE TO CHOOSE FROM:

Lasagnette alla Portofino
Lasagnette with Portofino sauce

Insalata di pasta con pomodorini Pachino, acciughe, capperi e basilico
Pasta salad with Pachinos, anchovies, capers and basil

***

DESSERT

Fresh Fruit salad, Selection of cakes
and the traditional Italian ice-cream

Vegan, Gluten-free, and alergies-free options are available.
Please check with our Staff the best meal for you!
**changes can occur*

D
5.1

DESIGN FOR A SUSTAINABLE LIFE (CASE STUDIES AND EXAMPLES (1)

CHAIR
Carolyn Conner Seepersad

2:00 pm
-
3:00 pm

WEDNESDAY
29
JUL

BL27.14

SYSTEMATIC FRAMEWORK FOR THE DEVELOPMENT OF FUONS

Hesamedin Ostad-Ahmad-Ghorabi (1), Daniel Collado-Ruiz (2)

(1) Ferchau Engineering GmbH, Germany; (2) Dynavio Cooperative

Life Cycle Assessment is one of the most popular environmental assessment tools. However, due to its comparative nature, assessing a newly developed product relies on having benchmark information. Since data on previous products is bound not to be of identical products, this entails scaling on functional terms (i.e., in terms of the product's functional unit). For that reason, the authors developed the concept of LCP-families for scaling, and that of fuons to standardize the parameters by which they would be scaled. In order to facilitate the development of new fuons, a systematic stepwise approach is presented in this paper. Step one defined the basic functional flows of the fuon, step two defines and analyzes the scaling parameters through a linear regression model, and step three covers parameters that can potentially differentiate between LCP-families. The framework is shown in the development of two fuons in a case study, and their statistical suitability to be used in scaling through LCP-families is assessed.

APPLICATION OF SUBTRACT AND OPERATE METHOD FOR DEVELOPING FUNCTION ENERGY STRUCTURES OF PRODUCTS AND SYSTEMS - A RULE-GUIDED APPROACH

Panagiotis Markos, Argyris Dentsoras

University of Patras, Greece

The relation between functionality and energy efficiency of products and systems is examined. An extended configuration of Function Structure scheme is proposed and named as Function Energy Structure (FES). (FES) represents in a qualitative, yet detailed manner, the actual functions performed by the components (assemblies, subassemblies or parts) of a product and depicts the energy type(s) used and the energy transformations and losses that take place. (FES) indicates also the components used for the embodiment of each separate function. In (FES), the represented functions are in general form-independent. However, some functions may be related to certain components if the latter embody the product's working principle. For the formulation of (FES), a Subtract and Operate approach is used that locates product functions. These functions are then transferred to a proper Function Structure form, where all necessary material and energy notations are added. The whole process is rule-guided and for that reason sets of proper rules are introduced. A case study of a traction elevator serves as a reference example and contributes to better perceiving and understanding of the proposed method.

STAKEHOLDER CENTRED APPROACH TO SUSTAINABLE DESIGN: A CASE STUDY OF CO-DESIGNING COMMUNITY ENTERPRISES FOR LOCAL FOOD PRODUCTION AND CONSUMPTION | *Yoonyee Pahk, JoonSang Baek*

Ulsan National Institute of Science and Technology (UNIST), Korea, Republic of South Korea

The demand for creating shared values has emerged as a new direction in a society in which the mutual prosperity of all stakeholders is often undermined and sacrificed for the benefit of a few. For a sustainable society, the 'symbiosis' of community members is one of the critical factors and shared values among them is essential to achieve sustainable development. In this study, we suggest a design methodological approach aimed at the co-existence and well-balanced development of stakeholders. We named this specific approach the symbiotic system, 'considerate design approach' and introduce a business model development workshop as a case study applying it. This is a stakeholder-centred design which aims to draw a win-win strategy based on stakeholders' needs by synthesizing the process using service design tools. As a result of this study, we will discuss the features of this considerate design approach, the features of the solution by it, and the relation with social sustainability.

CHAIR
Carolyn Conner Seepersad

DESIGN FOR A SUSTAINABLE LIFE (CASE STUDIES AND EXAMPLES (1)

D
5.1

2:00 pm
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3:00 pm

WEDNESDAY
29
JUL

BL27.14

SUBSTITUTING CONVENTIONAL MATERIALS AND MANUFACTURING FOR SUSTAINABLE, NEAR NET SHAPE GROWN COMPONENTS | *Manuel Löwer, Anna-Lena Beger, Jörg Feldhusen, Alexandra Wormit, Jürgen Prell, Björn Usadel, Thomas-Benjamin Seiler, Christoph Kämpfer, Henner Hollert, Franziska Moser, Martin Trautz*

RWTH Aachen University, Germany

Society's demand for ecologically produced and sustainably operable goods is a key driver to substitute conventional substances such as metals or plastics. Most of today's eco-design approaches are limited to the selection of the right material and the industrial processing, to manufacture the desired design. The authors of this work are scientists from the areas of cell-biology, eco-toxicology, engineering- and industrial-design, and teamed up to use directed natural growth of bio-materials. The aim is to minimize conventional production steps and decrease the amount of resources needed for manufacturing. In the first step the team categorizes and analyzes potential plants. In addition, requirements for different sorts of products are defined. Matching parts of both databases are identified. The aim of this research is to give an overview of possible function-plant relations of near net shape grown materials. Single materials as well as composites are taken into account. Eco-investigations include the whole Life Cycle Assessment. Additionally mechanical properties, design restrictions and surface quality are examined as major issues for sustainable, safe and sound products.

CHAIR
John Gero

DESIGN THEORY AND METHODOLOGY BIO-INSPIRED DESIGN (1)

D
5.2

2:00 pm
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3:00 pm

BL27.13

BIOCARDS AND LEVEL OF ABSTRACTION

Torben Anker Lenau (1), Sonal Keshwani (2), Amaresh Chakrabarti (2), Saeema Ahmed-Kristensen (1)

(1) DTU, Denmark; (2) Indian Institute of Science, India

Biocards are formal descriptions of biological phenomena and their underlying functional principles. They are used in bioinspired design to document search results and to communicate the findings for use in the further design process. The present study explored the effect of abstraction level used in biocards. This was done in two workshops conducted with design students in Denmark and India. Students were given a design assignment and instructions for how to perform the BID ideation work. Half of the students were given biocards with abstract descriptions while the other half got biocards with concrete descriptions. The novelty of found solutions was evaluated by the students by rating novelty of each solution on a scale from 1 to 5. Mean values for abstract descriptions were 0,3 higher than for concrete descriptions indicating that more innovative solutions were found when students used biocards with abstract descriptions compared to concrete descriptions. The difference in mean value is significant with a confidence level better than 1%. It seems likely that more abstract descriptions in biocards helps avoiding design fixation in biomimetic design work.

D
5.2

DESIGN THEORY AND METHODOLOGY
BIO-INSPIRED DESIGN (1)

CHAIR
John Gero

2:00 pm
-
3:00 pm

WEDNESDAY
29
JUL

BL27.13

USING BIOLOGY AS A MODEL FOR SUSTAINABILITY: INSIGHTS FOR ECODESIGN AND BIOINSPIRED DESIGN PRACTITIONERS | *Julia O'Rourke, Carolyn Conner Seepersad*

University of Texas at Austin, United States of America

Numerous authors in the bioinspired design and ecodesign research communities conceive of biology as a model for sustainability and use biological systems, organisms, and features as analogies when designing environmentally friendly products and systems. The purpose of this paper is to dig deeper into the issue of sustainability in biology, to better understand the ways biology is – and is not – sustainable and discuss the implications of these findings for ecodesign and bioinspired design researchers and practitioners.

INFLUENCE OF INFORMATION AND KNOWLEDGE FROM BIOLOGY ON THE VARIETY OF TECHNICAL SOLUTION IDEAS | *Helena Hashemi Farzaneh, Katharina Helms, Udo Lindemann*

Technical University Munich, Germany

Bio-inspired design aims at the development of novel, creative solutions with the potential for innovative technical products. It implies the use of different information sources, such as research publications or videos, and knowledge from biology. The influence of information and knowledge from biology on the variety of solution ideas as one criterion for creativity remains to be examined. In this work, we therefore analyse the impact of information and knowledge from biology on the variety of solution ideas generated by pairs of biologists and mechanical engineers working in uni-and bi-disciplinary pairs. The results show a positive influence of information and knowledge from biology on the variety of solution ideas. Moreover, they indicate the need for a support of biologists and mechanical engineers to effectively increase the variety of solution ideas on different levels of abstraction.

BIOLOGICALLY INSPIRED FAULT ADAPTIVE STRATEGIES FOR ENGINEERED SYSTEMS
David Charles Jensen, Nicholas Huisman

University of Arkansas, United States of America

In nature, the continued survival of a species depends on the adaptability to unexpected environmental factors. While major mutations may lead to the selection of preferred traits in the long term, in the short term there are a variety of principles found in nature which are seen across biomes which enable individual organisms and organism groups to be adaptive. For complex, human engineered systems the ability to adapt to broad environmental and mission changes is a growing research topic. This paper presents the findings of a review of biological science to identify general strategies of fault adaption. These strategies are categorized and then represented using a formal engineering model-based representation. This work demonstrates the ability to identify natural fault adaptive principles, the ability to use these principles in a guided design process, and presents a validation framework for comparing performance of biologically inspired fault adaptive technologies.

CHAIR
Katherine Kai-Se Fu

USER (ENTRED DESIGN (1)

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WEDNESDAY
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JUL

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COLLECTIVE BRAND IMAGERY WEAVE: CONNECTING BRAND VALUES TO PRODUCT CHARACTERISTICS USING PHYSICAL COMPLEX INSTALLATION
Maaike Mulder-Nijkamp (1), Priscilla Chueng-Nainby (2),(3)

(1) University of Twente, the Netherlands; (2) TU Delft, the Netherlands; (3) University of Edinburgh, United Kingdom

Branding is almost fully embedded as a strategic asset. Companies must develop products with designs that not only appear attractive but also carry distinctive references, manifest in the values of the brand. However, those values are sometimes intangible and evoke different meaning between consumers. Therefore it is a challenging job to manipulate design features to elicit the 'right' associations, especially for novice designers. This paper discusses a workshop where we implemented a method based on the collective imagery framework to explore seven values (prestige, superior, quality, excitement, audacious, performance, simplicity). The method establishes an embodied common ground for co-designers to envision, enact and connect the complex network, which connects brand values to product characteristics. In the workshop participants were asked to create visions with each other by sharing personal stories. The physical structure built by participants to show their values in spatial structure. We conclude that it is useful to use physical installation to determine meanings of values that inform product characteristic for a brand to be recognisable.

AIDING DESIGNERS TO MAKE PRACTITIONER-LIKE INTERPRETATIONS OF LIFE CYCLE ASSESSMENT RESULTS | *Praveen Uchil (1), Amaresh Chakrabarti (1), Peter Fantke (2)*

(1) Indian Institute of Science, India; (2) Technical University of Denmark

Detailed Life Cycle Assessment (LCA) provide tools to quantitatively illustrate the environmental impacts of a product throughout its life cycle. Effectively interpreting the results of a detailed LCA are fundamental for taking reliable decisions about evaluating design alternatives w.r.t environmental impact and for communicating the same across various actors. The goal of our research is to develop target specific interfaces to aid designers to make practitioner like interpretation of LCA results. In this paper we describe the challenges involved in practitioner like interpretation of LCA results and describe general requirement of a LCA interface to support effective (Practitioner –like) interpretation. We develop a novel questionnaire based evaluation method to identify the issues in LCA tools, faced by designers in pursuit of practitioner like interpretations. In order to describe underlying cause of these issues, we use two constructs derived from domain of information visualization, namely explanatory and exploratory mode of interfaces.

A MODEL OF LOST HABITS: TOWARDS A STRATEGY TO IMPROVE THE ACCEPTANCE OF PRODUCT SERVICE SYSTEMS | *Hendrikus Schotman, Geke D.S. Ludden*

University of Twente, The Netherlands

User acceptance is one of the largest barriers for the success of product-service systems (PSS). Often, PSS require a user to change his or her behaviour, which may conflict with existing habits. This results in non-acceptance of the PSS, which is disappointing for designers who aim to develop successful PSS. Research on acceptance of PSS has been focused on the context in which PSS could operate, and on how PSS should be designed and marketed, in order to trigger and stimulate behaviour change. These methods centre on the viewpoint that change is a necessity. However, change is difficult, because people tend to hold on to their habits. In this paper we will propose that habits can be used in the design process, for which we introduce the term "lost habits". When people lose habits due to undesired events, they may be very motivated to accept something that is instrumental to restore their habits. A PSS that addresses these so-called lost habits, might therefore be successfully accepted. In this paper, we will present a model that builds on this point of view, and we will present an explorative study to find how this model can be used in the beginning of a design process.

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WEDNESDAY
29
JUL

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USER CENTRED DESIGN (1)

CHAIR
Katherine Kai-Se Fu

INTEGRATION OF USER KNOWLEDGE ACROSS THE LIFECYCLE OF INTEGRATED PRODUCT-SERVICE SYSTEMS – AN EMPIRICAL ANALYSIS OF THE RELEVANCE FOR PSS DEVELOPMENT AND MANAGEMENT |

Danilo Marcello Schmidt (1), Stephanie Preißner (1), José Alonso Hermosillo Martínez (1),(2), Michael Quiter (2), Markus Mörtl (1), Christina Raasch (1)

(1) Technische Universität München, Germany; (2) YAMAICHI ELECTRONICS Deutschland GmbH

Integration of user knowledge in corporate innovation processes enhances firm innovation performance. Despite the relevance of the topic, research on when to integrate user knowledge into corporate innovation processes is scarce. We address this gap by empirically investigating the relevance of user knowledge across the lifecycle of complex product-service systems (PSS). Using matched interview data from both users and producers, we find, that user knowledge is useful for many important phases across the PSS lifecycle. When comparing the relevance of user and producer knowledge, we find that user knowledge is particularly relevant for early ideation- and late use-related phases, as well as for service-related development and delivery stages. With regard to product-related production and logistics, firms tend to rely on knowledge that is available internally. Our findings have several implications for the development and management of integrated product-service systems, including guidelines about when to integrate users into their PSS development.

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WEDNESDAY
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JUL

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DESIGN FOR X, DESIGN TO X ADDITIVE MANUFACTURING

CHAIR
Thomas J. Howard

A CALL FOR FDM DESIGN RULES TO INCLUDE ROAD DEPOSITION

Giacomo Fornasini, Linda C. Schmidt

University of Maryland, United States of America

The deposition paths, or roads, used to create FDM parts area a critical factor in determining part performance. In some cases, such as the FDM machines discussed in this work, there are no designer options to control road patterning, making it a hidden constraint in the design process. Even if the option is given, the designer must be aware that it is a variable. In either case, deposition road patterning is not something that can be taken for granted when designing parts. A new level of DfFDM guideline development must be implemented if AM is to reach the level of universality as other traditional machining methods.

DESIGN FOR X, DESIGN TO X ADDITIVE MANUFACTURING

CHAIR
Thomas J. Howard

REDEFINING PRODUCT FAMILY DESIGN FOR ADDITIVE MANUFACTURING

Ningrong Lei (1), Seung Ki Moon (1), David W. Rosen (2)

(1) Nanyang Technological University, Singapore; (2) Georgia Institute of Technology, United States of America

The paper highlights the opportunities for Additive Manufacturing (AM) based product family design to operate in a much broader design space that is free from constraints which arise in traditional product family designs from finding a compromise between commonality and performance. The proposed method starts by establishing design requirements and defining the customization space. Subsequently a utility-based objective function is employed to optimize individual products for multiple objectives. The final step identifies potential commonalities that can be exploited in order to reduce the manufacturing cost. We incorporate an AM cost model into the product family design process and to explore the effects of eliminating the commonality requirement. To show the feasibility of the method, a family of finger pumps is investigated. The results show a significant performance improvement when compared to conventional product family design methods. The results also show that, with the advantages of AM, the customization cost is consistently low. These results provide confidence that the proposed method yields affordable customization without compromising individual product performances.

COMBINING ADDITIVE MANUFACTURING WITH CFRP COMPOSITES: DESIGN POTENTIALS

REVIEWERS' FAVOURITE

Daniel-Alexander Türk (1), Andreas Züger (1), Christoph Klahn (2), Mirko Meboldt (1)

(1) ETH Zürich, Switzerland; (2) Inspire AG, Switzerland

The combination of Additive Manufacturing (AM) with Carbon-Fibre-Reinforced Polymers (CFRP) unlocks potential in the design and development of highly integrated lightweight structures. This paper introduces two different design potentials, where the combination of AM and CFRP can lead to better and lighter hybrid structures: First, Load Introductions often show complex superimposed loads and therefore lightweight metal alloys become a valuable alternative to CFRP. With AM, load-oriented designs that provide a more continuous introduction of the load into the fibers become possible. Secondly, tooling for complex composite structures is expensive and laborious. Here, inner tooling with AM can offer potentials in the design and development of complex-shaped composite parts. Within this paper, the potentials are highlighted by a case study that consists of the development of a Hydraulically actuated Quadruped robot (HyQ) leg. Based on the case study, the need for fundamental research in the design and processing of structures with AM and CFRP is pointed out in order to pave the way for its use in future high performance technological applications.

CROWDSOURCED DESIGN PRINCIPLES FOR LEVERAGING THE CAPABILITIES OF ADDITIVE MANUFACTURING |

K Blake Perez, David S Anderson, Katja Hölttä-Otto, Kristin L Wood

Singapore University of Technology & Design, Singapore

The proliferation of additive manufacturing technologies has inspired its use at different scales for both prototyping and production. Moreover, the accessibility of inexpensive machines has enabled design at the end-user level. However, the unique capabilities of these layer-based manufacturing processes are often underutilized or even unexplored. In this work, the authors leverage a crowdsourced repository of additive manufacturing design data to extract useful design principles for additive manufacturing. Herein, 23 design principles are discussed from said extraction. Many of the 23 principles are found throughout the literature. These lend validity to those that are novel and not yet existing in literature. It is found that the 23 principles range in specificity in how they relate to the manufacturing process The levels of specificity from most general to specific include (i) design for manufacturing, (ii) design for digital manufacturing, (iii) design for additive manufacturing, and (iv) design for fused filament fabrication. The principle, when implements can help designers to fully leverage the capabilities of additive manufacturing technologies.

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DESIGN METHODS AND TOOLS SIMULATION (1)

CHAIR
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2:00 pm
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WEDNESDAY
29
JUL

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SIMULTANEOUS OPTIMISATION: STRATEGIES FOR USING PARALLELIZATION EFFICENTLY

Andreas Wünsch, André Jordan, Sándor Vajna

Otto-von-Guericke University Magdeburg, Germany

Efficiency plays a major role in any facet of product development. The product has to be efficient itself, but the processes of product development have to be efficient as well. Analysis and simulation enable engineers to evaluate new products without the need for physical prototyping and improve them by optimisation methods. Since parallel computing was introduced the process of product optimisation became more efficient. However, it is very susceptible to bottlenecks like any the lack of available resources. We transfer the approach of simultaneous engineering to an optimisation framework. The term simultaneous optimisation is introduced in order to use the available resources in an efficient way and to reduce idleness of the resources. To verify the framework it was tested in an industry-related workstation cluster. In this approach resources are floating and can become available or busy in order to the current use of a machine or the unavailability of licenses. The presented approach works in both homogenous and heterogeneous workstation clusters.

STACK-UP ANALYSIS OF STATISTICAL TOLERANCE INDICES FOR LINEAR FUNCTION MODEL USING MONTE CARLO SIMULATION | *Akimasa Otsuka, Fusaomi Nagata*

Tokyo University of Science Yamaguchi, Japan

Tolerancing is important in the mechanical design process because it affects product quality and manufacturing cost. Various tolerancing methods have been studied while considering quality and cost of a product. However, tolerance for design element is rounded to one scalar value, even though designers decide the value statistically considering machining error. Therefore, a next generation tolerancing method is required. Fortunately, a useful tool called statistical tolerance index is available. This tool limits design drawing process capability indices on design drawing, so that a manufacture process may satisfy this limitation. To decide the limitation suitably, a stack-up problem of statistical tolerance indices is formulated like a problem of conventional tolerance analysis. The stack-up problem can be represented by Minkowski-sum on a hyper-plane of the mean and the standard deviation square. Therefore, the problem can be numerically solved using the convex envelope algorithm and Monte Carlo simulation. We first begin the study by analysing the problem using Monte Carlo simulation.

TAKING INTO ACCOUNT THE CHANGE OF GEOMETRY IN SYSTEM SIMULATION PROCESSES | *Kristian Mauser, Thilo Breitsprecher, Alexander Hasse, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany

In product development process of dynamic systems more than one technical field (i.e. mechanical, electrical or combustion technologies) affects the product. It is of particular importance to ensure the functionality of such multi-domain products especially after changing one of the domain-specific sub-process (i.e. CAD-data in mechanical design). This is possible by simulating the system behaviour of the overall product in a multi-domain system simulation. The consideration of the detailed information of each technical domain in the system simulation is not possible at moment. Therefore the relevant information in each sub-process have to be identified and insert into the system simulation. In this contribution focus is set on mechanical sub-process. An application is developed that identifies all changed information of a product design in the CAD-environment and provides this information to the system simulation. A proof of the functionality of the developed procedure in shown in a use case. The piston of a single-cylinder combustion engine model is changed by the designer. After that the developed application is executed and the changed simulation results are discussed.

CHAIR
William Ion

DESIGN METHODS AND TOOLS SIMULATION (1)

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2:00 pm
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WEDNESDAY
29
JUL

BL27.5

FUNCTIONAL ASSEMBLY USING SYNAPTIC NETWORKS: THEORY AND A DEMONSTRATION CASE STUDY | *Georgios Mavrikas (1), Vasilios Spitas (1), Christos Spitas (2)*

(1) National Technical University of Athens, Greece; (2) Delft University of Technology, The Netherthands

This paper proposes a methodology for the functional assembly of parts by creating synaptic networks between parts. Each synapsis contains both relative placement of part surfaces and features as well as the geometric tolerances that govern the functionality of the obtained part configuration. A case study is reported, where this method is seen in action and its merits are shown. The proposed method offers an integrated and concise approach to functional assembly modelling, by combining geometric placement of parts and tolerancing, which are normally treated separately by current CAD systems, with tolerances treated effectively as mere annotations, and largely neglected by current design theories.

CHAIR
Kristin Paetzold

DESIGN ORGANISATION AND MANAGEMENT (COLLABORATION IN DESIGN (1)

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MEETINGS IN THE PRODUCT DEVELOPMENT PROCESS: APPLYING DESIGN METHODS TO IMPROVE TEAM INTERACTION AND MEETING OUTCOMES | *Ann-Kathrin Bavendiek, Lisa Thiele, Patrick Meyer, Thomas Vietor, Simone Kauffeld, Tim Fingscheidt*

Technische Universität Braunschweig, Germany

Design methods are used to support single steps of the product development process. They are expected to contribute to reducing the development time and to enhancing the degree of innovation of the outcome. But as they are time-consuming, cost-intensive and so far of little practical use, there is a call for new approaches and more appropriate selection of methods. The high level of abstraction and the theoretical overload of many design methods and their descriptions are seen as their main deficits. The inclusion of team competencies and team aspects (e.g., team size) is proposed to achieve a greater acceptance of design methods in practice. Supporting this idea, we present and evaluate the results of a single case study aiming at demonstrating the benefit of design methods in team meetings. Finally, we introduce an approach for using the observatory data to improve the use of design methods by means of an advanced methods assistance system.

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DESIGN ORGANISATION AND MANAGEMENT (COLLABORATION IN DESIGN (1))

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Kristin Paetzold

2:00 pm
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WEDNESDAY
29
JUL

BL27.6

MODELLING OF IMMERSIVE SYSTEMS FOR COLLABORATIVE DESIGN

Serge Rohmer

University of Technology of Troyes, France

This paper proposes to explore the concepts related to immersive situations for collaborative design. The term immersion is investigated depending on the analysis of its constitutive elements, i.e. the actors and the workspace. Based on the feedback of experiments performed in the design process of products, a proposition of categorization of the actors and workspaces gives a conceptual basis for the modelling of immersive systems. An application with educational institutions supports the proposal and aims to prove the efficiency of immersive strategies.

ONLINE WAYS OF SHAREDNESS: A SYNTACTIC ANALYSIS OF DESIGN COLLABORATION IN OPENIDEO | *Joost Bianchi, Yuri Knopper, Ozgur Eris, Petra Badke-Schaub, Lampros Roussos*

Delft University of Technology, The Netherlands

This research aims to develop a language-based cognitive framework in order to evaluate the performance of virtual design communities. We leveraged two existing theories on the use of language as stimuli and constructive naming in developing a coding scheme, which we used to analyze the online collaboration communications of 9 teams in OpenIDEO. Successful teams used more noun phrases and verb-based syntax in the Idea phase, but less in the Refinement phase. This finding suggests that the successful teams were engaged in constructive naming and relied on verb-based syntax to express their ideas more than the unsuccessful teams early on in the design process. It also suggests that the unsuccessful teams attempted to "catch up" mid-process, but fell short. Despite the finding that the successful teams used more noun phrases in the Idea phase, their unique/non-unique noun phrase usage ratio was lower than the unsuccessful teams. This relationship was reversed in the Refinement phase. This finding suggests that expanding the concept space via constructive naming by unique noun phrases might not be sufficient for high performance, and that reusing those constructed names might also be necessary.

CAN ALGORITHMS CALCULATE THE "REAL" SHAREDNESS IN DESIGN TEAMS?

Kaori Yamada (1), Petra Badke-Schaub (2), Ozgur Eris (2)

(1) Kobe University, Japan; (2) Delft University of Technology, The Netherlands

Mental models have gained recognition as critical cognitive elements in design research. The members of a design team need to develop a shared mental model if their individual knowledge is to be used effectively. In this research, we investigate the development of shared mental models during team-based design collaboration by analyzing the words that are spoken by team members and focusing on the abstraction level of the discussion content. First, we apply the KeyGraph algorithm to differentiate spoken words according to their abstraction level. KeyGraph can extract words that represent the discussion based on their co-occurrence. We treat the extracted words as abstract level concepts. Next, we propose a method to analyse sharedness by identifying overlaps of the extracted words between team members. Then, we analyse a case by using the proposed method and compare the sharedness between abstraction levels. The results show that the general level sharedness is higher than the abstract level sharedness. They also show that a lack of sharedness among all of the members of a team does not imply lack of sharedness among subsets of the team members.

CHAIR
Sandro Wartzack

PRODUCT-SERVICE SYSTEMS (PSS)

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5.7

2:00 pm
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WEDNESDAY
29
JUL

BL27.7

PRODUCT-SERVICE SYSTEM (PSS) DESIGN PROCESS METHODOLOGIES: A SYSTEMATIC LITERATURE REVIEW | *Glauco H. S. Mendes (1), Maicon Gouvea Oliveira (2), Henrique Rozenfeld (3), Caio Augusto Nunes Marques (3), Janaina Mascarenhas Hornos Costa (3)*

(1) Federal University of Sao Carlos, Brazil; (2) Federal University of Alfenas, Brazil; (3) University of São Paulo, Brazil

Studies on Product-Service Systems (PSS) have risen significantly in the recent years driven by economic and sustainable benefits. In the PSS literature, the design of a PSS raises new issues since the service design and product design should be incorporated in the same design process. In this study a systematic literature review is conducted on PSS design process methodologies. The objective is to assess how five PSS design process methodologies support the integration between product and service design activities. Based on an analysis of 246 articles from Scopus database, some bibliometric indicators (number of papers published per year, the most important journals and the most cited papers) were provided. Considering this sample of articles, five PSS design process methodologies were analysed. The main characteristics of these methodologies were identified. More specifically, research findings were accumulated about the strategies used in each methodology for promoting the integration between product and service design activities.

FACILITATING INDUSTRIAL ADOPTION OF DESIGN METHODS FOR PRODUCT-SERVICE SYSTEMS | *Johannes Matschewsky, Mattias Lindahl, Tomohiko Sakao*

Linköping University, Sweden

In contrast to increasing evidence detailing both economic and environmental advantages of Product-Service Systems (PSS), the number of PSS provided in the market is still limited. Limited adoption in general can in part be linked to a limited implementability of PSS-focused design methods. This paper aims to provide a first account of characteristics intended to support developers of PSS design methods in providing high levels of implementability and usability. Since fields adjacent to PSS design, such as engineering design or eco-design, have experienced similar challenges in method adoption, literature focusing on this was reviewed. The applicability of the challenges found for PSS design methods was subsequently evaluated with a questionnaire among practitioners involved with the trial of a PSS design method over an extended timeframe. In order to tackle the challenges identified, beneficial properties found in the literature on PSS design methods were utilized in order to derive six characteristics. These are intended as a first orientation for developers aiming to facilitate a broad adoption and use of PSS design methods, and as a discussion basis in the research community.

AN EXPLORATORY STUDY TO EVALUATE THE PRACTICAL APPLICATION OF PSS METHODS AND TOOLS BASED ON TEXT MINING | *Caio Augusto Nunes Marques, Ivone Penque Matsuno, Roberta Akemi Sinoara, Solange Oliveira Rezende, Henrique Rozenfeld*

University of São Paulo, Brazil

Product Service System (PSS) is an approach in which the focus is on producing and delivering value in use instead of transferring physical goods ownership. In other to design PSS, some authors have been adapting methods and tools from traditional product design and others have been developing new specifically methods and tools. The description of those methods and tools is available in many sources of information, like thousands of publications in journals, and can only be analyzed based on Text Mining (TM) techniques. This paper reports an exploratory study whose purpose was to develop a procedure based on Text Mining techniques to support the identification of PSS design methods and tools which have been already applied in practical real cases. The research comprises the development of the first version of the procedure, employing TM techniques such as Named Entity Recognition, Association Rules and Bag of Expressions of the Domain. A Proof of Concept (PoC) was performed to verify whether the procedure is feasible and to identify future works possibilities. The PoC showed promising results and opened several possibilities to improve the procedure.

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PRODUCT-SERVICE SYSTEMS (PSS)

CHAIR
Sandro Wartzack

2:00 pm
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WEDNESDAY
29
JUL

BL27.7

PRODUCT-SERVICE SYSTEMS REPRESENTATION AND REPOSITORY FOR A DESIGN SUPPORT TOOL | *Yong Se Kim, Sohui Kim, Eunrae Roh*

Sungkyunkwan University, Republic of South Korea

Service elements are integrated with product elements to provice diverse values in product-service systems. Product-service systems vary a lot. Some have more product elements, while others have more service elements. Some services are to support products, and others are to support customers. A representation framework of product-service systems has been devised to support design process. A total of 12 dimensions are used to represent a product-service system, including value space, service space, business model space, customer space and actor space. A repository of product-service systems based on the framework has been developed so that many product-service system cases can be stored, retrieved and reviewed when a new product-service system is to be designed. Similarities among difference product-service systems can be assessed based on the dimensions of the representation framework. A prototype repository with the proposed representation framework will be described with examples on how product-service design processes can be supported.

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INNOVATION METHODS AND TOOLS (3)

CHAIR
Claudia Eckert

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BL27.8

ENABLING FRONT END OF INNOVATION IN A MATURE DEVELOPMENT COMPANY

Louise Broennum, Christian Clausen

Aalborg University Copenhagen, Denmark

Many mature development organizations finds it difficult to handle radical and incremental innovation within the same organizational structures. We examine how organizational structures, management, development mindsets and cultures represent a constitution of development for the thinking of development. We will through an in depth case study demonstrate how this constitution of development is enacted as best practice for development, making it difficult to bring forth radical ideas. Furthermore we will describe how navigation and (re)enactment of the constitution of development are practiced in staging new temporary development spaces framing for alternative Front End of Innovation opportunities in a mature development organization. The analysis indicates that it is important to know of the implicit and explicit rules of the constitution of development as these are re-enacted and points to the importance of being aligned with the strategy and mindset of the rest of the organization. This approximate alignment will induce alternative ways to set the stage for a development space that is configured to perform in new ways allowing for different types of development.

CHAIR
Claudia Eckert

INNOVATION METHODS AND TOOLS (3)

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WEDNESDAY
29
JUL

BL27.8

INVERSE TECHNOLOGY C-K IN ENVIRONMENT C-K TO OVERCOME DESIGN FIXATION

Fabien Jean (1),(2), Pascal Le Masson (1), Benoît Weil (1)

(1) MINES ParisTech, France; (2) SAFRAN, France

Formal theories of design have described design as a quest for the fit between two spaces such as form-context, solution-problem, structure-function and presently Technology-Environment (T-E). On the contrary, existing methods tempt to focus on E; most engineering disciplines serve T; designers are consequently left barehanded to apply formal principles. More specifically a design method should help to overcome design fixations and enable to steer T-E double exploration. First we extend Concept-Knowledge formalism by defining the inverse C-K of a considered C-K, i.e. the knowledge base is put into question to formulate a new initial concept and the initial concept has an assumed logical status to become the new knowledge base concept. In this configuration, one C-K can benefit from expansions of the other. Second a method is deduced by applying this principle to the T-E framework: designers should steer their exploration by drawing simultaneously T C-K and E C-K. Four empirical cases are analysed. The results suggest that the method enables to identify a maximum of fits before converging on one when used from the start or can provide defixating knowledge expansions when not.

MASLOW MEETS THE STONECUTTER

Paul Martin Winkelman

University of British Columbia, Canada

Hierarchies are commonly used in engineering to make data more accessible and concepts more understandable. Engineers readily recognize hierarchies and are quite aware of their presence within engineering work. Maslow's hierarchy of needs is also used in engineering, but its presence is much more subtle. Engineering is seen by many to offer many "problem-solving" opportunities which allows engineers to meet their "self-actualization" needs at the top level of Maslow's hierarchy. Yet these same engineers assume that the problems they solve will all be found in the bottom two levels (the more "practical" physiological and safety needs). Neglecting the problems of the higher levels, engineers often find their best efforts compromised as the effects of their "low level" solutions travel up the hierarchy. A good example of this can be seen in the negative effects the installation of latrines in developing countries has had on women. The insistence that all problems come from the bottom and solutions come from the top closes the loop, to some extent, on Maslow's hierarchy. As the tale of the stonecutter reminds us, hierarchies may not be hierarchies after all.

DESIGN ACUMEN

Søren Ingomar Petersen

Ingomar & Ingomar - Consulting, United States of America

Over the past decade, design has earned the respect of most established firms and even cash-strapped entrepreneurial startups and their investors have begun to focus on design. They are becoming more mindful of nurturing and including elements such as design expression to assess the performance of a new venture. Academic studies have also shown that good visual expression alone can aid in users' interface with products and with pre-established criteria in place, users can now more readily agree on what constitutes a good visual design expression. By applying the Industrial Design Excellent Award reception as a standard for good visual design expression, this study examines how laymen, novice designers, design experts and design researches intuitively judge design. In conclusion, we show how to ensure that one has included a sufficient number of these elements when assessing the performance of a visual design expression and how this can dramatically improve the performance of design centric ventures.

VISUALIZING THE EFFECTIVENESS OF PRODUCT PORTFOLIO WITH RESPECT TO PRODUCT SPECIFICATIONS |

Gyesik Oh (1), Chang Muk Kang (2), Kilmo Kang (3), Yoo S. Hong (1)

(1) Seoul National University, Korea, Republic of South Korea; (2) Soongsil University, Korea, Republic of South Korea; (3) Samsung Electronics, Korea, Republic of South Korea

Most companies consistently analyze product portfolio to gain insights for establishing future strategies. The effectiveness of portfolio a kind of analysis index referring to market share of portfolio with respect to the number of models in portfolio. Since there are too many products in the market, companies need to divide market into comprehensible size for analysis. Traditionally, market segmentation is used for categorization. However, it has limitations on implementation especially in fast-changing markets consisting of an excessive number of products. To overcome this issue, we propose a new method to divide a market with respect to product specifications in the perspective of engineering design. Since it is conducted on market data, practitioners are able to analyze market objectively by reflecting up-to-date market situation. We adopt self-organizing map as a clustering method to visualize the effectiveness of portfolio. Engineering designers are able to gain clues on candidate models for elimination and the direction of specifications for new models from visualized analysis results. We develop a Matlab-based software to enhance usability for practitioners.

A STRATEGY FOR ARTEFACT-BASED INFORMATION NAVIGATION IN LARGE ENGINEERING ORGANISATIONS |

David Edward Jones (1), Nicolas Chanchevrier (2), Chris McMahon (1), Ben Hicks (1)

(1) University of Bristol, United Kingdom; (2) Airbus, Toulouse, France

Central to an effective information management or knowledge management strategy - particularly where the KM strategy focuses on the capture and codification of knowledge - is the ability to efficiently and effectively access information. This includes finding and re-finding the right information in the right amount at the right time. For many large organisations, and in particular engineering organisations that design, build and service a wide range of complex long-life products, the volume of information (knowledge) that is captured and stored, and the variety of users and their information needs make the provision of appropriate information access tools a major challenge. By way of an alternate to extant text-based tools, the work reported in this paper explores the concept of artefact-based information search within the context of large engineering organisations.

VISUAL CONJOINT – FROM DISCRETE TO CONTINUOUS

Seth Orsborn (1), Jonathan Cagan (2), Peter Boatwright (2)

(1) Bucknell University, United States of America; (2) Carnegie Mellon University, United States of America

One goal of designers is to find what users most likely appreciate and translate that into successful product designs. Over the past 15 years, the efficacy of visual conjoint analysis as a means to assess the visual preference of users has been explored and has demonstrated immense potential for product development and aesthetic design. Visual conjoint started within marketing but was adopted by engineering design due to its ability to map visual product attributes to quantifiable mathematical representations. Conjoint studies initially presented only discrete verbal options, which severely limited types of feedback that designers could acquire. As conjoint evolved and was adopted by engineering design, it began to include discrete imagery with verbal representations. This provided more information without requiring more cognitive processing by respondents. Engineering design then realized the advantage of having purely visual conjoint studies in that mathematically represented images could contain immense amounts of information in simple representations. Continuous visual conjoint leverages imagery that represents mathematical models of continuously variable design attributes.

CHAIR
Jami Shah

DESIGN INFORMATION AND KNOWLEDGE VISUALISATION TECHNIQUES

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WEDNESDAY
29
JUL

BL27.12

INTEGRATED VALUE ENGINEERING - FRAMEWORK FOR THE APPLICATION OF METHODS FOR VISUALIZATION OF INFORMATION |

Tarek Sadi, Florian G. H. Behncke, Sebastian Maisenbacher, Simon Kremer

Technische Universität München, Germany

Technical products are becoming more demanding in terms of their requirements for functionality to the customer and price. Approaches of cost management companies in increasing the customer value of their products. A relatively new approach in cost management is the approach of integrated value engineering (ive). It combines structure-based matrix methods with approaches from cost management to systematically identify potentials for cost optimization. A benefit is that all steps of the approach are displayed in one model and correlations between cost potentials on several product domains are traceable. However a major challenge in the application of new methods results from their increasing specification on certain topics, what easily results in difficulties concerning the flow of information. Information sharing is based on specific forms of representation, which cannot readily be interpreted by all stakeholders involved in the product development project. Therefore, this paper presents a framework for an early-phase stakeholder analysis that extracts relevant information to fit individual stakeholder interests concerning the underlying level of detail and result-orientation.

D
6.1

DESIGN FOR A SUSTAINABLE LIFE (CASE STUDIES AND EXAMPLES (2)

CHAIR
Carolyn Conner Seepersad

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.14

SIMILARITIES AND DIFFERENCES BETWEEN ENVIRONMENTAL SOUNDNESS AND RESOURCE EFFICIENCY AND THEIR CONSEQUENCES FOR DESIGN SUPPORT

Sandra Link (1), Hermann Kloberdanz (1), Naemi Denz (2)

(1) TU Darmstadt, Germany; (2) VDMA - German Engineering Federation

Environmental soundness and resource efficiency are important issues that should both be taken into account when engaging with sustainability. In recent years, several tools to assist designers to do this have been developed in design research. It is often incorrectly assumed that existing EcoDesign methods are absolute suitable to support designers in the development of resource efficient products. The comparison of the two topics, environmental soundness and resource efficiency, shows that although they have an overlap, significant differences can be identified. For design methodology, this means that some existing EcoDesign methods can be used to develop resource efficient products or can be adapted to resource efficiency. However, this is not sufficient. There is a lack of support for the anticipation of possible supply bottlenecks, which is a central characteristic of resource efficiency. How to integrate this topic into companies remains unclear.

INTEGRATED DESIGN OF DYNAMIC SUSTAINABLE ENERGY SYSTEMS

James T. Allison, Daniel R. Herber, Anand P. Deshmukh

University of Illinois at Urbana-Champaign, United States of America

Recent advancements in the development and investigation of integrated methods for the design of dynamic engineering systems have made possible the achievement of new levels of system performance and now support the ability to systematically identify synergy mechanisms that can improve the effectiveness of system design processes at both early and late stages. Significant efforts in the last several years have focused on using integrated dynamic system design methods to enhance the performance and economic competitiveness of sustainable energy systems. Improvements in energy sustainability include both renewable energy production (e.g., wind, wave, and solar energy) and improved efficiency of energy consuming systems (e.g., buildings, manufacturing, transportation systems). This article reviews important results of these efforts and presents integrative concepts based on these studies in a single cohesive article. Three case studies are reviewed, and generalizable design concepts are presented for the design of dynamic sustainable energy systems.

EXPLORING SUSTAINABILITY IMPACT ON INTERIOR DESIGN SOLUTIONS

Wael Rashdan

Al Ghurair University, United Arab Emirates

The interior design industry consumes significant amounts of natural resources, making designers morally obligated to the planet and its inhabitants. Designers must consider sustainable solutions to avoid the depletion of fragile ecological systems; they must employ different strategies to adjust all aspects of interior design to incorporate sustainable solutions, despite the many obstacles. This paper aims to explore the barriers preventing the implementation of sustainable design. This study focuses on sustainable practice within the context of interior design solutions.

CHAIR
Carolyn Conner Seepersad

DESIGN FOR A SUSTAINABLE LIFE (CASE STUDIES AND EXAMPLES (2)

D
6.1

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.14

STUDY ON A DETERMINATION OF DESIGN POLICIES FOR SOLAR-BOATS WITH DIFFERENT DESIGN PHILOSOPHIES | *Kazuya Oizumi, Kazuhiro Aoyama*

The University of Tokyo, Japan

As complexity of products increased, management of product design becomes difficult. For better management of product design, a method for the determination of design policy based on extended quality function deployment (QFD) was proposed. To realize computer-aided support for designers to determine design policy, the method makes use of a product model that can be retrieved from the extended quality function deployment table. In this paper, the proposed method was applied to two solar-boats whose design philosophies are different. One is to be designed for sprint race while the other is for endurance race. Comparison of the suggested design policies is discussed whether the difference properly captures change of design policies. As a result, it is verified that proposed method can satisfactory suggest design policies.

CHAIR
John Gero

DESIGN THEORY AND METHODOLOGY BIO-INSPIRED DESIGN (2)

D
6.2

3:15 pm
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4:15 pm

BL27.13

VISUAL REPRESENTATIONS AS A BRIDGE FOR ENGINEERS AND BIOLOGISTS IN BIO-INSPIRED DESIGN COLLABORATIONS | *Helena Hashemi Farzaneh, Katharina Helms, Udo Lindemann*

Technical University Munich, Germany

In technical product development, engineers address technical problems by developing innovative solutions. An approach to develop ideas with a high potential for technical innovation is bio-inspired design or biomimetics. It implies the transfer of information and knowledge from biology to develop a technical solution. This transfer is a challenge, since engineers do not necessarily have sufficient knowledge in biology. On the other hand, biologists do not necessarily have knowledge in technical product development. Direct collaboration between engineers and biologists can be a solution, but due to the different educational background, misunderstandings can be a barrier. In this work, we develop common visual representations for biologists and engineers to overcome this barrier, based on the analysis of representations in both disciplines. We evaluate the guidelines for modeling technical and biological systems with these common visual representations in tests with engineers and biologists.

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6.2

DESIGN THEORY AND METHODOLOGY
BIO-INSPIRED DESIGN (2)

CHAIR
John Gero

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.13

SYSTEM FOR DERIVING DIVERSE SOLUTIONS VIA A MODIFICATION METHOD FOR EMERGENT DESIGN | *Koichiro Sato, Yoshiyuki Matsuoka*

Keio University, Japan

This paper describes efficiency of introducing a modification method that we proposed into a system for deriving diverse solutions. Moreover, a guideline of system parameter is proposed so as to utilize the effect that the modification method brings. Based on the concept of emergent design, the system for deriving diverse solutions can derive diverse and novel design solutions. However, most of the solution candidates that have novel shapes are inapplicable as solutions because of their low mechanical characteristics. For this reason, we have proposed a modification method by increasing and decreasing elements to reinforce the solution candidates. Setting local rules for modification, the method can reinforce the solution candidates without loss of their diversity. Though, the effect of the modification method is not clear, and the guideline of system parameter is not provided. Therefore, we make the effect of the modification method clear by comparing the solutions derived by the system with and without the modification method. Moreover, we provide a parameter guideline of system to effectively utilize the modification method.

DESIGN REPOSITORY & ANALOGY COMPUTATION VIA UNIT-LANGUAGE ANALYSIS (DRACULA) MATCHING ALGORITHM DEVELOPMENT | *Lucero Briana (1), Linsey Julie (2), Cameron Turner (1)*

(1) Colorado School of Mines Golden, United States of America; (2) Georgia Institute of Technology Atlanta, United States of America

Analogical reasoning is not the only approach for achieving innovation, but it is a highly effective and noted method. To avoid relying on chance identification of analogies through unique individual knowledge and experience, this research considers the potential impact of a system where an engineer could begin with their existing design, specify to a computer a set of critical functions and desired design performance improvements, and be returned with design analogies intended to inspire avenues for design improvements. This system, called Design Analogy Performance Parameter System (D-APPS), implements performance metric matching to retrieve examples and stimulate analogical mapping, enabling innovative design advances.The D-APPS software, Design Repository & Analogy Computation via Unit-Language Analysis (DRACULA), produces matches using topological isomorphism. The user provides information that derives a graph using the DRACULA algorithm to locate a matching graph set in an analogy space of the critical pairs and critical chains. DRACULA receives input from the user as a single flow associated with an engineering parameter, and a sequential set of critical functions.

MODELING BIOLOGICAL SYSTEMS TO FACILITATE THEIR SELECTION DURING A BIO-INSPIRED DESIGN PROCESS | *Pierre-Emmanuel Ifeolohoum Fayemi (1),(2), Nicolas Maranzana (1), Ameziane Aoussat (1), Tarik Chekchak (3), Giacomo Bersano (2)*

(1) Arts & Métiers ParisTech, France; (2) Active Innovation Management, France; (3) EFREI, France

The bio-inspired design process implies a multiplicity of actors. Engineers and biologists are usually among them. Mobilize cross-disciplinary and/or highly specialized biologists is a complex task and tools have been developed to address this specificity of the biomimetic approaches. However, the selection of biological model(s) of inspiration does not appear to have yet been tackled. This paper aims at proposing a way to define a benefit/effort ratio for considered biology to technology analogies, which should allow designers to sort these analogies on their own, easing the global biomimetic process. For such need, the paper presents a model revolving around the concepts of ideality and resources coupled with Living System Theory principles. The thorough analysis proposed here shows a consideration on what biological systems are, particularly for a bio-inspired design purpose. This analysis feeds the discussion on how biological systems could be appropriately modeled in order for them to be compared with technical ones, which is the initial need for the described model completion.

CHAIR
Katherine Kai-Se Fu

USER CENTRED DESIGN (2)

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6.3

3:15 pm
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WEDNESDAY
29
JUL

BL27.3

AN INVESTIGATION OF DIET APPS FOR ENHANCING PEOPLE'S HEALTH AND WELLBEING

Nur Nagihan Tuna (1), Bahar Şener (1),(2)

(1) Middle East technical University, Turkey; (2) University of Liverpool, United Kingdom

Since inactivity and unhealthy eating are amongst the biggest health problems of our era, weight monitoring applications are becoming favoured options. However, in order to ensure people's health and wellbeing, not only their physical state but also mental and social states should be supported by these applications. Recently, studies indicate the power of mobile applications in promoting health and wellbeing but there are still a limited number of studies about how these apps can be improved with the aim of better supporting wellbeing. For this reason, in this study, mobile diet apps were examined in the context of design for wellbeing. Three mobile diet apps were used by 15 participants who had an interest in healthy eating or weight loosing for one week. Three phased study was conducted to learn about the users' before and after weight control preferences and the strengths and weaknesses of the diet control apps. Consequently, suggestions were presented for improvement of weight control body monitoring apps with the aim of enhancing people's wellbeing.

THE SHAPE OF LIGHT: AN INTERACTIVE APPROACH TO SMART MATERIALS

Agnese Piselli (1),(2), Paola Garbagnoli (1),(2), Giorgia Cavarretta (1), Barbara Del Curto (1),(2)

(1) Politecnico di Milano, Italy; (2) INSTM – National Interuniversity Consortium of Materials Science and Technology, Italy

The research is focused on designing interactive products, in particular on the process that leads to the conception of innovative interfaces. The interfaces discussed are tangible interfaces, which exploit their physicality and their material characteristics as input and output mechanisms in the human-product interaction process. The objective of the research is to investigate the use of interaction design methodologies in the design of Smart Material Interfaces: interactive tangible products consisting primarily of smart materials. The overlapping between the discipline of interaction design and the world of smart materials generates new design opportunities. Thanks to this overlapping, objects of daily use become able to convey information through their physical properties and use the material they are made as a communicative medium. The paper is divided in three parts. The first part investigates the role of materials in interaction design, the second part presents the brief of the research and the third one reports an experimental workshop conducted in order to elaborate new interactive metaphors for lighting design.

HCI/HMI PLEASURE: PUSH YOUR BUTTONS

Robert E. Wendrich

University of Twente, The Netherlands

The four pleasures; a feeling of happy satisfaction, enjoyment, entertainment and sensorial gratification. "What's your pleasure?", asked Mr. Einstein. "Push my buttons, bleeped the machine." "With pleasure...here we go...!" cried Albert and pushed some buttons on the machine interface. The machine riposted; "Creativity is the residue of time wasted, design for life is to learn how to use creativity in our daily lives to fulfill our dreams and passions. Our tools dictate the nature of our work, whereby our hands are the instruments of our mind. Often software interfaces define the boundaries of our work, but only exploration into the margins of these tools, beyond the intended use pattern can really expose these boundaries. In that sense in order for us to break out of the design paradigm embedded in software we must use it "the wrong way". Hybrid software tools and blended spaces for design and creativity try to provide a simple, flexible and efficient workflow whilst still not limit the creative output." "Oh, thank you! Great answer", replied Albert pleased. "My pleasure!", the machine responded.

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6.3

USER CENTRED DESIGN (2)

CHAIR
Katherine Kai-Se Fu

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.3

PRINCIPLES FOR DESIGNING FOR PERCEPTION

Marta Perez Mata, Saeema Ahmed-Kristensen

Technical University of Denmark, Denmark

The paper presents an overview on the different design principles that influence the aesthetic experience of consumers regarding products. Three levels of design principles are presented: 1) general principles regarding how humans group elements together, 2) principles that when applied to products can generate a range of emotional responses and; 3) detailed principles relating aesthetics with perceptions (normally product or category specific). Results from the evaluation of the literature show that more research is necessary in areas where a large number of terms are not defined to a level that is detailed enough to show what the influence of modifying the aesthetic properties are in regards to the perception one wants to achieve. Future work could focus on building generative design tools (e.g. spatial grammars) or tools for the evaluation of designs (e.g. using fuzzy logics).

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6.4

DESIGN METHODS AND TOOLS ROBUST DESIGN

CHAIR
Thomas J. Howard

3:15 pm
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4:15 pm

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INTEGRATED APPROACH FOR EFFICIENT TOLERANCE OPTIMIZATION ON SHEET METAL PARTS | *Frank Litwa (1), Martin Gottwald (1), Michael Vielhaber (2)*

(1) Daimler AG, Germany; (2) Saarland University, Germany

The focus of this paper is on pointing out the opportunities of a deeper interlinking of dimensional management into product-/ and production-development environment. Today, these opportunities are arising because of a reduction in hardware prototypes during the development process. Instead of prototype build-up a shifting into the digital CAx-world is performed, caused by the cut down of development time. To ensure the deeper interlinkage, an integrated approach is set up to efficiently optimize the data. Thereby data from both domains (product-/ and production development) is considered and the optimization is based on the results of a tolerance analysis. An implementation of the approach offers several opportunities. Tolerance analysis can then be used, to rapidly calculate several options which result out of a Design of Experiments of the optimization. This offers the possibility to increase the product maturity level at a very early stage of the development process.

CHAIR
Thomas J. Howard

DESIGN METHODS AND TOOLS ROBUST DESIGN

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6.4

3:15 pm
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WEDNESDAY
29
JUL

BL27.4

AN APPROACH TO ANALYSING INTERFACE UNCERTAINTY USING THE CONTACT AND CHANNEL MODEL | *Tillmann Freund, Hermann Kloberdanz, Julian Lotz, Jan Würtenberger*

TU Darmstadt, Germany

The authors give a short introduction to uncertainty and introduce uncertainty terms for modular systems: Interface Uncertainty and Configuration Uncertainty. In order to control these forms of uncertainty a particular robust design methodology is needed that consists of models, methods and tools to describe, analyse, assess and finally control uncertainty. In this context, the authors provide a characterisation of what interfaces are and how they can be described through adequate properties, functions and other characteristics. To analyse interfaces, the Contact and Channel Model is adapted to consider the main Working Surface Pairs in Working principle Sketches or rather to simplify existing interfaces aiming at a better understanding for the designer in order to make a design more robust. Uncertainty and Interfaces, both represented in adequate models, are then brought together in one single model that can now be used to consistently describe uncertainty in the whole product lifecycle.

A ROBUST DESIGN APPLICABILITY MODEL

Martin Ebro (1),(2), Lars Krogstie (3), Thomas J. Howard (1)

(1) Technical University of Denmark, Denmark; (2) Valcon A/S; (3) Nammo A/S

This paper introduces a model for assessing the applicability of Robust Design (RD) in a project or organisation. The intention of the Robust Design Applicability Model (RDAM) is to provide support for decisions by engineering management considering the relevant level of RD activities. The applicability assessment is based on two considerations: 1) Whether there is a correlation between the factors that are important to the project or organisation and the factors that impact from the use of RD and 2) What is the occurrence level of the given factor in the organisation. The RDAM defines RD to be applicable in organisations assigning a high importance to one or more factors that are known to be impacted by RD, while also experiencing a high level of occurrence of this factor. The RDAM supplements existing maturity models and metrics to provide a comprehensive set of data to support management decisions. The factors in the RDAM were derived by analysing a combination of RD literature and industrial cases involving RD. The RDAM is used on a case company to illustrate its use.

MEASURING FUNCTIONAL ROBUSTNESS WITH NETWORK TOPOLOGICAL ROBUSTNESS METRICS | *Brandon Haley (1), Andy Dong (2), Irem Tumer (1)*

(1) Oregon State University, United States of America; (2) The University of Sydney, Australia

This paper describes a study on the use of network topological robustness metrics to measure the functional robustness of complex engineered systems. The goal of the research is to identify network metrics capable of accounting for the functional robustness of a system without the need for a behavioral simulation. Three network topology metrics, average shortest path length, network diameter, and a robustness coefficient, were evaluated given their prominence in characterizing the topological robustness of networks but lack of evidence of their correlation to functional robustness in engineered systems. A bipartite 'behavioral' network of a drivetrain was modeled and simulated for failure using a model-based simulation package, Modelica, and a network attack approach. Average shortest path length and the robustness coefficient showed consistent topological disintegration, revealing the effect of a failure on system performance. Network diameter does not show topology changes when the failure is located outside of the cluster containing the failure. The research demonstrates the plausibility of certain network metrics to characterize the functional robustness of systems.

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DESIGN METHODS AND TOOLS SIMULATION (2)

CHAIR
William Ion

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.5

INTEGRATING THE ABILITY FOR TOPOLOGY OPTIMIZATION IN A COMMERCIAL CAD-SYSTEM | *Johannes Schmelcher, Ralf Stetter, Markus Till*

University of Applied Sciences Ravensburg-Weingarten, Germany

An promising approach in optimizing parts with respect to their weight and simultaneously preserve their functionality, is designing parts in a way, where material is only present in regions, which are important for the functionality, and all other regions which do not contribute to the stiffness remain void. This is called topology optimization and leads to a design which is optimal concerning the distribution of forces. Since these benefits of topology optimization are readily known, research activities are very high in the past decades. Numerous methods have been developed and existing methods have been further advanced. Research activities can be divided into density-based methods, hard-kill methods, boundary variation methods and biologically inspired methods. One aspect which is not the focus of papers currently published is the integration of the actual optimization method into the product development process. Therefore this work focuses on the integration of topology optimization into product development processes by developing an easy deployable topology optimization tool which is completely integrated in the CAD system Creo Parametric 2.0.

CONCEPT AND APPLICATION OF AUTOMATIC PART-RECOGNITION WITH ARTIFICIAL NEURAL NETWORKS FOR FE SIMULATIONS | *Tobias C. Spruegel, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Currently available finite element software is consequently getting more and more user-friendly, and simulation knowledge must be expanded to a growing pool of new and less-experienced users; for example designers. These users need to be assisted when performing simulation tasks. A promising way is to check the FE results for plausibility, but therefore, it is essential to know what kind of parts should be simulated and checked for plausibility. This paper presents a concept for the automatic recognition of standard parts within the FE software, using a predefined Artificial Neural Network (ANN). An existing approach is extended to deal with the issues of arbitrarily oriented parts in CAD (computer-aided design) assemblies of differing size in 3D space. Hence a Principal Component Analysis (PCA), and a spherical detector surface for FE nodes in spherical coordinates is used to gain input parameters for an ANN. In the paper, the concept and an application for certain standard components are demonstrated.

SIMULATION READY CAD-MODELS AS A MEANS FOR KNOWLEDGE TRANSFER BETWEEN TECHNOLOGY DEVELOPMENT AND PRODUCT DEVELOPMENT | *Joel Johansson, Samuel André, Fredrik Elgh*

Jönköping University, Sweden

Manufacturing companies tend to separate technology development (TD) from product development (PD) as has been devised by research within the field of innovation management. When a technology is ready it somehow has to be made available to the PD teams so that the engineers working in PD projects can adapt the new technology into new products. The question is how that work can be supported. The ultimate goal of the research presented in this paper is to develop methods and tools to assist the knowledge transfer between TD and PD with a focus on supporting the actual use of the new technology in PD. This paper presents an industrial case along with a proposed method to achieve this. The TD and PD processes in the case company were reviewed with focus on how simulation models evolve over time and how they are used for different purposes. It was discovered that simulation ready CAD-models can be used to transfer the output from TD to PD.

CHAIR
William Ion

DESIGN METHODS AND TOOLS SIMULATION (2)

D
6.5

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.5

DEFINITION OF THE COLLABORATIVE SIMULATION SYSTEM (CM&SS) FROM A SYSTEMIC PERSPECTIVE IN VEHICLE INDUSTRY CONTEXT | *Laura Roa Castro (1),(2), Julie Stal-Le Cardinal (2)*

(1) Institut de Recherche Technologique IRT SystemX, France; (2) Ecole Centrale Paris, France

During the last decades modelling and simulation technics has grown in importance in the product development context. For example, from an industrial point of view, simulation models seem to be an excellent alternative on vehicle construction and more specifically, in the decision making process. Nevertheless, the simulation activity becomes more difficult with the complexity of the product, highlighting more and more often a collaborative problem on the organization of the product development. But, how can this problem be defined? Several collaborative approaches have been proposed in this field. However, the majority of those approaches concern only one dimension of the problem. This paper introduces the Collaborative Modelling & Simulation System (CM&SS) from a systemic perspective in vehicle industry context. The systemic approach enables the definition of different dimensions of the system aiming at a successful performance of a collaborative simulation.

CHAIR
Kristin Paetzold

DESIGN ORGANISATION AND MANAGEMENT (COLLABORATION IN DESIGN (2)

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6.6

3:15 pm
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BL27.6

HOW AN OPEN SOURCE DESIGN COMMUNITY WORKS: THE CASE OF OPEN SOURCE ECOLOGY | *Víctor Macul, Henrique Rozenfeld*

University of São Paulo, Brazil

Literature presents a huge number of studies related with the design process, but the open source design may present an environment fundamentally different. The involvement of a large number of people self-organized in the design process may generate some negative effects. Therefore, there is a necessity of better understanding of the open source design process and the tools that aid this process management. The objective of this paper is to increase the understanding on open source design and identifies research questions in this field. In order to achieve the proposed objective was realized an ethnographic case study in a non-profit organization called Open Source Ecology (OSE), which included an extensive document analysis added to about 800 hours of participant observation over a period of three months. We identified some big challenges faced by OSE regarding the design process, community, platform and business, which were deployed in some open research questions. Our findings indicate that, even though many accomplishments have been achieved, the open source design movement still has a low level of maturity, and is far from showing its full potential.

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6.6

DESIGN ORGANISATION AND MANAGEMENT (COLLABORATION IN DESIGN (2))

CHAIR
Kristin Paetzold

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.6

A FRAMEWORK OF WORKING ACROSS DISCIPLINES IN EARLY DESIGN AND R&D OF LARGE COMPLEX ENGINEERED SYSTEMS | *Anna-Maria Rivas McGowan (1), Panos Papalambros (2), Wayne Baker (2)*

(1) NASA Langley Research Center, United States of America; (2) University of Michigan, United States of America

This paper examines four primary methods of working across disciplines during R&D and early design of large-scale complex engineered systems such as aerospace systems. A conceptualized framework, called the Combining System Elements framework, is presented to delineate several aspects of cross-discipline and system integration practice. The framework is derived from a theoretical and empirical analysis of current work practices in actual operational settings and is informed by theories from organization science and engineering. The explanatory framework may be used by teams to clarify assumptions and associated work practices, which may reduce ambiguity in understanding diverse approaches to early systems research, development and design. The framework also highlights that very different engineering results may be obtained depending on work practices, even when the goals for the engineered system are the same.

IDENTIFYING AND VISUALISING KPIS FOR COLLABORATIVE ENGINEERING PROJECTS: A KNOWLEDGE BASED APPROACH | *Lei Shi (1), Linda Newnes (1), Steve Culley (1), James Gopsill (2), Simon Jones (1), Chris Snider (2)*

(1) University of Bath, United Kingdom; (2) University of Bristol, United Kingdom

Nowadays manufacturing involves high volume of complex operational processes, distributed resources and international/intersectional collaborations, which cause the evaluation of performance for related engineering projects to become a challenge. The performance of project is a key factor that determines the quality of output, and its temporal changes could reflect the status of project execution at current time, as well as indicate the potential issues for the near future. As a result, monitoring the change of performance is an essential approach to ensure the project execution is on track. It could raise awareness of project participants upon any issue occurs, and enable them to make appropriate decisions on a real-time basis. To facilitate the evaluation of project performance in collaborative environments, this research aims to propose an automatic approach to extracting key performance indicators (KPIs) from project related data, and also to demonstrate how the domain knowledge can facilitate the process of KPIs identification and visualisation.

THE SENSORY DELIVERY ROOMS OF THE FUTURE: TRANSLATING KNOWLEGE ACROSS BOUNDARIES IN A PUBLIC-PRIVATE INNOVATION PARTNERSHIP | *Signe Pedersen*

Aalborg University, Denmark

One of the biggest challenges when co-designing new and innovative products, services or systems is to handle the different knowledge perspectives of the involved project partners. In design and innovation processes the ability to translate knowledge across knowledge boundaries by enrolling actors and building up stable networks is crucial for success. Transferring knowledge across functions within the same company, has proved to be a problem, however, this might be an even bigger issue when it comes to Public Private Innovation Partnerships (PPIs), where the project participants (both the selected representatives and their organisations) might have very different backgrounds, incentives and motivations for participating in the design project. This article is following the partners involved in a successful PPI, in their efforts to design 2 sensory delivery rooms at a Hospital in Denmark. The research revolves around the efforts of the lead designer from one of the private companies in building up the network around the new Sensory Delivery Rooms by drawing on previous experience and using various boundary objects at different stages in the design process.

CHAIR
Sandro Wartzack

SYSTEMS ENGINEERING

D
6.7

3:15 pm
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WEDNESDAY
29
JUL

BL27.7

AN ALGORITHM FOR BEHAVIOUR PREDICTION OF COMPLEX TECHNICAL SYSTEMS

Krešimir Osman (1), Mario Štorga (2), Dorian Marjanović (2)

(1) Termo Servis Ltd., Zagreb, Croatia; (2) University of Zagreb, Croatia

The objective of the research presented in this paper is to develop an algorithm for predicting behaviour of complex technical systems in an uncertain working environment. System's dynamic behaviour modelling and simulation should help to develop new and improve existing architectures of complex technical systems by mapping in both directions, from the structural to the behavioural domain and vice versa. The algorithm for predicting behaviour during system's architecture development consists of several operations shortly described in this paper. The proposed algorithm was verified on an example of a complex technical system – an air-handling unit.

COST-BENEFIT ANALYSIS IN MODEL-BASED SYSTEMS ENGINEERING: STATE OF THE ART AND FUTURE POTENTIALS | *Martin Eigner (2), Christian Huwig (1), Thomas Dickopf (2)*

(1) Daimler AG, Germany; (2) University of Kaiserslautern, Germany

The increasing complexity and shorter time-to-market cycles demands enhancement methods for conceptual design phases. An instrument to promote product development activities by enlarging document-based methods on system level via increasing modeling effort is Model-Based Systems Engineering (MBSE). The intention of shifting this effort into early phases by frontloading-concepts on the one hand should reduce costs in the series development on the other. The resulting cost-benefit coherences of these correlations on system level as a symbiosis of mechanical-, electrical- and software engineering is currently a small highlighted research topic. Therefore, the paper analyzes the recent state of the art by evaluating industrial cost-benefit-theories in MBSE. The summary of existing industrial studies and indicators transferred to thereof resulting cost-benefit models consolidates a lack of research regarding the product system level. An initial approach to create new indicators, based on recorded expert interviews, for the development of an industrial MBSE benefit-model regarding costs is focussed after this summary. For this model, a MBSE pilot project in industry is discussed.

IMPROVING ORDER FULFILLMENT PROCESSES WITH MBSE

Thorsten Westermann, Harald Anacker, Roman Dumitrescu

Fraunhofer-Institute for Production Technology IPT, Germany

Highly customized products dominate in the mechanical engineering industry. Products like machine tools, food processing or packaging machines are characterized by a high complexity, a low quantity and a long-term machine life. This leads to a high number of variants and project specific modules and components. High efforts during order fulfillment processes occur. The development of mechanical embossed products to Cyber-Physical Systems reinforces the difficulties of the mechanical engineering industry. The interdisciplinary approaches of Systems Engineering and Model-Based Systems Engineering are suitable to improve order fulfillment processes. Therefore we introduce an approach to improve order fulfillment processes with Model-Based Systems Engineering. Our results meet the challenges of the mechanical engineering industry as follows: creating a domain-spanning description of the system and the business process to gain a common understanding; optimizing the system architecture by defining mechatronic modules; improving the sustainable communication within the company and with customers by training courses and tool support. The results are validated by a practical example.

D
6.7

3:15 pm
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WEDNESDAY
29
JUL

BL27.7

SYSTEMS ENGINEERING

CHAIR
Sandro Wartzack

INDUSTRIAL APPLICATION OF A MECHATRONIC FRAMEWORK

Jonas Mørkeberg Torry-Smith (1), Niels Henrik Mortensen (2), Ole Ploug (4), Sofiane Achiche (3)

(1) Novo Nordisk A/S, Denmark; (2) Technical University of Denmark, Denmark;
(3) Ecole Polytechnique de Montréal, Canada; (4) R&D Manager, Denmark

Design of mechatronics is greatly challenging due to its multi-disciplinary nature. On one hand companies need to facilitate integration between engineering domains while they on the other hand need to manage dependencies created between the exact same domains as the development process progresses. This paper proposes a way to identify, model and clarify dependencies by use of a "Mechatronic Integration Concept". The usefulness of the Mechatronic Integration Concept has been tested in an industrial development project showing positive results of shortening the lead-time, minimizing rework and increasing the performance of the product. The literature review on the topic of dependency modelling in mechatronic products seems to reveal a lack of proposals for how to represent the dependencies graphically which can facilitate cross-domain discussions.

D
6.8

3:15 pm
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4:15 pm

BL27.8

INNOVATION METHODS AND TOOLS (4)

CHAIR
Claudia Eckert

THE IMPACT OF DESIGN METHODS ON THE CREATIVITY OF 1ST-YEAR ENGINEERING STUDENT PROJECTS: THE CASE OF COMPUTER PROGRAMMING |

Alejandra Beghelli (1), Pablo Prieto (2)

(1) Faculty of Engineering & Sciences, Universidad Adolfo Ibañez, Chile;
(2) Product Design Engineering Dept., Universidad Técnica Federico Santa María, Chile

Engineers able to produce creative products are very much required everywhere. However, classical engineering courses – especially the courses of the first two years of the career- tend to be content-intensive, focused on technical skills, with little space to foster creativity. As a result, when faced with the requirement of devising a creative product, engineering students often are unprepared to do so. In this paper we show that the introduction of design methods into the 1st-year engineering course of Computer Programming significantly improved the novelty of final-term projects. Each design-method was selected according to the stage of the creative process the course was going through: preparation, incubation, illumination or verification. Our hypothesis is that by blending design and engineering teaching with enough time to go through the creative process, novel ideas emerge more fluently. In this paper we provide a weekly description of the course activities and the results obtained. We expect this work helps to re-design some engineering courses towards a more design-engineering blended teaching to trigger creative thinking.

CHAIR
Claudia Eckert

INNOVATION METHODS AND TOOLS (4)

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6.8

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.8

FUSION OF OLD AND NEW, CREATIVITY IN EDUCATIONAL AND HISTORICAL WAY: BOARD GAME WITH SERVICESCAPE CONCEPT IN TAIPEI TECH UNIVERSITY TOWN

Sheng-Ming Wang (1), Chieh Ju Huang (2),(1)

(1) National Taipei University of Technology, Taiwan; (2) Chienkuo Technology University, Taiwan

The quality of life is a feeling of well-being, fulfilment, or satisfaction on the part of residents or visitors to that place. "Smart Cities" is the answer and a response to these challenges. Four major districts of the study areas are: Taipei Tech University, Huashan Park, Guanghua Area, and JianGuo Beer Factory. There are observations within the study area to reveal significant information about people's preferences. Service design can influence the user's behaviour and also can improve the quality of the public space. This study will focus on observing user behaviour towards implementing a board game in Taipei Tech University corners, as a public space that helps give travel guide and introduction to other historical districts. The board game is being developed with augmented reality, RFID and mobile app: the "good life" mobile game app information and maps will be on the mobile screen, and when the players walked around the real area, directions will be projected to interact with people on the floor. The proposed prototype will be a user-friendly based application that helps to understand and navigate easily and also create user-oriented, innovative concept for Smart City.

REGGIO EMILIA ENGINEERING EDUCATION

Matteo Vignoli, Francesco D'Onghia

University of Modena and Reggio Emilia, Italy

How do we prepare future engineers to face 21th century challenges? This paper confronts the issue of what it really means to be an engineer and how to design a learning experience that influence the process of formation of one's identity, as a professional and as a human being. In this effort we have been deeply inspired by a pedagogy directed to preschool and primary education of Reggio Emilia (Italy): Reggio Emilia Approach. Starting from 2010, Project-based Learning was introduced in a MS&E capstone master degree class. New practices inspired by Reggio Emilia Approach were progressively implemented from 2011 to 2013. Every year, students completed a formal evaluation survey and answered to semi-structured interviews. The study reveals that there has been a significant increase of student interest toward the discipline. Students also showed to consider themselves more creative and confident about their capabilities. This experience shows that it is not enough to design the education of the engineer, but we must consider as equally important the education of the human being and of the citizen, by focussing on relations, on collectivity and on participation.

FORMULATIONS OF PARADIGMS OF TECHNICAL INHERITANCE

Iryna Mozgova, Roland Lachmayer, Philipp Gottwald

Leibniz Universität Hannover, Germany

The fourth industrial revolution is associated with changing production and design principles of machine parts. The purpose of this study is the development, elaboration and practical testing of an approach firstly proposed within the scope of the Collaborative Research Center (CRC) 653 "Gentelligent Components in Their Lifecycle". This approach is based on the adapted principles of evolution in nature: efficient development of the next generation of smart products based on the analysis of the life cycle data of the previous generations of the product and relevant information about their operation conditions. An analysis of contemporary trends in the technological community is provided and a brief overview given about existing approaches in optimization theory and technology using adapted mechanisms of nature. Basic determinations of the developed paradigm of Technical Inheritance are discussed. Using the example of within the scope of the CRC developed materials and methods the vision of applying the paradigm of technical inheritance is evaluated for the development and exploitation of smart components.

D
6.9

DESIGN INFORMATION AND KNOWLEDGE
STRUCTURING KNOWLEDGE

CHAIR
Jami Shah

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.12

AN INTEGRATED RFBSE MODEL FOR MANAGING AND REUSING ENGINEERING DESIGN KNOWLEDGE | *Hao Qin (1), Hongwei Wang (1), Yusheng Liu (2)*

(1) University of Portsmouth, United Kingdom; (2) Zhejiang University, People's Republic of China

Design efficiency has significant influence on a company's sustainable competitiveness. Reusing part of the previous product design can undoubtedly improve design efficiency, and thus the need of design knowledge management and reuse is raised. In order to reuse the previous design effectively and efficiently, informal design knowledge, e.g. design experience and design rationale, is required to understand the previous designs completely before reusing them. However, most of the knowledge management activities undertaken in the companies are focused on formal design data and information. Therefore, this research aims to fill in this gap by proposing an integrated knowledge model to guide engineers in capturing useful design knowledge within the design process. The knowledge model integrates four key design elements, namely requirement, function, behaviour, structure, and considers the evolution of the design, to capture informal design knowledge with specific design context. This model has been used in the design and development of a Web-based knowledge management system and preliminary evaluation shows it can achieve effective knowledge capture and reuse.

BUILDING A COHESIVE BODY OF DESIGN KNOWLEDGE: DEVELOPMENTS FROM A DESIGN SCIENCE RESEARCH PERSPECTIVE | *Philip Cash, Kalle A Piirainen*

Technical University of Denmark, DTU

Design is an extremely diverse field where there has been widespread debate on how to build a cohesive body of scientific knowledge. To date, no satisfactory proposition has been adopted across the field – hampering scientific development. Without this basis for bringing research together design researchers have identified difficulties in building on past works, and combining insights from across the field. This work starts to dissolve some of these issues by drawing on Design Science Research to propose an integrated approach for the development of design research knowledge, coupled with pragmatic advice for design researchers. This delivers a number of implications for researchers as well as for the field as a whole.

KNOWLEDGE MANAGEMENT IN CUSTOMER INTEGRATION: A CUSTOMER INPUT ONTOLOGY | *Kathrin Füller, Hanxi Liu, Markus Böhm, Helmut Krcmar*

Technische Universität München, Germany

Exchanging and analyzing customer input across different departments and software tools in a company is a prerequisite to successfully implement the co-creation of innovations with customers. Ontologies pose helpful tools to support knowledge representation and retrieval in a company. Prior research has developed ontology-based frameworks to manage idea generation and assessment in the early phases of the innovation process. However, these approaches do not address the holistic management of customer input across all phases of the innovation process. Based on a review of existing ontologies as well as types and characteristics of customer input, we develop the customer input ontology. With competency questions we show how the ontology might be used to generate knowledge and value of obtained customer input in form of ideas, concepts, or feedback. The customer input ontology supports knowledge management in customer integration since it provides a common language and format to collect and save customer input in a structured manner. Further, the customer input ontology allows the tracking and reuse of customer input throughout different departments and innovation cycles.

CHAIR
Jami Shah

DESIGN INFORMATION AND KNOWLEDGE
STRUCTURING KNOWLEDGE

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6.9

A PROPOSAL FOR KNOWLEDGE FORMALIZATION IN PRODUCT DEVELOPMENT PROCESSES | *Patrick Klein (1), Johannes Lützenberger (2), Klaus-Dieter Thoben (1)*

(1) University of Bremen, Germany; (2) BIBA - Bremer Institut für Produktion und Logistik GmbH, Germany

With respect to time-to-market and product development Knowledge Based Engineering (KBE) solutions, which enable an automation of design tasks, can contribute to a significant reduction of development time. But to develop KBE solutions, not only engineering but also informatics competencies are required, which leads often to case-based solutions and in addition to costly extra effort, even in those cases where solutions only have to be adapted to a new context. This way, KBE becomes too expensive for development teams, because they are only useful in a specific context and expensive to be managed. Enabling a broader usage context for KBE solutions, e.g. for different domains or in different projects, increases the efficiency of KBE. This paper aims to support designers to set-up and maintain KBE solutions, which address diverse product development tasks at once. Against this background, this paper identifies a need for a framework-independent solution to formalize design knowledge and derives corresponding objectives to be fulfilled by this solution. Further, an extension of an existing modelling language to become a new framework-independent standard for KBE projects is proposed.

3:15 pm
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4:15 pm

WEDNESDAY
29
JUL

BL27.12

DESIGN SOCIETY GENERAL MEETING

4:30 pm
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5:30 pm

BL27.1

AGENDA

The Design Society will hold a General Meeting on the afternoon of 29th July 2015 at Politecnico di Milano, Milan, Italy during the ICED15 Conference. All members of the Society are invited to attend the Meeting, which will have the following provisional Agenda:

1. Minutes of Meeting of August 2013
2. Report of the Board of Management
3. Membership
4. Finances
5. Elections – ratification of the election results
6. Changes to Memorandum and Articles of Association
7. Special Interest Groups
8. Publications
9. Events
10. Young members' activities
11. Future activities of the Society
12. ICED conference
13. Others

THURSDAY 30TH JULY 2015

	8:30 - 10:15 am	10:45 am - 12:30 pm	2:00 - 3:00 pm	3:15 - 4:15 pm	4:45 - 5:45 pm	5:45 pm - 6:15 pm
MARQUEE					**Keynote 6** see p. 215	**CLOSING SESSION**
BL27.1	**Podium 3.1** Design for a Healthy Life - Medical Devices and Systems	**Podium 4.1** Design for a Healthy Life - Methods, Tools and Case studies				
BL27.2	**Podium 3.2** Design Theory and Methodology	**Podium 4.2** Design Information and Knowledge				
BL27.3	**Podium 3.3** Design Methods and Tools - Early Phases	**Podium 4.3** Design Methods and Tools - Enhanced Product Models	**Discussion 7.3** User Centred Design - Methods and Tools	**Discussion 8.3** User Centred Design - Case Studies		
BL27.4	**Podium 3.4** Design Methods and Tools - Collaborative Design	**Podium 4.4** Design Methods and Tools - Case Studies in/for Industry	**Discussion 7.4** Design Education - Courses and Curricula	**Discussion 8.4** Design Education - Designerly Thinking		
BL27.5	**Podium 3.5** Design Organisation and Management - Failure and Risk Management	**Podium 4.5** Design Organisation and Management - Complexity and Change Management	**Discussion 7.5** Design Methods and Tools - Decision Support			
BL27.6	**Podium 3.6** Additive Manufacturing in/for Industry	**Podium 4.6** Production and Sustainability	**Discussion 7.6** Design Organisation and Management - Collaboration in Design (3)	**Discussion 8.6** Design Organisation and Management - Team Organisation		
BL27.7	**Podium 3.7** Idea Generation and Innovation in/for Industry	**Podium 4.7** Product Service Systems (PSS)	**Discussion 7.7** Design of Socio - Technical Systems			
BL27.8	**Podium 3.8** Human Behaviour in Design - Phenomena	**Podium 4.8** Human Behaviour in Design - Collaboration	**Discussion 7.8** Design Organisation and Management - Failure and Risk Management			
BL27.12			**Discussion 7.9** Design Information and Knowledge - Acquisition and Use	**Discussion 8.9** Design Information and Knowledge - Management Systems		
BL27.13			**Discussion 7.2** Design Research Methodology - Design Experiments	**Discussion 8.2** Design Research Methodology - New Methods and Tools		
BL27.14			**Discussion 7.1** Design for a Healthy Life (1)	**Discussion 8.1** Design for a Healthy Life (2)		

COFFEE BREAK

LUNCH BREAK & MEETINGS see page 192

LUNCH BREAK & MEETINGS see page 17

FAREWELL APERITIVO

CHAIR
Mieke van der Bijl-Brouwer

DESIGN FOR A HEALTHY LIFE MEDICAL DEVICES AND SYSTEMS

P 3.1

8:30 am - 10:15 am

BL27.1

THURSDAY 30 JUL

REMEMBER TO REMEMBER: A FEASIBILITY STUDY ADAPTING WEARABLE TECHNOLOGY TO THE NEEDS OF PEOPLE AGED 65 AND OLDER WITH MILD COGNITIVE IMPAIRMENT (MCI) AND ALZHEIMER'S DEMENTIA |

Anja M Maier (1), Ali Gürcan Özkil (1), Maria M Bang (2), Birgitte H Forchhammer (3)

(1) Technical University of Denmark (DTU), Denmark; (2) Rigshospitalet, Blegdamsvej, Denmark; (3) Rigshospitalet, Glostrup, Denmark

Designing for a healthy life includes addressing the needs of an ageing population. The number of people aged 65 and older with mild cognitive impairment and dementia is rising. Whilst there is to-date no pharmacological cure, treatments for symptoms and studies into the effect of non-pharmacological interventions have become more widely available, with the goals of maintaining and supporting cognitive function, helping the person compensate for impairments, and improving the quality of life. Promising yet nascent is the use of wearable technology for cognitive rehabilitation. We conducted an exploratory feasibility study adapting wearable technologies to support the above-mentioned elderly user group remember to remember their daily activities such as non-routine appointments. Six design concepts with smartwatches, smart bands, smartphones, smart calendar boards, NFC tags, and augmented reality glasses were sketched and two low-fidelity prototypes, Memofy and Komihu, were developed and tested with three patients and their caregivers. Technology acceptance was high both amongst patients and health personnel, encouraging further in-depth and longitudinal tests for health outcomes.

PROTOTYPING AND TESTING BASIC DESIGNS OF CENTRIFUGAL MICROFLUIDIC PLATFORMS FOR BIOMEDICAL DIAGNOSTICS

REVIEWERS' FAVOURITE

Stephan Cecil Fox, Quentin Lohmeyer, Mirko Meboldt

ETH Zürich, Switzerland

This paper presents a design approach, based on the idea to develop a product that allows a considerably faster diagnose of bacterial infections in the physicians office and thus, supports avoiding the unnecessary use of antibiotics. Nowadays, physicians send probes to central labs for diagnoses. These Labs usually use either manual work or microfluidic platforms. Most microfluidic platforms require expensive machinery for realizing complex motion sequences. However, there also is a cost-efficient alternative: centrifugal microfluidic platforms, which are also known as 'lab-on-a-disk'. In order to control flows, these disks take advantage of centrifugal forces, which can be easily regulated via rotation speed. In a first step, the technical feasibility was investigated with focus on basic designs of centrifugal microfluidic platforms for reliable controlling flows, only by regulation of rotation speed. The channel and reservoir designs were evaluated based on the results gained by physical testing of a lab-on-a-disk prototype in operation. The results and implications support the further development of a fully automated diagnostic device to be used as point-of-care.

A NEW DESIGN SYSTEM OF BELOW-LIMB PROSTHESES: THE ROLE OF A VISUAL PROSTHETIC DESIGNER

REVIEWERS' FAVOURITE

Stefania Sansoni, Andrew Wodehouse, Arjan Buis

University of Strathclyde, United Kingdom

This paper analyses the model of prosthetic design in the context of the public prosthetic centres in the UK, and proposes a new system of design including the role of the visual prosthetic designer. The visual aspect of prosthesis can favour a positive body image in the users; however they are often not advised or provided with models responding to their needs. We claim that the visual designer would improve the process for the appearance of the prosthesis, provide the amputees with visual solutions and support the prosthetists in the design process. The aim of this research is to highlight that more attention is needed for the visual needs of prosthetic users and that a change is needed in the current design approach of public prosthetic centres.

P
3.1

DESIGN FOR A HEALTHY LIFE MEDICAL DEVICES AND SYSTEMS

CHAIR
Mieke van der Bijl-Brouwer

8:30 am
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10:15 am

BL27.1

THURSDAY
30
JUL

FEATHERS, A BIMANUAL UPPER LIMB REHABILITATION PLATFORM: A CASE STUDY OF USER-CENTRED APPROACH IN REHABILITATION DEVICE DESIGN

Navid Shirzad (1), Bulmaro A. Valdés (1), Chai-Ting Hung (1), Mimi Law (2), Justin Hay (2), H.F. Machiel Van der Loos (1)

(1) University of British Columbia, Canada; (2) Emily Carr University of Art and Design, Canada

The healthcare sector is increasingly becoming dependent on medical devices and technologies. This is facilitated, in part, by the emphasis that is being put on the robustness of the design of medical and rehabilitation devices. The robustness of the design, and thus the adoption of a new medical device, relies heavily on its ability to fit into the multifaceted medical environment and satisfy a wide range of user needs. In order to achieve this, users and stakeholders must be involved early and frequently in the design process. In this paper, we outline a user-centred approach to design of physical therapy devices using a case study on developing an upper-body motor rehabilitation platform.

A KNOWLEDGE-BASED DESIGN PROCESS FOR CUSTOM MADE INSOLES | *Paola Marinelli, Marco Mandolini, Michele Germani*

REVIEWERS' FAVOURITE

Università Politecnica delle Marche, Italy

The Custom Made Insoles (CMI) context is characterized by a lot of software tools mainly used by skilled technicians of manufacturing companies. It is missing a tool to support the prescription of a CMI, mainly oriented to the podiatrists, but that could be used, at the same time, by customers, for self-monitoring activities, and by controllers to monitor the work of podiatrists. The paper aims to illustrate an innovative design process to prescribe a CMI, by using a knowledge-based web application: the prescription is based on configuration rules and templates, that provides to the clinicians a set of insole geometries and materials (knowledge-based approach). The proposed web platform Insole Designer is fully integrated with the most common monitoring devices (3D scanners and baropodometric platforms), 3D modelling software, and interactive shoes catalogues. The main output is the order (XML file) of the customised insole, used by an insole manufacturing company to produce the CMI. The validation is an ongoing activity, even if preliminary results are available. Italian podiatrists have been involved to evaluate each software module giving a score in a 3-point scale.

CHAIR
Yoram Reich

DESIGN THEORY AND METHODOLOGY

P
3.2

8:30 am
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10:15 am

BL27.2

THURSDAY
30
JUL

GENERIC TECHNIQUE AND THE DYNAMICS OF TECHNOLOGIES: USING MATROID AND DESIGN THEORY TO DESIGN TECHNIQUES WITH SYSTEMIC IMPACT

Pascal Le Masson, Armand Hatchuel, Olga Kokshagina, Benoit Weil

Mines ParisTech, France

As underlined in Arthur's book "the nature of technology" we are very knowledgeable on the design of objects, services or technical systems, but we don't know much on the dynamics of technologies. Still contemporary innovation often consists in designing techniques with systemic impact. They are pervasive– both invasive and perturbing-, they recompose the family of techniques. Can we model the impact and the design of such techniques? More specifically: how can one design generic technology, ie a single technology that provokes a complete reordering of families of techniques? Recent advances in design theories open new possibilities to answer these questions. In this paper we use C-K design theory and a matroid-based model of the set of techniques to propose a new model (C-K/Ma) of the dynamics of techniques, accounting for the design of generic technologies. We show: F1: C-K/Ma offers a computational model for designing a technique with systemic impact; F2: C-K/Ma accounts for some phenomena associated to generic technology design. F3: C-K/Ma offers an efficient guide for the design of technologies with systemic impact, based on generativity and genericity criteria.

DEFINITION OF THE FORM-BASED DESIGN APPROACH AND DESCRIPTION OF IT USING THE FBS FRAMEWORK | *Stefano Filippi, Daniela Barattin*

University of Udine, Italy

The most of design methods and tools consider product functions as the basis to generate design solutions, but in the aesthetic and industrial design the situation is different. The sensorial experience during the interaction between users and products is the focus of the design process. It is composed by three elements: form, function and emotion; functions are only one of the elements. There is not a clear definition of this design approach, and no methods exist to describe its processes. The FBS framework allows describing design approaches based on user needs and functions, from which the technical requirements of the products are derived. It is not suitable as it is, but its flexible and generic structure makes it the candidate to become a descriptive method for the form-based design approach. The goal of this research is to define the form-based design approach and to describe it by exploiting the FBS framework. To achieve this, the form is introduced as a variable and the processes exploiting it are defined. Thanks to a comparison with the processes belonging to the FBS framework, this is modified and integrated to be able to describe the form-based design approach.

EFFECTIVENESS OF THE SYSTEMATIC ENGINEERING DESIGN METHODOLOGY | *Damien Motte*

REVIEWERS' FAVOURITE

Lund University, Sweden

This paper reviews a set of published industrial applications and research studies in order to assess the effectiveness of the systematic engineering design methodology. Effectiveness, which can be considered as the degree to which the final design solution fulfils the design requirements, is one of the critical features of a design methodology. It cannot be concluded upon the reviewed publications that the methodology is not effective but it cannot be concluded either that the methodology is superior to an intuitive approach. The published industrial applications that have been identified have served mainly to confirm that the systematic engineering design methodology can lead to successful results. The identified research studies present more mixed results and show that several factors such as the engineering designer's experience and motivation dramatically influence the outcome, at least as much as methodology. Both proponents and opponents of the systematic engineering design methodology seem to agree that the systematic methodology used flexibly is more effective, but guidance on how to use the methodology in this way is required.

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3.2

DESIGN THEORY AND METHODOLOGY

CHAIR
Yoram Reich

8:30 am
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10:15 am

BL27.2

THURSDAY
30
JUL

PRODUCT LINE DESIGN, EVOLUTION, AND PRICING

Shuli Wu, Songlin Chen

NTU, Singapore

Firms usually design their product lines with products phased in and phased out in response to market or technology changes. This adaption of a product line has complicated implications on market demand and fracturing cost due to the coexistence of both competitive and complimentary relationship among different product models. This paper proposes a computational model to facilitate decision making regarding attribute determination, product line evolution and pricing. A logit discrete choice model is developed to estimate the purchase probability of a product model via the preferences on consumer attributes. An activity-based costing model is developed to estimate the manufacturing costs of a product line by aggregating the volume of components using bill of materials, and considering volume discounts and common overhead activities. Product line design is then formulated as a mixed integer non-linear programming problem with the objective to maximize expected profit by determining new products' attributes, the existence of old products and the price for each product model. The proposed model is illustrated with an example of a mobile phone product line adaptation.

CHAIR
Umberto Cugini

DESIGN METHODS AND TOOLS EARLY PHASES

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3.3

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10:15 am

BL27.3

THURSDAY
30
JUL

INTEGRATED FUNCTION MODELLING: COMPARING THE IFM FRAMEWORK WITH SYSML

Boris Eisenbart (1), Constantin Mandel (2), Kilian Gericke (2), Lucienne Blessing (2)

(1) University of Sydney, Australia; (2) University of Luxembourg, Luxembourg

This paper presents a comparison between the Integrated Function Modelling framework and SysML with the aim of deriving specific potentials for cross-fertilisation and further improvement regarding their application for function modelling in interdisciplinary design. The presented comparison comprises literature reviews as well as the practical application of both the IFM framework and SysML for modelling the functionality of an exemplary mechatronic system. The research leads to the identification of advantages and shortcomings in both approaches. Based on these insights, the paper further presents a conceptual adaptation of the IFM framework with the intention to improve its practical applicability and reducing modelling efforts.

CAPTURE OF ACTUAL DEVELOPMENT PROCESSES OF HYBRID INTELLIGENT DESIGN ELEMENTS IN ORDER TO DEFINE A TARGET DEVELOPMENT PROCESS

Alexander Crostack, Hansgeorg Binz, Daniel Roth

University of Stuttgart, Germany

Product development is characterised by an improvement of functional integration and a lack of new adapted design elements. For those reasons, within research unit 981 a new class of design elements called Hybrid Intelligent Design Elements (HIKE) has been developed. In order to enable companies to develop these design elements, developers have to understand the features of HIKE as well as the development processes resulting from them. This paper focuses on development processes of such HIKE. The paper presents the overall approach of how such a development process for HIKE shall be defined, as well as the results of the first important step: the capture of the actual development processes. For this, existing procedures from the field of process management are analysed, adapted and used to capture actual development processes through interviews. Furthermore, the paper briefly describes the performed interviews and captured processes of a HIKE lever. Finally, the paper ends with a critical discussion of the results and gives an outlook for subsequent research activities in order to define a target process for the development of HIKE.

IMPROVING GENERATIVE GRAMMAR DEVELOPMENT AND APPLICATION THROUGH NETWORK ANALYSIS TECHNIQUES

REVIEWERS' FAVOURITE

Corinna Königseder, Tino Stanković, Kristina Shea

ETH Zurich, Switzerland

Design grammars have been successfully applied in numerous engineering disciplines, however, the lack of support for grammar development is seen as one of the major drawbacks of grammatical approaches in Computational Design Synthesis (CDS). In this paper, a method is presented that supports the development and application of design grammars. Concepts from compiler design and transition graphs are used to help designers understand developed grammars in depth. The grammar designer is given feedback on a) the rules, e.g., if there are redundant or do-undo rules, and b) rule application sequences, e.g., which sequences should be preferred or avoided. This feedback can be used to a) improve the grammar, and b) apply it more efficiently. The case study demonstrates how the method is used to analyze a grammar for a sliding tile puzzle. Knowledge learnt on small scale was then successfully applied to solve a larger scale problem. The results show the feasibility of the method and its generality is discussed.

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3.3

DESIGN METHODS AND TOOLS EARLY PHASES

CHAIR
Umberto Cugini

8:30 am
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10:15 am

BL27.3

THURSDAY
30
JUL

MANAGEMENT AND VISUALIZATION OF RELATIONSHIPS BETWEEN ENGINEERING OBJECTS | *Neven Pavkovic (1), Tomislav Martinec (1), Danijel Rohde (2), Bruno Sikic (1)*

REVIEWERS' FAVOURITE

(1) University of Zagreb, Croatia; (2) INETEC d.o.o., Zagreb, Croatia

The paper discusses methods and interfaces for manual recording, management and visualization of relations between engineering objects aiming to suggest most convenient interface tools and methods for relating objects of a particular pair or set of domains. The tools/methods considered are browser, diagram and matrix. The browser interface was used to relate objects from hierarchically structured domains such as file system and product structure. Objects belonging to domain pairs without hierarchical structure were interrelated using the matrix interface. For engineering objects involved in multiple complex relations (both intra- and inter-domain) we argue that the most convenient technique is to create and visualize such a network of relations directly by drawing diagrams using the specific diagram methodology and tool. A matrix style interface concept integrates different methods and tools in a way that should contribute to building of shared understanding of design projects on the company level. Elements of interface could be considered as predefined contexts for relation recording and indexing as well as guidance for information and knowledge retrieval.

EVALUATING THE NEED FOR TRACEABILITIY IN PRODUCT DEVELOPMENT: A PRELIMINARY STUDY | *Nico Koehler, Thomas Naumann, Sandor Vajna*

Otto-von-Guericke University Magdeburg, Germany

This paper presents a novel approach on how to evaluate the need for further traceability support in integrated product development. For the purpose of an descriptive study, a universal questionnaire is developed in order to determine this need for traceability. The questionnaire focuses on measuring, from an engineer's point of view, the ability to follow engineering objects from the origin to the use in the final product. However, considering only the dimension of traceability isolated from its context is not sufficient. Thus, we extended the questionnaire with two new dimensions, one considering the problem solving and the other one considering complexity. Starting from theory based constructs, for each dimension we developed specific and applicable items. With the help of those items related to all three dimensions: (1) traceability, (2) problem solving and (3) complexity, we are able to statistically determine the need for traceability support in integrated product development.

CHAIR
Ian Whitfield

DESIGN METHODS AND TOOLS COLLABORATIVE DESIGN

P
3.4

8:30 am
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10:15 am

BL27.4

THURSDAY
30
JUL

FAIRNESS AND MANIPULATION: AN EMPIRICAL STUDY OF ARROW'S IMPOSSIBILITY THEOREM | *Christopher McComb, Kosa Goucher-Lambert, Jonathan Cagan*

REVIEWERS' FAVOURITE

Carnegie Mellon University, United States of America

The design process often requires work by teams, rather than individuals. During these times it is likely that situations will arise in which members of a team have different opinions, yet a group decision must still be made. Unfortunately, Arrow's Impossibility Theorem indicates that there is no method for aggregating group preferences that will always satisfy a small number of "fair" conditions. This work seeks to identify methods of combining individual preferences that can come close to satisfying Arrow's conditions. Experiential conjoint analysis was used to obtain empirical utility functions for drinking mug designs. A number of functions for constructing group preference were then analysed using both empirical conjoint preferences and randomly generated preferences. This analysis involved checking each of Arrow's conditions, as well as computing the likelihood that a method will be susceptible to manipulation by a dishonest individual. Based on the results, methods that should be used to aggregate group preference in practice are recommended.

PROPOSAL OF A FRAMEWORK FOR CHARACTERIZING VIRTUAL COLLECTIVES IN THE ENGINEERING DESIGN FIELD | *Rachad El Badawi El Najjar (1),(2), Eric Blanco (1), Franck Pourroy (1), Guy Prudhomme (1), Nicolas Maussang-Detaille (2)*

(1) Univ. Grenoble Alpes, France; (2) Alstom Renewable Power - Hydro, France

To manage global innovation firms organize their global R&D footprint all around the world to optimize knowledge access. This has lead to distributed design teams around the world. It is the case of Alstom Renewable Hydro Power where this research has been conducted. Hydro business designs turbines and generators that entails different types of objectives that can be: standardization of engineering processes, development of common design guides for engineering tools, harmonization of quality sheets and troubleshooting procedures. Hydro has entrusted these objectives to distributed engineering collectives. Most of these collectives are supported by ICT tools and qualified as design communities, virtual teams and networks of experts inside the company. Our research aims to clearly define the design choice of a virtual engineering collective type for a specific objective related to knowledge creation or knowledge exchange. This paper's objectives are to define, to characterize and to differentiate every virtual engineering collective. Our finding is a virtual collective framework that is composed of 7 critical differentiator factors that will characterize these virtual collectives.

BRIDGING THE 'VALLEY OF DEATH' IN PRODUCT DEVELOPMENT: A CASE STUDY OF THE DRILL COVER PROJECT | *Florin Gheorghe, Antony J. Hodgson, H.F. Machiel Van der Loos*

University of British Columbia, Canada

Innovation in the medical device industry is frequently driven by collaborations between engineers and clinicians in an academic setting. However, many such projects, especially within student design courses, end up abandoned and orphaned when approaching the proverbial "Valley of Death" in product development. In this paper, this challenge is described as three separate Valleys: a financial valley, an expertise-driven valley, and an academic-specific valley. This paper then presents a case study of the Drill Cover Project, a student design project in the Engineers in Scrubs Program at the University of British Columbia. Observations of the Project's success to date are presented in a resulting model for how engineering design and technology commercialization courses can increase the likelihood and ability of student groups to bridge the three Valleys. This model includes close collaboration with users, strong early leadership and team culture, supporting networks of mentors and product champions, and an impact-focused mission, which are all contributing factors to the success of the Drill Cover Project thus far.

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3.4

DESIGN METHODS AND TOOLS COLLABORATIVE DESIGN

CHAIR
Ian Whitfield

8:30 am
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10:15 am

BL27.4

THURSDAY
30
JUL

INTERACTIVE IMMERSIVE ENGINEERING SYSTEM FOR DISTANT COLLABORATION

Marius Fechter (1), Roy Gerhardus Johannes Damgrave (2), Sandro Wartzack (1)

(1) Friedrich-Alexander University Erlangen-Nürnberg, Germany; (2) University of Twente, The Netherlands

Complex products consisting of various components are designed in collaboration of multi-disciplinary engineering teams with different expertise. Expert groups involved in the development process are possibly based at geographically distributed locations. The purpose of this contribution therefore is the development of a framework, enhancing the quality of communication and facilitating the exchange of information and expertise in engineering projects over distance. This framework provides the capability to visualise a product model and the avatars of distant people in one shared immersive virtual environment. Furthermore the integration of product information exceeding the pure geometry and features for direct modification of the visualised product are achieved through the connection to CAD software. The intuitive interaction interface utilises hand gestures based on normal physical interaction with real objects. Being able to see both the 3D model and the other participant in one shared virtual environment creates a natural communication and interaction process, without being distracted by new communication or interaction methods forced by the technology.

SUBJECT LINES AS SENSORS: CO-WORD ANALYSIS OF EMAIL TO SUPPORT THE MANAGEMENT OF COLLABORATIVE ENGINEERING WORK | *Simon L. Jones (1), Stephen J. Payne (1), Ben J. Hicks (2), James A. Gopsill (2), Chris Snider (2), Lei Shi (1)*

(1) University of Bath, United Kingdom; (2) University of Bristol, United Kingdom

This paper presents a topic-based analysis of email subject line data from a large-scale engineering project and explores its utility for supporting the management of collaborative work. The main contributions of the paper are a novel interpretation of the co-word network analysis method for application within an engineering project management context, and the appraisal of the method for finding patterns within subject line data. Our findings suggest that the approach has the potential to contribute to monitoring work complexity, tracking progress, recognizing synergy and divergence, detecting scope creep, and supporting knowledge capture.

CHAIR
Josef Oehmen

DESIGN ORGANISATION AND MANAGEMENT FAILURE AND RISK MANAGEMENT

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3.5

8:30 am
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10:15 am

BL27.5

THURSDAY
30
JUL

CONSIDERING RISK ATTITUDE IN A VALUE OF INFORMATION PROBLEM

Chuck Hsiao, Richard Malak

Texas A&M University, United States of America

In many decisions, one of the available alternatives is to gather more information about the situation at hand, which incurs a cost but leads to a more informed and thus improved decision. Thus, the decision problem is two-fold: first, whether or not to gather additional information, and second, which course of action or design to select based on the available information as a result of the first decision. Such problems are Value of Information problems, which seek to quantify the value of the potential information to guide the decision maker on whether or not it is worthwhile. However, approaches to Value of Information problems typically implicitly assume that the decision maker is risk neutral, in the formulation of the problem. This paper considers how the inclusion of risk attitude affects a decision maker's decision about whether or not additional information is worthwhile. This leads to a more accurate model of decision problems typically facing decision makers. It discusses some of the mathematical complexities and illustrates the problem with an engineering example.

CRISIS SITUATIONS IN ENGINEERING PRODUCT DEVELOPMENT - A METHOD TO IDENTIFY CRISIS | *Christopher Muenzberg, Srinivasan Venkataraman, Nicolas Hertrich, Carl Fruehling, Udo Lindemann*

Technische Universität München, Germany

An observational case study and an observation method are presented in this paper. The goal of the observation method is to identify, observe, document and analyse crisis situations in engineering product development teams. Crisis situations are characterized as unexpected or undesired situations with time pressure and pressure to act. The case study observes an academic student team designing and developing a racing car, as part of an inter-university racing car challenge. An introduction about case study design and a classification of the presented case study is given. The various steps in the observation method are described with the corresponding tools used in each step. Further, the application of this method is also explained and an initial framework of crisis situation is shown.

SAFETY OF INDIVIDUAL PRODUCTS – PERSPECTIVES IN THE CONTEXT OF CURRENT PRACTICES AND CHALLENGES | *Michael Roth, Steffi Gehrlicher, Udo Lindemann*

Technische Universität München, Germany

The safety of products is one essential feature on the way to approval. Methods of safety analysis are applied to ensure this. Facing growing demand for individual products and stricter regulations, these analyses require increasing efforts. In mechanical and mechatronic engineering, these analyses in practice are dominated by traditional methods. Current research aims to improve and enhance this process of considering safety during all stages in design. However, these works mainly focus on software or embedded systems. Thus, this paper aims to understand the current practices and challenges in mechanical or mechatronic engineering. It examines existing approaches from literature and records the industrial practices within an interview study. Challenges in safety analysis are discussed with special focus on increasing variance and user innovation concepts. By that our paper contributes to a better understanding of current and upcoming challenges in the domain of mechanical and mechatronic engineering and identifies the needs and directions for further research.

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DESIGN ORGANISATION AND MANAGEMENT
FAILURE AND RISK MANAGEMENT

CHAIR
Josef Oehmen

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THURSDAY
30
JUL

UTILIZING FAILURE INFORMATION FOR MISSION ANALYSIS FOR COMPLEX SYSTEMS | *Charlie DeStefano, David Jensen*

REVIEWERS' FAVOURITE

University of Arkansas-Fayetteville, United States of America

This paper presents a new failure analysis method, Failure Identification for Mission Analysis (FIMA), which performs an overall and mission-specific failure analysis for complex systems. The FIMA method identifies all possible functions of a complex system and then analyzes how various failures may have differing effects on these functions. Then, the FIMA method uniquely uses this information to analyze specific mission plans, which are made up of individual mission tasks that a system must complete. The FIMA method uses multiple unique metrics to determine the effects of a given failure scenario on a potential mission plan and then uses other unique metrics to assess and optimize a new mission plan based on the system's remaining tasks and functionality. This method aims to utilize failure information to enhance the adaptability of complex systems in order to reduce the effects of failures and extend lifespans.

FRAMING IN DESIGN: A FORMAL ANALYSIS AND FAILURE MODES

Pieter Vermaas (1), Kees Dorst (2),(3), Clementine Thurgood (2)

(1) Delft University of Technology, Netherlands; (2) University of Technology Sydney, Australia;
(3) Eindhoven University of Technology, Netherlands

This contribution presents a formal description of the design practice of framing and identifies two general modes in which framing can lead to failure in design projects. The first is called the goal reformulation failure mode and occurs when designers reformulate the goal of the client in a design task and give design solutions that solve the reformulated goal but not the original goal. The second is called the frame failure mode and occurs when designers propose a frame for the design task that cannot be accepted by the client. The analysis of framing and its failure modes is aimed at better understanding this design practice and provides a first step towards arriving at criteria that successful applications of framing should meet. The description and the failure modes are illustrated by critically considering an initially successful case of framing, namely the redesign of the Kings Cross entertainment district in Sydney.

CHAIR
Kristina Shea

ADDITIVE MANUFACTURING IN/FOR INDUSTRY

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3.6

8:30 am
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THURSDAY
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JUL

ADDITIVE MANUFACTURING DESIGN FEATURE SELECTION FOR VARIABLE PRODUCT PLATFORMS | *Xiling Yao (1),(2), Seung Ki Moon (1), Guijun Bi (2)*

REVIEWERS' FAVOURITE

(1) Nanyang Technological University, Singapore; (2) Singapore Institute of Manufacturing Technology, Singapore

Additive manufacturing (AM) technologies enable new capabilities in producing innovative products with complex geometries, superior performance, and low material wastage. In this research, design for additive manufacturing (DFAM) freedoms and constraints are integrated with product platform design, aiming to help companies generate innovative platform-based product families by selecting appropriate AM design features to meet platform modules' design requirements in multiple market segments. In this paper, the concept a variable product platform is proposed to describe new characteristics of additive manufactured product platform modules. An object-oriented technique is used for representing design knowledge. A binary coding system is applied to code AM design features and platform variants' design requirements. Hierarchical agglomerative clustering is performed to create clusters that indicate appropriate AM design feature selection, and to group similar AM design features in terms of functionalities, materials, and key design parameters. The result provides a design proposal to explore AM-enabled design space at the conceptual design stage.

APPROACH FOR A COMPARATIVELY EVALUATION OF THE SUSTAINABILITY FOR ADDITIVE MANUFACTURED ALUMINUM COMPONENTS | *Roland Lachmayer, Philipp Gottwald, Rene Bastian Lippert*

Leibniz Universität Hannover, Germany

Nowadays new manufacturing technologies like the additive manufacturing in conjunction with the associated resources utilization requires a rethinking about sustainability. To continue the idea of an efficient technology the evaluation of sustainability is analyzed in this article. The examination starts with a general description of sustainability by the combination of different definitions. Based on this knowledge, the challenge to evaluate different process chains in various manufacturing technologies is investigated. As a result an approach for the evaluation of the sustainability in relative comparison of different process chains is developed. In the study the additive manufacturing process chain is faced with the shape cutting process chain regarding an aluminum component. After the introduction of the approach to evaluate the sustainability of both technologies the methodology is applied at a demonstrator. Thereby a geometrically complex component is used, which is shown based on a reflector from the automotive industry. The calculated results allow an assessment of the sustainability of individual process chains in a relative comparison to each other.

INDICATORS AND DESIGN STRATEGIES FOR DIRECT PART PRODUCTION BY ADDITIVE MANUFACTURING | *Bastian Leutenecker (1), Christoph Klahn (2), Mirko Meboldt (1)*

(1) ETH Zürich, Switzerland; (2) Inspire AG, Switzerland

Additive manufacturing (AM), a layer based material addition technology to create three-dimensional objects directly from a 3D CAD model with little restrictions regarding the shape of the object. Today AM is already a proven technology for direct part production. The challenge is to identify suitable components of a product that will benefit from AM's capabilities. To support the identification of parts this paper presents indicators to parts where a re-design for additive manufacturing will create the most added value. Furthermore the benefits of additive manufacturing are subdivided into process advantages and design advantages. This distinction is fundamental, because it represents a great impact on the development process itself and the design strategy. The advantages, indicators and design strategies are explained and illustrated on two cases.

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ADDITIVE MANUFACTURING IN/FOR INDUSTRY

CHAIR
Kristina Shea

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THURSDAY
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JUL

DESIGN METHOD AND TAXONOMY OF OPTIMIZED REGULAR CELLULAR STRUCTURES FOR ADDITIVE MANUFACTURING TECHNOLOGIES | *Gianpaolo Savio, Flavio Gaggi, Roberto Meneghello, Gianmaria Concheri*

University of Padova, Italy

Additive manufacturing technologies enable the fabrication of innovative parts not achievable by other technologies, such as cellular structures, characterized by lightness and good mechanical properties. In this paper a novel modeling and optimization method is proposed to design regular cellular structures. The approach is based on generative modeling of a structure by repeating a unit cell inside a solid model, obtaining a beam model, and on an iterative variation of the size of each section in order to get the desired utilization for each beam. Different structures have been investigated, derived by six cell types in two load conditions. Taxonomy of cell types as a function of relative density and compliance were proposed in order to support the design process for additive manufacturing of cellular structures.

DESIGN FOR MASS CUSTOMIZATION USING ADDITIVE MANUFACTURE: CASE-STUDY OF A BALLOON-POWERED CAR | *Tian Chen, Stöckli Fritz, Kristina Shea*

Swiss Federal Institute of Technology in Zurich, Switzerland

Additive Manufacturing offers unique advantages to produce customized designs. This paper demonstrates the capability for mass customization using Additive Manufacture through a case-study of a balloon powered car developed for a course. Two components of the assembly, the body and wheels are individualized by each student. To reduce the design-print iterations to a maximum of one while maintaining success rate of the fabricated parts, nine AM process constraints are determined through systematic physical tests. These are minimum dimensions, feature spacing and angles, and press fit tolerances and minimum overhang angle for self-supporting fabrication. A total of 2300 unique designs are created by the students and fabricated with Fused Deposition Modeling (FDM) using uPrint SE Plus. All function as intended with the exception of one set of wheels and many car bodies that omitted the press fit joint from the first iteration. No car bodies failed from the second iteration or due fabrication limitations. This demonstrates the effectiveness of the AM constraints determined and their upfront use in design to reduce design-print iteration rather than as a post-process.

CHAIR
Julie Stal-Le Cardinal

IDEA GENERATION AND INNOVATION IN/FOR INDUSTRY

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THURSDAY
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JUL

DESIGN METHODOLOGY APPLIED FOR PRODUCT INNOVATION IN A MULTI-DISCIPLINARY PROJECT – A CASE STUDY | *Lars Almefelt (1), Anders Claesson (2)*

(1) Chalmers University of Technology, Sweden; (2) HolPD AB, Sweden

This paper takes its departure in the results of a research project aiming to develop resource-economic and lightweight car concepts and subsystems, as well as to stimulate cross-company business networking. The project was carried out through collaboration between an automotive manufacturer, 35 automotive suppliers, and six universities, most with Swedish affiliation. The initial phase of the project was devoted to a creative concept study. For this purpose, a research team selected and facilitated systematic design methods for requirements setting, creation, and evaluation of product concepts. Through a workshop-based approach, 63 individuals organised in eight sub-teams set out on developing innovative product concepts using the methods. This paper describes these methods as well as demonstrates their application.

A NEW KNOWLEDGE SOURCING FRAMEWORK TO SUPPORT KBE DEVELOPMENT

Santiago Quintana-Amate (1),(2), Pablo Bermell-Garcia (2), Luis Balcazar (2), Ashutosh Tiwari (1)

(1) Cranfield University, United Kingdom; (2) Airbus Group Innovations, United Kingdom

Knowledge-Based Engineering (KBE) has been traditionally used to source engineering knowledge by integrating software and expertise, thus automating repetitive tasks and speeding up the engineering design process. However, to adequately perform the knowledge sourcing process it is a must to carry out an efficient capture, manage and reuse engineering knowledge. In this regard, this paper presents a Knowledge Sourcing Framework (KSF) to methodologically source engineering knowledge. This research makes a novel contribution to current knowledge sourcing practices thanks to the proposed integration of expert and machine knowledge in a common environment. In doing so, a better link between knowledge acquisition and KBE is delivered. To achieve the main aim of this work, research efforts were focussed on: (i) identifying AI tools to extract engineering knowledge more efficiently; (ii) adopting a widely used methodology to allow the systematic capture and reuse of engineering knowledge. Finally, a case study has been successfully realised in the context of the aerospace industry, supporting the assumptions made in this research.

AN IDEA GENERATION METHOD FOR THE LATE PHASES OF ENGINEERING DESIGN

Andreas Wilhelm Meyer (1), Andreas Wünsch (1), Sándor Vajna (1), Oliver König (2)

(1) Otto von Guericke University Magdeburg, Germany; (2) IFA ROTORION - Powertrain GmbH, Germany

Creativity processes and idea generation techniques play an important role in innovation processes. They are necessary to get economic success. There are more than hundred techniques for creativity and problem solving. However, the space of techniques has been unstructured, and clear guidelines haven't been available for the selection of an appropriate technique for a given innovation goal. Idea Engineering provides an engineering approach to the problem of producing ideas. We used methods of the approach of Idea Engineering and combined them with well-known evaluation methods from the field of engineering to evaluate these ideas. By using this approach we changed the design of a sealing of a universal joint of a powertrain shaft and reduced significantly the number of fails during the manufacturing process. The Idea Engineering approach was used in a late phase of the engineering design process.

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IDEA GENERATION AND INNOVATION IN/FOR INDUSTRY

CHAIR
Julie Stal-Le Cardinal

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THURSDAY
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JUL

THE CHARACTERISTICS OF EXCELLENT DESIGNERS – FINDINGS FROM AN INTERVIEW STUDY WITH SWEDISH INNOVATORS |

Louise Axelsson, Simon Blome, Dennis Nourbarpour, Johan Nänzen, Platon Yvonne, Johan Lars Malmqvist

Chalmers University of Technology, Sweden

Some designers are more successful than others. They have the ability to repeatedly generate new and innovative solutions to challenging problems. In this paper, we refer to designers who possess this level of skill as "excellent designers". It would seem interesting to identify the characteristics of such individuals in order to better understand why they succeed while ordinary designer do not. However, there have been few published studies of excellent designers, and these studies have focused on one or a few individuals. In this paper, we account for a study of a larger group (15) of excellent designers. The aims were first to identify their particular set of knowledge, experience, working practices and personal characteristics and then to use the findings to generate proposals for how employers and educator can nurture excellent designers.

IDEA DEVELOPMENT AND ITS CONSTITUTING ELEMENTS – AN EMPIRICAL INVESTIGATION

Anna Karlsson (1),(2)

(1) Luleå University of Technology, Sweden; (2) Sandvik Coromant, Sweden

The aim of this paper was to explore approaches used by companies to support idea development. This is of interest because creative ideas meet more resistance and reluctance towards their implementation and idea development can improve the quality of an idea and thereby increase the ideas chance of adoption. Despite this, little research has focused on ways a company can go about supporting idea development. An exploratory approach was chosen in order to gather information about companies' ways of working. Respondents from seven companies were interviewed, and two different views of idea development were identified: either as a way to propel an idea forward, or as a prerequisite for good decision-making. Also three constituting elements of idea development were identified (i.e. conceptualization, contextualization and co-evolution) and supporting mechanisms used by companies to target each of them is listed. These constituting elements of idea development are believed to be valuable to both practice and theory as they provide a valuable framework and capture the challenge of idea development in practice.

CHAIR
Chris Snider

HUMAN BEHAVIOUR IN DESIGN PHENOMENA

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3.8

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THURSDAY
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JUL

DEVELOPING A FRAMEWORK OF NEW MIXED METHOD, SOCIAL NETWORKING SERVICES GROUP DIARY AND ITS APPLICATION IN PRACTICE |

Jieun Bae, Kwangmin Cho, Chajoong Kim

UNIST, South Korea

As understanding use context is considered a key factor to deliver better user experience, designers have spent much time and money investigating the context. Despite the presence of various user research methods, it is still insufficient to figure out the context of use in actual situations. On the other hand, as Social Networking Services (SNS) based on real time interaction have been popular, its potentiality as a research method has been spotlighted. Under this circumstance a framework of new mixed method, SNS Group Diary, was developed in which SNS technology was applied to better capture the real time use context. Therefore, this paper presents an empirical study that includes a case study on multi-refrigerator that was conducted through SNS group diary. For the study eleven housewives were recruited and an experiment was conducted for two weeks to prove the validity of the new method. The overall results indicate that SNS Group Diary is an effective method to figure out the actual use context. The implications and limitations of the SNS Group Diary are discussed as well.

PHYSIOLOGICALLY BASED SEGMENTATION OF DESIGN PROTOCOL |

REVIEWERS' FAVOURITE

Philon Nguyen, Thanh An Nguyen, Yong Zeng

Concordia University, Canada

The measure of a design problem's hardness is a window into human intelligence. We propose a new measure of problem hardness based on the transient microstate percentage of EEG signals. Based on the heuristic that different segments of design protocol data have different perceived hardness, we use this transient microstate percentage to segment design protocol data into domain-valid segments. Currently, two main techniques exist to analyze design protocol data: simultaneous thinking aloud and retrospective protocol analysis. Our method based on physiological measurements (EEG) mitigates the strengths and weaknesses of both methods. It was able to classify some segments as expected and discover new segments. Using EEG to solve this problem is a typical inverse problem where a thought process is reconstructed from potential-valued signals of the brain. We discuss limitations and challenges of such an approach.

SURPRISE AS A SITUATED PHENOMENON

Niccolò Becattini (1), Yuri Borgianni (2), Gaetano Cascini (1), Federico Rotini (2)

(1) Politecnico di Milano, Italy; (2) Università di Firenze, Italy

Among the studies dedicated to design creativity, a significant attention is given to the investigation of its dimensions, such as novelty and usefulness. The underlying assumption is that an enhanced knowledge of them is helpful to better understand limitations of current design approaches, and improve methods and tools. While there is still a lively discussion about these dimensions, some authors highlight that among them surprise deserves to be considered an independent aspect that differs from novelty. In fact, the latter concerns unprecedented peculiarities of an artefact, while surprise tells about the unexpectedness of a feature whatever is the degree of difference with pre-existing ones. Having observed the lack of reference models to investigate the emergence of surprise when a user first meets a new artefact, the authors propose an original model to describe the occurring cognitive processes. The model exploits some fundamental concepts of Gero's situated FBS framework and represent surprise as a mismatch between the interpretation of reality given by an observer and her/his expectations due to previous experiences. The model is illustrated by means of three examples.

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HUMAN BEHAVIOUR IN DESIGN PHENOMENA

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Chris Snider

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THURSDAY
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JUL

CREATIVITY INTERVENTION: USING STORYTELLING AND MATH PROBLEMS AS INTERVENING TASKS FOR INDUCING INCUBATION

REVIEWERS' FAVOURITE

Evan Al-Shorachi, Koonlada Sasasmit, Milene Gonçalves

Delft University of Technology, The Netherlands

Past studies have intermittently shown evidence of incubation effects. In the design field, incubation can occur when designers step away from a problem but continue to think about it unconsciously. However, little is known about which kind of activities should designers engage to prompt creative results. The purpose of this research is to investigate the role of two types of intervening tasks during idea generation, in order to induce incubation effects. A math quiz and a storytelling task were used to represent two different types of intervening tasks. Based on our findings, when compared to the control condition, the math task was able to induce incubation effects, especially on fluency and overall creativity score. Conversely, the storytelling task did not seem to induce incubation effects when compared to the other conditions, although it had an influence on the originality of the ideas. This study shows that it is preferable to switch from creative to well-structured tasks to promote incubation effects. Nevertheless, swapping between creative tasks can contribute to the generation of more original ideas, but less feasible, which can be beneficial for brainstorm sessions.

INFLUENCE OF INFORMATION COLLECTION STRATEGY IN PROBLEM FORMULATION ON DESIGN CREATIVITY THROUGH MENTAL STRESS: A THEORETICAL ANALYSIS

Xiaoying Wang, Thanh An Nguyen, Yong Zeng

Concordia University, Canada

Problem formulation is an important process in design. A right solution comes from a right problem statement; creative solution may come from a creative problem statement. In this paper, three strategies for collecting information in the problem formulation process are identified: depth-first, breadth-first and hybrid search. How each strategy affects the creativity through its impact on designer's mental stress is examined. Among the three strategies, the hybrid approach is found to be the best as it allows designers to minimize uncertainty and focus on important design components.

COFFEE BREAK
10:15 - 10:45 am
Dining area

CHAIR
Amaresh Chakrabarti

DESIGN FOR A HEALTHY LIFE METHODS, TOOLS AND CASE STUDIES

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4.1

10:45 am
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12:30 pm

BL27.1

THURSDAY
30
JUL

IMPROVING WELLBEING FOR VICTIMS OF CRIME

Lucy Joanna Kaldor, Rodger Watson

University of Technology Sydney, Australia

Being the victim of a crime constitutes a profound and lasting trauma for individuals and their communities. Depending on the circumstances of their victimisation, crime victims have little choice but to live with painful feelings, memories and ongoing physical and emotional experiences that can make wellbeing difficult to achieve. Additionally, victims of crime continue to report that their experiences of, and interactions with criminal justice systems in the pursuit of justice and recovery has not restored agency or dignity, and instead add to their feelings of powerlessness, anonymity and trauma. For governments, the policy challenge is how the criminal justice system can play an active role in helping victims regain wellbeing, and particularly of agency and control in their lives. This paper offers a case study of a project undertaken by the criminal justice system in (anonymised), using a human centred design approach to create design directions that will better meet victims' needs. The paper will present the workshop methodology and outline the policy directions that resulted.

APPLYING DESIGN ETHNOGRAPHY TO PRODUCT EVALUATION: A CASE EXAMPLE OF A MEDICAL DEVICE IN A LOW-RESOURCE SETTING | *Ibrahim Mohedas, Amir Sabet Sarvestani, Shanna R. Daly, Kathleen H. Sienko*

University Of Michigan, United States of America

The use of design ethnography for the design of human-computer interfaces and computer supported cooperative work systems has become increasingly common both in industry and as a topic of study within the research community. However, as of yet, few studies have been performed where ethnographic techniques have been applied during the design of other products or services. Furthermore, of these studies, even fewer have provided the methodological detail necessary in order to understand how ethnographic techniques and data influenced the design or how these methods may be best implemented. This study sought to address this gap in the literature by using and methodically documenting the use of design ethnography during the design of a medical device (specifically for low- and middle-income countries). Below we detail the methodology used for data collection and analysis as well as present the findings from the ethnographic study and how it informed the revised device design. A discussion on the benefits and challenges of using ethnographic methods in this context is presented and recommendations for developing and implementing design ethnography during medical device design are given.

APPLYING FISHBEIN'S MULTI-ATTRIBUTE ATTITUDE MODEL TO THE TATA SWACH WATER PURIFIER | *Sean T Ricks, Amos G Winter V*

Massachusetts Institute of Technology, United States of America

In this paper, user feedback is used to calculate the relative importance of several attributes of a water purifier by applying Fishbein's Multi-Attribute Attitude Model. Survey data is collected from 35 users of a particular water purifier in India. Their beliefs regarding 10 attributes and their overall attitude toward the product are quantified. Least squares regression is used to calculate the relative importance of each attribute to the average user, and a comparison is made between users' reported overall attitude and that predicted by the Fishbein model. Though some results are inconclusive, it is shown that filter efficacy and ease of maintenance may be the most important factors in determining user attitude toward the purifier. Limitations of the Fishbein model in this context are discussed including the fact that this model assumes that all attributes are linearly related to overall attitude. It is recommended that more data be collected and the model be expanded before these findings are used to inform future design decisions.

DESIGN FOR A HEALTHY LIFE METHODS, TOOLS AND CASE STUDIES

CHAIR
Amaresh Chakrabarti

DESIGN FOR PHYSICAL ACTIVITY: DESIGN ASPECTS OF WEARABLE ACTIVITY TRACKERS

Armağan Kuru (1), Çigdem Erbuğ (2)

(1) TOBB Univerity of Economics and Technology, Turkey; (2) Middle East Technical University, Turkey

Many people use wearable activity trackers to gather personal behavioral data, make better decisions, and make changes to their behavior. While the proliferation of new products on the market makes collecting personal data easier, what people expect from these products remains an open question. To uncover which features of these products lead people keep using, a one-week user study was conducted with people who use these products to support or track their behavior. Baseline interviews were conducted and participants were asked to interact with a typical wearable activity tracking product. The study reveals that people are open to use and accept these kinds of products. Still, resistance to keep using the system can be a major common point of the people, even though they can be volunteer and enthusiastic to use these products. This research also reveals the product qualities that people expect from these products to keep using the system. At the end, design implications for future products are offered.

CAN THE SPORTS DESIGN PROCESS HELP THE INCLUSIVE DESIGN COMMUNITY?

Nicky Wilson, Avril Thomson, Philip Riches

Strathclyde University, United Kingdom

As the global population ages, inclusive design is becoming more important to companies due to customer demands and increased competition. It is also acknowledged that the use of a formalized design process is of commercial benefit to a company. There is therefore a need to consider the user more fully throughout the design process. Sports products are highly user-centered due to their need to improve the overall sporting performance of an athlete, therefore it hypothesized that strengths from the sports product design process could be utilized within the inclusive design approach. This paper reports on practical study, which investigated the similarities and differences between the sport and product design processes followed by companies in practice. It was found that there was little variation between the core stages of the design process, although large companies were found to follow a more structured approach than small companies. A key difference observed between the sports and product design approaches was the level of user involvement within the process. Sports companies showed greater user involvement, with usability and user performance being the emphasis of the process.

DESIGN INFORMATION AND KNOWLEDGE

UNFOLDING THE DESIGN PROCESS ARCHITECTURE: A NETWORKED PERSPECTIVE ON ACTIVITIES | *Pedro Parraguez, Anja M. Maier*

REVIEWERS' FAVOURITE

Technical University of Denmark, Denmark

A number of network-based process models have been developed to guide the design of engineering systems. Many such models represent design activities only as single nodes. As a result, the architecture, i.e. the network structure and composition of each activity, remains invisible and inaccessible for further analysis. However, when we unfold the architecture of activities we see the organisation network through which activities are conducted by people. The architectures of such organisation networks matter as they affect performance outcomes of activities. We propose and empirically test a framework for systematic characterisation and subsequent clustering of activities based on the architecture of the activities' organisation networks. Architecture characteristics examined include network size, network density and compositional diversity. The proposed framework not only enriches current process models, but also enables a more systematic analysis of the relationship between the organisation network of each activity and performance. The framework is tested with data from the design process of a biomass power plant where we identified architecture-performance relationships.

DATA SCIENCE AS A NEW FRONTIER FOR DESIGN

Akin Osman Kazakci

Mines ParisTech, France

The purpose of this paper is to contribute to the challenge of transferring know-how, theories and methods from design research to the design processes in information science and technologies. More specifically, we shall consider a domain, namely data-science, that is becoming rapidly a globally invested research and development axis with strong imperatives for innovation given the data deluge we are currently facing. We argue that, in order to rise to the data-related challenges that the society is facing, data-science initiatives should ensure a renewal of traditional research methodologies that are still largely based on trial-error processes depending on the talent and insights of a single (or a restricted group of) researchers. It is our claim that design theories and methods can provide, at least to some extent, the much-needed framework. We will use a worldwide data-science challenge organized to study a technical problem in physics, namely the detection of Higgs boson, as a use case to demonstrate some of the ways in which design theory and methods can help in analyzing and shaping the innovation dynamics in such projects.

SUPPORTING THE CONFIGURATION OF NEW PRODUCT VARIANTS BY REUSING THE IMPLICIT KNOWLEDGE OF PAST SOLUTIONS | *Marco Malatesta (1), Paolo Cicconi (1), Roberto Raffaeli (2), Michele Germani (1)*

(1) Università Politecnica delle Marche, Italy; (2) Università degli Studi eCampus, Italy

The market globalization pushes for ever new products in order to reach new niches. In the household appliances field, the marketing specialists daily configure new combinations of numerous functional and product requirements seeking new product definitions. Each novel combination requires an assessment of technical and economic feasibility by the design departments. This paper proposes a method for a preliminary validation of new configurations at the marketing stage. Indeed a tentative Bill of Materials (BOM) and a cost of the product are obtained. A knowledge base is derived by eliciting the requirement compatibilities from existing products. The approach is matrix based and it analyzes recurrent dependencies between requirements and components variants to determine which parts are most likely to appear in the BOM. Then, the knowledge base is integrated with rules that are input by experienced designers through a simple syntax. The approach has been tested moving from the requirements of some instances of a family of cookers, and comparing the results obtained from the application of the method with the actual product BOM.

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4.2

DESIGN INFORMATION AND KNOWLEDGE

CHAIR
Eswaran Subrahmanian

10:45 am
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12:30 pm

BL27.2

THURSDAY
30
JUL

EVALUATING THE EFFECTIVENESS OF METHODS FOR CAPTURING MEETINGS |

Mark John Hall (1),(2), Pablo Bermell-Garcia (1), Chris A McMahon (2), Anders Johansson (2), Mar Gonzalez-Franco (1)

REVIEWERS' FAVOURITE

(1) Airbus Group Innovations, United Kingdom; (2) University of Bristol, United Kingdom

The purpose of this paper is to evaluate the effectiveness of commonly used methods to capture synchronous meetings for information and knowledge retrieval. Four methods of capture are evaluated in the form of a case study whereby a technical design meeting was captured by; (i) transcription; (ii) diagrammatic argumentation; (iii) meeting minutes; and (iv) video. The paper describes an experiment where participants undertook an information retrieval task and provided feedback on the methods. This work contributes to knowledge by presenting the relative merits and weaknesses of existing methods through the use of a mixed qualitative and quantitative experimental approach. The conclusions from this study show that there is no evidence of a single method for capturing meetings that is effective at providing an overview of the meeting, capable of containing its details and decision rationale, while remaining retrievable in a timely manner. Consequently different methods are recommended depending on retrieval requirements. Recommendations are provided for the appropriate selection of a method to capture a meeting, depending on retrieval requirements.

IT'S NOT PERSONAL: CAN LOGBOOKS PROVIDE INSIGHTS INTO ENGINEERING PROJECTS?

Chris Snider (1), Hamish McAlpine (1), James A. Gopsill (1), Simon Jones (2), Shi Lei (2), Ben Hicks (1)

(1) University of Bristol, United Kingdom; (2) University of Bath, United Kingdom

Engineering projects are often large, complex, high-value, high-risk, and distributed. As a result, it is vital to monitor and understand what is happening within each as it progresses, and highly challenging to do so. Without detailed understanding, management becomes difficult and falls back upon generic principles that are not always appropriate for each project context. To approach this issue, this paper studies the written logbooks of three engineers, and explores how the marks within can be analysed to generate project-level understanding, particularly that which informs engineering project management. This occurs through the study of three engineering logbooks using two detailed coding schemas, one classifying content and the other activity, creativity and novelty. By this analysis, this paper aims to understand and assess efficacy of studying logbooks given their time-consuming and difficult-to-code nature. From the results, feasibility is shown of developing detailed understanding of typical project progress, and the identification of specific events within a project upon which a manager may act. The efficacy of the study of logbooks for this purpose is then assessed.

CHAIR
Mike Van der Loos

DESIGN METHODS AND TOOLS ENHANCED PRODUCT MODELS

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4.3

10:45 am
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12:30 pm

BL27.3

THURSDAY
30
JUL

DIGITAL SUPPORT OF WIRING HARNESS DEVELOPMENT (BASED ON THE 3D MASTER METHOD) |

Jonas Neckenich (1), Roland Winter (1), Michael Vielhaber (2)

(1) Daimler AG, Germany; (2) Saarland University, Germany

The challenges for designing and developing automotives increase and create the need for a change in developing processes. One solution to support digital processes in today's developing processes is the 3D master method. Advantages and disadvantages of the 3D master method are analyzed in comparison to 2D drawings. The implementation of 3D master method as a digital support for the development processes of wiring harnesses is described and new methods which are needed for a complete integration of 3D master method into wiring harness development processes are presented.

GENERATING HYBRID GEOMETRY MODELS FOR MORE PRECISE SIMULATIONS BY COMBINING PARAMETRIC CAD-MODELS WITH 3D SURFACE SCANNED GEOMETRY INSERTS |

Sebastian Katona (1), Michael Koch (1), Sandro Wartzack (2)

(1) Technische Hochschule Nürnberg Georg Simon Ohm, Germany; (2) Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

In general, every component shows differences to its ideal geometry of the designed CAD-model, i.e. due to deformations in the production process. Despite knowing the effects of deformations, the product developer always uses the ideal, non-deformed design model of the CAD-system for FE-simulations of a component. It seems rather doubtful that further refinement of simulation methods (e.g. using different non-linearities) makes sense, if the real manufactured geometry of the component is not considered for in the simulation process. Therefore, this paper describes an approach to use hybrid geometry models for simulations, which are mostly built of the parametric CAD-model, but areas with large deviations are substituted with surface reconstructed scan-inserts based on 3d surface scanned data, reconstructed to NURBS-patches. This procedure allows a more precise simulation as it considers deviations by minimizing the amount of data and the time for model preparation.

VISUALISATION OF BIOMECHANICAL STRESS QUANTITIES WITHIN CAD ENVIRONMENTS

Daniel Benjamin Krüger, Sandro Wartzack

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Germany

The demographic development in many industrialised societies and markets with a growing power of the customers augments the importance of user-centred design approaches. In this regard it is crucial for design engineers to understand how the use of a product is affecting the prospective user physically and emotionally. In this contribution an attempt is made to quantify physical effects on the human body during the interaction with technical systems. We present an approach to visualise biomechanical stress quantities obtained from simulations with musculoskeletal human models within CAD engineering environments. The objective is to enable designers to intuitively estimate how their solutions will influence the physical state of the user. The topic is relevant for the design of technical artefacts that are characterised by a close interaction with people. This comprises ergonomic questions in product design but also the planning of manufacturing processes as well as the development of medical devices for training and rehabilitation.

P 4.3

DESIGN METHODS AND TOOLS ENHANCED PRODUCT MODELS

CHAIR
Mike Van der Loos

10:45 am - 12:30 pm

BL27.3

THURSDAY 30 JUL

ISSUES IN LEARNING ENGINEERING GRAPHICS FUNDAMENTALS: SHALL WE BLAME CAD?

Riccardo Metraglia, Gabriele Baronio, Valerio Villa

University of Brescia, Italy

Several studies report that many novice engineers result to be skilled in CAD but poor in knowledge of the basics, visualization and spatial skills and ability in freehand sketching. There is a debate on if such lack of fundamentals dues or not to the increasing role of CAD and the decreasing role of manual drawing in the basic courses of engineering graphics. This study aimed to investigate the issues related to the use of CAD and manual drawing in teaching engineering graphics fundamentals by a review of the literature of the Engineering Design Graphics Journal and the International Journal of Technology and Design Education from 2000 to date. It was found that current students: have a lower initial level of knowledge and experience; have little chance to develop sketching and visualization skills if trained only by CAD; and their assessment usually focuses more on CAD skills than on the knowledge of the basics. Solutions proposed to such issues are: introductory courses of manual drawing at college and high schools; assessment of students' initial skills; and tests more focused on the knowledge of the rules and basics of engineering graphics language.

ANALYZING THE GENERATIVE EFFECTS OF SKETCHES WITH DESIGN THEORY: SKETCHING TO FOSTER KNOWLEDGE REORDERING | *Juliette Brun, Pascal Le Masson, Benoit Weil*

REVIEWERS' FAVOURITE

MinesParistech - PSL Research University, France

Sketching constitutes an essential work tool for designers. On the first hand, sketches allow to externalize ideas, being then very economic cognitively. If they help to process information very quickly, sketches are also an integral part of the thinking process, without which the designer would not be able to access originality and novelty: in particular, the fact that some sketches bring new insights to the designer seems to play an important role for the emergence of ideas. Our research project aims to clarify how architects use sketches to reach generative effects by analyzing their design strategies and the way their drawings can support these strategies. We especially focus on the role of knowledge in comparison to concepts. Three sequences of sketches were analyzed thanks to the C-K design theory: two sequences of thinking sketches and one sequence of talking sketches. We show that most drawings refer to both knowledge and concepts. Moreover, our study reveals that architects carry out through sketching an important work of knowledge structuration. Indeed, generative effects often result from the introduction of new knowledge reordering the initial knowledge basis.

CHAIR
Srinivasan Venkataraman

DESIGN METHODS AND TOOLS CASE STUDIES IN/FOR INDUSTRY

P 4.4

10:45 am - 12:30 pm

BL27.4

THURSDAY 30 JUL

A VISUAL INTERFACE DIAGRAM FOR MAPPING FUNCTIONS IN INTEGRATED PRODUCTS

Mattias Ingerslev, Mikkel Oliver Jespersen, Simon Moritz Göhler, Thomas J. Howard

Technical University of Denmark, Denmark

In product development there is a recognized tendency towards increased functionality for each new product generation. This leads to more integrated and complex products, with the risk of development delays and quality issues as a consequence of lacking overview and transparency. The work described in this article has been conducted in collaboration with Novo Nordisk on the insulin injection device FlexTouch® as case product. The FlexTouch® reflects the characteristics of an integrated product with several functions shared between a relatively low number of parts. In this article we present a novel way of visualizing relations between parts and functions in highly integrated mechanical products. The result is an interface diagram that supports design teams in communication, decision making and design management. The diagram gives the designer an overview of the couplings and dependencies within a product that can be used to estimate higher level consequences when making design changes. The diagram has further been used as a basis for evaluating the criticality of internal parts and functional organs.

HOW TO DEFINE A SUSTAINABILITY DESIGN SPACE

REVIEWERS' FAVOURITE

Sophie Hallstedt

Blekinge Tekninska Högskola, Sweden

In order for a company to define a sustainability design space and become more sustainable it must know: what sustainability means; how sustainability can be achieved; and, how sustainability can be measured. The main contribution of this paper is an approach to define the design space for sustainability, with purpose to give support in the early product innovation process. A novel approach is presented for how to identify strategic sustainability criteria, tactical design guidelines and sustainability compliance index that are important parts of a sustainability design space. A case company within the aerospace industry has been chosen to test and validate the sustainability criteria and how it can give support in evaluating the current sustainability profile of a product component by using the suggested Sustainability Compliance Index (SCI). The result from company feedback and early pilot-testing showed that the sustainability criteria and sustainability compliance index can give support in decisions regarding sustainability perspective in early concept development. The pilot-tests also indicated that there is a need for further development and validation.

HIGHLIGHTING THE IMPORTANCE OF TESTING IN THE PRODUCT DEVELOPMENT PROCESS

Khadija Tahera (1), Claudia Eckert (2), Chris Earl (2)

(1) University of Huddersfield, United Kingdom; (2) The Open University, United Kingdom

A product development is not a linear process of "design-build-test"; rather, the design process and the testing process are closely integrated throughout the product development process. The main objective of this paper is to understand how testing is integrated into the product development process and how that effects the product development processes in companies. This paper reports case studies in UK based manufacturing companies where physical testing are essential activities but key concern in reducing design time and cost. Based on these case studies, this paper proposes a product development process framework that highlights the importance of testing and it's intertwined nature with design activities.

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DESIGN METHODS AND TOOLS CASE STUDIES IN/FOR INDUSTRY

CHAIR
Srinivasan Venkataraman

10:45 am
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BL27.4

THURSDAY
30
JUL

REROUTING FAILURE FLOWS USING LOGIC BLOCKS IN FUNCTIONAL MODELS FOR IMPROVED SYSTEM ROBUSTNESS: FAILURE FLOW DECISION FUNCTIONS | *Adam R. Short, Douglas Lee Van Bossuyt*

REVIEWERS' FAVOURITE

Colorado School of Mines, United States of America

Functional modelling methods used in the early conceptual phases of complex system design allow system designers to better understand and refine system architecture from a functional perspective. A family of methods exist to model functional failures and failure flows. These failure flow modelling methods provide the opportunity to understand potential system failure sources and redesign systems for more robustness. One area lacking from the family of function failure and flow methodological family is the ability to model failure flow decision-making. This paper presents the Function Flow Decision Functions (FFDF) methodology that allows system designers to model failure flow decision-making where critical functions and flow exports are protected from failure flows by sacrificing less critical functions and flow exports. By sacrificing less critical functions and flow exports, mission-critical functions and flow exports can be preserved in order to accomplish the primary mission objectives of a system. A case study based upon the Mars Exploration Rover platform is presented in this paper.

CHAIR
Petra Badke-Schaub

DESIGN ORGANISATION AND MANAGEMENT COMPLEXITY AND CHANGE MANAGEMENT

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4.5

10:45 am
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12:30 pm

BL27.5

THURSDAY
30
JUL

IMPACT OF ARCHITECTURE TYPES AND DEGREE OF MODULARITY ON CHANGE PROPAGATION INDICES

REVIEWERS' FAVOURITE

Edoardo Filippo Colombo (1), Gaetano Cascini (1), Olivier L. de Weck (2)

(1) Politecnico di Milano, Italy; (2) Massachusetts Institute of Technology, United States of America

Change propagation has been investigated in many case studies; anyway, the effect of architectural choices like the degree of modularity or the presence of bus elements is still unclear. This paper evaluates the probability density functions of three change propagation indices (Incoming Change Likelihood, Incoming Change Impact and Outgoing Change Risk) in order to understand if architectural choices affect the change propagation behaviour of a technical system. The indices are obtained from 13,824 DSMs generated with Monte-Carlo methods; on each DSM, 12 feasible change behaviour samples are mapped. First, a small set of synthetic results is compared with a case study as an initial validation. Then, the three indices' overall distributions are shown. Finally, the entire indices' database is subdivided into four clusters (Integral, Modular, Star, Modular-Star) according to the architecture type of the original DSM. The comparison of the clusters shows that the presence of modules in the architecture significantly decrease the risk for change propagation, while the presence of bus components has a more limited effect.

DEPENDENCY IDENTIFICATION FOR ENGINEERING CHANGE MANAGEMENT (ECM): AN EXAMPLE OF COMPUTER-AIDED DESIGN (CAD)-BASED APPROACH

Mahmoud Masmoudi (1),(2), Patrice Leclaire (1), Marc Zolghadri (1), Mohamed Haddar (2)

(1) SUPMECA, France; (2) Université de Sfax, Tunisia

Engineering change management is a research field in which the goal is to deal with modifications of products and systems. Methods and tools are set up to predict more efficiently the propagation of changes or to assess the consequences of these changes. This paper addresses the fundamental research question of dependency identification in a product. We propose an approach based on the use of specialised support tools and knowledge to map the dependency links among components or parameters of a product. These dependencies are expressed quantitatively, qualitatively or as a polynomial function. The general approach is here applied to a geometric 2D model of a bicycle. The analysis of the obtained dependency graph gives insights to designers for modification of existing products or for creation of new robust products.

AN INTELLIGENT DESIGN ENVIRONMENT FOR CHANGEABILITY MANAGEMENT - APPLICATION TO MANUFACTURING SYSTEMS | *Nadège Benkamoun, Khalid Kouiss, Anne-Lise Huyet*

Université Blaise Pascal, France

Design for system changeability and reusability has been sought by engineers from several disciplines. It has lead to the emergence of numerous strategies and paradigms. Especially in conceptual design phase, when knowledge about requirements, design problem and system specifications is incomplete, the future for effective changeability is already at stake. This work presents knowledge related to changeability strategies as well as enablers, namely modularity, interfacability, changeability and reusability ontologies. It is illustrated by examples of manufacturing system design. The established formalism leads to a formal organization of the required functionalities for changeability management; the paper presents an intelligent design environment for changeability management. Its collaborative architecture is based on two concurrent and continuous processes: designing changeability and leveraging on it during the whole system (re)design lifecycle. Dedicated agents cooperate together, so they offer an intelligent and distributed design environment. As a result, designers are assisted to adopt a systemic design approach to analyse, design, evaluate and maintain changeability.

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4.5

10:45 am
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BL27.5

THURSDAY
30
JUL

DESIGN ORGANISATION AND MANAGEMENT COMPLEXITY AND CHANGE MANAGEMENT

CHAIR
Petra Badke-Schaub

CHANGES ON CHANGES: TOWARDS AN AGENT-BASED APPROACH FOR MANAGING COMPLEXITY IN DECENTRALIZED PRODUCT DEVELOPMENT | *Stefan Kehl (1), Patrick Stiefel (2), Jörg P. Müller (1)*

(1) Clausthal University of Technology, Germany; (2) Volkswagen Group

In this concept paper, we report on ongoing work aimed at a novel approach to developing complex products. Based on an analysis of the requirements of product development in the automotive industry, the main problems we observe are limited transparency, patency, and reuse. These problems are even more pronounced - and more difficult to manage - in multi-brand product development settings, with spatially distributed and organizationally autonomous development partners. In order to decrease the amount of information each actor has to manage, we propose and illustrate the novel notion of virtual product model components (VPM-C) as an approach to address these challenges. We propose a conceptual architecture of virtual product models, which supports four concepts (views) as first-class citizens: parts, geometries, features, and processes. To handle the dependencies between elements of a VPM-C, we further suggest an agent-based approach, and outline a corresponding architectures and design alternatives. We illustrate these basic concepts by use case scenarios derived from an analysis of automotive product development practices.

HOW TO INTEGRATE INFORMATION ABOUT PAST ENGINEERING CHANGES IN NEW CHANGE PROCESSES? | *Martina Carolina Wickel, Udo Lindemann*

Technische Universität München, Germany

When implementing engineering changes (EC) in companies many information about ECs and associated processes is stored and forgotten. However, an extraction of information about correlations in past ECs can have advantageous. In the decision phase of ECs, it is very crucial to identify the relevant stakeholders and to know which further parts could be affected by the proposed EC in order to create a good basis for decision. Especially for ECs in complex products, which can affect the whole product lifecycle it is an important and difficult task. This paper presents an approach of how information about past EC processes can be extracted by knowledge discovery in database (KDD) methods in order to support the EC coordinator. The EC coordinator gets recommendations based on past interrelations of EC data and for probably relevant stakeholders and affected parts. Here the data mining technique association rule is applied. The approach was developed while using a real and large database of approximately 53,000 past ECs of a car manufacturer. A preliminary test has been conducted and the feasibility of the approach was proven as well as first positive results.

CHAIR
Harrison Kim

PRODUCTION AND SUSTAINABILITY

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4.6

10:45 am
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12:30 pm

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THURSDAY
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JUL

ENERGY EFFICIENCY ORIENTED DEVELOPMENT OF PRODUCTION SYSTEMS

Pascal Stoffels, Michael Vielhaber

Saarland University, Germany

Based on rising energy prices, stricter regulations of carbon dioxide emissions and a rising awareness for our environment, it is not sufficient to optimize energy consumption only during the utilization of products; production, including assembly, has to become more energy efficient, too. In order to reduce the energy demand, the later energy consumption must be considered early in the development of the production system. In these phases, characteristics that are responsible for the later energy consumption are predetermined. A methodology for the development of assembly systems that is aiming at energy efficiency is currently being developed by the authors. Both lifecycles, of product and the corresponding production system are examined and correlations worked out.

EXPLORING THE SIGNIFICANCE OF IN-PROCESS KNOWLEDGE TO COMPOSITES DESIGN AND PRODUCTION | *Helene Victoria Jones, Anna Chatzimichali, Kevin Potter, Carwyn Ward*

University of Bristol, United Kingdom

This work is an initial attempt to explore how knowledge generated during the fabrication of advanced composite components is relevant to their design and production. Despite their high performance applications their manufacture often relies on a manual process. The aim is to suggest mechanisms to integrate this knowledge to facilitate industry growth. A case study approach was taken to map the learning cycle during product innovation processes. The assumption was that a complete learning cycle leads to production efficiency. Differences in this process for a high performance product in an industrial environment and sculptures in an art fabricators' practice were investigated. It was found that the high performance composites industry has an incomplete learning cycle, with in-process knowledge not entering back into concept development. The art fabricators have a complete learning cycle; this has been attributed to their collaborative way of working and the knowledge generated by their material explorations. To complete the learning cycle in an industrial environment it has been suggested that tangible products are used to transfer knowledge about how the material is handled.

NATURAL FIBRE-REINFORCED, INJECTION MOULDED POLYMERS FOR LIGHT WEIGHT CONSTRUCTIONS – SIMULATION OF SUSTAINABLE MATERIALS FOR THE AUTOMOTIVE INDUSTRY | *Katharina Albrecht (1), Tim Osswald (2), Sandro Wartzack (3), Jörg Müssig (1)*

(1) University of Applied Sciences Bremen, Germany; (2) University of Wisconsin-Madison, USA;
(3) Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Besides low fuel consumption and vehicle safety, more and more clients focus on sustainability issues buying a new car. Here not only the energy consumption during the production but also during the usage of the product has to be considered. To fulfil all these requirements natural fibre-reinforced polymers are a very good solution, combining light weight construction with renewable resources. To guarantee the crash-safety numerical simulations are essential in the product development process. Until now only functions to simulate glass fibre- or carbon fibre-reinforced polymers exist in the common software programs, but not for natural fibres. To close this gap the project NFC-Simulation was established. One of the main parts of this project was the characterization of natural fibres (like hemp, flax, sisal and regenerated cellulose fibres), including mechanical & morphological analyses and fibre orientation measurements. Crash-relevant components, glove boxes, were injection moulded with 30 mass% sisal fibre-reinforced polypropylene and experimental crash-tests were performed. The experimental results fit very well with the results from the process and crash-simulation.

PRODUCTION AND SUSTAINABILITY

EVALUATION OF A STRATEGIC METHOD TO IMPROVE PROTOTYPE PERFORMANCE WITH REDUCED COST AND FABRICATION TIME | *Bradley Adam Camburn (1), Daniel Jensen (2), Richard Crawford (3), Kevin Otto (1), Kristin Wood (1)*

(1) Singapore University of Technology and Design, Singapore; (2) United States Air Force Academy, United States of America; (3) The University of Texas at Austin, United States of America

Prototyping is tied into many stages of product development, where implementation choices have critical effects on overall design outcome. We review six techniques for strategic prototyping and synthesize empirically derived heuristics for their application. The heuristics are integrated in a generalized method for strategic prototyping. Two complementary experiments are conducted to evaluate each technique, as well as one potential form of the method. Direct performance measurement quantifies the continued marginal performance increases associated with iteration (build and test cycle of a single concept), and the benefit of pursuing multiple design concepts. Results also show scaled prototyping, subsystem isolation, requirement relaxation, and virtual prototyping can reduce cost and fabrication time. The method is correlated with increased use of these techniques, and higher quantitative final performance. The strategy method is a broad planning tool that leads to improvement of final design performance and reducted fabrication cost and time. Potential areas for improvement are evaluation of: marginal benefits from many parallel concept tests, and alternate method layouts.

A GENERIC APPROACH TO SENSITIVITY ANALYSIS IN GEOMETRIC VARIATIONS MANAGEMENT | *Benjamin Schleich, Sandro Wartzack*

REVIEWERS' FAVOURITE

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Engineering design teams are increasingly required to consider sustainability in the design of products and related manufacturing and assembly processes. In this regard, the economic and ecological sustainability of products as well as their quality and cost is influenced by geometric part deviations, which are inevitably observed on every manufactured artefact. Thus, the management of geometric deviations along the product lifecycle is a key issue for companies to living up to modern innovation requirements. The aim of this paper is to provide an overview of tools for the tolerance analysis in different stages of geometric variations management and to propose a versatile approach for the sensitivity analysis applicable in these different stages. This approach is to support decision making in the geometric variations management during integrated product and process design.

PRODUCT-SERVICE SYSTEMS (PSS)

A TOOL FOR FACILITATING SEMANTIC REFRAMING OF SERVICE DESIGN INSIGHT DISCOVERY | *Soe-Tsyr Daphne Yuan, Pei-Kang Hsieh*

National Chengchi University, Taiwan

Developing a desirable service requires in-depth understanding of customers. However, in the past, discovering insights from customers has usually depended on designers' experiences. It is hard for novice designers and designers at enterprises with G-D logic mindsets to do this well. A partial solution rests on challenging the core design practices of reframing and frame creation. However, it is rare to see how these framing design activities can be supported and analyzed by relevant tools. In this study, we present an IT-based tool with commonsense knowledge in ConceptNet to facilitate a variety of association reasoning methods in the reframing and frame creation process of service design insight discovery. We also propose the concept of insight depth to serve as a metric for measuring the influential extent of insights. This study ends up with an exploration of how the quality of the reframing and frame creation process can be improved for experienced and novice designers when supported by our tool.

A MODEL TO DESCRIBE USE PHASE OF SOCIO-TECHNICAL SPHERE OF PRODUCT-SERVICE SYSTEMS | *Christoph Hollauer, Srinivasan Venkataraman, Mayada Omer*

Technische Universität München, Germany

Development processes of product-service systems are faced with an increased complexity, among other reasons due to a larger number of stakeholders. This makes it necessary to focus development not only on the technical aspects of product-service systems but also on the sociotechnical aspects. It also becomes important to foster system understanding over a number of domains in early development phases in order to manage this increasing complexity. In this paper, a use-case-based approach for the identification of product-service-system elements such as requirements, functions, components and services is presented. The approach supports the identification of use cases by using a method from the domain of user experience design and subsequently offers support in graphically modeling the use case scenarios and in identifying system elements. Experimental application of the method has been conducted in the context of an academic case study.

POTENTIAL OF NATURE-INSPIRED APPROACH FOR ORGANISATION DESIGN IN PRODUCT-SERVICE SYSTEM | *Sojung Kim, Joon Sang Baek*

REVIEWERS' FAVOURITE

UNIST, Korea, Republic of South Korea

The importance of organisational properties in PSS development has been emphasised by previous research but the attempts to handle complex structure and communication network of PSS has been lacking. In this research, the potential of natural ecosystem as a source of inspiration for organization design in a PSS development was explored. The organisational problems in practice were investigated through the literature reviews and expert interviews with practitioners. In addition, the characteristics of natural ecosystem on different developmental stages were compared to those of systems in industry to identify the strengths of nature to be learned. This study suggests that further studies involving sufficient cases of corporations and natural ecosystem are required to specify the relationships between artificial and natural systems and contribute to organisational improvement. Moreover, methodological approach to support practitioners to design organisational structures and communication strategies is necessary.

CHAIR
Mirko Meboldt

DEVELOPING A COMPUTATIONAL FRAMEWORK TO STUDY THE EFFECTS OF USE OF ANALOGY IN DESIGN ON TEAM COHESION AND TEAM COLLABORATION

Vishal Singh (1), Hernan Casakin (2)

(1) Aalto University, Finland; (2) Ariel University, Israel

This paper presents a framework for a computational model about analogizing during team interactions when dealing with design problems. The framework is based on prior empirical research about the use of two types of analogies and their effect on team cohesion and team collaboration. The framework is a step towards developing an agent based simulation tool that will be used for studies on the use of analogy in design and their effects on team cohesion and team collaboration. This paper describes the key parameters, independent and dependent variables, and assumptions. At the agent level the independent variables pertain to parameters such as level of multidisciplinarity (range) and expertise. At the team level, aspects such as team size and team composition are considered. At the concept level, parameters such as analogical distance (within-domain and between-domain) and analogical purpose (problem identification, function finding, explanation, and solution generation) are considered. Team cohesion and team collaboration are the dependent variables. This research aims to lay the computational foundation for a means of studying design team behaviour when using analogies.

EXPLORING PROBLEM DECOMPOSITION IN DESIGN TEAM DISCUSSIONS

Connor Tobias (1), Jeffrey W. Herrmann (1), Erica Gralla (2)

(1) University of Maryland, United States of America; (2) George Washington University, United States of America

When faced with the problem of designing a complex system, a design team must make many decisions. Because many design problems are too difficult to solve all at once, the team will decompose the design problem into more manageable subproblems. Although studies of individual designers have shown that explicit decomposition is seldom used, we conducted a pilot study to determine whether, because they need to communicate about their design decision making activities, design teams explicitly decompose their work. This paper describes the results of our study, in which we observed four teams of professional engineers who redesigned a manufacturing facility and analyzed their decision-making processes. The goal of the study was to gain insights into whether and when teams select a decomposition of the problem and whether they utilize explicit or implicit decomposition. The results show that the teams did discuss their decompositions, but not every subproblem was discussed, and they did not decompose the entire problem upfront. Future research will determine if other teams behave similarly and will investigate how teams determine which subproblem to solve next in the design process.

PHYSIOLOGY AND SENSORIAL BASED QUANTIFICATION OF HUMAN-OBJECT INTERACTION – THE QOSI MATRIX | *Stephanie Balters, Matilde Bisballe Jensen, Martin Steinert*

Norwegian University of Science and Technology, Norway

This paper addresses the need to quantify human-object interactions in order to get insights into the sensorial variables influencing the actual user-experiences in interaction and human centered design. The resulting framework is generally applicable and allows the exploration of more fundamental human-object interaction relationships, including better benchmarking and comparison of alternative design options and the development of controlled experimental setups. We approach the problem of capturing human-object interactions from a sensorial perspective. Based on the functioning of the five human sensory systems (visual, auditory, somatosensory, gustatory, and olfactory), we distil 21 quantifiable and measurable input dimensions, which may come into play when a person interacts with an object. The resulting Quantified Object Sensation Input (QOSI) matrix gives the possibility to very specifically and precisely quantify and describe any human-object interaction based on the sensorial information it delivers. The matrix allows comparing different human-object interactions in a standardized and generally applicable manner, even if the objects have fundamentally different properties.

CHAIR
Mirko Meboldt

HUMAN BEHAVIOUR IN DESIGN COLLABORATION

P
4.8

10:45 am
-
12:30 pm

BL27.8

THURSDAY
30
JUL

PROVOKING ITERATIONS IN IDEATION WORKSHOPS – AN EXPLORATIVE STUDY

Johannes Heck (1), Martin Steinert (2), Mirko Meboldt (1)

(1) ETH Zurich, Switzerland; (2) NTNU, Norway

There are at least two different perspectives on iterations in product development processes (PDP), a negatively connoted management perspective and a positively connoted engineering perspective. This paper aims at revealing more about both perspectives on iterations in early phases of product development, and to provide hints about the impact these iterations might cause. In an explorative study with eight organisations, we observe their earliest phase of new product development during their participation in ideation workshops. So far, the differences of both perspectives seem to be smaller than expected. With research being ongoing, the ideation space at Thun castle functions as a learning lab and seems to be a promising research platform for further studies.

NOVICE ENGINEERS' PREDISPOSITION TO COMPASSIONATE DESIGN

Priya Seshadri, Tahira Reid

Purdue University, United States of America

The objective of this research paper is to study the ways in which engineering students naturally apply elements of compassionate design thinking to design tasks. We hypothesize that engineers will engage in compassionate design ways of thinking only when explicit information is provided and/or if they have had prior experience with the design context. The goal here was to understand whether or not engineers are able to intuit the need for compassionate design thinking and if their experience guides their approach. A mixed methods approach was used to study novice engineers in design contexts that warrant the need for compassionate design thinking. A 'Think Aloud protocol' was used and a coding scheme was developed to analyze the documented video/audio recordings. The results show that participants with experience invest more thought in framing the problem as compared to those without experience. Observations showed that factors like 'dignity' were less discussed and need more probes to be included in the design process. These results will provide information that will lead to the development of a tool, such as Design for Compassion or DfC for compassionate design thinking.

12:30 pm - 2:00 pm

DINING AREA

THURSDAY 30 JUL

LUNCH BREAK

1:00 pm - 2:00 pm

MEETING 1

North American Chapter meeting

BL27.1

1:00 pm - 2:00 pm

MEETING 2

RED: Research in Engineering Design editorial board meeting

INVITED

BL27.11

LUNCH MENU*

STARTERS

Tortino di acciughe
Anchovies savoury pies

Salmone al vapore in salsa tartara leggera
Steamed salmon with light tartar sauce

Roast beef con rucola, grana e dressing alla senape
Roast beef with rocket, Grana and mustard dressing

accompagnato da
Formaggio del giorno, Torte di verdura assortite
Verdure cotte e crude di stagione

served with
A variety of Italian cheeses, Mixed savoury pies
and raw/warm vegetables

***

1 FIRST COURSE TO CHOOSE FROM:

Crespella di magro zucchine e ricotta al limone
Meatless crespella with zucchini and lemon-flavoured ricotta

Minestra fredda di verdure e orzo
Cold soup with fresh vegetables and barley

***

DESSERT

Fresh Fruit salad, Selection of cakes
and the traditional Italian ice-cream

Vegan, Gluten-free, and alergies-free options are available.
Please check with our Staff the best meal for you!
**changes can occur*

CHAIR
Yong Zeng

DESIGN FOR A HEALTHY LIFE (1)

D 7.1

2:00 pm - 3:00 pm

BL27.14

THURSDAY 30 JUL

THE EFFECTS OF TRAINING BACKGROUND AND DESIGN TOOLS ON MULTI-LEVEL BIOSYSTEMS DESIGN | *Paul Egan (1), Tiffany Ho (1), Christian Schunn (2), Jonathan Cagan (1), Philip LeDuc (1)*

(1) Carnegie Mellon University, United States of America; (2) University of Pittsburgh, United States of America

Biotechnologies could promote healthier lives through advancements such as complex multi-level muscle tissues. Here, cognitive processes among mechanics experts, physiology experts, and novices were investigated to determine what types of knowledge and training are beneficial. An initial hypothesis proposed that domain knowledge is not sufficient for predicting how system redesign affects performance, which was supported by all populations performing poorly on muscle redesign questions; mechanics experts outperformed other populations on force-related questions. A second hypothesis suggested that learning with multi-level design interfaces could aid participants in system redesign, which was supported by all populations performing well after training. A final hypothesis proposed that experts would excel in describing redesign effects, which was supported by expert populations describing more higher-level effects than novices, and the physiology experts suggesting the most effects on patient health. This study lays the foundation for investigating medicine and engineering in design, which has great potential for improving patient health with novel products.

DESIGNING FOR THE DEEPEST NEEDS OF BOTH PUBLIC SERVICE CONSUMERS AND PROVIDERS; INNOVATION IN MENTAL HEALTH CRISIS RESPONSE

Mieke van der Bijl-Brouwer, Rodger Watson

University of Technology, Sydney, Australia

Design is increasingly used as an approach to support innovation outside the traditional design domain, including the public sector. One of the design principles that is used in these so-called design innovation processes is gathering 'deep' insights into users or customers needs to support reframing of problems. In an earlier publication we proposed a model of levels of depth of insights into human needs. This model indicates that the deepest level to analyse human needs for design innovation is the thematic level which describes human values and meanings outside the context of the problem. Analysing those themes supports reframing of problems. In this paper we argue that innovation in the public sector can benefit from analysing these deepest needs beyond the needs of just the public service consumer, to include the needs of public service providers. Meeting the needs of service providers might positively influence the quality of the service itself. We illustrate this through a case study which was aimed at developing solutions for the systemic problem of supporting people with severe and persistent mental health problems.

DESIGN AND VALIDATION OF DIAGNOSIS TOOL OF INCLUSION OF CHILDREN WITH DISABILITIES IN PLAYGROUNDS | *Tatiana Mejia Piedrahita*

Universidad EAFIT, Colombia

The last years in Medellin has been developed actions to create normative that promote the inclusion of people with disabilities in the different public spaces. Nevertheless even recreation is recognized as a fundamental right, it is needed to stablish guidelines for the design of inclusive playgrounds. In this investigation were analysed 5 factors that are important for the design of inclusive playgrounds: surrounding environment, context, the user, activities and objects. When these factors were analysed, it was possible to identify the areas of a playground and its components that need to be evaluated, to design a diagnosis tool of the inclusion of children with reduced lower limb mobility in playgrounds. Then the diagnosis tool was evaluated in a series of validation cycles with different stakeholders to make an usable tool that takes into account the technical normative in the design of a playground. The diagnosis tool evaluates 3 areas (surrounding environment accessibility, play area accessibility and play area objects) and its components, to allow professionals to evaluate playgrounds in any stage of the design process to improve its accessibility and inclusion.

D
7.1

DESIGN FOR A HEALTHY LIFE (1)

CHAIR
Yong Zeng

2:00 pm
-
3:00 pm

BL27.14

THURSDAY
30
JUL

THE HESD-MODEL: MERGING MULTIPLE PERSPECTIVES AND CREATING FLEXIBLE USE SCENARIOS FOR SERVICE DESIGN IN HEALTHCARE | *Tommaso Sarri, Maaike Kleinsmann, Marijke Melles*

TU Delft, The Netherlands

Designers are increasingly asked to create solutions for complex problems in for example healthcare. To serve the design of these complex systems, there is a need for new, design methods. While current design methods allow design for multiple users, they often restrict flexibility of adding new solutions to the final product service system (PSS). This paper presents the Healthcare Service Design Model (HESD-model), which was used as a method to design a PSS that supports teamwork and parental involvement in the context of child oncology. This method was developed by the authors, while carrying out a design project within the context of paediatric oncology. The design project concerned the design of a support system that improved the non-technical skills of different actors present in the hospital. A critical reflection of the model and the evaluation of the design outcomes of the model showed that the method allowed taking into account the viewpoints of multiple users as well as the addition of new solutions to the system, leading to valuable results for multiple users.

D
7.2

DESIGN RESEARCH METHODOLOGY DESIGN EXPERIMENTS

CHAIR
Johan Lars Malmqvist

2:00 pm
-
3:00 pm

BL27.13

MEASURING PROTOTYPES - A STANDARDIZED QUANTITATIVE DESCRIPTION OF PROTOTYPES AND THEIR OUTCOME FOR DATA COLLECTION AND ANALYSIS

Matilde Bisballe Jensen, Stephanie Balters, Martin Steinert

Norwegian University of Science and Technology, Norway

This paper addresses the need to learn about the characteristics, functionalities, and intended purposes of prototypes by proposing a standardized framework to describe (1) the characteristics of prototypes and (2) their generated (intended) outcome in a quantified and generally applicable way. Text-analysis software enabled us to merge the diverse concepts from literature regarding definitions and descriptions on the characteristics of prototypes and their generated outcome into one single reference, and to further cluster the entire content into newly defined themes. We further defined 51 closed, quantifying questions, which consistently inquire the entire scope of content-definition of each theme and therefore (indirectly) quantifies prototypes and their generated output in a standardized way. Lastly, we provide a case scenario applying these 51 questions as input values in a prototype library to uniformly capture standard parameters of prototypes and their outcome at any stage within a product development process. The analysis of the library data will allow identifying first principles of prototypes and their intended purposes for the engineering design community.

CHAIR
Johan Lars Malmqvist

DESIGN RESEARCH METHODOLOGY DESIGN EXPERIMENTS

D
7.2

2:00 pm
-
3:00 pm

BL27.13

THURSDAY
30
JUL

MODELLING IN BUSINESS MODEL DESIGN: REFLECTIONS ON THREE EXPERIMENTAL CASES IN HEALTHY LIVING | *Lianne W.L. Simonse, Petra Badke-Schaub*

Delft University of Technology, The Netherlands

This paper reviews the origins of modelling in design theory and reflects on its application within the new mode of innovation: business model design. Three main principles of modelling are identified in association to design theory: (1) modelling as a visual reasoning, as a (2) prescriptive aggregation of complex systems, as the (3) creation of an artefact. Drawn from designer's experiences in three experimental cases of healthy living, three additional principles of business modelling are identified: (1) prescriptions of value exchanges in network model visualisations, (2) modelling as a shared vision, communication and commitment of multiple actors and as (3) dynamic modelling across time zones. The paper proposes that by modelling, designers can offer a useful contribution to business model design.

DISTRIBUTED EXPERIMENTS IN DESIGN SCIENCES, A NEXT STEP IN DESIGN OBSERVATION STUDIES? | *Carlo Kriesi (1) et al.*

(1) NTNU Trondheim, Norway et al.

This paper describes and proposes a new method for conducting globally distributed design research. Instead of using e.g. a software we tried out a completely analogue approach: Five carefully prepared packages, containing all the necessary materials and instructions for a design challenge, were sent out to supervisors in Norway, Finland, Italy, and Australia. These local supervisors then conducted the egg-drop exercise with students that are part of an international course held at CERN. As the task is conducted according to a previously tested protocol, the results gathered with this new method can then be benchmarked with this available data. This new approach to globally conducted engineering design activities avoids local bias and enables for gathering large amounts of diverse data points. One can also think of a research community where every member can send out one experiment per year and, in return, receives data points from across the world. Based on the feedback from the supervisors we can say that from an organisational standpoint of view, this method works well. The comparison to the existing data has yet to be done.

TEACHING NURSES CAD: IDENTIFYING DESIGN SOFTWARE LEARNING DIFFERENCES IN A NON-TRADITIONAL USER DEMOGRAPHIC | *Katherine Jo Stephenson, David Pickham, Lauren Aquino Shluzas*

Stanford University, United States of America

This pilot study examines CAD software learning differences between a group of non-technical innovators (clinical nurses) and traditional CAD users (design engineers). This research was motivated by the rapid growth of digital fabrication methods and the proliferation of low cost, semi-professional CAD software, both of which have reduced prototyping barriers for innovators outside of professional design. The study's methodology consisted of (i) a pre-test survey to assess each subject's degree of computer usage and confidence in 3D modeling, (ii) the completion of a CAD tutorial on a laptop, and (iii) an interview to record each participant's impressions of the design experience. Based on a mixed-methods analysis of qualitative and quantitative data, the study showed that the nursing cohort had both the strong motivation and technical ability to learn CAD software. However, their profession enforces a low tolerance for ambiguity or time inefficiency, making the traditional engineering methods of "explore and learn" inappropriate. The output of this study will be used to assemble an extensive experimental curriculum for nurse innovators interested in medical device design.

D
7.3

USER CENTRED DESIGN METHODS AND TOOLS

CHAIR
Sven Matthiesen

2:00 pm
-
3:00 pm

BL27.3

THURSDAY
30
JUL

THE "IDEAL" USER INNOVATION TOOLKIT - BENCHMARKING AND CONCEPT DEVELOPMENT | *Michael Roth, Jonas Harmeling, Ioanna Michailidou, Udo Lindemann*

Technische Universität München, Germany

User innovation toolkits offer many benefits, for example the efficient access to customer needs, the realisation of individual products and reduced development risks. While these toolkits are spread in many industries, they are not very common for mechanical or mechatronic products. To improve the applicability of these toolkits, our paper develops a general concept of an "ideal" user innovation toolkit. It examines existing applications in a benchmark analysis, develops seven dimensions to categorize user innovation toolkits and identifies best practices. Based on these findings the general concept is derived. It provides support in the early phase of user innovation toolkit design and helps companies to find suitable trade-offs and to develop a tailored solution for their purposes. By that our paper contributes to a better applicability of the user innovation approach.

A V-MODEL FOR MORE. AN INCLUSIVE DESIGN MODEL SUPPORTING INTERACTION BETWEEN DESIGNER AND USER | *Elke Ielegems, Jasmien Herssens, Jan Vanrie*

UHasselt - Hasselt University, Belgium

Designers aiming to design for all users experience difficulties when realizing this in practice. More insight is needed into practical constraints and potential obstacles regarding inclusive designing. Therefore, this paper proposes a design model of an inclusive design process focussing on the interaction between designer and user information from the start of the project. The presented model, based on a V-model created in software design, differs from well-known inclusive design models at three general aspects: it emphasises the implementation of user information as an equal, continuous, and separated track; secondly, the interaction between these two tracks is regarded as a key activity; thirdly a built-in flexibility is provided, enabling the architect to manage an inclusive design process. It is the combination of these aspects, which results in a more supportive model for inclusive designing in the built environment. This way, more insight can be gained to improve the interaction between designer and user information. Therefore, this model serves the architect in his/her aim towards Inclusive designing.

INTEGRATION OF END-USER NEEDS INTO BUILDING DESIGN PROJECTS: USE OF BOUNDARY OBJECTS TO OVERCOME PARTICIPATORY DESIGN CHALLENGES

Xavier Latortue (1),(2),(4), Stéphanie Minel (1), Stéphane Pompidou (2),(4), Nicolas Perry (3),(4)

(1) ESTIA-Recherche, France; (2) Univ. de Bordeaux, France; (3) Arts et Metiers ParisTech, France; (4) I2M, France

Participatory design is perceived as a way of improvement in both manufactured and building design. Nonetheless high level of user involvement has its limits. Part of the difficulties of the participatory design is due to the tacit nature of conventions that are shared between professionals. Boundary objects are described as an interesting tool to bridge those boundaries and should be investigated in the context of participatory design in building projects.

CHAIR
Sven Matthiesen

D
7.3

USER CENTRED DESIGN METHODS AND TOOLS

2:00 pm
-
3:00 pm

BL27.3

THURSDAY
30
JUL

PHOTOGRAPHY - A NEW TOOL IN NEEDFINDING

Andreas Wulvik, Stephanie Balters, Martin Steinert

Norwegian University of Science and Technology (NTNU), Norway

In this paper we are proposing the use of photography as a dedicated tool to capture latent needs and create anchor points for future solutions in engineering design. We are grounded in user centric design. Based on a needfinding project in India we demonstrate the usage of sequential photography techniques to identify and propose needs through priming the viewer into modes of divergent and convergent thinking. We have selected 49 out of a total of 381 pictures taken in October 2014. These pictures have been processed to our three types: snapshot, emphasized picture, and illustrated picture. Each technique and usage is described in detail, together comprising a proposed new method for needfinding.

CHAIR
Balazs Vidovics

DESIGN EDUCATION COURSES AND CURRICULA

D
7.4

2:00 pm
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3:00 pm

BL27.4

CONCEPT AND STRUCTURE OF A NEW MASTER-PROGRAMM "SYSTEMS ENGINEERING"

Kristin Paetzold, Förstner Roger, Tillmanns Clara

University Bundeswehr Munich, Germany

Nowadays engineered systems become more and more complex and more and more systems are complex due to the technological developments. At the same time there is a lack of good and systematically trained systems engineers who are able to guide, to coordinate and to manage the technical design, development, integration and implementation of those systems. One reason for this situation lies in the fact that the education and training of systems engineers is a quite difficult task. This is because systems engineering has also a lot to do with experience and with a certain way of thinking, the so called "systems thinking". Therefore, the "art & science" of systems engineering cannot be taught only in a classical way but it must also be learned by applying the new knowledge continuously to practical problems and exercises. Due to this situation and the increasing importance of systems engineering capabilities for companies and future projects, a new Systems Engineering Master program is offered and will be explained in this paper.

NEW WAYS IN EDUCATION WITH SHAPE DESIGN

Felix Heimrich, Reiner Anderl

Technische Universität Darmstadt, Germany

Today's product development process is characterized by increasing complexity of products. Subsequently universities have to adapt and constantly improve the content of their courses to prepare the future graduates for the free market economy. An approach at Technische Universität Darmstadt to expand the scope of CAD education, is the introduction of a new one-week tutorial on shape design with Siemens NX. This paper will describe the teaching concept and its implementation. The concurrently submissions of the examinations with content from realistic industrial tasks play an important role during the course.

D
7.4

DESIGN EDUCATION COURSES AND CURRICULA

CHAIR
Balazs Vidovics

2:00 pm - 3:00 pm

BL27.4

THURSDAY 30 JUL

A DESIGN COURSE COMBINING AESTHETICS AND ENGINEERING KNOWLEDGE IN PBL STYLE | *Hsiang-Tang Chang*

National Kaohsiung First University of Science and Technology, Taiwan, Republic of China

This paper is to display the effect of a PBL (Project Based Learning) style design course, which was constructed by the author, and combined aesthetics and engineering knowledge. The author considered that current Taiwanese industrial design collegiate students are not strong in engineering design, and they often emphasize appearance of product but ignore function; therefore, the author tried to develop pedagogy which involves the above-mentioned idea to lead students to develop buckle design and fabricate it. Through the experimental project in the course, most of the students were satisfied with the learning style and find the fulfillment in engineering design.

ADVANCED BUSINESS COACHING APPROACH IN COMBINATION WITH SYSTEMIC CONSTELLATION WORK TO IMPROVE THE BUSINESS ENGINEERING PROCESS

Carsten Burchardt

Siemens Industrie Software GmbH

Business coaching and consulting as a systemic constellation approach is a solution-focused process, which helps leaders of organizations to identify the complex, often informal, relationships and inter-dependencies within their organization and to develop a deeper understanding about the underlying dynamics in a very time- and cost-efficient manner. The effectiveness of this method has of late been scientifically proven by various research studies. It has become at business engineering as a business coaching a widely accepted discipline in business consultancy, organizational development and change management. The process serves as a platform to solve business issues and to create future change – e.g. developing a sustainable corporate culture, optimizing the organization's performance and enabling the strengths of individual team members as well as the team as a whole to fulfill their tasks in the most productive way in business.

D
7.5

DESIGN METHODS AND TOOLS DECISION SUPPORT

CHAIR
Peter R.N. Childs

2:00 pm - 3:00 pm

BL27.5

EXTENSION OF THE LIGHTWEIGHT DESIGN THINKING TOOLS FOR THE APPLICATION ON MORE COMPLEX PROBLEMS | *Benedikt Posner, Hansgeorg Binz, Daniel Roth*

University of Stuttgart, Germany

The Thinking Tools after Nature are a bionic approach based on simple rules in order to develop lightweight design structures without need for topology optimisation software. The Lightweight Design Thinking Tools are a further development of that approach in order to respect space limitations and more dynamic problems. Nevertheless, both tools are limited to two dimensional problems. The major aim of this research is to make the ideas of the Thinking Tools after Nature applicable in the field of mechanical engineering and product development. In order to reach this aim, the application of the method on three dimensional problems will be analysed and an approach for developing three dimensional lightweight structures using the Lightweight Design Thinking Tools will be presented. Furthermore, in the existing approaches only very simple force application cases and bearings are considered. Since there are often more complex surfaces in the field of mechanical engineering on which forces are applied these more complex surfaces will also be discussed in the contribution.

CHAIR
Peter R.N. Childs

DESIGN METHODS AND TOOLS DECISION SUPPORT

D
7.5

2:00 pm - 3:00 pm

BL27.5

THURSDAY 30 JUL

A METHODICAL APPROACH TO MODEL AND MAP INTERCONNECTED DECISION MAKING SITUATIONS AND THEIR CONSEQUENCES | *Thomas Luft, Samuel Schneider, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

As products become more and more complex and have to be developed in less time, decision makers are facing the need to achieve good decisions efficiently. While some of the decision making processes are easy to undergo and their respective consequences can be identified with precision, other decision situations are characterized by complex steps and by consequences which are hard to predict. Therefore, the objective of this paper is to identify, analyze and evaluate conflicting decision making situations whose consequences are difficult to predict. The goal is to elaborate on a methodology in order to categorize and structure decision making situations and their respective consequences. This methodology is intended to support decision makers in evaluating decision making situations with regard to their interconnectivity and potential consequences. Future steps are the application of the overall methodology in a case study and its improvement due to the lessons learned.

USING BALANCE VARIABLES TO DESCRIBE SYSTEM INTERFACES AND ASSESS IN-PROGRESS DESIGNS | *Filippo Arnaldo Salustri (1), Damian Rogers (2)*

(1) Ryerson University, Canada; (2) Ionada Incorporated, Canada

To balance effectiveness and efficiency in design, a method is needed that can capture the range of expected behaviours (effectiveness) as well as their quality (efficiency) of artefacts existing in specific situations. The authors introduce "balance variables" for this purpose. A balance variable (BV) is a pair of triplets, each of the form (minimum, nominal, maximum) that represent the range of values that a flow between two system interfaces can reasonably obtain. One triplet quantifies a flow from outside the object system and represents a requirement on the object system; the other triplet represents the flow handled by the object system and represents a measure of performance. BVs can capture cases of over- and under-design. A BV that is neither over- nor under-designed is said to be balanced. Measures of balance are normalized and non-dimensional, thereby permitting (a) balance measures for difference system flows to be reasonably compared, and (b) overall design balance measures to be trivially calculated. Using the example of an electric kettle, all these characteristics are shown.

REAL-TIME PRODUCT RECOVERY DECISION MAKING ALGORITHM FOR SUSTAINABILITY

Passaporn Kanchanasri (1), Seung Ki Moon (1), Gary Ka Lai Ng (2)

(1) Nanyang Technological University, Singapore; (2) Advanced Remanufacturing and Technology Centre, Singapore

Supporting long term benefits towards our society, a product recovery becomes a good alternative for handling End-of-Life (EOL) products. Instead of disposing all used products and producing waste, recovery options such as repair and reuse can be considered. They could be more cost-effective while saving our natural resources. A decision on product recovery option selection is necessary especially for an automated inspection. In this study, we propose a real time decision making algorithm for product recovery option selection. The proposed algorithm is focused on social and ecological impacts together with engineering and economic aspects. The objective is to develop a decision making algorithm to handle multiple conflicting criteria including natural resource consumptions, cost, and quality. The algorithm is designed to ensure that a product recovery decision is economy-effective and good for an environment and a human life in a long term. The modelling and simulation shows a potential to be implemented practically to support sustainability.

D
7.6

DESIGN ORGANISATION AND MANAGEMENT (COLLABORATION IN DESIGN (3)

CHAIR
Jean-François Boujut

2:00 pm
-
3:00 pm

BL27.6

THURSDAY
30
JUL

MEANING MAKING IN THE INTERSECTION BETWEEN SKETCHES AND 3D MOCK-UP

Abu Ali, Andre Liem

Norwegian University of Science and Technology (NTNU), Norway

This paper presents a report of a workshop held in Konfack, University College of Art, Craft and Design, Sweden. The objective is to investigate how designer creates the meaning in the intersection between sketches and 3D physical mock-up. The method of the study is using sketches to act as a medium to transmit the meaning to 3D physical mock-up (clay modeling) by designers to resolve the task "Object for seating". The authors analyze the data from the lines of sketching through comparisons of aspects such as variation, physical effects, and psychological effect. Meanwhile, the 3D physical mock-up shape is formalized according to principles of design. The reflection of the sketches and 3D physical mock-up shows that some meaning occur at the intersection between them. This study reveals that participants generate a variety of meaningful designs using sketches and mock-ups throughout the design process.

ARGUMENTATION ANALYSIS IN AN UPSTREAM PHASE OF AN INNOVATION PROJECT

Fatima-Zahra Abou Eddahab (1), Guy Prudhomme (1), Cedric Masclet (1), Kris Lund (2), Jean-François Boujut (1)

(1) Univ. Grenoble Alpes, France; (2) ICAR, France

Nowadays the innovation process has become a collective activity where designers have no longer to work only in their own field of expertise but they have also to work with others in project meetings in order to make decisions collectively. The main purpose of this study is to understand how participants argue and converge toward one solution in an upstream phase of an innovation project. Our work is based on a case study. We captured video and audio data and we gathered working documents from an innovation project meeting in a French company. Our first macro analysis showed that during this meeting there were no explicit decisions concerning both technical and business model solutions. We also noticed that the technical discussions converged towards a solution. This convergence was based on a multitude of mobilized criteria that we structured in different categories. In future research we plan to carry out micro analyses of particular moments highlighted in our current work in order to understand this convergence process.

RETHINKING OPERATING MODELS FOR INTANGIBLE SERVICES: FROM A MECHANISTIC STRUCTURE TO A SUSTAINABLE MODEL | *Angela Minzoni, Eleonore Mounoud*

Ecole Centrale Paris, France

This paper presents a co-design process in which operations managers and researchers engage in designing within the aim of radically innovate the operations' management thinking focusing on the whole operation's environment and system, beyond operation's optimization. Organization's operating models have a key influence on the organization's governance and strategy. The design of operating models is thus pivotal for organizations and a key stake for those whose operations are based on high speed information and sophisticated knowledge, such as intangible services like banking, financial, insurance or internet services. A main challenge is to produce new knowledge and tools to address specific intangible services' operating models at a time where service systems' operations cannot any more be understood and planned under a mechanistic view of pre-established continuous chains of standardized micro tasks. The focus in this paper is specifically on the challenges related to pass from a static and mechanistic middle and back office operation's system view to a dynamic, living system like operation's model. The design process itself is designed as an iterative action-learning process.

CHAIR
Torben Anker Lenau

DESIGN OF SOCIO-TECHNICAL SYSTEMS

D
7.7

2:00 pm
-
3:00 pm

BL27.7

THURSDAY
30
JUL

DESIGNING FOR CHILDREN'S PLAY GROUND, A SOCIAL SKILLS IMPROVEMENT APPROACH

Ghazaleh Sepahpour (1), Hamid Reza Shahabi Haghighi (1), Vahid Choopankareh (2)

(1) Amirkabir University of Technology, Iran; (2) Tehran University, Iran

Many children learn how to communicate by playing. The objective of this research is to identify a suitable method to improve children's social interactions, by designing a toy, according to children's needs. To achieve this objective, some necessary information about children's play and social interaction environment, children's favorite plays, and social skills which improve social interaction were obtained by literature review, interview and a questionnaire. Then a toy was designed, considering the research results and was evaluated by experts. The selected concept which is usable at park and school is a balance base type for maze and marble which is suitable for both solitary and social plays. It stimulates children to social interaction in a physical process and improves their social skills.

DESIGNING WITH DAYLIGHT; THE RELATIONSHIP BETWEEN DAYLIGHT AND HEALTH

Bettina Hauge

Technical University of Denmark (DTU), Denmark

Daylight is not only fundamental for architecture and renovations, modernizations and transformations of cities and buildings - it is fundamental for people's well-being.This paper describes the significance of daylight to people. Based on a qualitative research project in Denmark in 2012 about the use of windows among 13 families I will show how daylight is perceived, used, coped with, and negotiated by people in their homes, thus exploring the social character of a natural phenomenon. A metaphor will be used from biomimetics, claiming that - like plants - the Danish participants need daylight. People's day-to-day entanglements with daylight are illustrated, highlighting the social qualities of daylight. The paper concludes that access to daylight is vital for existential reasons (health, social reasons and to feel connected to one's natural environment), showing the window as much more than a technical artefact. Based on this I argue for the window to be acknowledged as vital for creating dwelling and for its inclusion in bio-inspired design and biophilic architecture that so far have focused more on the inclusion of nature and views to greenery, less on daylight.

THE DESIGN AND DIMENSIONS OF SOCIAL INNOVATION: THE BRAZILIAN CASE OF THE "ECOLOGICAL NETWORK" | *Amanda Fernandes Xavier (1), Ricardo Manfredi Naveiro (1), Améziane Aoussat (2), Carlos Henrique Pereira Mello (3)*

(1) Federal University of Rio de Janeiro, Brazil; (2) École Nationale Supérieure d'Arts et Métier, France;
(3) Universidade Federal de Itajubá, Brazil

The design has been receiving a increasing importance due to the market complexity and environmental unsustainability concerns, being it a strategic tool for positioning of sustainable products and development of welfare concepts. This approach brings systemic alternatives, with the discontinuation of present consumption system to a process of social learning. This process refers to the changes of a behavioral nature, the so-called social innovations. In this context, in order to understand the organization and management model of such social innovations, a single-case research was performed on a Brazilian social entity, renowned by its innovative, supportive and ecological character. This case was analyzed and compared with the dimensions and social innovation indicators proposed by literature, in order to verify its correspondence with a social innovation model. The main aspects perceived were the partnership and transparence among producers and associated members, compromise and auto-coordinated participation in the operation of the network and environmental and social preservation as a principle.

D
7.7

DESIGN OF SOCIO-TECHNICAL SYSTEMS

CHAIR
Torben Anker Lenau

2:00 pm
-
3:00 pm

BL27.7

THURSDAY
30
JUL

EFFECTIVE SIMPLIFICATION FOR LOGO DESIGN

Chung-Yun Chen, Vien Cheung, Dian Li, Thomas Cassidy

University of Leeds, United Kingdom

As a graphic mark, logo applied by companies to aid public recognition and identification that it is traditionally applied on print advertisements and in recent years in digital devices. The logo recognition ability becomes a challenge to make it readable in a small display. Therefore, there is a need for brands to ensure their logo is recognisable in different media. According some previous research, simplifying shape might be one of the solutions to increase the recognition ability that will be the core concept in this study. Therefore, this study seeks to investigate a systematic method to evaluate the level of simplicity. The result of experiment aims to provide a reliable and systematic measurement for logo recognition development in different media display and able to enhance the recognition ability before works be printed.

D
7.8

DESIGN ORGANISATION AND MANAGEMENT FAILURE AND RISK MANAGEMENT

CHAIR
Warren Seering

2:00 pm
-
3:00 pm

BL27.8

DESIGN DRIVEN STARTUPS

Søren Ingomar Petersen

Ingomar & Ingomar - Consulting, United States of America

This paper explores how market, technology and design execution risks influence a startups' performance. First, we uncover relationships between market and technology risk and the startups' success, as defined by their ability to receive financing and be acquired. We then establish unique opportunity areas for startups, based on a capital framework perspective. To assess a startup's design execution performance, in a selected market - technology position, we then develop a multi-variable linear prediction model of the startup's design execution, assessing risk based on data from previously conducted studies of eighteen design teams. Finally, we test the model's predictive power on a second set of previously conducted studies of thirteen design projects. The design driven startup predictive model can be applied to evaluating the strength of business opportunities of startup entrepreneurial ventures in the "seed stage" of Angel and Venture Capital investors' selection and financing funnel process. In conclusion, we outline opportunities for implementing the model in a double-sided online business model to collect further evidence for the model's predictive capabilities across industries.

CHAIR
Warren Seering

D
7.8

DESIGN ORGANISATION AND MANAGEMENT FAILURE AND RISK MANAGEMENT

2:00 pm
-
3:00 pm

BL27.8

THURSDAY
30
JUL

CHARACTERISTICS AND ENABLERS OF TRANSPARENCY IN PRODUCT DEVELOPMENT RISK MANAGEMENT |

Ryan M. Shaffer (1), Alison L. Olechowski (1), Warren P. Seering (1), Mohammad Ben-Daya (2)

(1) Massachusetts Institute of Technology, United States of America;

(2) King Fahd University of Petroleum and Minerals, Saudi Arabia

Risks in product development lead to schedule and cost overruns and poor product quality. While many risk management frameworks have been published and research on specific practices has been conducted, little is understood of key characteristics of successful risk management in product development and how they manifest in real development projects. This research consists of two phases. The first phase is a survey on 171 best practices in risk management. Analysis of over 200 responses from industry practitioners identified transparency as a key characteristic of successful risk management in product development. Due to the limited exploration of the concept of transparency in the literature, the second phase of this work consisted of a qualitative investigation of transparency through interviews with 15 industry practitioners. Analysis of the interview results suggests a hierarchical structure which decomposes transparency into several characteristics and identifies enablers for each of these characteristics. We propose that transparency can be a valuable lever for product developers and managers. Future work is needed to validate the generalizability of the observations provided.

ACTOR-BASED SIGNPOSTING: A MODELING TOOL TO IMPROVE THE SOCIO-TECHNICAL DESIGN PROCESSES |

Mohammad Hassannezhad, Marco Cantamessa, Francesca Montagna

Politecnico di Torino, Italy

Socio-technical aspect of engineering design is an inter-disciplinary domain, an integrated organization of human- and non-human interactions. Modeling socio-technical design processes can therefore be influenced not only by the complexity of technical decisions, but also by that of social interactions. This paper is dealt with design process improvement through modeling and management of complexity and uncertainty, which is mainly associated with activities' and actors' behavior and multiple types of interactions among them. Hence, a modeling tool is proposed, by making a balance between detailed rigor nature of dynamic task models and the flexibility and abstraction of social networks models, so-called "Actor-Based Signposting" (ABS). We aim to come up designers and design managers with a guidance on not only the content of the work, but also on the way to carry it out, acting as an information mechanism to facilitate communication. A flexible and scalable simulation tool presented and exemplified in support of ABS system, which can be adapted to any kind of design processes.

THE IMPACT OF TECHNOLOGY UNCERTAINTY ON EARLY SUPPLIER INTEGRATION IN PRODUCT DEVELOPMENT |

Lukas Geissmann (2), Eric Scott Rebentisch (1)

(1) MIT, United States of America; (2) The Schindler Group

This study examines how the presence of technology uncertainty affects the benefits of integrating suppliers in the product development process. A framework was created to cover the different aspects of technology uncertainty discussed in current empirical studies. From this a survey instrument was created and a sample of data collected from companies engaged in product development projects. The analysis confirmed most aspects of the technology uncertainty framework. A tendency towards strategic and long-term buyer-supplier relationships leading to better product development performance was shown. Thorough supplier assessment using cross-functional teams and formal IP and confidentiality agreements were shown to benefit supplier integration in the Fuzzy Front End of product development. The benefits from integrating suppliers in the Fuzzy Front End seem to be positively moderated by the level of experience the buying-organization has with the technology provided by the supplier. This runs counter to the prediction that supplier integration should be more beneficial if the buying-organization has less knowledge about the supplier's technology.

DESIGN INFORMATION AND KNOWLEDGE ACQUISITION AND USE

CHAIR
Klaus-Dieter Thoben

ANALYSING THE EFFECTS OF VALUE DRIVERS AND KNOWLEDGE MATURITY IN PRELIMINARY DESIGN DECISION-MAKING |

Alessandro Bertoni, Marco Bertoni, Christian Johansson

Blekinge Institute of Technology, Sweden

The paper presents the results of a three-days experiment to test the use of information from a value assessment model and from a knowledge maturity scale in decision-making in preliminary design. A visual analogue scale was used to collect individual information from designers through questionnaires. Bivariate statistical analysis was applied to study the correlations between both the use of value drivers and knowledge maturity and the designers' awareness of the design problem to be addressed. Results show that value drivers and knowledge maturity information increase the decision makers' awareness of (1) the different perceptions of design team members about the needs to be satisfied and (2) the technical solution to be developed in the product concept under consideration.

IDENTIFICATION OF KNOWLEDGE AND PROCESSES IN DESIGN PROJECTS

Danilo Marcello Schmidt, Daniel Kammerl, Bernhard Schultz, Sebastian Alexander Schenkl, Markus Mörtl

Technische Universität München, Germany

As market's requirements change, companies have to conserve, develop and manage their knowledge to provide more complex products. For this reason and in the background of knowledge management, it is necessary to detect knowledge gaps in the company or in a department. We built a methodology, which firstly identifies the processes running in the concerned unit and the knowledge, which is needed to complete those processes. Thereby, our approach focus on the granularity of the knowledge and process elements. This enables quantitative analysis methods for knowledge structures to provide results that are more valid. To evaluate this granularity, we applied our approach in a design project.

PROPOSED EVALUATION OF THE USE OF K-BRIEFS FOR KNOWLEDGE ACQUISITION IN KBE |

Ivar Marthinusen, Christos Kalavrytinos, Ole Ivar Sivertsen

Norwegian University of Science and Technology, Norway

In Knowledge Based Engineering (KBE), knowledge about a product family is stored in a computer system in order to automate routine engineering work. Two challenges associated with this is acquiring the knowledge from a domain expert, and to make the knowledge visible to the users of the KBE-system. One proposed tool for working with both these challenges is the Knowledge Brief (K-brief). The K-brief is a structured evolution from the A3 thinking of Lean Product Development, and can be used both as a tool for documentation and knowledge acquisition. In order to evaluate K-briefs as a tool, a questionaire is proposed as a tool for data collection during a full day workshop with various stakeholders using a KBE-system.

CHAIR
Klaus-Dieter Thoben

DESIGN INFORMATION AND KNOWLEDGE ACQUISITION AND USE

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7.9

2:00 pm
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3:00 pm

BL27.12

THURSDAY
30
JUL

KNOWLEDGE MANAGEMENT TOOLS AND TECHNIQUES: EXTENT OF USE IN ORGANIZATIONS AND SUPPORT FOR MODULARIZATION |

Daniel Stenholm (1), Monica Rossi (2), Dag Bergsjö (1), Sergio Terzi (2)

(1) Chalmers University of Technology, Sweden; (2) Politecnico Di Milano, Italy

Customers always hold a lot of needs and requirements that are essential to undertake during every design decision. One way to meet these different needs and generate product family members that all have some commonality are by modularization and platform based product development (PBPD). Modularization and PBPD strongly deal with knowledge management (KM) and considerable slice of the knowledge of the company is included in the products and can be reused in the earlier stages of the development.Literature describes several KM tools that have the ability to support organizations in their product development process. Despite organizations recognize more and more knowledge as a strategic lever that can be used and managed, it is not still clear the role of KM as a support for modularization and standardization. Therefore, this paper contributes to the discussion on how knowledge management can serves as leverage for modularization. First, it defines general KM techniques and tools, and by looking at 103 organizations it also shows how well they are used. Secondly, via statistical analysis significant relationships of variables representing the KM tools and modularization are shown.

D
8.1

DESIGN FOR A HEALTHY LIFE (2)

CHAIR
Yong Zeng

3:15 pm
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4:15 pm

BL27.14

THURSDAY
30
JUL

A MULTI-LEVEL ACTIVITY ANALYSIS FOR HOME HEALTHCARE ICT TOOL REDESIGN

Katarzyna Borgiel (1),(2), Merlo Christophe (1),(2), Stéphanie Minel (1)

(1) ESTIA, France; (2) University of Bordeaux, France

When organizations want to innovate in their Information Systems, they often base the new ICT tools on already existing applications. However, each organization is different and has different needs towards the ICT use. The redesign of software requires a lot of resources (people, time, money), and is not always possible. Moreover the transformational link between the user task and the tool will lead to the organizational change, that has to be anticipated in order to promote the integration of the sociotechnical innovation. In this study we therefore sketch the framework of an approach for the management of sociotechnical innovation; including (1) ICT redesign, (2) business process redesign, and (3) user support for the appropriation of change. We develop more particularly the approach of Activity-Artefact Cycle Analysis, based on Activity Theory and Task-Artefact Cycle. Our first results show how the detailed activity analysis can guide to the redesign of existing software. The work presented in this paper is part of a PhD research project in partnership with a home healthcare organization, whose objective is to introduce electronic healthcare record at patient's house.

A COMPREHENSIVE PROCESS OF CARE COORDINATION: A SKIN CANCER APPLICATION

Sonia Boudjemil, Tu-Anh Duong, Marija Jankovic, Julie Stal-Le Cardinal

Ecole Centrale Paris, France

The Care Coordination improvement represents a challenge for the effectiveness and the quality of care delivery. Impacts of the care coordination can be seen on the care assess, patients benefits and healthcare costs. In order to better understand the care coordination process and it is actual support within a hospital, a skin cancer care coordination process was identified. Several analysis have been done: process modelling, identifying information/data exchange and actors participating in this process. Herein, the study gathered the clinical route of 132 patient data, and care providers interviews i.e the dermatologists. The aim of this study is to identify the difficulties and the needs in this process in order to provide to care givers different support tools. At the end we discuss the challenge to define adapted care coordination approach for a given context.

THE COMPETITIVE ADVANTAGE OF USING 3D- PRINTING IN LOW-RESOURCE HEALTHCARE SETTINGS | *Shalaleh Rismani, H.F.Machiel Van der Loos*

University of British Columbia, Canada

Fabrication of medical devices using 3D-printing (3DP) technology can reduce the lack of adequate supply of medical devices in low-resource hospitals. Similar to Information and Communication Technologies (ICTs), 3DP facilities can be established with a low start-up cost and they can leverage the support of existent open-source community. This paper highlights how ICTs implementations have been successful in addressing information management issues in low-resource healthcare setting and from there argues how 3DP can offer similar advantages by providing low-cost medical devices. Three main case studies of 3DP applications are explained in-depth.

CHAIR
Johan Lars Malmqvist

DESIGN RESEARCH METHODOLOGY NEW METHODS AND TOOLS

D
8.2

3:15 pm
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4:15 pm

BL27.13

THURSDAY
30
JUL

DIFFERENCES IN ANALYSIS AND INTERPRETATION OF TECHNICAL SYSTEMS BY EXPERT AND NOVICE ENGINEERING DESIGNERS | *Anne Ruckpaul, Thomas Nelius, Sven Matthiesen*

Karlsruhe Institute of Technology, Germany

A major part of daily work for engineering designers is the analysis of existing products for finding malfunctions and possibilities to improve them. The visual perception and cognition are very important. The paper focuses on differences in the perception and cognition during analysis and interpretation of technical drawing between expert and novice engineering designers. An experiment with 34 subjects, 11 novices and 23 experts, investigates those differences. For observing the input and output parameter of the perception and cognition processes, eye trackers record the point of gaze during the experiment and the subjects verbalise their thoughts. The experiment shows, the interpretation of the system differs significantly. Expert engineers analyse technical systems more in depth, interpreting the embodiment design in the context of the overall system. Novices describe systems on a surface structure of components and its functions and hardly connect the embodiment to the systems context. The findings support the development of methods for guiding novice engineering designers to interpret the embodiment design on the level of the overall system and not only on a surface level.

MOBILE EYE TRACKING IN USABILITY TESTING: DESIGNERS ANALYSING THE USER-PRODUCT INTERACTION | *Moritz Mussgnug, Michael Frederick Waldern, Mirko Meboldt*

ETH Zurich, Switzerland

Today, mobile eye tracking systems have reached a high level of maturity. They are minimal invasive, allow to record a user-product interaction in its real environment and can reliably detect the user's gaze. Hence their implementation in usability testing of physical products promises great potential. This paper investigates whether the application of mobile eye tracking adds value to usability tests conducted by designers. The research question is approached in two steps. First, a laboratory experiment is conducted comparing designer`s analysis of a user-product interaction through videos recorded either from the mobile eye tracking perspective or out of the third-person perspective. Second, different types of mobile eye tracking analyses are applied to usability tests in three case studies. The results of both studies show that compared to the third-person perspective those designers seeing the eye tracking perspective describe a scene significantly more detailed and isolate significantly more causes of problems. Furthermore the application of object-based, sequence-based and visual pattern-based analysis have the potential to uncover relevant users' needs.

HOW WE UNDERSTAND ENGINEERING DRAWINGS: AN EYE TRACKING STUDY INVESTIGATING SKIMMING AND SCRUTINIZING SEQUENCES | *Quentin Lohmeyer, Mirko Meboldt*

REVIEWERS' FAVOURITE

ETH Zurich, Switzerland

Engineering drawings representing machine systems are usually sectional drawings showing the inner mechanical mechanisms. A precondition for understanding such a drawing is to be familiar with the notation of its basic elements. However, in order to really understand how a represented machine system works, additional cognitive processes have to be initiated. This paper presents an eye tracking study investigating how engineers behave while trying to understand such a sectional engineering drawing. The eye tracking data collected during the experiment was analyzed by an approach that for the first time combines the evaluation methods of skimming and scrutinizing sequencing and transition matrix analysis. Based on this procedure, three behavioral patterns have been identified that, if found in a person's eye tracking data, allow drawing substantial conclusions about the cognitive processes run through.

D
8.2

DESIGN RESEARCH METHODOLOGY NEW METHODS AND TOOLS

CHAIR
Johan Lars Malmqvist

3:15 pm
-
4:15 pm

BL27.13

THURSDAY
30
JUL

REVIEWING PEER REVIEW, AN EYE TRACKING EXPERIMENT OF REVIEW BEHAVIOUR

Duncan R Boa, Ben Hicks

University of Bristol, United Kingdom

The quality of peer reviews is a longstanding issue within the Design Society with concerns over the consistency and transparency of reviews raised frequently. Previous research has sought to qualify these concerns by describing the variability of review scores and correlating them with academic's backgrounds. This paper aims to update and advance the current understanding of peer review within the Design Society by characterising review behaviour through the addition of eye tracking. Seventeen academics attending Design 2014 took part in an experiment. The results of the experiment are discussed in this paper with the aim of answering two research questions: do different review strategies exist and what are they? And, do character traits of reviewers affect reviewer strategy? Results confirm findings from previous research, suggesting little has changed since the topic was last reported and that inconsistency remains a problem. However, some of the cause of review inconsistency is potentially explainable through identified review strategies evident from eye tracking data.

D
8.3

USER CENTRED DESIGN CASE STUDIES

CHAIR
Sven Matthiesen

3:15 pm
-
4:15 pm

BL27.3

INTEGRATION OF UNIVERSAL DESIGN PRINCIPLES INTO EARLY PHASES OF PRODUCT DESIGN - A CASE STUDY | *Susan Gretchen Kett, Sandro Wartzack*

Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany

Universal design (UD) is a strategy for designing societal and individual living environments. We outline how its generic guidelines need more concretization to be applicable to product development processes. Although the value of UD is widely known, its potentials are often still left unused. This paper's contribution is to bring UD theory into product development practice by extending the processes that are currently used. Therefore, an appropriate application scenario in mobility and daily needs is proposed. It is proven that this area affects a wide range of users with different requirements and thus has great value for UD. By using the example of a shopping aid, several approaches in creativity can be used in the early phases of product design. Two exemplary methodologies are presented to demonstrate UD integration. We outline that research success can be met in multiple ways. Among other things, we show the integration of UD into systematic product design and the controllability of its value in an ex-ante and accompanying way. Within this process, the holistic view of users will be extendable, e.g. taking sociological, psychological or cultural aspects into account.

CHAIR
Sven Matthiesen

USER CENTRED DESIGN CASE STUDIES

D
8.3

3:15 pm
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4:15 pm

BL27.3

THURSDAY
30
JUL

ANALYSIS OF THE PERCEPTION OF FUTURE DESIGNERS ABOUT USAGE SCENARIO INTEGRATION IN PRODUCT DESIGN (SIPD) | *Marta Royo, Elena Mulet, Julia Galán, Francisco Felip, Carlos García-García*

Universitat Jaume I, Spain

It is expected that in the near future new products that would be able to adapt to different usage scenarios in order be more used will increase. For example, nowadays new modular smartphones are being develop that will be able to adapt to future needs of the user reducing the frequency of substitution of an old product for a new one. The authors argue that this approach could be applied to more products and it could be extended in practice with the appropriate knowledge and methods. The aim of this communication is to analyse the perception of future designers about the advantages of these products. To assess this a workshop has been done in which a smartphone is compared with a modular mobile phone, a new sports bag that adapts to be used in winter and summer is conceptualised and an opinion questionnaire is asked in different phases of the workshop. The conclusions obtained show that they perceive the products that adapt to different scenarios as better in terms of frequency of use, use and saving of materials and adaptability. So, providing appropriate information about this approach opens the designers' minds and make them start thinking about products that can be more used.

DESIGNED FOR, WITH, AND BY KIDS. INTEGRATING CHILDREN'S APPROACH INTO DESIGN TEACHING AND RESEARCH VISUALISATION | *Martin Luccarelli, Mariagiovanna Di Iorio*

Free University of Bozen-Bolzano, Italy

This work addresses the creativity and intuitive approach of children to improve design teaching and research visualisation. Three experiments involving children as user, tester, and informant are presented. Methods and results obtained by each experiment are described herein. Parts of the results are consistent with past research. In particular, children proved to be free from certain creativity barriers observed in students. Other findings are described and discussed. The results of the aforementioned experiences led to the development of two further experiments to target design teaching and research visualisation. The former experience involved undergraduate design students to test the disciplined improvisation teaching method. The latter involved children and researchers to test tangible representation in shared understanding. This last experience highlights certain challenges of the child's role for researchers.

THE ROLE OF THE INNER CHILD IN PROCESS OF DECISION MAKING FOR PRODUCT SELECTION | *Ghazaleh Sepahpour*

Amirkabir University of Technology, Iran

This study explores characteristics and role of the inner child in choosing a product to get some product design specifications desirable for inner child and lead to choose the product. Child ego state or inner child is a state of personality that would like to act like a normal child. It is related to memories saved on brain from childhood. In many cases, desired chosen product among products with similar function is the one which responses well to people's feelings by attracting their inner child. In this case study, 30 people 18 years and older, randomly were asked to answer a questionnaire about cell phone selection criteria. Defining each of ego states role rate in choosing a product indicated that inner child has noticeable role in choosing a product. Considering inner child characteristics and issues of emotions and child's first experiences, whatever is remembrance of good experiences from childhood like plays and pleasure, stories and fantasies, and childhood sense of security can serve as design specifications to attract ones inner child to a product in order to select it among the other products.

D
8.4

DESIGN EDUCATION
DESIGNERLY THINKING

CHAIR
Balazs Vidovics

3:15 pm
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4:15 pm

BL27.4

THURSDAY
30
JUL

UNDERSTANDING THE CHARACTERISTICS BETWEEN DESIGN AND NON-DESIGN BACKGROUND STUDENTS IN PRODUCT DEVELOPMENT PROCESS AND ITS IMPLICATIONS

Chajoong Kim (1), Yeonghun Kim (2)

(1) UNIST, South Korea; (2) Korea Institute of Design Promotion, South Korea

As only technical advancement in the market is not enough to meet increasingly higher expectations of users, companies have tried to take the initiative through multi-disciplinary approach in the product development process. As their influencing the academia, non-design background students are expected to experience innovation through design. However, there has been a lack of understanding of their characteristics comparing to design background students. Therefore, this study aims to find out the similarities and differences between design and non-design background students in the product development process. Through a design course where both groups of students had taken, distinctive characteristics between groups were identified. The key contribution of this study lays a good foundation for the development of design education for non-design background students. The implications and limitations are discussed as well.

INTERDISCIPLINARY LEARNING THROUGH DESIGN ACTIVITIES UNITING FUNDAMENTALS OF ENGINEERING CURRICULUM |

Katherine Kai-Se Fu (1), U-Xuan Tan (2), Tee Hui Teo (2), Gim Song Soh (2), Kristin L. Wood (2)

(1) Georgia Institute of Technology, United States of America; (2) Singapore University of Technology and Design, Singapore

An interdisciplinary design approach is essential to solve critical engineering challenges, yet few eng. curricula cultivate interdisciplinary design thinking, particularly early on. Most fundamentals courses are taught independently, often viewed as isolated subjects. We consider a framework for core eng. subjects, Structures & Materials and Circuits & Electronics, to gauge if proposed design activities can 1) reinforce concepts taught in each course, 2) enable students to see coexistence of both subjects in applications, 3) advance innovation/design skillsets/mindset and 4) increase confidence in solving interdisciplinary problems. To achieve concrete experience and reflective observation of Kolb's model, three design problems are posed to target challenges in energy, aerospace and healthcare. The activities foster deductive learning based on earlier concepts and require their interdisciplinary application. Participants report more confidence with interdisciplinary design projects and better grasp of interdisciplinary requirements in solving technical challenges ($p<0.05$). Positive feedback from instructors/ students indicates attainment of additional desired learning objectives.

DESIGN LEARNING MIND-SETS

Basyarah Hamat (1),(2), Petra Badke-Schaub (1), Ozgur Eris (1)

(1) TU Delft, The Netherlands; (2) Universiti Teknologi Malaysia, Malaysia

It is postulated that students have prevailing mind-sets which influence the performance of their design learning during their university education. These mind-sets - when identified - can be influenced appropriately to augment students' design learning capabilities. In light of this assumption, this paper intends to present insights towards characterizing design learning mind-sets. This will be based on a theoretical framework that involves two main constructs: pedagogy and student's learning approaches. These two constructs are explored through the Approaches and Study Skills Inventory for Students (ASSIST survey) and semi-structured interviews administered to industrial design students. This paper presents the results obtained from one university. Based on examining the ASSIST survey and transcripts of the semi-structured interviews conducted, insights were obtained regarding: 1) the learning approaches that industrial design students deployed; and 2) how learning approaches that industrial design students deployed and pedagogy administered by teachers informs the state of students' design learning mind-sets.

CHAIR
Balazs Vidovics

DESIGN EDUCATION
DESIGNERLY THINKING

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8.4

3:15 pm
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4:15 pm

BL27.4

THURSDAY
30
JUL

APPLYING A COMBINED USER-CENTRED DESIGN APPROACH TO ASSISTIVE SHOPPING TROLLEY DEVELOPMENT IN DESIGN EDUCATION |

Maura Mengoni (1), Roberta Bevilacqua (2), Margherita Peruzzini (1)

(1) Polytechnique University of Marche, Italy; (2) Italian National Institute on Aging (INRCA)

In the field of Ambient Assisted Living, the present research proposes a combined User-Centred Design approach that exploits the strengths of systematic and participatory design methodologies with the final aim to design an assistive device to solve mobility problems of elderly people in crowded environments. The application of the approach allows research to investigate which information gathering technique is more effective for this context of use and to find out competitive AAL solutions for specific target users. The experimentation is carried out by students attending an industrial design course. An experimental protocol is arranged to compare the outcomes from the different stages of the approach application. The scientific contribution of the present work regards both the presented results, that confirm how much effective is ethnography in respect to role-playing and traditional desk research in case of products oriented to special target users, and the educational experiences in the field of AAL.

CHAIR
Jean-François Boujut

DESIGN ORGANISATION AND MANAGEMENT
TEAM ORGANISATION

D
8.6

3:15 pm
-
4:15 pm

BL27.6

PRAGMATIC TEAM COMPOSITIONS IN SCRUM-BASED DEVELOPMENT PROJECTS

Nis Ovesen

Aalborg University, Denmark

Agile Development techniques have become the industry standard in Software Development in the pursuit for better performance. The popularity of these techniques and methods has caused them to slowly spread to other domains. Thus, the aim of this paper is to identify how some of these Agile Development techniques influence the team organisation, when implemented in the development environments of traditional product development companies. A case study of seven companies has been carried out in order to identify and analyse the challenges of composing teams in development environments where the agile process framework called Scrum is implemented. The case study has resulted in the identification of five specific challenges in regard to team composition when implementing Scrum in integrated development environments. The challenges are analysed and discussed and the team organisation of the respective companies are furthermore presented.

D
8.6

DESIGN ORGANISATION AND MANAGEMENT
TEAM ORGANISATION

CHAIR
Jean-François Boujut

3:15 pm
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4:15 pm

BL27.6

THURSDAY
30
JUL

A LONGITUDINAL STUDY OF GLOBALLY DISTRIBUTED DESIGN TEAMS: THE IMPACTS ON PRODUCT DEVELOPMENT | *Thomas Paul Taylor, Saeema Ahmed-Kristensen*

Denmarks Technical University, Denmark

Globally distributing design teams during Product Development is increasingly common across a wide range of industries. Factors impacting the success such as communication, documentation and maintaining a common vision are intensified in comparison to when design teams are co-located. Much of the research towards the impacts on the Product Development process in distributed design teams consists of interviews and observations of short design sessions, with few observational studies focusing on the whole process of Product Development. With the results from a longitudinal observational study and interviews with key members of a project team, this paper investigates the factors impacting the success of Product Development when teams are distributed globally, from the early planning and development phase through to the final testing and refinement. The results indicate an increased requirement for project control strategies during the early phases of Product development to ensure a common vision is maintained throughout the phases of Product Development.

BOUNDARY OBJECTS IN OPEN SOURCE DESIGN: EXPERIENCES FROM OSE COMMUNITY

Claudia Andressa Cruz Affonso, Daniel Capaldo Amaral

University of Sao Paulo, Brazil

The open source design (OSD) is an autonomous community dedicated to design new products, peer-to-peer, and with intellectual property copyleft. Boundary Objects (BOs) are objects to aid on the collaboration and they are used as mediators between the proposals and the repertory of each team member. This concept is consolidated on the tangible world of participatory design, but what about the digital world? How the BO had been used in Open Source Design Communities? This study aimed to investigate this aspect in a specific community named Open Source Ecology (OSE). An exploratory research was realized to identify the OSE Design Phases and the main types of boundary objects used, as well the limitations of their utilization. The results identify a gap: the members of OSE indicate low usage of Boundary Objects but considered them as essential for collaboration. The low usage was justified by complexity. The creation of prototypes or mock-ups would require more design skills than is possible for regular user; finally, the study demonstrates an indication that the proposition and use of specific BOs for OSE is a theme that must be addressed by the design management community.

WORK SAMPLING APPROACH FOR MEASURING INTELLECTUAL CAPITAL ELEMENTS IN PRODUCT DEVELOPMENT CONTEXT | *Stanko Škec (1), Mario Štorga (1), Zlatka Tečec Ribarić (2), Dorian Marjanović (1)*

(1) University of Zagreb, Croatia; (2) Končar - Electrical Engineering Institute, Inc., Croatia

By embracing insights from project management and intellectual capital measurement research fields, basis can be established for development of new performance indicators for monitoring intangible project aspects of individual and team work within the product development context. Focusing on individual and team level of product development projects, data gathering is hampered by constraints of the real organizational environment. Therefore, in this research paper, development of work sampling self-report application is presented which allows data capturing for real-time measurement of intellectual capital elements in a practical and straight-forward way. Preliminary work sampling study was executed in R&D company whose main preocupation is development of the electro-mechanical devices for distribution and transformation of the electrical energy within the energy infrastructure or mass transportation systems. Information about potential trends of particular underperforming values related to the communication and information sharing, innovativeness/ideation and motivation/satisfaction on individual or team level, could provide added value for the project managers and decision makers.

CHAIR
Klaus-Dieter Thoben

DESIGN INFORMATION AND KNOWLEDGE MANAGEMENT SYSTEMS

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3:15 pm
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BL27.12

THURSDAY
30
JUL

DIGITAL REPOSITORY FOR DESIGN KNOWLEDGE REUSE

Mochammad Firdaus (1), Hongwei Wang (1), Hao Qin (1), Yusheng Liu (2)

(1) University of Portsmouth, United Kingdom; (2) Zhejiang University, China

Many companies in the engineering sector are currently facing the challenge of producing accurate documentation which can be reused during design activities in order to support the life cycle of their products. This is a consequence of the process of transformation in the organisation and the industry, due to the fact that reinvention often occurs because people do not realise that they are trying to do what others have finished doing. To meet the need to records richer and more accurate information in order to synchronise the design activities, this research aims to develop a working prototype of the Digital Knowledge Repository for Engineering Designer system. This knowledge repository not only documents the discussions and decisions related to design, but also the sources of information available on the specific design situation. Through a case study, the system highlights the possibility of a complete picture of a positive direction for the future development of a documentary activity, with a focus on the engineering industry.

APPROACH FOR MODELLING KNOWLEDGE MANAGEMENT SOLUTIONS WITHIN THE PRODUCT DEVELOPMENT PROCESS USING THE 'KNOWLEDGE MODELING AND DESCRIPTION LANGUAGE' | *Alexander Laukemann, Hansgeorg Binz, Daniel Roth*

University of Stuttgart, Germany

In the research field of knowledge-based product development, a huge number of knowledge management solutions is available and enjoys high attention in the entrepreneurial environment. In contrast to whole knowledge-intensive business processes, which are partially modelled by means of a modelling language, the importance of a modelled knowledge management solution is not considered yet. A modelled knowledge management solution by means of the Knowledge Modeling and Description Language (KMDL) offers high potential for supporting the product development process. This paper describes an approach for developing product-development-process-specific knowledge management solution models by using KMDL. As a frame of reference, the generic procedure model in KMDL projects, which KMDL provides, has been adapted and optimised. The derived approach is described with several process steps. Finally, the presented approach is critically discussed and the paper ends with a brief conclusion as well as an outlook for subsequent research activities.

DESIGN KNOWLEDGE REPRESENTATION AS AN INTEGRATION OF FUNCTIONAL KNOWLEDGE MODELLING AND DESIGN STRUCTURE MATRIX | *Guo-Niu Zhu, Jie Hu, Jin Qi, Chao-Chen Gu, Ying-Hong Peng*

Shanghai Jiao Tong University, P.R. China

Design knowledge representation has been regarded as a key aspect in design processes, especially at the early stage of conceptual design as it establishes the basis for the subsequent design activities. This paper presents a systematic knowledge representation model called Requirement-Function-Principle solution-Structure (RFPS), in which functional knowledge model (FKM) is proposed to represent the mapping relationships between the function layer and structure layer and to strengthen the design knowledge reuse in conceptual design. By investigating the mapping process, a transformation matrix (TM) is developed to reveal the mapping relations between the function representations and structure parameters and to identify whether the decomposition of the function layer reaches the lowest level. Then design structure matrix (DSM) is introduced to combine with RFPS to enhance the representation of the internal interactions of the function layer and structure component. A matrix transformation algorithm is put forward to facilitate the conversion procedure between TM and DSM. Finally, a case study is presented to demonstrate the proposed approach.

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DESIGN INFORMATION AND KNOWLEDGE MANAGEMENT SYSTEMS

CHAIR
Klaus-Dieter Thoben

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THURSDAY
30
JUL

KNOWLEDGE SHARING IN HETEROGENEOUS DATA CONTEXT: APPLICATION IN PLM

Cong Cuong Pham (1), Nada Matta (2), Alexandre Durupt (1), Benoit Eynard (1), Guillaume Ducellier (2)

(1) Université de Technologie de Compiègne, France; (2) Université de Technologie de Troyes, France

PLM systems have emerged as effective solutions to handle the complexity, heterogeneity and quickly increasing of data. However, the complex dependencies among heterogeneous data is still a big issue to overcome. Querying this type of database is difficult for non-technician users of system. Based on some knowledge sharing techniques, the ontology-based query interface presented in this paper is expected as a good solution to simplify the database interrogation and to enhance the knowledge sharing among users. A query example in PLM domain will be used to illustrate capacities of this interface.

MODERATOR
Marco Cantamessa

KEYNOTE

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4:45 pm
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5:45 pm

MARQUEE

THURSDAY
30
JUL

34 years of ICED
Impact for a better world: conversation on research achievements and challenges about design for sustainability

LUCIENNE BLESSING[1], LAURA HAY[2], KEVIN OTTO[3] AND CASSANDRA TELENKO[4]

[1] *University of Luxembourg,*

[2] *University of Strathclyde,*

[3] *Singapore University of Technology and Design,*

[4] *Georgia Institute of Technology*

ABSTRACT
The global academic community that biannually meets at ICED casts an impressive amount of effort on improving knowledge on design, on developing support methods and tools and, finally, on finding ways to transfer all of this to practice, either via teaching or by direct contact with industry. The debate will focus on evaluating the degree with which this effort is having an impact on industry and society, especially concerning the key issue of sustainability. The question will be discussed under two perspectives. The former has to do with the effectiveness with which our research community is able to develop sound technology transfer strategies. The latter has to do with our capability of intercepting the technological trajectories that have greater societal relevance, and that may benefit from the intellectual insight that comes from design research.

CLOSING SESSION

5:45 pm
-
6:30 pm

MARQUEE

WRAP-UP SPEECH & GREETINGS FROM
Gaetano Cascini and Marco Cantamessa, ICED15 Conference Chairs
Dorian Marjanović, President of the Design Society

CHAIR OF ICED17
ANNOUNCEMENT OF THE 2017 VENUE AND DATES

HEALTHY AGEING | PATIENTS | NEW THERAPIES | SOLIDARITY & RESPECT | NEW MEDICAL TECHNOLOGIES | EFFICIENT HEALTHCARE | DETECTION, DIAGNOSIS & MONITORING | CLIMATE CHANGE | POLLUANT EMISSIONS | QUALITY OF LIFE | CONSUMER PROTECTION | KNOWLEDGE-BASED BIO-ECONOMY | RENEWABLE ENERGY SOURCES | ENVIROMENTAL CHALLENGES | CREATIVITY | EDUCATION & VALUES | NEW EXPRESSIVE PRACTICES | CULTURAL DIVERSITY AND HERITAGE | SOCIAL REVOLUTION | HAPPINESS | LIFE SATISFACTION | SELF ACTUALISATION | HABITS | LIFESTYLE | TRAINING PROTOCOLS | DESIGNING WELLNESS | PHYSICAL & PHYSIOLOGICAL WELLBEING | HEALTH TECHNOLOGY SOLUTIONS | BIOMECHANICS AND ERGONOMICS | BIODIVERSITY | HUMAN ACTIVITIES | CLEANER FUTURE | ENERGY USE OPTIMIZATION | INTEGRATED SOLUTIONS | SUSTAINABLE MANAGEMENT OF RESOURCES | ELECTRIC & HYBRID VEHICLES | CREATIVITY | EDUCATION & VALUES | KIDS' ENTERTAINMENT | CULTURAL DIVERSITY AND HERITAGE | INTERACTIVE MEDIA | RAINBOW | GAMES, TOYS & FUN

THANK YOU!

ICED15
Organising Committee and Staff

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INFORMATION

Don't lose the opportunity to visit EXPO after ICED15.
If you registered to ICED15 before 15th March 2015 and you confirmed your intention to join the EXPO visit, you'll find a complimentary ticket for you and your accompanying persons in your personal envelope.
Those who are interested to purchase further tickets can proceed through the EXPO website:
http://www.expo2015.org/en/tickets

The complimentary ticket are open date, this means that you can decide to organize your visit when it is more convenient for you. **However, it is recommended to confirm the date of your access through the section MyExpo (on EXPO website).** If you need any assistance on this issue, please visit the ICED15 Registration Desk: during every afternoon coffee break our staff will provide you with information and support concerning the Expo visit.

About EXPO

Since 1851, the "World Exposition" fair shows to the world the mankind's technologic development in different fields. This year, Milan hosts this fair dedicated to the theme "Feeding the planet, energy for life". 145 countries and 3 International Organizations show their vision about food culture in the past and in the future, working in a multi-ethnic world to solve the collective food problem. "Expo 2015" is organized in Pavilions and Clusters devoted to food themes and sustainability for the future. ICED15 organizing team has selected for you a path to get a comprehensive overview on the Expo buildings and contents on Friday 31st in the morning. You will have plenty of time to visit the interior of your favourite pavilions in the afternoon and in the evening by yourself with your closest colleagues and friends. This QR CODE contains our advices about conferences, places to eat, clusters to follow and suggested pavilions.

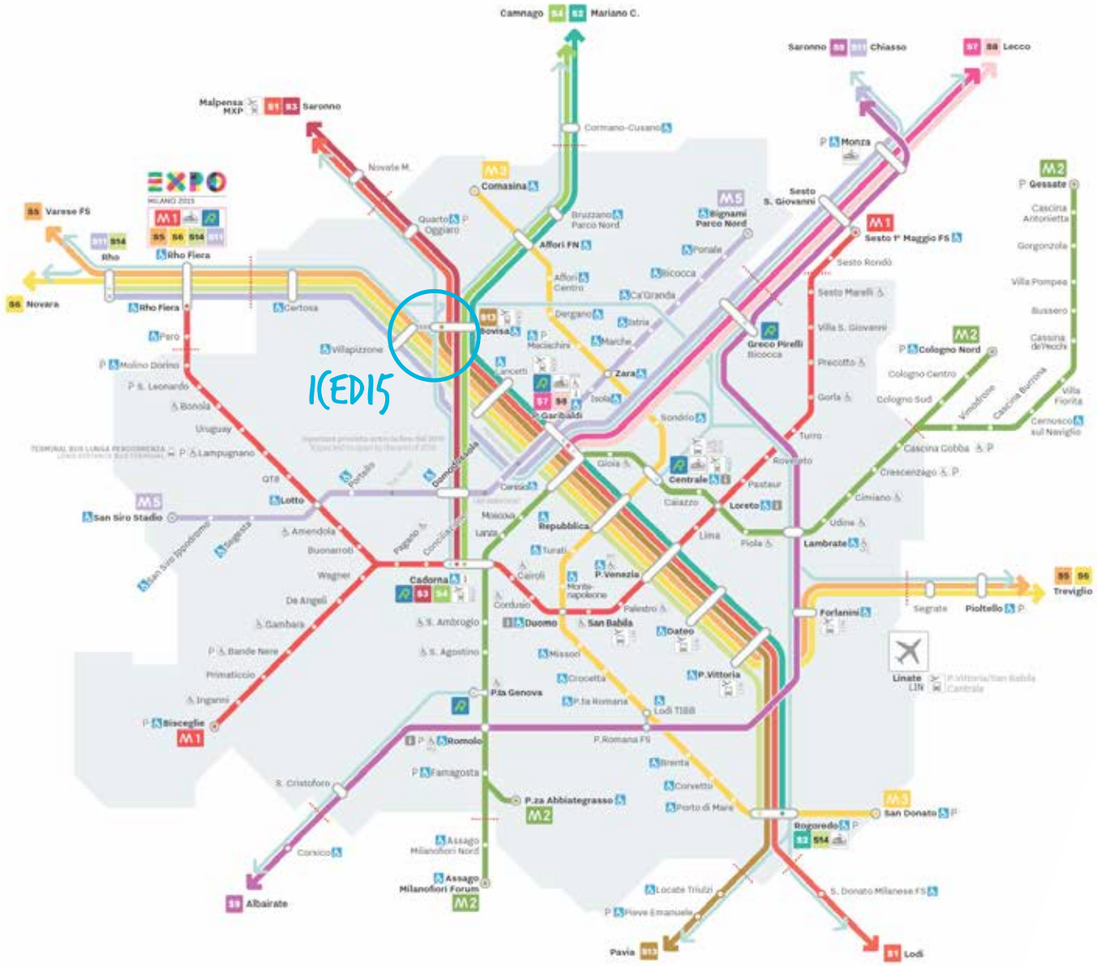
Meeting point and Travelling

Rho Fiera Milano hosts the "Expo Milano 2015" fair. The fastest way to reach the site is travelling by train. We suggest to travel in groups of 50 people maximum. Trains leave from Villapizzone train station, just behind the conference marquee.

MEETING POINT:
Bovisa Campus, conference marquee (plenary sessions), Friday 31st July at 9:00 am.

DEPARTURE (Destination EXPO): Milano Villapizzone train station (5 minutes walking from Bovisa Campus).
TRAINS: eight trains per hour. Tickets will be provided by ICED15 organizing team.
ARRIVAL: Rho Fiera EXPO Milano 2015 train station (2 stops).

We plan to complete the tour around 2:00 pm and get back to Bovisa Campus by 2:30 pm. Those who like to continue the visit can enjoy Expo until 11:00 pm. The last train to Milano Villapizzone is at 11:58 pm. Please consider that for security reasons an ID card or passport is required to access the Expo area and it is not allowed to enter with dangerous objects (as in international airports).



APP
Download the Conference application for Android, iOS and Windows users on www.guidebook.com (code: ICED15).

ATM MACHINES
There are two Cash Machines around the Conference Venue. Check map on p.220 for details.

EMERGENCY SERVICES
Police - Ambulance - Fire Brigade, dial: 112

LIABILITY AND INSURANCE
Neither the Organisers (ICED) nor the Conference Secretariat will assume any responsability whatsoever for damage or injury to persons or property during the Conference. Participants are recommended to arrange for their personal travel and health insurance. Mind your personal belongings (especially laptops, smartphones, etc.) out and inside university! Occasional robbery is at risk.

LOCAL TRANSPORTATION
The Conference Venue can be reached from two stations, Bovisa Politecnico and Villapizzone. Bovisa Politecnico is served with Suburban lines (S1, S1, S3, S4, S13, Malpensa Express). Villapizzone with other two lines (S5, S6). Trains are very frequent during daily hours. You may also download the Apps of Trenord (Suburban lines) and ATM-MI (Public transportation of Milan). To call a taxi, dial +39 026969, +39 024040, or +39 028585.

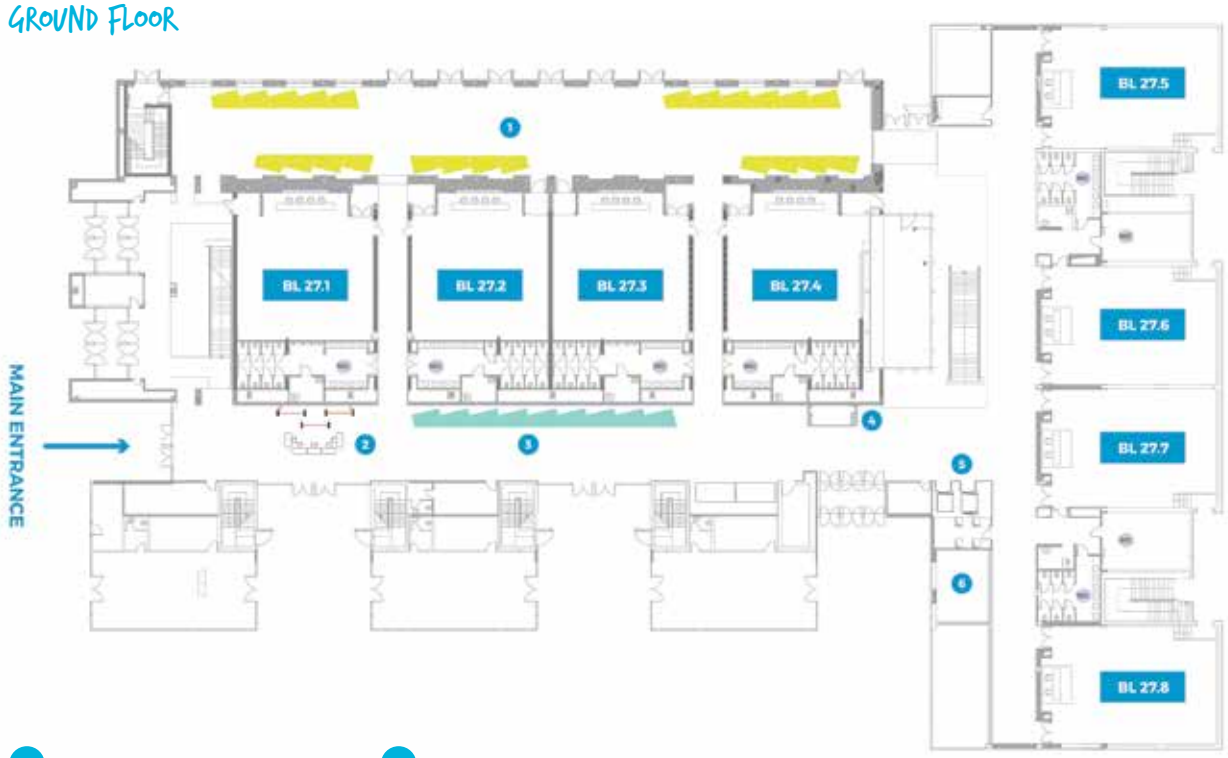
WIRELESS INTERNET
You will find your access to wireless connection (WiFi: eduroam) in your Participant bag. Please mind not to lose it!

CONFERENCE AREA

MAIN CONFERENCE VENUE - BUILDING BL27

Workshop, Podium & Discussion Sessions - ATM - Dining Area

GROUND FLOOR



1. DINING AREA
2. REGISTRATION DESK
3. SPONSOR EXHIBITION
4. ATM MACHINE
5. ELEVATORS
6. PRESENTER DESK

FIRST FLOOR