



DESIGN 2012

May 21 - 24, 2012 Dubrovnik - Cavtat - Croatia

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H. Birkhofer
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BOOK OF ABSTRACTS



12th INTERNATIONAL DESIGN CONFERENCE

DESIGN 2012

May 21 - 24, 2012, Dubrovnik - Croatia

BOOK OF ABSTRACTS

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All the papers submitted for the DESIGN 2012 conference have been reviewed by at least two members of the Scientific Advisory Board.

Authors were asked to submit manuscripts in electronic version. The layout, the figures and tables of some papers did not conform exactly to standard requirements. In some cases the layout of the manuscript has been redone. The readers are therefore asked to excuse any deficiencies, which may have arisen, from the above causes. If you have any difficulty interpreting the text or diagrams, please contact the author who supplied name and address at the end of the paper.

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www.designconference.org

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Faculty of Mechanical Engineering
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The 12th International Design Conference - DESIGN 2012 follows the experience, understanding and research streams from the past DESIGN conference events.

The conference motto "Excellence in Design" has not changed and has become a watermark of DESIGN conference events. With such a call authors have submitted 305 manuscripts for DESIGN 2012 conference. Based on 811 reviews, prepared by the members of Scientific Advisory Board, programme chairs have selected 211 papers to be included in this proceedings. The research reports published in DESIGN 2012 three volume proceedings illustrate the many facets of design, both as an activity and as an outcome.

Design knowledge is founded on academic subjects, but the essence of design is much more, in all it's appearances. Design is the essence of everything produced by humans, from the first stone tools to the modern carbon fibre supercars. It is behind the spark that leads to invention, it is the centre of every production. It is the collaborative endeavour of many and the inspiration of one. Its complexity is often best reflected in the simplest of solutions. Design comes to life only at the end of its journey. And excellent design is one that at the end of that journey changes the lives of others.

We believe in transformative power of excellent design, design that effortlessly ebbs and flows through society, design that shapes the lives of many enabling society to function in a better way, for people to live easier, safer and healthier. Concurrently this same design is a direct answer to demands, albeit sometimes unawares asked by the society in a constant interaction of shaping and reshaping of each other.

No matter which way we look at it, change is the only constant of design. This change can be a radical leap forward shaping our future or a reminiscent pause, reminding us of often forgotten wisdom behind past solutions. The reality of change in technology, environment, demands and expectations is all-too evident. In thirty years since the first DESIGN conference was organised in Zagreb almost nothing is the same. Nothing but the rationale behind engineering and design in the heart of profession.

Changes in product development, methods and tools used in design and manufacturing lead to outcomes that cost less and use fewer materials, demand less energy and human work, all of the time delivering more of the value for the price. Production is becoming vastly more efficient and the cost of labour as a proportion of the total cost of production is diminishing. As a consequence and in opposition to mass production we are witnessing the growth of products designed and manufactured to address individual needs. With this idea in mind partners, developers and customers are coming ever more closely together in order to plan, engineer, manufacture and fulfil vast range of projects.

We are on the verge of new paradigm of "social production", where the borders between engineering and design, production and use are fading. How do we react? How does this influence engineering design methodologies and tools in practice? How is it possible to improve design projects and processes? How can we improve the development of products and services? Which competencies, information and communication technologies are needed? What is the impact on the everyday design work? What social and legal issues should be considered? What are the new advances in design theory and research?

DESIGN 2012 conference provides a unique platform for discussion on these questions. Just browsing through the conference topics can illustrate the fact. That essence of design is what we are trying to research and understand again on the DESIGN 2012 conference.

Dorian Marjanović
Mogens M. Andreasen
Herbert Birkhofer
Steve J. Culley
Udo Lindemann



CONFERENCE VENUE

The conference will take place at the Hotel Croatia CAVTAT.

Registration desk working hours are:

Sunday, 20th May 18:00 - 19:30

Monday to Thursday 21st - 24th May 08:00 - 19:00

SPECIAL EVENTS

MONDAY, 21th May

09:15 - 12:45

INDUSTRIAL FORUM

Congress Hall Ragusa

09:15 - 17:45

CONFERENCE WORKSHOPS

14:15 - 17:45

PHD STUDENTS' FORUM

Congress Hall Ragusa

OPENING SESSION

TUESDAY, 22nd May

Congress Hall Ragusa

09:00-10:15

FACULTY OF MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE WELCOME ADDRESS

Ivan Juraga - Dean FSB University of Zagreb (HRV)

THE DESIGN SOCIETY WELCOME ADDRESS

Chris McMahon - President of the Design Society (GBR)

A WORD BEFORE

Dorian Marjanović – Conference Chair (HRV)

CLOSING SESSION

THURSDAY, 24th May

Congress Hall Ragusa

16:45-17:45

CITATIONS AND THE DESIGN SOCIETY: INVITATION TO AN EXPERIMENT TO EXPOSE OUR COMMUNITY'S RESEARCH RESULTS

McAlloone Tim - Technical University of Denmark (DNK)

CONFERENCE REFLECTION AND CLOSING

Udo Lindemann - Technical University Munich (DEU)

REFRESHMENTS AND LUNCHES

Refreshments and lunches will be served in the Hotel Croatia from 21st - 24th May

SOCIAL EVENTS

MONDAY, 21st May

18:30 - 19:30

Welcome cocktail - Hotel Croatia Terrace

WEDNESDAY, 23rd May

17:00

Excursion to Dubrovnik and

20:00

Conference dinner – Restaurant Klarisa

THURSDAY, 24th May

19:30

Farewell party

FRIDAY, 25th May

09:00

Optional full day excursion. Rate per person EUR 67.

This excursion is NOT included in the conference fee.

Further information on conference reception desk.

GUEST PROGRAMME

Although designed especially for accompanying guests, delegates are, of course, very welcome to attend. Information, schedule and reservations are available at the desk.

Hours	MONDAY, MAY 21				TUESDAY, MAY 22					
08:00	REGISTRATION				REGISTRATION					
08:15										
08:30										
08:45										
09:00										
09:15	D114 INDUSTRIAL FORUM	D111 WORKSHOP 1: IS CREATIVITY A DESIGN-DISCIPLINE OR GENERAL CAPABILITY?	D112 WORKSHOP 2: DESIGNING THE COLLABORATIVE DESIGN SIG	D113 WORKSHOP 3: A BALANCING AND ALIGNMENT OF END USER ISSUES IN PRODUCT DEVELOPMENT	OPENING					
09:30										
09:45										
10:00										
10:15										
10:30					REFRESHMENT BREAK					
10:45										
11:00										
11:15										
11:30										
11:45					D2-P PLENARY SESSION I					
12:00										
12:15										
12:30										
12:45										
13:00	LUNCH				LUNCH					
13:15										
13:30										
13:45										
14:00										
14:15	D124 PHD STUDENTS' FORUM	D121 WORKSHOP 4: A FRAMEWORK FOR DECISION MAKING (PROCESS)	D122 WORKSHOP 5: BENCHMARK POOL FOR SYSTEM STRUCTURE ANALYSIS AND OPTIMIZATION	D123 WORKSHOP 6: EXPLORING FORMS OF OPERATION OF DISTRIBUTED CROSS-INSTITUTIONAL AND CROSS-DISCIPLINARY DESIGN TEAMS	SALON 5 ADOBE SOLUTIONS FOR EDUCATION	D231 DESIGN THEORY AND RESEARCH METHODS				
14:30						D232 EVALUATING COLLABORATION APPROACHES				
14:45						D233 SUPPORTING CREATIVITY				
15:00						D234 MANAGEMENT OF DESIGN PROJECTS				
15:15						D235 ECO DESIGN				
15:30						REFRESHMENT BREAK				
15:45										
16:00										
16:15										
16:30										
16:45						D241 OPEN INNOVATION	D242 KNOWLEDGE REPRESENTATIONS	D243 NOVEL APPROACHES TO COLLABORATION	D244 REQUIREMENTS ACQUISITION	D245 USER EXPERIENCE IN DESIGN
17:00										
17:15										
17:30										
17:45										
18:00	REGISTRATION				WELCOME COCKTAIL					
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19:00										
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19:30										



CONGRESS HALL
RAGUSA

CONGRESS HALL
BOBARA



CONGRESS HALL
ORLANDO

CONGRESS HALL
KONAVLE



CONGRESS HALL
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SALON 5

WEDNESDAY, MAY 23					THURSDAY, MAY 24					FRIDAY, MAY 25	Hours
REGISTRATION					REGISTRATION					FULL DAY EXCURSION (OPTIONAL)	08:00
D311 USABILITY AND BENEFIT OF METHODS - GENERAL REFLECTIONS	D312 MODELS FOR ENHANCED DESIGN TOOLS	D313 EVALUATION OF CREATIVITY	D314 ENGINEERING DESIGN PRACTICE	D315 AESTHETIC-VISUAL IMPRESSION	D411 METHODS IN SYSTEMS ENGINEERING	D412 SIMULATION BASED DESIGN	D413 PRODUCT ARCHITECTURE AND FAMILIES	D414 CASE STUDIES ON DESIGN METHODS	D415 DESIGN EDUCATION		08:15
											08:30
											08:45
											09:00
											09:15
REFRESHMENT BREAK					REFRESHMENT BREAK						09:30
D321 USABILITY AND BENEFIT OF METHODS - EMPIRICAL STUDIES	D322 ORGANISATIONAL MANAGEMENT OF PRODUCT DEVELOPMENT	D323 DATA AND INFORMATION VISUALISATIONS	D324 PRODUCT-SERVICE SYSTEMS	D325 BIO-INSPIRED DESIGN AND ERGONOMICS	D4-P PLENARY SESSION II						09:45
											10:00
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											10:30
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LUNCH											11:00
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D331 DESIGN INFORMATION SUPPORT APPROACHES	D332 SYSTEM MODULARITY AND VARIANTS	D333 DESIGN FOR X	D334 ENHANCED CAE APPLICATIONS	D335 SOCIAL IMPLICATIONS OF DESIGN	D431 ENGINEERING CHANGES AND RISK MANAGEMENT	D432 KNOWLEDGE EXTRACTION	D433 SYSTEMS ARCHITECTURE	D434 FUNCTIONAL REASONING	D435 LIFE SCIENCE AND DESIGN FOR HEALTHCARE		
											16:15
											16:30
										16:45	
										17:00	
EXCURSION TO CITY OF DUBROVNIK AND CONFERENCE DINNER					CLOSING					17:15	
										17:30	
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										19:00	
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										19:30	
					EXCURSION TO CITY OF DUBROVNIK AND CONFERENCE DINNER					FAREWELL PARTY	

D114 INDUSTRIAL FORUM

Chairman: Marjanović Dorian (HRV)

Congress Hall Ragusa

DESIGN 2012 Industrial forum will offer a platform for debate among decision makers, practitioners and academics about the future of design research, needs and expectations from the industry.

Companies that have consistently invested in research and development have been seeing their competitiveness increase. The global operation paradigm has raised new questions. Innovation, sustainability, environmental awareness, social, and governance issues are becoming driving forces of new product development. The design research is maturing into an overall and consistent theory of engineering design, but the results still seem to be used by industrial practitioners in a fragmented manner.

DESIGN 2012 industrial forum will be an opportunity to discuss industrial views, needs and expectations of design research tracing emerging trends in industrial innovation and the right strategies for a sustainable future. The forum will be opportunity for the companies from the region and Europe wide to present academia their research and development capacities and potential to be involved into the future joined projects. Program of the forum is as follows:

09:15-11:00

Presentation of research and innovation potential of the industrial partners
by representatives of the companies (short oral presentation – 10 minutes each)

AVL AST d.o.o., Zagreb, Croatia (powertrain systems)

Brodarski institut d.o.o., Zagreb, Croatia (shipbuilding, safety, environmental engineering, renewal energy)

EADS Innovation Works, Germany (global network of technical capability centres for aerospace and defence sector)

FINI Novo mesto, Slovenia (industrial engineering)

HSM informatika d.o.o., Zagreb, Croatia (cross media publishing and e-business)

INETEC Institute for Nuclear Technology, Zagreb, Croatia (nuclear technology)

Inteco Robotics/INTECO Ltd., Zagreb, Croatia (autonomous robots for hydrodynamic treatment of concrete and metal surfaces)

KONČAR - Electrical Engineering Institute, Inc., Zagreb, Croatia (energy conversion and power transmission)

TPV Group/SiEVA, Novo mesto Slovenia (automotive engineering)

Ziegler d.o.o., Zagreb, Croatia (fire-fighting vehicles and equipment)

11:00-11:15

Coffee break

11:15-12:00

Presentation of the Innovation Horizon 2020 – EU research and development framework for 2014-2020 by Dr. Erastos Filos, Head of Sector Intelligent Manufacturing Systems at European Commission

In late 2008 the Factories of the Future initiative was launched by the European Commission. The initiative aims to support Europe's industry in meeting increasing global consumer demand for greener, more customised and higher quality products by converting to a demand-driven industry with lower waste generation and less energy consumption. Under this initiative the Europe encourages the rapid set up of industry-driven R&D projects for the years 2010-2013 under its 7th Framework Programme for research. The initiative is implemented as a public-private partnership with a particular emphasis on SMEs. Its total budget envelope is €1.2 billion, with more than half of the funds provided by the public sector. The thematic content of the foreseen four annual calls has been elaborated in cooperation with industry and laid down in a multiannual roadmap. The "ICT-enabled Intelligent Manufacturing" part of this roadmap builds on a three-fold concept for ICT-driven factories, namely "smart factories" – based on shop floor optimisation through automation, "virtual factories" – supporting an optimal management of distributed factory assets and "digital factories" – addressing design, simulation across the total lifecycle. Eight R&D projects related to design aspects were selected in 2011 with a total public funding support of EUR 35 million. The talk will focus on first achievements of these eight industry-driven projects and will further provide a perspective for research and innovation in this domain under the Horizon 2020 programme.

12:00-12:45

Round table discussion and results of the Industrial forum summarisation chaired by Prof. Ola Isaksson PhD, Senior Specialist Product Development, Volvo Aero Corporation (SWE)

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D111 WORKSHOP 1: IS CREATIVITY A DESIGN-DISCIPLINE OR GENERAL CAPABILITY?

Chairmen: Badke-Schaub Petra (NLD), Taura Toshiharu (JPN)

Congress Hall Bobara

Creative behavior is an important and interesting topic in design. This workshop aims to create a forum to discuss the characteristics and potentials of creative behavior from theoretical and methodological viewpoints. In particular, the workshop focuses on the question in how far creativity is specific to the particular design discipline such as architecture or is creativity a more general ability serving all kinds of different design disciplines? And if both aspects play a role, is that different for different design disciplines? Answers to this question relate directly to education and the issue to which extent creativity methods need to take into account design-field-specific elements. Two presentations of designers from different fields will provide answers to this question Dr. Thomas Howard (Technical University of Denmark) and Dr. Hernan Casakin (Ariel University Center / TU Delft). After this input, two short (5-7 min) comments of contributions of two other design fields will add further insights: Dr.-Ing. Dipl.-Psych. Bettina Schleidt (virtual product development, TU Karlsruhe, Germany) and Prof. Dr.-Ing. Christos Spitas (embodiment design/ TU Delft). Depending on the number of participants we will then divide the group into small groups for further discussion of those issues which came up in the previous presentations.

D112 WORKSHOP 2: DESIGNING THE COLLABORATIVE DESIGN SIG

Chairmen: Whitfield Ian (GBR), Thomson Avril (GBR)

Congress Hall Orlando

The Collaborative Design SIG is new to the Design Society having been formally established in January 2012. Despite being new, the SIG already has 30 members from 12 countries and all researchers in the Collaborative Design community are welcome to attend the Design 2012 workshop to find out more about the SIG and participate further. Specifically, it will aim to build upon the existing SIG membership and focus towards defining the scope of the SIG. Furthermore, it will provide all those attending the workshop with an opportunity to gain an initial understanding of the specific areas that researchers within the Collaborative Design community are investigating and the particular research problems and challenges that are developing and can be addressed together as a community. The workshop will last three hours and will be scheduled as follows. The first hour will allow all attending the workshop to gain an overview of the research areas being addressed by the SIG chairs and it's International Steering Group (ISG) through brief poster presentations. The second hour will engage all attendees in mapping the scope of the SIG taking account the opinions and interests of the SIG group. During the third hour we will explore key challenges and evolving research problems. The workshop will represent the first stage of designing the Collaborative Design SIG by providing a mechanism for understanding the needs for the members.

D113 WORKSHOP 3: A BALANCING AND ALIGNMENT OF END USER ISSUES IN PRODUCT DEVELOPMENT

Chairman: Vajna Sándor (DEU)

Congress Hall Konavle

Product development has different target groups, among which the end user as target subject is of highest interest. However, the end user is integrated in different environments, e.g. legal, ecological, financial, cultural, which influence the key aspects of the end user's needs, wants, and wishes. It is the aim of this workshop to point out such different influences and to pave a way for a better understanding of their highly networked and intrinsically multi-disciplinary structure.

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D121 WORKSHOP 4: A FRAMEWORK FOR DECISION MAKING (PROCESS)

Chairmen: Le Cardinal Julie (FRA), Wartzack Sandro (DEU)

Congress Hall Bobara

The idea for the SIG workshop at DESIGN CONFERENCE is to create a framework for the field of decision making. This framework consists out of the following essential questions: How can different scientific approaches in the field of decision making be validated? On which level can they be validated and what are the limits of those scientific approaches? What are the consequences of decision making processes and how are strategically decisions connected to engineering decision? How can this complexity of dependencies described? How can different decision making situations be characterised and what are the key indicators for different decision making processes? In order to get into deeper discussion, some short presentations are planned: On one hand, we plan to get oral information about existing methods and tools that support the decision making process. That should help us, to understand the limits of decision making process. For the understanding of the characterization, consequences and complexity of decision making processes, we plan to get on the other hand some case studies from the Special Interest Groups (SIG) Collaborative Modeling, Eco Design and Management of Engineering Processes. Together with our partners from these SIG groups we will have an intensive discussion on applying decision making methods on the case-study decision making processes. Expected outcome of this workshop will be an understanding of chances and limits of existing decision making methods as well as the challenges for further activities on the decision making situation.

D122 WORKSHOP 5: BENCHMARK POOL FOR SYSTEM STRUCTURE ANALYSIS AND OPTIMIZATION

Chairmen: Maurer Maik (DEU), Wynn David (GBR)

Congress Hall Orlando

The importance of structural complexity in engineering design can be seen by applications like product modularization or change management. Most research work concentrates on analysis and optimization of system structures. For example, many clustering algorithms exist for product modularization. Today, acquisition of system structures is not a research focus. However, quality of information acquisition affects possibilities of analysis and optimization. Approaches on analysis and optimization of system structures mostly apply published or self created test structures. Published structures are often unsuitable for the specific context. And application of e.g. a cluster algorithm on self created structures impedes comparison with other algorithms. Whereas standard tests exist e.g. for genetic algorithms, applications in the field of structural complexity can not be benchmarked so far. The SIG develops benchmarks for testing and comparing approaches in the field of structural complexity. Benchmarks are classified by the application context (software, product etc) or optimization objectives (minimum process time etc). The benchmark pool requires adaptations over time. The SIG sets up a process for proposing, approving and implementing these adaptations. Not only benchmark structures, but also analysis/optimization results shall be provided. This allows comparing different approaches. During the DESIGN'12 workshop the state of development of the benchmark pool will be presented. And participants will discuss and decide on details for further implementation.

D123 WORKSHOP 6: EXPLORING FORMS OF OPERATION OF DISTRIBUTED CROSS-INSTITUTIONAL AND CROSS-DISCIPLINARY DESIGN TEAMS

Chairmen: Kovačević Ahmed (GBR), Bohemia Erik (GBR), Fain Nuša (SLN)

Congress Hall Konavle

The purpose of this workshop is to discuss issues associated with distributed cross-institutional and cross-disciplinary design teams. To start exploration and discussions with the workshop participants, these points will be used to stimulate the discussion: How do members of the product development team from different disciplinary areas structure and interpret problems? What are the differences and similarities? How do product development team members from different subject backgrounds approach collaboration? How do organisational cultures impact on the way cross-institutional projects are conducted and their ability to be sustained? What challenges and opportunities do cross-cultural and cross-disciplinary teams provide for product development process and outcomes? How are product development processes managed in globally distributed design teams? How can the formal education of designers, engineers and other professionals be activated for effective engagement in distributed product development enterprises. What new opportunities are the digital technologies opening for 'designers' in areas of interaction, information sharing, communication and creativity? How are translating and transforming of design ideas/proposals from one medium to another affecting designer approaches? How might design processes change in response to these translations and transformations? The workshop will start with the following paper presentation.

• WORKSHOP DISCUSSION PAPER: EXPLORING NEW FORMS OF ONLINE COLLABORATIVE DESIGN

Bohemia E., Blythe M., Cruickshank L., Fain N., Kovačević A., Steane J.
/ Northumbria University (GBR)

391

The purpose of this paper is to initiate discussion and to use it as guide for a proposed workshop on issues in distributed cross-institutional and cross-disciplinary design. In order to do this, we overview issues associated with undertaking design by distributed product development teams. We suggest that many of the challenges are associated with 'distances' on dimensions of time, technology, geography, culture, and discipline. Finally, we outline the proposed workshop activities.

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D124 PHD STUDENTS' FORUM

Chairmen: Langer Stefan Frederik (DEU), Stanković Tino (HRV), Cash Philip (GBR)

Congress Hall Ragusa

Research within the DESIGN 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. Therefore, the DESIGN conference 2012 offers a PhD Forum.

The aims of the PhD Forum are:

- 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 with both PhD students and experts

The forum will be an opportunity for PhD students to discuss their research questions and ideas with experienced researchers, practitioners and R&D managers in order to facilitate their research efforts. Therefore, 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. The participating students will have a short presentation (max. 5 min) of their research on:

- **Research topic**
 - research objectives / question(s) and relevance considering published research and industrial needs
 - research methodology applied
 - current work status
 - expected results and benefits
- **Personal questions (1 or 2) for discussion, e.g.**
 - Research methodology
 - Research methods
 - Potential ideas for enhancing the approach

The PhD Forum is aimed at PhD students participating at the DESIGN 2012 conference. 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.

SUPPORTED BY:



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REFRESHMENT BREAK					10:00	CONGRESS HALL ORLANDO
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D2-P PLENARY SESSION I					10:30	CONGRESS HALL ORLANDO
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LUNCH					12:15	CONGRESS HALL KONAVLE
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D231 DESIGN THEORY AND RESEARCH METHODS	D232 EVALUATING COLLABORATION APPROACHES	D233 SUPPORTING CREATIVITY	D234 MANAGEMENT OF DESIGN PROJECTS	D235 ECO DESIGN	14:00	CONGRESS HALL ŞİPUN
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REFRESHMENT BREAK					15:45	CONGRESS HALL ŞİPUN
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D241 OPEN INNOVATION					16:15	CONGRESS HALL ŞİPUN
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D242 KNOWLEDGE REPRESENTATIONS					18:15	CONGRESS HALL ŞİPUN
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D244 REQUIREMENTS ACQUISITION					19:15	CONGRESS HALL ŞİPUN
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THE PROBLEM OF SOLVING PROBLEMS: TENSIONS, AMBITIONS AND VISIONS IN THE HISTORY OF ENGINEERING DESIGN

Heymann M. / *Aarhus University (DNK)*

Since the 19th century engineering increasingly became an academic discipline taught and further developed in technical schools and universities. Scientific and theoretical ambitions thrived in the new academic profession and prepared for an avalanche of spectacular innovations. But solving engineering problems remained a multifaceted, heterogeneous and difficult task, which could not easily be guided by standardized theories and practices. Quite to the contrary, engineering knowledge proved hard to be fully and adequately described and represented in neat theories (like in physics), taxonomies (like in botany), books (like in philosophy) or paragraphs (like in law). Engineering knowledge comprised many different types of knowledge and information, drew from many sciences as well as from practice and changed and expanded continuously. How did academic engineers attempt to tackle the problem of solving problems in the past and to this day? Many engineers sought to bring order into the complex and heterogeneous realm of engineering knowledge and practice. Some dreamt a holistic dream, pursuing the ambition to solve the problem of solving problems once and forever by shaping comprehensive and coherent design theories. The lecture will trace the challenges of engineering design and attempts to solve the problem of solving problems through 150 years of the history of engineering design. It will show that engineers suffered from and complained about the open character of problems in engineering design and created holistic visions of engineering theory suited to solve these problems.

TECHNOLOGY INNOVATION MANAGEMENT AND DESIGN: AN EDITOR'S PERSPECTIVE

Linton J. / *University of Ottawa, Telfer School of Management (CAN)*

The various roles that an editor plays are offered and described. Insights into the direction that research at the interface between technology innovation management and design is then given. The intent is to assist the researcher better understand the review process, positions research, and to offer a perspective on which areas research seems to be moving towards.

DEMISTIFYING DESIGN THINKING: IMAGES OF A DESIGNERLY APPROACH

Kleinsmann M. / *Delft University of Technology (NLD)*

Recently, many managers and business people adopted Design Thinking as the new paradigm to increase their creative power and to broaden their repertoire of strategies in order to stay competitive and to survive the financial crisis. The design research community received this recent popularization of design thinking with some unease and the concern is that its uncritical deployment in contexts other than design represents a fad rather than a real opportunity for exploration. The discrepancy between these two views was the reason for us to set up a study in which we investigated the role of a designerly approach. There was no comprehensive definition of a designerly approach available. Yet, there exists a comprehensive body of literature on the particular skills and capabilities of expert designers. These formed the base for a card set that we developed consisting of 48 cards with each a drawing and a statement about the designerly approach. These cards enabled rich storytelling and were used while we interviewed our respondents. We interviewed 55 people, all with a proven track record within the field. From the interviews appeared that there was no card that was chosen by all respondents, nor there was a card that was left out by all respondents. So, our study did not bring us towards a definition of a designerly approach. However, what became evident is that the context in which a respondent acted played a major role in how the designerly approach was applied. The rich interviews with vivid stories allowed us to distinguish different images of a designerly approach which I will explain in more detail in my keynote presentation.

Congress Hall Ragusa

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FROM DESIGN RESEARCH TO RESEARCH DESIGN - TRANSFER OF DESIGN THEORY TO NATURAL SCIENCE

Schöfer M., Maranzana N., Aoussat A., Bersano G. /
Arts et Métiers ParisTech / Active Innovation Management (FRA)

1243

Researchers in natural science must create new knowledge in ever more specialized disciplines and at the same time indicate the economic and scientific value of their work. In this article we summarise past work regarding creativity and method application in natural science. Further we point out the need for a model which describes the research process and give indications of promising design theories (e.g. C-K Theory and TRIZ) whose adaption could be useful for this purpose. Finally we give an example for the application of TRIZ tools for facilitating problem exploration in life sciences.

IMPROVING CONFIDENCE IN SMALLER DATA SETS THROUGH METHODOLOGY: THE DEVELOPMENT OF A CODING SCHEME

Snider C. M., Dekoninck E. A., Culley S. J. / University of Bath (GBR)

1253

Content analysis is a valued method of data analysis, used for qualitative and quantitative data. During its use, there are many considerations that must be made to ensure rigour, validity and reliability in results and conclusions drawn. This paper presents several important considerations and how they can be addressed in the context of engineering through the example of a coding scheme for creative designer behaviour. Although important in all cases, careful methodology is vital during preliminary research to provide confidence in results and future research directions that they provide.

AN ANALYSIS OF DESIGN PROCESS MODELS ACROSS DISCIPLINES

Gericke K., Blessing L. / University of Luxembourg (LUX)

171

This paper presents a comparison of design methodologies and process models from nine disciplines. The evolutionary development of the approaches, which can be traced back to similar roots, lead to process models which are now adapted to specific design disciplines but still have many similarities. Most of the established approaches have not been adapted to many of the challenges of current design practice and represent isolated views on the design process. This comparison is intended to provide a basis for consolidation and reformation of design methodology.

INTERPRETING PARAMETER ANALYSIS THROUGH THE PROTO-THEORY OF DESIGN

Kroll E., Koskela L. / Technion - Israel Institute of Technology (ISR)

1233

The parameter analysis methodology of conceptual design is interpreted through the reconstructed proto-theory of design, which draws on the similarity of design and geometrical analysis, as suggested by Aristotle. The notions of the proto-theory are found to create added clarity when applied to this contemporary design approach. Especially, they allow interpreting each of the parameter analysis steps separately in terms of the types of reasoning involved. Also it is clarified that reasoning backwards towards a solution and reasoning forwards towards the proof are integrated into one process.

A CYBERNETIC PERSPECTIVE ON METHODS AND PROCESS MODELS IN COLLABORATIVE DESIGNING

Maier A. M., Wynn D. C., Andreasen M. M., Clarkson P. J. / University of Cambridge (GBR)

233

This article considers the creation and use of design methods and process models from a cybernetic perspective. We suggest that a process model and method are similar in nature, in that they both give guidance for progressing the design according to the circumstances encountered. Cybernetic principles are interpreted to explain the role of modelling and method use in design process evolution. By identifying virtues that support creation and use of methods and process models during designing, cybernetics could help teams to design more effectively.

IDEA – INVENTION – INNOVATION: STRATEGIES, APPROACHES, RESEARCH CHALLENGES

Weber C. / Technical University Ilmenau (DEU)

1265

Since its beginnings Design Theory and Methodology (DTM) has dealt with understanding and supporting (product) innovation. Today, increased innovation activities are paid great attention for many reasons. This article tries to contribute to the discussion about innovation and innovation methods from the perspective of DTM by reasoning about innovation strategies and approaches and by drawing conclusions for research challenges. In contrast to many other contributions, it has its main focus on "incremental innovation", i.e. improving existing products.

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CONNECTING GLOBAL PRODUCT DEVELOPMENT WITH CORPORATE STRATEGY

Hansen Z. N. L., Ahmed-Kristensen S. / *Technical University of Denmark (DNK)*

465

This paper investigates the complications with global product development and how these can be addressed, with special focus on the role of corporate strategy. The research is based upon case studies of six companies involving 35 interviews. The results suggest that global product development need to become an integrated part of the organisation's corporate strategy so that the interfaces of the global task and the structure, processes and procedures in the company to handle these can complement the strategic goal with globalising the product development process.

CHARACTERIZING COLLABORATIVE ENGINEERING NETWORKS

Karvonen I. / *VTT Technical Research Centre of Finland (FIN)*

1055

Engineering is increasingly distributed to different organizations and locations, thus driving for collaborative engineering and enterprise networking. This paper analyses the characteristics of engineering networks based on industrial use cases participating in a Finnish research project studying Future models for digital and global extended enterprises (Fudge). The analysis applies two approaches of previous research, like Collaborative Networks (CN) and Global Engineering Networks (GEN) research to identify the key patterns, characteristics and challenges of engineering networks.

5 SENSES OF INTERACTION - A MODEL FOR CATEGORISING COLLABORATIVE TOOLS AND CREATIVE METHODS

Törlind P., Garrido P. / *Lulea University of Technology (SWE)*

569

Collaborative tools today are not adapted to the real needs of the collaborators, instead the collaborators have to adapt to existing technology. This work explore the designer's behaviour in creative collaborative design meetings and create a graphic approach – 5 senses of interaction which can be used to assess and evaluate interaction needs for a meeting or for assessing an existing collaborative technology. The visual method gives the user a better understanding of the interaction requirements and can be used to find out a suitable collaboration tool.

A STANDARDIZED MEASUREMENT TOOL FOR EVALUATING AND COMPARING TEAM REFRAMING CAPABILITIES

Kress G., Schar M., Steinert M. / *Stanford University (USA)*

513

As designers approach a problem, they form a mental frame that is the scaffolding around which to build a solution. When presented with new information, skilled designers reframe the problem and the solution space; these iterative cycles are central to a successful design process. A team's capacity and willingness to reframe can be measured by means of a standardized assessment tool, providing a reliable and objective means of measuring team effectiveness. We have developed the Stanford Design Thinking Exercise (SDTE) as a quick measure of reframing behavior and capability.

ANALYSING PRODUCT DEVELOPMENT WORKING PRACTICES FOR ENHANCING INNOVATION THROUGH COLLABORATION AND SIMULATION

Galea A., Francalanza E., Farrugia P. J., Borg J. C. / *University of Malta (MLT)*

445

Both stakeholder collaboration and artefact simulation are important for supporting innovation, the first through the availability of more ideas and the latter for analysing the feasibility of these ideas prior to their implementation. However, these topics have not, to date, been considered collectively. Furthermore, it was observed that the use of collaboration tools and simulation tools is still lacking in practice. Thus, there is a need to amplify product development stakeholders' motivation to use these tools with the ultimate aim of enhancing innovation in product development.

ASSUMPTIONS FOR DISTRIBUTED CONCURRENT DESIGN AND DECISION MAKING

Nyström C. A., Olsson H., Asproth V. / *Mid Sweden University (SWE)*

543

This paper identifies and presents assumptions and critical factors for succeeding with Distributed Concurrent Design. The method used, is a brief literature study and experiences based on empirical results in some ongoing projects. Design environment, awareness and trust are identified as crucial for initial success. Furthermore, type of design, initial decisions, representative and empowered team, and the facilitator are important issues. Further research will focus on a project where DCD will be used in collaboration between emergency authorities in Mid Sweden and Trøndelag in Norway.

Congress Hall Bobara

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SOURCES OF CRITICAL SITUATIONS AS CRUCIAL ACTIONS IN DESIGN

da Silva Vieira S. L., Badke-Schaub P., Fonseca T. M., Fernandes A. A. /
Delft University of Technology (NLD)

1851

The fundamentals of this research rely on the need to study designers' behavior to improve designers' performance. The research places in perspective the concepts of the Lean Thinking (LT) as dimensions to study designers behavior in different design disciplines. In this study, the situation of Muda (LT central concept) is seen as sources of critical situations, that can limit but can also increase designers' behaviour and performance if the appropriate actions are taken. The study reports on the sources of critical situations and crucial actions across five case studies in design domains.

ORIGINALITY AND NOVELTY: A DIFFERENT UNIVERSE

Verhaegen P. -A., Vandevenne D., Dufflou J. R. / Katholieke Universiteit Leuven (BEL)

1961

In order to validate and steer the development of ideation methods, in recent years, a number of quantitative metrics were developed aimed at measuring the effectiveness thereof, e.g. novelty and variety. It is shown that different interpretations of the universe of ideas for comparison underlying the novelty calculation are being applied, leading to different results for novelty value. A theoretical discourse discerns between both approaches and identifies the error in approximating the universe of ideas for comparison, while implications on the results are illustrated by means of an example.

MEANING-BASED ASSESSMENT OF TYPOLOGY IN CREATIVE DESIGN

Casakin H., Kreitler S. / Ariel University Center of Samaria (ISR)

1841

The paper explores the role of typology and its relation to creativity in design product and process. The Meaning Theory served to assess the pattern of Meaning Dimensions related to typology. Findings from the regression coefficients between factors of typology and creativity showed that whereas teachers considered Appearance as a main aspect of typologies, students valued Function more. Appearance was related negatively to creativity, whereas Function was related positively to it. Cognitive processes related to the use of typology in creative design are considered for teaching and practice.

EXPERIENCING PROTOCOL ANALYSIS OF COMPUTER-GUIDED DESIGN TASKS

Beccattini N., Borgianni Y., Cascini G., Rotini F. / Politecnico di Milano (ITA)

1821

The paper presents an exploratory study on the chance of using Computer-Aided tools to carry out protocol design tasks, by exploiting an already-existing dialogue-based support for problem setting. The results show that the Protocol Analysis process can be considerably speeded up by suitable computer instruments, thanks to the automation of several phases. A consequent advantage concerns the possibility of performing tests with a higher number of involved designers, so as to obtain statistically sound indications about individuals' reasoning and the constraint posed by computerized systems.

DESIGNING FOR UNREVEALED VALUES

Mekhilef M. / University of Orleans (FRA)

1903

This paper addresses the issue related to the apparent inadequacy between the user needs and the technological solutions provided by the industry in the area of cars' safety systems. The objective is to understand what matters for the consumer beyond the monetary value, what makes him/her buying an additional safety solution, and how to provide designers with a comprehensive set of requirements in order to secure the buying decision. The study covers a) an understanding of the concept of value, its components and the interactions between the values b) the methodology that gathers the product potential characteristics from which we derive recommendations for the designers.

SEARCHING FOR INSPIRATION DURING IDEA GENERATION: PICTURES OR WORDS?

Cardoso C., Gonçalves M., Badke-Schaub P. / Delft University of Technology (NLD)

1831

In design, looking for inspiration is a frequent activity, designers being quite sensitive to various types of external stimuli, especially visual representations in their surroundings. In this paper we argue that despite the attractiveness, memorability and accessibility of pictorial stimuli designers so often prefer, creativity is about diversity and this should expand to the sources of inspiration one searches for. Our study expands on previous research by exploring the role that different representation modalities, such as textual stimuli, might play during creative idea generation.

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NUCLEOCYCLE - THE BUILDING BLOCK OF PROCESS MODELS

Sadlauer A., Hehenberger P., Zeman K. / *Johannes Kepler University Linz (AUT)*

289

This paper presents a micromanagement method for product design that is based on the problem solving cycle of VDI 2206 with the distinction between executing agents and managers. The method addresses their respective tasks and duties in two different building blocks that (in combination with a control bus) allow the inclusion of the lowest hierarchical levels in process models. This work includes modeling guidelines for the arrangement of such building blocks adapted from business process models, discusses the application within matrix structured organizations and provides a case-study.

DECISION-MAKING AND FEEDBACK AS FOCI FOR KNOWLEDGE-BASED STRATEGIES SUPPORTING CONCEPT DEVELOPMENT

Marini V. K., Ahmed-Kristensen S. / *Technical University of Denmark (DNK)*

61

Prior studies revealed the incompleteness of information from early phases for current methods for robustness, reliability and safety. A longitudinal study was performed to describe the influence of design decisions and feedback during the concept development activity. For that purpose, it discusses strategies to evaluate and mitigate failures in solution alternatives. Results demonstrate: the need to support the evaluation of several options; the failure of current practice to avoid the repetition of flaws; and, the need to address decision-making and feedback with knowledge-based support.

TARGET VALUE DESIGN

Ballard G. / *University of California Berkeley (USA)*

11

The applicability of product development managerial innovations such as target costing, concurrent engineering and supply chain management to construction projects has not been adequately evaluated. This paper is a contribution to that evaluation, presenting results to date of applying an adaptation of target costing and other management practices in construction. Among the results achieved are outturn costs consistently below market and cost estimates that fall as design becomes more detailed, both anomalistic to conventional construction project management.

A COMPREHENSIVE EMPIRICAL APPROACH FOR DETERMINATION OF SUCCESS FACTORS OF PRODUCT DEVELOPMENT PROJECTS

Wörz U., Göhlich D. / *Technical University Berlin (DEU)*

133

Goal of this engineering design research study is to obtain a better understanding how product design is influenced by certain factors. A new method is proposed which is currently applied to 50 power generation equipment projects. The approach suggests that the success of a product development process can be modelled as a matter of cause and effect. By quantifying all causes and the effect and performing a hypothesis check, the relevant success factors can be identified which contribute in particular to successful product design.

CRITERIA FOR EVALUATING THE SUCCESS OF LARGE-SCALE ENGINEERING PROGRAMS

Steuber M., Oehmen J. / *Massachusetts Institute of Technology (USA)*

103

The success framework describes performance aspects of large-scale engineering programs. It consists of 26 metrics in 5 categories. They are: 1. Enterprise strategy alignment, 2. Performance and quality, 3. Learning and change, 4. Process quality and efficiency, and 5. Financial and business success. It adds to the current literature accounting for added complexity and uncertainty when progressing from the project to the engineering program level. The findings are based on an extensive literature review and validation through an industry focus group.

TECHNICAL-COMMERCIAL INTERFACE - A BASELINE FOR SUCCESSFUL NEW PRODUCT DEVELOPMENT

Fain N., Kovačević A., Fairbairn J. / *City University London (GBR)*

33

The paper reports on a joint industry-academia project, aiming at integrating functions involved in New Product Development (NPD) for a faster and more effective commercialization of innovation. The project is currently in the testing stage, so the authors are reporting on the analysis and model proposal stages of it. The major purpose of this paper is to emphasise how theory can be translated into practice and what challenges arise from such processes.

Congress Hall Konavle

SESSION D234

21 May 2012
Monday

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23 May 2012
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IDENTIFICATION AND SELECTION OF ECO-INNOVATIVE R&D PROJECTS IN COMPLEX SYSTEMS INDUSTRIES

Cluzel F., Yannou B., Millet D., Leroy Y. / *Ecole Centrale Paris (FRA)*

767

An eco-innovation process is proposed to identify and select at a strategic level and with limited time and resources eco-innovative R&D projects for complex industrial systems. First, an eco-ideation stage is performed with a multidisciplinary working group. Then the group qualitatively assesses the projects with a multicriteria approach that takes into account the individual expertise on each topic. An application is proposed on complex electrical substations. It is further validated according to its ability to generate R&D ideas in terms of their quantity, quality, variety and novelty.

INTRODUCTORY APPROACH FOR SUSTAINABILITY INTEGRATION IN CONCEPTUAL DESIGN

Thompson A. W., Hallstedt S., Isaksson O. / *Blekinge University of Technology (SWE)*

1151

This work introduces an approach for how to develop and put into use sustainability criteria in conceptual design by utilizing a set of sustainability principles as design boundaries and aligning sustainability criteria throughout each of the steps of a generic design cycle. This addresses two problems: 1) sustainability criteria are not robust enough, while sustainability principles are seldom directly applicable for use in requirements specifications, and 2) in an operative design situation, there is little or no time and data available to undertake the work to integrate sustainability.

TOWARD UNIFIED ENVIRONMENTAL ACTIVITIES IN ENTERPRISE

Zhang F., Zwolinski P. / *University of Grenoble (FRA)*

1205

This paper classifies some eco activities in different companies' corporate functions. Two main categories are identified: one for eco activities contributing to the global performance development and one for eco activities contributing at the product level. It is shown that coordination between those categories has to be developed to increase the whole company eco efficiency while accelerating the identification and the integration of suitable eco design activities. Requirements for a systematic analysis model to consider the relationships among different eco activities are identified.

COMPARISON OF ENVIRONMENTAL CHARACTERISTICS OF FUNCTIONALLY EQUIVALENT DEVICES BY WEIGHTED PRODUCT METHOD

De Napoli L., Rizzuti S., Rocco C. / *University of Calabria (ITA)*

777

The paper proposes to perform a sustainability benchmark among different solutions, related to functionally equivalent devices, by means of the Weighted Product Method on the basis of seven EPIs. Among the MCDM techniques, WPM is employed for its simplicity and low efforts of computation. The procedure is presented, discussing the main steps of the methodology that designers have to follow. The assignment of the weights is suggested as a liberal choice of the design team and a specific subsection is dedicated to the exceptions during the WPM run. The method is applied to a case of study.

ECO-DESIGN FOR MICROELECTRONIC PRODUCTS: MEASUREMENT AND INTEGRATION OF ENVIRONMENTAL CRITERIA FOR PACKAGE DESIGN

Villard A., Petit L., Lelah A., Brissaud D. / *G-SCOP Grenoble (FRA)*

1177

This paper presents an eco-design tool, dedicated to designers of packages for microelectronic components. The tool aims to increase designers' environmental consciousness and to drive them to explore innovative opportunities. It has been developed in close collaboration with a design team so as to help designers in developing and integrating their own eco-design approach. The environmental evaluation is based on life cycle assessment (LCA) and parametric models are integrated to assess "Quick-LCA" and so predict the future environmental impact of new packages.

A LIFECYCLE DESIGN APPROACH TO ANALYZE THE ECO-SUSTAINABILITY OF INDUSTRIAL PRODUCTS AND PRODUCT-SERVICE SYSTEMS

Favi C., Peruzzini M., Germani M. / *Università Politecnica delle Marche (ITA)*

879

Lifecycle design are widely used in industry to support designers in product development and to give them a tangible value in terms of efficiency and costs. Nowadays, the growth of product-service systems enlarges the product boundaries and change the design perspectives. This paper uses the lifecycle design approach to understand the eco-sustainability of product-service systems and compares them with traditional industrial products. The method follows the LCA approach and exploits LCA and LCC indicators to estimate and compare eco-sustainability for product and product-service solutions.

ON THE USE OF DESIGN THEORIES TO SUPPORT INNOVATION AND ORGANIZATIONAL PROCESSES

Kazakci A. O., Le Masson P. / *Mines ParisTech (FRA)*

201

The paper considers the ongoing debate about the utility of general design theories. We defend the idea that design theories allow modeling design strategies, thus facilitating their elicitation and revision. Through a case study, we illustrate the use of several such models that have been helpful in diagnosing and improving the overall innovation process. The discussion is placed within the broader literature about the roles of models in organisations.

UTILIZATION OF OUTSIDE-IN INNOVATION INPUT FOR PRODUCT DEVELOPMENT

Kain A., Kirschner R., Lindemann U. / *Technical University Munich (DEU)*

191

Open Innovation makes the company's border permeable for knowledge exchange. However transferring Open Innovation input into the company (outside-in innovation) and applying it in product development poses the problem of processing it specific to the needs of the recipients. To utilize outside-in innovation input in product development we contribute a process-related approach consisting of the steps (1) Collection, (2) Operationalization, and (3) Substantiating Results. We validate the approach and especially step 2 in an empirical case study together with industry.

PROPOSAL OF A RADICAL INNOVATION PROJECT SELECTION MODEL BASED ON PROOFS OF VALUE, INNOVATION, AND CONCEPT

Zimmer B., Yannou B., Stal-Le Cardinal J. / *Ecole Centrale Paris (FRA)*

141

This paper presents a selection model of an innovative idea, concept or project, based on the three proofs of value, innovation and concept which are one of the basis of the Radical Innovation Design® methodology. It is used to evaluate the potential for success of an innovation in the market by a manager in a company, or by a jury of experts in an innovation contest. This selection model is applied on an actual innovation contest for developing new products and services for ageing people. The jury experts acknowledge that this model helps to get a common view of the innovation potentials.

STARTING UP NETWORKED INNOVATION PROJECTS

Maurer C., Valkenburg R. / *The Hague University of Applied Sciences (NLD)*

241

Networked innovation, the collaboration of companies as partners, is increasingly put forward as a potential means to boost innovation. Yet, still little is known about the way networked projects actually carry on. In a study within a long-term research project, nine companies were interviewed about their motivations to engage in networked innovation, finding partners and how to start a collaborative project. The paper compares the expectations of a company to the actual unfolding of a project and identifies factors that seem to be influential, but are yet underrated.

OPEN DESIGN AND CROWDSOURCING: MATURITY, METHODOLOGY AND BUSINESS MODELS

Howard T. J., Achiche S., Özkil A., McAloone T. C. / *Technical University of Denmark (DNK)*

181

This paper describes how Crowd sourcing is now a mature field and how it can and should be used to support innovation and product development. The paper then explores the new paradigm of Open Design (open source hardware) which is a product-business design strategy that promotes the free sharing and distribution of product blueprints rather than their protection. Open Design has proven potential for social innovation but we ask whether it is a viable 'for profit' strategy. A descriptive model of the Open Design process is proposed along with several revenue creation strategies.

DESCRIPTIVE MODEL FOR INTERPRETING INNOVATIVE DESIGN

Zhang Q., Deniaud I., Caillaud E., Baron C. / *INSA de Strasbourg (FRA)*

343

The complexity and uncertainty of innovative design require a comprehensive model to understand the process. In this paper, we introduce a descriptive model of innovative design. We construct the basic model of innovative design based on the FBS model. Referring to the chained-linked model and the creative problem process model, our model is extended to locate innovation in this process. Further, the designer and the environment spaces are introduced into this model, in order to consider the external and internal factors affecting the success of innovative design.

Congress Hall Ragusa

SESSION D241

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PARTBOOK - A SOCIAL MEDIA APPROACH FOR CAPTURING INFORMAL PRODUCT KNOWLEDGE

Gopsill J. A., McAlpine H. C., Hicks B. J. / *University of Bath (GBR)*

1435

There is a gap within the current capability of engineering companies' information system infrastructure where there is no system that currently captures, manages and shares the full scope of informal engineering communication. This paper presents an overview of the research being undertaken to create a social media tool for the capture, management and sharing of informal engineering communications. The focus of the paper is on the social media approach being taken and demonstrator system being used to evaluate and validate the underlying framework.

THE USE OF DESIGN REPRESENTATIONS FOR DESIGN COMMUNICATION: INSIGHTS FROM PRACTICE

Özçelik Buskermolen D., Terken J. M. B. / *Eindhoven University of Technology (NLD)*

1535

This research aims to reveal the factors which motivate designers to use particular design representations in their communication with different stakeholders. The study describes the types of design representations preferred by designers, why they prefer to use certain representations for certain goals and audiences and how they tend to use them in their practice. The collected insights are used to derive requirements for future tools and methods for design communication, as they represent the concerns of the designers who will be the users of these tools and methods.

PATTERN-BASED INTEGRATIVE DESIGN OF MOLDED INTERCONNECT DEVICES (MID)

Dumitrescu R., Gaukstern T., Jürgenhake C., Gausemeier J., Kühn A. / *University of Paderborn (DEU)*

1415

In this contribution we introduce design pattern for the development of electromechanical parts, which we call mechatronic integrated devices. The patterns describe design features for product requirements and MID-manufacturing restrictions in an integrative manner. They contain design characteristics, possible product functions and process restrictions. For the identification of the patterns we have analyzed existing successful MID-applications. We also demonstrate briefly how those patterns support the development of a new sensor platform.

A REFLEXION ABOUT REVERSE ENGINEERING FOR DMU MATURITY MANAGEMENT

Herlem G., Adragna P.-A., Durupt A., Ducellier G. / *Université de Technologie de Troyes (FRA)*

1455

Reverse Engineering (RE) of mechanical parts consists in creating a 3D virtual model using data that are often gathered by 3D measurement systems like laser scanners. The purpose is to make maintenance or redesign operations easier. Because of on-field maintenance, a long time running in-use product may not reflect its Digital Mock-Up (DMU) anymore. To maintain an efficient product lifecycle, this paper focuses on a knowledge-based RE methodology to support the DMU maturity management: to identify the maturity defaults, which correspond to unreported changes, in the CAD assembly model.

KNOWLEDGE SHARING IN PRODUCT DEVELOPMENT - EXPLORING THE EFFECTS OF POWER STRUGGLE AND TASK CONFLICT

Karlsson A., Lund K. / *Sandvik Coromant (SWE)*

1485

For organisations striving towards generating innovations, creating and sharing new knowledge are central activities. This quantitative study analyses the relation between organisational factors, such as power and territorial struggles, trust and lack of time with intensity of knowledge sharing. Results show that neither trust, i.e. handling conflicts and opposing views openly, nor existence of power and territorial struggles or lack of time significantly affect knowledge sharing. However, important predecessors are affected by lack of time and how long time employees have been employed.

A FRAMEWORK FOR REACHING COMMON UNDERSTANDING DURING SKETCHING IN DESIGN TEAMS

Nik Ahmad Ariff N. S., Badke-Schaub P., Eris O., Suib S. S. S. / *Delft University of Technology (NLD)*

1525

This study investigates communication processes during sketching in design teams on theoretical and empirical levels, and propose two frameworks. First, the design-communication block framework, categorizes activities during sketching, and constitutes analysis scheme for empirical dimension of the work. Second, a framework for reaching common understanding during sketching in teams. Main finding are detailing, explaining and transferring activities make ideas more concrete, understandable and transferrable. Also, when verbal communication is blocked, the distinction between drawing activity and findings become even clearer.

SESSION D242

Congress Hall Bobara

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MULTIMODAL INTERACTION, COLLABORATION, AND SYNTHESIS IN DESIGN AND ENGINEERING PROCESSING

Wendrich R. E. / *University of Twente (NLD)*

579

The introduction of CAD in design and education created simultaneously a user-experience void along with a user- interaction gap. Consequently this often leads to frustration, time loss, problem reduction, mediocrity in solution and creativity. We present a hybrid tool approach to stimulate and intuit interaction, ideation and creative processing based on distributed cognition, physical interaction and assisted by computational processing and synthesis. As a bonus we will show that to process in a hybrid way the user experience will be enhanced, motivation stimulated and trigger enjoyment.

A FRAMEWORK FOR DOMAIN ALLOCATION IN EARLY PHASES OF INDUSTRIAL PRODUCT-SERVICE SYSTEM DESIGN

Köster M., Sadek T. / *Ruhr-University of Bochum (DEU)*

1331

The possibility of mutually interchange products and services complicates the development of an industrial Product- Service System (IPS²) that meets the requirements in an optimal manner. In this contribution, challenges concerning IPS² domain allocation during the conceptual design phase are discussed by using an IPS² specific issue in the micro manufacturing industry. Furthermore, a framework of an IPS² domain allocation method is presented. This method helps both, to structure the problem and to systematically determine and analyze product and service components and their interdependencies.

BENEFITS OF THE USE OF VIRTUAL ENVIRONMENTS IN PRODUCT DESIGN REVIEW MEETING

Aromaa S., Leino S. -P., Viitaniemi J., Jokinen L., Kiviranta S. / *VTT Technical Reseach Centre of Finland (FIN)*

355

Design reviews are important milestones within a product development process and efficient tools for sharing information about the product. By using Virtual Environments (VEs) in the review meetings it is possible to gain new benefits and make the reviews more efficient. This paper describes the benefits of the use of VEs in the design review meetings by investigating two industrial cases. Benefits are classified in three different categories based on findings: (1) VEs; (2) design, and (3) business. Relations between different types of benefit categories are also represented.

SENIORPRENEURSHIP AS AN OPPORTUNITY FOR SUPPORTING SCIENCE AND TECHNOLOGY TRANSFER AT UNIVERSITIES

Gaus O., Neuschel B., Raith M. G., Vajna S. / *Otto-von-Guericke-University Magdeburg (DEU)*

1987

The paper examines how on the one hand the generation of entrepreneurs 50+ should be addressed in order to raise their interest for improving their skills and on the other hand how young entrepreneurs and students can profit from the seniorpreneurs' expertise in production processes and market knowledge as well as from their networks. To promote the promising synergies arising from the collaboration of young and elderly entrepreneurs the Otto-von- Guericke-University Magdeburg in Germany initiated a project that combines an integrated product development with business plan design support.

A TESTBED FOR STUDYING VENTURE DESIGN TEAMS IN EMERGING MARKETS

Sonalkar N., Mabogunje A., Parmar V., Cannon D., Leifer L. / *Stanford University (USA)*

561

Research on design teams engaged in entrepreneurial activity is rare. There is little understanding of how design teams that found ventures behave when they are engaged in both product design and venture creation. This paper presents the design of testbeds to study venture founding teams in emerging markets. Four aspects of testbeds – physical space, product based learning approach, coaching paradigm and regional networks are described with reference to two operational testbeds in India and Nigeria. A multi-level research approach to conducting studies in such testbeds is outlined.

RETAIL DESIGN: A NEW DISCIPLINE

Christiaans H. H. C. M., Almendra R. A. / *Delft University of Technology (NLD)*

1893

This paper has the aim to address Retail Design as a new research and education discipline that because of its multidisciplinary asks for a holistic approach. The term 'retail design' encompasses all aspects of the design of the physical store as well as, in a technological sense, a virtual store. The presented case from education with students shows that industrial design students are quite well equipped to design concepts for a retail design environment. However, they miss the experience yet to satisfy the two paradigms for retail design regarding an innovative strategy and solution.

Congress Hall Orlando

SESSION D243

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STANDARDIZED REQUIREMENT ACQUISITION THROUGH CLUSTERING: A TOOL FOR ENERGY-EFFICIENT PRODUCTS

Rath K., Röder B., Birkhofer H., Bohn A. / *Technical University Darmstadt (DEU)*

1081

This paper presents a tool helping designers acquiring requirements for the development of energy-efficient products. Therefore, based on the requirement-cluster approach for an optimized and complete requirement acquisition, a requirement-cluster catalogue has been created, structuring the energy-efficiency requirements for products derived out of environmental laws and labels. Besides the description of the relevant steps needed to create this requirement-cluster catalogue, this paper shows application possibilities of a potential energy-efficiency cluster-tool.

CONCEPTUAL AND PRACTICAL USER INTEGRATION INTO THE DESIGN PROCESS - A FOUR STEP STAKEHOLDER APPROACH

Agrawal V., Vaidya A. R., Shluzas L. A., Steinert M., Katila R. / *Stanford University (USA)*

705

This paper examines user interaction for the design and development of complex products and systems. We first present a literature-based comparison between artistry inspired (Schön-type) versus science inspired (Simon-type) design methods. We then discuss the conflicting notion of users in these methods, and the importance of selecting the "right" users. To evaluate stakeholders with a high degree of influence over product adoption, we propose the Design Stakeholder Identification, Assessment and Ranking Framework, which may be applied across industries involving a network of stakeholders.

HOLISTIC LIGHTWEIGHT DESIGN FOR FUNCTION AND MASS: A FRAMEWORK FOR THE FUNCTION MASS ANALYSIS

Posner B., Keller A., Binz H., Roth D. / *University of Stuttgart (DEU)*

1071

Holistic design for function and mass and thus for lightweight implies respecting mass as an optimisation criterion as well as respecting the distribution of mass and the resulting mass moment of inertia. In the state of the art of lightweight design and design methodology there is no method which holistically respects the mass as optimisation criterion and which supports the designer in setting up goals for the mass of a product. To close this gap, the paper presents a framework for a new method for holistic design for function and mass which is called the Function Mass Analysis (FMA).

THE FUNCTIONS OF THE DESIGN BRIEF

Read D., Bohemia E. / *Northumbria University (GBR)*

1587

We will aim to discuss the potential role a design brief can play in relation to design results. We will firstly outline design briefs roles; functions and contents. Then we will use a case study of an international student design project to contextualise how briefs informed progress and development of design concepts. The discussion will include reflective accounts from the students and provide insight as to how the design brief may unify understanding among teams. Finally the paper will discuss how the concept of fixation and the level of in a brief may limit the possibilities of a project.

MODELING OF THE FAILURE PROPAGATION OF AN ADVANCED MECHATRONIC SYSTEM WITHIN THE SPECIFICATION OF ITS PRINCIPLE SOLUTION

Dorociak R., Gausemeier J. / *Heinz Nixdorf Institute, University of Paderborn (DEU)*

807

The assurance of the reliability of mechatronic systems is very challenging. There is a need for reliability analysis methods, which are used from early on. The main reason: the later failures are discovered, the more does it cost to eliminate them. In this contribution, an extension of the method for the description of failure propagation of an advanced mechatronic system within its principle solution is presented. The extension is inspired by the state-of-the-research Dynamic Fault Tree framework. The case study is the innovative autonomous railway vehicle RailCab.

TOWARDS AN INTEGRATION OF SUPPLY CHAIN REQUIREMENTS INTO THE PRODUCT DEVELOPMENT PROCESS

Brosch M., Beckmann G., Krause D. / *Hamburg University of Technology (DEU)*

23

Various factors and an increase of the product variety leads to an increase in complexity both at the level of product and the level of the supply chain design. A study has identified the need to integrate the supply chain requirements into the product development. This paper describes an approach which closes this gap. The approach is divided into six different blocks, the analysis of the supply chain, the identification of complexity, the capabilities of the supply chain stations, the requirements of the requirement engineering, the evaluation of complexity and the knowledge management.

SESSION D244

Congress Hall Konavle

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EFFECT OF INFORMATION ASSIMILATION ON PRODUCT EVALUATION

Kim S. K., Cho Y. I., Niki K., Yamanaka T. / *University of Tsukuba (JPN)*

1301

This study investigates if information assimilation affects product evaluation considering various factors of product, and Reality Sets (Uninominal-Binominal). Car images are used as stimuli. The experiment consists of item screening and product evaluation. Subjects are participated in both. Item screening aims to select subjectively preferred/non-preferred images per subject. The selected images are reconciliated and used as stimuli in product evaluation. The findings show that information assimilation by Reality Sets influences product evaluation differently.

EXPLORING USER NEEDS IN AUTOMOBILES

Normark C. J., Gkouskos D. / *Lulea University of Technology (SWE)*

1369

This study aims to present an alternative method for capturing the user's needs and experiences of in- vehicle human machine interfaces. For this purpose, a set of workshops and a repertory grid technique was employed. The combination was tested with a sample of ten participants. Preliminary results indicate that the combination of the workshop and the repertory grid methods have a strong potential to effectively capture users' needs as well as highlight important factors that affect the users' perceptions regarding in- vehicle interactions.

A PRODUCT DESIGN METHOD PROPOSAL FOR BABIES' PLAY AND LEARNING

Monsalve J., Maya J. / *EAFIT (COL)*

1351

Literature regarding design for children is considered limited; there is not a procedure available in accessible literature specifically addressed to design for babies' play and learning. A bachelor graduation project brought as a result a systematically recorded product design method proposal for babies play and learning; in addition, the project undertook the "development of a playful system to support baby swimming and to assist the process of strengthening parent's and babies' emotional link with babies from 6 to 24 months old" in order to validate in a certain extent the method proposal.

PRODUCT EXPRESSION AND SELF-CONSTRUAL: DOWNSTREAM EFFECTS OF CONNECTED SHAPES ON SOCIAL CONNECTEDNESS

Kim J., Yoon C., Gonzalez R. / *University of Michigan (USA)*

1311

Two studies were conducted to investigate what design features represent connectedness and how they influence self-construal. In Study 1, logos representing connectedness were found to have specific identifiable features (e.g., shapes intertwined in complementary relationships). In Study 2, participants primed with connectedness cues expressed higher levels of interdependent self-construal, and thereby greater social connectedness. Implications for product design, priming techniques and promoting pro-social behaviors are discussed.

CUSTOMER EXPERIENCE INTERACTION MODEL

von Saucken C., Schröder B., Kain A., Lindemann U. / *Technical University Munich (DEU)*

1387

We suggest the Customer Experience Interaction Model (CEIM) to support the design of User Experience (UX). It provides a holistic view on the interaction of users with products. Therefore, CEIM incorporates different relevant models and views from the disciplines of engineering, human factors, industrial design and psychology. It supports the communication between developers by creating a shared understanding and a common terminology. Products that really meet the user's psychological needs can be designed only by combining knowledge of the mentioned specializations.

CONCEPT DESIGN AS KNOWLEDGE CONSTRUCTION – THE CASE OF USER-CENTERED DESIGN

Liikkanen L. A., Laakso M. / *Aalto University (FIN)*

1341

The domain of design is associated with creativity. One recent debate concerns the influence of user-centered design (UCD) on creativity. This paper analyzes this influence based on a cognitive design theory, describing concept design as knowledge construction. We discuss the role of mental representations, explicit and implicit design constraints in design thinking. We use the theory to explicate how UCD methods can influence creativity. We claim that user-data can support creativity if it is used as inspirational and managed with appropriate techniques. Otherwise it may be just a limitation.

Congress Hall Šipun

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WEDNESDAY, MAY 23					Hours	
REGISTRATION					08:00	CONGRESS HALL RAGUSA
D311 USABILITY AND BENEFIT OF METHODS - GENERAL REFLECTIONS	D312 MODELS FOR ENHANCED DESIGN TOOLS	D313 EVALUATION OF CREATIVITY	D314 ENGINEERING DESIGN PRACTICE	D315 AESTHETIC-VISUAL IMPRESSION	08:15	
					08:30	
					08:45	
					09:00	
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					09:30	
					09:45	
CONGRESS HALL BOBARA	10:00					
	REFRESHMENT BREAK					10:15
						10:30
	D321 USABILITY AND BENEFIT OF METHODS - EMPIRICAL STUDIES	D322 ORGANISATIONAL MANAGEMENT OF PRODUCT DEVELOPMENT	D323 DATA AND INFORMATION VISUALISATIONS	D324 PRODUCT-SERVICE SYSTEMS	D325 BIO-INSPIRED DESIGN AND ERGONOMICS	10:45
11:00						
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CONGRESS HALL ORLANDO	12:30					
						12:45
						13:00
						13:15
LUNCH					13:30	
					13:45	
					14:00	
D331 DESIGN INFORMATION SUPPORT APPROACHES	D332 SYSTEM MODULARITY AND VARIANTS	D333 DESIGN FOR X	D334 ENHANCED CAE APPLICATIONS	D335 SOCIAL IMPLICATIONS OF DESIGN	14:15	
					14:30	
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CONGRESS HALL ŠIPUN	16:00					
						16:15
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EXCURSION TO CITY OF DUBROVNIK AND CONFERENCE DINNER					17:00	
					17:15	
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AN INVESTIGATION INTO LIMITED INTEGRATION OF COMPUTATIONAL DESIGN SYNTHESIS IN COMMON DESIGN PRACTICE

Bolognini F., Jauregui Becker J. M., Schotborch W. O. / University of Cambridge (GBR) 727

The paper is an investigation into the limited integration of computational design synthesis (CDS) in common design practice. The work analyses the problem from three different points of views: designers, synthesis tools developers and industry. Topics of the discussions are: the structured approach and implementation issues of synthesis methods, as well as the scarce involvement of multiple players in the development of synthesis tools. The paper also drafts some solutions for best integration of CDS in design practice.

THE UNDERLYING RELATIONSHIPS BETWEEN SUCCESS CRITERIA & SUCCESS FACTORS IN NPD ACTIVITIES

Achiche S., Howard T. J., McAloone T. C., Deng L., Baron L.
/ Technical University of Denmark (DNK) 1

This paper concerns the success criteria used to measure short, medium and long term project success at different managerial levels, as well as mapping the relationships between the success criteria and the success factors of NPD. Interviews with 26 managers at a multinational company were studied, where questions were asked on the influence of the NPD manager-related factors, such as experience, location, etc on the perceived importance of the success metrics. The results showed that managers perceive the success of NPD differently depending on the time perspective.

FLEXIBILITY OF CHOICE AND PERCEIVED IMPACT OF USING DESIGN METHODS

Owusu I. A., Daalhuizen J. J., Stappers P. J. / Delft University of Technology (NLD) 1061

Existing studies show that designers that feel free to adapt a method to the situation at hand tend to perform better than designers that either 'muddle through' without a method or that strictly follow one. Comparing education with industry in a qualitative study, this paper investigates how designers perceive the impact of design methods in relation to their freedom to choose and apply them. Drawing on interview data, we introduce a possible explanation why psychological factors like self-efficacy seem to influence students more than practitioners; equal context and experience are discussed.

INVESTIGATING ELEMENTARY DESIGN METHODS - USING THE GENOME APPROACH FOR CREATING COMPLETE AND ADAPTABLE METHOD DESCRIPTIONS

Zier S., Bohn A., Birkhofer H. / Technical University Darmstadt (DEU) 1215

The aim of investigating elementary methods is to increase the acceptance of methodical working in practice by developing a systematic approach for the deduction, description and improvement of design methods. However, the so called Genome Approach is introduced as a systematic approach for investigating elementary design methods. This approach differs substantially from a wide range of other research work that intends to capture the basic nature of design methods.

A FRAMEWORK FOR EVALUATING APPLICABILITY OF DESIGN METHODOLOGIES

Vanhatalo M., Lehtonen T., Juuti T., Pakkanen J., Riitahuhta A. / Tampere University of Technology (FIN) 1167

The aim of this research was to find out what was the focus areas of the development process theories presented in Design 2010 conference. The results are presented in a framework which visualises clearly that there is a need for a development model which represents how the whole development process should be defined in manner to combine the theory and the practice. The existing design theories do not match the challenges and requirements which the industry has. Thus in this paper the areas of presented methods in design10 are viewed in correlation to whole development process.

SUPPORTING VALIDATION IN THE DEVELOPMENT OF DESIGN METHODS

Marxen L., Albers A. / Karlsruhe Institute of Technology (DEU) 1009

The contribution belongs to design research methodology. It shows that existing approaches need to be complemented with concrete test and validation strategies for newly developed design methods. It therefore suggests combining Blessing's and Chakrabarti's "Design Research Methodology" with Albers' "Integrated Product Engineering Modell" and to include the design method's starting point – best practice driven as opposed to problem driven development – to plan and conduct the evaluation of a design method according to its intended application in the design process and according to its origin.

Congress Hall Ragusa

SESSION D311

21 May 2012
Monday

22 May 2012
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23 May 2012
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24 May 2012
Thursday

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PERMANENTLY ESTIMATION OF ASSEMBLY COSTS DURING PRODUCT DEVELOPMENT

Husung S., Holle W., Hilmer F., Weber C. / *Technical University Ilmenau (DEU)*

497

In product development processes computer-based tools are indispensable for the support of synthesis and analysis steps. For an efficient process short closed loops are necessary, i.e. generating information about the impact of modifications of product characteristics on the properties. Therefore, one requirement is a continuous use of virtual prototypes. A relevant product property is the behaviour during the assembly. In this paper, a method and a tool is presented which enables an estimation of time and costs for manual assembly during product development, based on virtual prototypes.

DESIGN OF ROBUST SERVICE OPERATIONS USING CYBERNETIC PRINCIPLES AND SIMULATION

Wynn D. C., Cassidy S., Clarkson P. J. / *University of Cambridge (GBR)*

331

Information flows in a service organisation allow business units to co-ordinate their response to changes in the operating environment. Processes and interactions can be designed so that the right information flows to the right people, at the right time to make effective decisions regarding the allocation of limited resource. In this paper, an analysis framework and simulation approach is developed to identify the internal information flows an organisation needs to "tune itself" for changing conditions, thus making itself robust to uncertainties. The method is applied in a telecoms company.

ASSEMBLY TIME ESTIMATION MODEL FOR EARLY PRODUCT DESIGN PHASES – CONCEPT DEVELOPMENT AND EMPIRICAL VALIDATION

Halfmann N., Krause D. / *Hamburg University of Technology (DEU)*

455

Concept development for products designed for assembly requires continuous analysis of the resulting production processes. Existing methods for assembly time calculation require high quality of product information to provide significant results and their application proves to be difficult. Core element of the approach presented in this paper is a table based data set that can be adopted to a company specific assembly environment. Two comparative empirical studies showed the high level of correspondence to reality and low application efforts for assembly time estimation in early design phases.

A DESIGN ASSISTANT ARCHITECTURE BASED ON DESIGN TABLEAUX

Hendriks L., Kazakci A. O. / *Mines ParisTech (FRA)*

485

We provide the basis for a tool that is both compatible with the most recent trends in agent technology and which is inspired from a particular design theory, namely, the C-K design theory. We present a method, Design Tableau, which can be used as an automated reasoning engine for a local agent providing design assistance in the construction and verification of a design description. The system is based on Description Logics and it has the advantage of being compatible with flexible and abstract ontologies such as the OWL DL, an ontology developed for the Semantic Web.

ENHANCED OBJECT-DRIVEN DESIGN (EOD) BASED ON PRODUCT PROPERTIES – FUNDAMENTALS AND IMPLEMENTATION IN THE ENGINEERING NETWORK CONCEPT

Dankwort C. W., Eigner M., Faißt K. G., Keßler A. / *Technical University Kaiserslautern (DEU)*

421

The Enhanced Object-Driven Design (EOD) approach provides a formal frame for the characterisation of products or parts by formally defined Enhanced Objects, supporting Design by Properties with a focus on product and customer-related properties and supporting the Views and the way of thinking of the people involved in the product development process. An overview of the approach and of its implementation in the new innovative Engineering Network concept, offering a flexible multidisciplinary information federation backbone for a better management of product and process complexity, is given.

AN INTEGRATED STACK-UP ANALYSIS TOOL

Corallo A., Lazoi M., Pascali G. / *Universita del Salento (ITA)*

399

Stack-up analysis is a technique used to evaluate tolerance chains created joining the physical elements of a product during its design and it is used to check problems in the final assembly for reducing costs and organizational impacts. The paper wants to describe an industrial case study based on the results of an action research in which Sstack-up analysis problems in an aerospace company are analyzed and a new design tool is developed. The new stack-up tool is actually used by the company designers and allows them to reduce design time and human error.

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IDEATION METRICS: INTERDEPENDENCY BETWEEN AVERAGE NOVELTY AND VARIETY

Jagtap S., Larsson A., Hiort V., Olander E., Warell A. / *Lund University (SWE)* 1881

The importance of ideation in the conceptual design phase has been widely accepted. Shah et al. (2003) developed four key metrics for evaluating a designer's exploration and expansion of design space. The four metrics are: novelty, variety, quality, and quantity of designs. The mean of novelty scores of ideas in a set (i.e. Average Novelty - AN) has also been used in some ideation studies. However, many of the studies that have computed AN and variety, have not examined the interdependency between them. This research aims at examining the interdependency between AN and variety.

EXISTING PROBLEMS OF IDEA EVALUATIONS AND POSSIBLE AREAS OF IMPROVEMENT

Messerle M., Binz H., Roth D. / *University of Stuttgart (DEU)* 1917

The paper describes and analyses the problems of idea evaluations that exist in business practice. Therefore, the results of expert discussions and a literature research are specified. To get an overview, the problems are classified into different groups according to their causes. Additionally, it is shown which approaches can form the basis for overcoming the identified problems and for improving the evaluation of product ideas in business practice. For this purpose, a number of new approaches are developed and approaches that are described in the relevant literature are mentioned.

METHOD OF CREATIVITY INCLUDING AN IDEAS EVALUATION TOOL: APPLICATION IN AN INTERNATIONAL WORKSHOP

Roussel B., Bary R., Ferioli M. / *INPL-ERPI (FRA)* 1941

Since 10 years, during creativity sessions called "48hours", a lot of ideas is generated. To avoid losing any information and prepare the following phases of the innovation process, we have developed with EDF R&D, an application called "Ideofil®" to store, organize ideas. Evaluating ideas in the early stages of design is considered to be one of the most critical stages in the development of innovating products (Ozer,1999). Therefore, we have done a study of existing practice and we proposed a method, named "IdéoVal", to assist the ideas evaluation during early phases of the innovation process.

HOW FAR IS TOO FAR? USING DIFFERENT ABSTRACTION LEVELS IN TEXTUAL AND VISUAL STIMULI

Gonçalves M., Cardoso C., Badke-Schaub P. / *Delft University of Technology (NLD)* 1861

Designers are continuously compelled to produce creative ideas. Therefore, designers are prone to rely on inspiration search, mainly on visual stimuli. However, prior research has shown the beneficial and detrimental influence of such stimuli, whilst it is still not clear the role of text stimuli in idea generation. This study examines how far texts, entailing different abstraction levels, influence designers, when compared to images. The results show the positive influence on fluency, flexibility and originality of ideas text stimuli (with an appropriate distance to the problem) can enhance.

EVALUATION OF CREATIVITY – STRUCTURING SOLUTION IDEAS COMMUNICATED IN GROUPS PERFORMING SOLUTION SEARCH

Hashemi Farzaneh H., Kaiser M. K., Schröer B., Srinivasan V., Lindemann U. / *Technical University Munich (DEU)* 1871

Particularly in the phase of searching for solutions to technical tasks, group creativity sessions are recommended to create new, unobvious solutions. There are a number of methods and recommendations to improve the "creative output", but the evaluation of these influencing factors remains a challenge. We develop an approach to structure documented and undocumented solution ideas that are often incomplete and have a different level of detail. This approach facilitates a detailed comparison and assessment of solution ideas and the evaluation of factors influencing group creativity sessions.

DECISION SUPPORT SYSTEM FOR IDEA SELECTION

Stevanović M., Marjanović D., Štorga M. / *Markot.tel (HRV)* 1951

This paper presents one of the possibilities of the idea selections for NPD. The focus is on the attributes that describe the ideas and selection criteria for ideas. The attributes for describing the ideas in the process of idea generation and management are defined. The criteria for reviewing the ideas through the ranking and prioritization processes are proposed. The requirements, objectives and goals used for product definition are systematized. The criteria for evaluation of a ranked ideas set and the brief description of the idea validation process in product development are presented.

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CASE EXAMPLE IN SYSTEMATIC DESIGN ENGINEERING - LEEBOARD MOUNTING

Eder W. E. / *Royal Military College of Canada (CAN)*

607

Engineering Design Science enables prescription of a systematic method for the design process, followed in this case example. The creative search for solutions can be helped by this systematic and methodical approach, which encourages full documentation of the thoughts, alternatives and decisions. This case example applies the recommended method, and shows the scope of the output, with emphasis on conceptualizing. The novel design problem a leeboard bearing arrangement for a sailing barge that is used as an outdoor stage for a traveling theatre company.

MATERIALS SELECTION AND SOFTWARE APPLICATION AS DESIGN TOOLS FOR MARINE PROPULSION SHAFTING BEARINGS

Roldo L., Komar I., Vulić N. / *Federal University of Rio Grande do Sul (BRA)*

679

The selection of the material regarding specific design of the sterntube journal bearings in vessels is critical taking into account the lubrication system, whether oil or water, and the consequent lubricant leakage. To examine the advantages of polymer propeller shaft bearings compared with conventional white metal bearing, this study uses characterization methods and a software application based upon data of stern tube bearing collected from three different ships. Results showed that power loss in polymer bearings is at least 6.5 times less than in conventional white metal ones.

INTERDISCIPLINARY SYSTEM MODEL FOR AGENT BASED MECHATRONIC DESIGN OF TURBOCHARGING SYSTEMS

Schmelcher J., Stetter R., Kaufmann A., Voos H. / *Hochschule Ravensburg-Weingarten (DEU)*

687

To deal with the challenges in mechatronic design, research and industry encourage the idea of a domain-spanning system model. One promising approach to survey these interdisciplinary information and relations is based on multi- agent systems. The basis on which a multi-agent system is able to make decisions concerning the cross-domain information and relations can be a model using the modelling language SysML. This paper will present an approach how these system models can be developed using the modelling language SysML and will discuss an example – a turbocharging system for a car engine.

DEVELOPING VIP2M: A VIRTUAL ENVIRONMENT FOR PROTOTYPING MOBILE WORK MACHINES

Kuusisto J., Kaapu T., Ellman A., Tiainen T. / *Tampere University of Technology (FIN)*

657

This paper focuses on shaping a virtual environment (VE) as a new instrument to facilitate co-creation, and, more specifically, on the practical machine design case of designing the control cabin of a mobile work machine. The action research project included phases for creating, deploying, evaluating and improving a VE for prototyping mobile work machines, named VIP2M. We summarize the developed design objectives to the following two key lessons: (1) Support presence experience, and (2) Simulate the functions and design of real-world machines.

INTEGRATION OF PLM AND ERP SYSTEMS AT KONČAR – INSTRUMENT TRANSFORMERS

Pavlić D. / *KONČAR Instrument Transformers Ltd. (HRV)*

673

For the vast majority of manufactures, the question should not be ERP or PLM system but how to most effectively implement and integrate these two solutions. This paper presents one way of integration between PLM and ERP systems. It shows the integration as a process of exchanging data between two systems. The process of exchange data comprises four steps in which the designer, using visual inspections, quickly and easily detects data that are different in the systems. Once the data are consistent in both systems, the data exchange is performed.

USING FEEDBACK FROM END USERS TO IMPROVE DESIGN OF PRODUCT SERVICE SYSTEMS

Lawlor-Wright T., Rainey M., Al Ghazal H., Ferrario M., Simm W., Whittle J. / *University of Manchester (GBR)*

667

The importance of recognizing user needs and incorporating them in the design of products is widely recognized. This is also true for buildings and services. The views of end-users can be helpful in making decisions at all stages of design. This paper describes an innovative post-occupancy consultation method developed by the EPSRC Voice Your View Project. Using this, detailed public feedback was captured following a library refurbishment. The comments helped to improve services and are also useful in the detailed design of other public buildings.

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AESTHETICS AS PARAMETER OF INTELLIGENT DESIGN SUPPORT

Kaljun J., Sancin U., Harih G., Dolšak B. / *University of Maribor (SVN)*

1293

It is hard to imagine a modern design process without using a computer. Adding the intelligence to the existing computer aids, leads to significant improvements of the effectiveness at performing various engineering tasks, including design. This is even more important in some design areas that have specific constraints and criteria and therefore require specific approach in design process. For all these reasons intelligent computer support to design aspects like aesthetics is still partial and therefore insufficient. The paper presents aesthetic design from »intelligent design« point of view.

WORKING TOWARDS BUILDING A SENSITIVITY INDEX FOR A VEHICLE CONTROL DEVICE: A METHODOLOGY USING CONCEPT NETWORK ANALYSIS

Georgiev G. V., Nagai Y., Taura T., Noda S. /

Japan Advanced Institute of Science and Technology (JPN)

1283

This research discusses an advanced methodology to assess human sensitivity and behaviour when operating a device or using a product. In particular, we focus on the human-computer interface work in a vehicle. We provide an example of the methodology in a test case study comparing the use of devices in two vehicles. The human sensitivity was identified on the basis of conscious and unconscious indicators of the human state. Moreover, we identified particular sensitivity events. The results contribute to the user-centred design, particularly when alternatives have to be compared and evaluated.

EVALUATING SIMILARITY AND EXPLORING BRANDING IN VEHICLE STYLING USING FOURIER DECOMPOSITION

Ranscombe C. H., Mullineux G., Hicks B. J. / *University of Bath (GBR)*

1377

Vehicle appearance and branding have been shown to play a significant role in the commercial success of products. Despite this importance, there exists few strategies that designers may use to review potential designs to evaluate appearance with respect to brand. While research has been conducted to address this issue, resulting strategies remain qualitative in nature. The research reported in this paper presents a method to use Fourier decomposition to provide a quantitative review of similarity in appearance with respect to brand. Results demonstrate the use of the method to evaluate similarities across brands and in potential concepts.

METHODS USE IN EARLY STAGES OF ENGINEERING AND INDUSTRIAL DESIGN – A COMPARATIVE FIELD EXPLORATION

Wölfel C., Debitz U., Krzywinski J., Stelzer R. / *Technical University Dresden (DEU)*

1397

This study provides multifaceted empirical data from interviews with engineering and industrial designers about professional product development processes in German industry. The study aims to describe differences and consistencies in general proceeding in the early design stages as well as in the use of industrial and engineering design methods. The findings may complement the basis for further research on the integration of both design disciplines into broader product development processes.

COLOR, COGNITION, AND RECYCLING: HOW THE DESIGN OF EVERYDAY OBJECTS PROMPT BEHAVIOR CHANGE

Montazeri S., Gonzalez R., Yoon C., Papalambros P. Y. / *University of Michigan (USA)*

1363

In this paper we studied the role of color in triggering recycling behavior. According to the elaboration likelihood model of persuasion we hypothesized that the visual salience of recycling bins encourages recycling behavior, presumably through a peripheral route and would increase the probability that the recycling bin will be seen and used. In a behavioral lab setting we compared the recycling behavior of subjects between two conditions of grey and green recycling bin. We found that color can affect the salience of an object and consequently trigger the associated desired behavior.

INDUSTRIAL DESIGN / DESIGN ENGINEERING AND THE “FACILITATOR TRAP”

Kokotovich V. / *University of Technology Sydney (AUS)*

1321

This paper discusses preliminary results of one aspect of a Delphi type study investigating technological change and the potential impacts of this on Industrial design/Design engineering education and indeed the profession. More specifically this paper discusses aspects of what we are calling the “FACILITATOR TRAP”. As technological change is advancing at an exponential rate there is the real possibility in the future the Industrial designer/Design engineer may be trapped in the role of being a mere facilitator. We will discuss results from our study and suggest ways we may prevent this.

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A COMPARISON OF THE BEHAVIOUR OF STUDENT ENGINEERS AND PROFESSIONAL ENGINEERS WHEN DESIGNING

Cash P. J., Hicks B. J., Culley S. J. / *University of Bath (GBR)*

757

Lab-based studies play a critical role in design research. However, challenges exist associated with relating results from the lab to practice. This paper begins the development of a robust link between these two contexts. This is achieved by presenting a method for comparison of various design situations before results for one of the situations is presented. These results reveal correlation between industrial and lab-based teams in the reduction in ideation rate over time. Further work is highlighted in the development of these relationships for other design situations and in other contexts.

TOWARDS AN EARLY CONSIDERATION OF RAMP-UP PHASE IN THE PRODUCT DEVELOPMENT OF COMPLEX PRODUCTS

Elstner S., Krause D. / *Hamburg University of Technology (DEU)*

859

The shorter product life cycles and the increasing market competition forces the companies to accelerate the introduction of new products into the market. The ability to realize an efficient transfer from development into production represents an important success factor. The aim is to develop a methodology for the early identification and minimization of ramp-up risks with the help of response strategies in the product development. This paper highlights a framework for the risk assessment regarding the success factors from product development perspective for an efficient ramp-up.

IS THERE A NEED FOR DECISION SUPPORT IN SUSTAINABLE R&D PORTFOLIO MANAGEMENT?

Decouttere C. J., Vandaele N. J. / *Flanders InShape (BEL)*

797

Seminated from an industry need in Flanders of how to introduce sustainability in the R&D portfolio decision process, we observed that particular decision support issues came back time after time. A research intermediary (Flanders InShape) and a university (KU Leuven) got together to turn this concern into research questions. This paper covers the industrial problem setting and possible solution to incorporate sustainability in R&D portfolio decision making. This is illustrated with two real-life examples: an industrial supplier of raw materials and a producer of consumer products.

HOW DO DESIGN HEURISTICS AFFECTS OUTCOMES?

Yilmaz S., Christian J. L., Daly S. R., Seifert C., Gonzalez R. / *Iowa State University (USA)*

1195

Design Heuristics were developed by analyzing trends in innovative products and patterns in ideation processes by expert engineers and industrial designers. The research reported in this paper studies the outcomes of the application of Design Heuristics instruction in a classroom setting, specifically their role in solving design problems and overcoming fixation. In this study, 20 sophomore industrial design students were given a short design task and a set of twelve Design Heuristics cards. They were asked to generate design concepts using the heuristics.

A NEW METHODOLOGY FOR ADVANCED ENGINEERING DESIGN: LESSONS FROM EXPERIMENTING C-K THEORY DRIVEN TOOLS

Hooge S., Agogu  M., Gillier T. / *Mines ParisTech (FRA)*

937

This research shows that C-K Design Theory provides fruitful connections between New Product Development and Knowledge Management issues. Our purpose is to go a step further on the benefits of C-K Theory-based design tools for managing the upstream phases of innovative design processes. Based on 14 industrial case-studies conducted between 2009 and 2011, we find that C-K Theory-based design tools enable practitioners to generate and explore various design paths while converging on the most competitive one.

AN EXPERIMENTAL STUDY ON IMPROVING DEPENDABILITY BY INVERSE FUNCTIONAL MODELLING

Wendland M., Sadek T., Labenda P. / *University of Bochum (DEU)*

1185

In this paper, a modelling approach for mechatronic products (heterogeneous concept modelling - HCM) is combined with a method to increase dependability of such concepts (inverse functional modelling - IFM). By applying both approaches, it is possible to help the designer detect non-intended functions and physical effects as well as potential failures. This helps to reduce the inherent uncertainty that goes along with the early design phases. The combined approach of HCM and IFM is evaluated by means of an experimental study with n=108 probands and compared to the classical FMEA method.

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RELATING VALUE METHODS TO WASTE TYPES IN LEAN PRODUCT DEVELOPMENT

Siyam G. I., Kirner K., Wynn D. C., Lindemann U., Clarkson P. J. / *University of Cambridge (GBR)* 93

The aim of this study is to examine the relationship between value and waste of information in LPD. Using a literature review, the paper explores 1) lean value methods developed to support the creation of valuable information 2) types of information waste and 3) the relationship between lean value methods and waste types. The study focuses on value and waste in three main dimensions of the PDP: transformation, deliverable, and transmission. The results of the study are integrated in a guideline that could help to eliminate waste through applying lean value methods and monitoring their impact.

STRUCTURAL MODELLING AND ANALYSIS OF ORGANIZATIONAL CHANGE DURING LEAN DEVELOPMENT IMPLEMENTATION

Helten K., Lindemann U. / *Technical University Munich (DEU)* 51

The implementation of Lean Development (LD) can be enhanced by investigating its use in pilot projects. The underlying change processes need to be analyzed in detail to derive appropriate schemes. This paper explores how methods of structural modeling and analysis can be used to gain better insight into the complex procedures during LD transformation. As a first step, relevant elements and relations for such change models were defined. The new procedure will be applied to three implementation processes in industry, with an aim to collect evidence identifying important success factors.

TRANSFORMATION TO LEAN PRODUCT DEVELOPMENT – APPROACHES AT TWO AUTOMOTIVE SUPPLIERS

Ström M., Alemyr M., Bükk S., Gustafsson G., Johannesson H. Chalmers / *University of Technology/Swerea IVF AB (SWE)* 113

The transformation to a lean product development system was studied at two automotive suppliers. The study covers the transformation approach, the problems along the way, some early results of the transformation and a comparison between the two firms in this respect. Both strive to change their operations to add more value in their delivery to the OEM (Original Equipment Manufacturer). The results show that the transformations are experienced as positive in both firms. It is demonstrated that this success is due to methods and principles included in the lean product development framework.

MATURITY BASED IMPROVEMENT OF PRODUCT DEVELOPMENT PROCESSES IN SMALL AND MEDIUM-SIZED ENTERPRISES

Gausemeier J., Bensiek T., Kühn A., Grafe M. / *University of Paderborn (DEU)* 41

This paper introduces the VPS-Benchmark – a maturity model for performance evaluation and improvement in SMEs with a special focus on virtual prototyping and simulation (VPS). By giving a brief overview on existing approaches for performance evaluation and improvement we point out the demand for a new maturity approach specialized on the requirements of SMEs. The new maturity model will then be introduced. The model determines an individually appropriate maturity level and recommends concrete measures to achieve it. A prototypical implementation supports the application in industry.

PRODUCT ORIENTED ORGANIZATION OF PEOPLE TOWARD FOSTERING CAPABILITIES IN PRODUCT DESIGN

Oizumi K., Aoyama K. / *The University of Tokyo (JPN)* 71

To survive in the competitive global market, companies designing products need to strengthen their organizations. This paper proposes a decision support tool for co-ordination of organizational structure by analysing products and people who are involved in product design from the viewpoint of capability. The proposed method comprises integrated model of a product and an organization, which can be depicted in Multiple Domains Matrix. Clique detection suggests possible organizational structure, and comparison of different matrices on a same domain shows strengths and weaknesses of the structure.

INTRAORGANIZATIONAL BENEFITS FROM PRODUCT CONFIGURATION INFORMATION – A COMPLEMENTARY MODEL

Persson Slumpi T., Ahlin K., Öberg L. -M. / *Mid Sweden University (SWE)* 83

Configuration management (CM) of products has a long tradition but among practitioners the benefits of CM are not clearly expressed. Our empirical study shows example of benefits of CM (process related) and PCI (information related) that not have been identified in earlier research. Hence we suggest that a model of benefits related to CM really should be including benefits related to both CM and PCI. The model is a contribution since practitioners can use it order to strengthen CM's position in the organization.

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TRACEABILITY VISUALISATION TOOLKIT

Stanković T., Štorga M., Stojić I., Savšek T. / University of Zagreb (HRV)

1617

This paper is presenting an organic based approach to visualisation of engineering information evolution and traceability during product's lifecycle. The work presented is a part of the TRENIN research project aimed to development of semantic Traceability Records for integration of process and product information that is fragmented across different information objects. Dynamical information provided as input is processed and displayed by Visualisation Toolkit as interactive and visually refined enabling users to understand the engineering information content and context development.

INTERACTIVE CASE BASED REASONING THROUGH VISUAL REPRESENTATION - SUPPORTING THE REUSE OF COMPONENTS IN VARIANT-RICH PRODUCTS

Johansson J., Cederfeldt M. / Jönköping University (SWE)

1477

This paper shows how to make use of the Case Based Reasoning (CBR) method in order to search for existing components when introducing new variants of variant-rich products. The CBR method is mature and the use of it is straight forward, but in this paper it is investigated how to enhance it by human interaction (through the integration with CAD). The method is described along with an in-production-system where the process of selecting components for roof racks for cars is supported through the use of CBR.

DESIGN FOR HUMAN - VIRTUAL ENGINEERING IS A MEDIA FOR KNOWLEDGE TRANSFER

Leino S. -P., Pulkkinen A. / VTT Technical Research Centre of Finland (FIN)

1507

Aim of our research is to develop support for better human-machine system design. The fundamental idea of the support introduced in this paper is based on virtual engineering based knowledge transfer within a product life, between designers and other stakeholders. This paper proposes a holistic practical framework model which describes needed elements to conduct the knowledge transfer, i.e. PLM model and enabling embodiments of the model. Examples of the model usage are described in the paper as well. The practical model is based on case studies.

DEMYSTIFYING INNOVATION AND DESIGN – THE IMPORTANCE OF VISUALIZATION IN IDEATION AND CONCEPTUAL DESIGN

Wikström A., Jackson M. / Mälardalen University (SWE)

1627

This paper will discuss how design and design thinking can contribute to an innovative development process in a conscious, controlled, and cost effective way. The subject will be reviewed from a theoretical and a practical point of view. In order to analyse and build an understanding of the design thinking phenomenon in practice, the paper will analyse a case study based on interviews at IDEO, a company successful in its work with innovative development using design thinking and comparing this with generic success factors and Schön's paradigm of the reflective practice.

APPLYING BIOINFORMATICS ANALYSIS PRINCIPLES TO CAD DATA TO BETTER CHARACTERIZE AND IMPROVE THE ENGINEERING DESIGN PROCESS

Nguyen P. T., Steinert M., Carroll A., Leifer L. / Stanford University (USA)

1049

We propose to systematically collect CAD data from users and to analyse them algorithmically in order to understand, model and improve engineering design processes. We classify designers in this case to be firstly the engineer users of various CAD software, and secondly that they are creators of digital artifacts. Our method of analysis is inspired by the field of bioinformatics and proposes to employ algorithms such as Edgar's program MUSCLE (Multiple Sequence Comparison by Log Expectation) that uses a 3-stage refinement algorithm to efficiently calculate distances and clustering.

THE USE OF DESIGN VISUALISATION METHODS TO SUPPORT DECISION MAKING

Yee J., Walker A., Menzfield L. / Northumbria University (GBR)

1637

This paper examines and describes how design visualisation methods support decision making processes in two strategic projects currently running in an engineering SME company. We first describe the range of visualisation methods and how they are used in relation to decision making in management and design fields. We then describe four design visualisation methods used in these two projects in order to evaluate their effectiveness in supporting decision making. The paper concludes with benefits and challenges in using design visualisation methods in a management context.

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ENABLING PRODUCT-SERVICE SYSTEM DEVELOPMENT USING CREATIVE WORKSHOPS: EXPERIENCES FROM INDUSTRY CASES

Wallin J., Kihlander I. / Lulea University of Technology / Volvo Aero (SWE)

321

Manufacturing industries are undergoing a transition from manufacturing of products towards integration of services and providing Product-Service Systems. To support this transition, creative workshops are an example of a means to be used. A number of creative methods were tested in two actual industrial cases: one aerospace and one automotive case. The findings show that it is important to pay extra attention to certain factors when conducting creative workshops for PSS-development: visualization of time perspectives, sampling of participants, focus on customer needs and making of prototypes.

DEVELOPMENT OF A SYSTEM FOR KNOWLEDGE-BASED PRODUCT-SERVICE SYSTEM DESIGN SUPPORT

Nemoto Y., Akasaka F., Shimomura Y. / Tokyo Metropolitan University (JPN)

259

Compared to product design, a broader range of knowledge is required to Product-Service System (PSS) design, since both products and services are included in its design object. In this paper, a method for knowledge-based PSS design support is proposed. The proposed method is based on the research on Japanese Service Engineering, which provides design methodology of the integrated provision of products and services. In addition a prototype of computer-aided design (CAD) system to realize knowledge-based PSS design support is developed. The method and system supports the acquisition of new PSS design solutions by integrating knowledge accumulated in a knowledge base.

PRODUCT'S LIFE CYCLE MODELLING FOR ECO-DESIGNING PRODUCT-SERVICE SYSTEMS

Fargnoli M., De Minicis M., Tronci M. / Ministry of Agriculture (ITA)

869

Shifting from product use to service use represents one of the most powerful approaches for the achievement of a sustainable society. The paper combines product's life-cycle simulation with industrial Product-Service Systems (PSS), underlining the beneficial effects of refurbishing/reconditioning operations. This also enables the evaluation of product's environmental performances, helping designers in understanding the potential benefits of product servification. The integration of PSS strategies within ecodesign issues was carried out through the development of an industrial case.

ESTABLISHING COLLABORATIVE NETWORKS FOR THE CONCEPTUALISATION OF PSS

Mougaard K., Howard T. J., McAloone T. C., Neugebauer L., Bey N. / Technical University of Denmark (DNK)

249

Product/Service-Systems (PSS) can be seen as an innovation strategy, where companies can (re)position themselves in a value system by focusing on adding value throughout the product lifecycle and the total experience cycle of the customer. This paper presents (i) an initial normative approach for setting up and screening the value system for potential new relationship opportunities and (ii) new models to use in conceptualising collaborative PSS and (iii) presents a model with an overview of where and how to integrate the value network analysis into the PSS conceptualisation framework.

A DESIGN CASE OF PRODUCT-SERVICE SYSTEMS – URBAN UMBRELLA RENTAL PSS

Kim Y. S., Lee S. W., Kim J. H., Do S. H. / Sungkyunkwan University (KOR)

213

A successful PSS should satisfy economical, ecological and experience values to meet the value creation paradigm. A systematic design method for PSS has been developed where activities of stakeholders are designed to support those values reflecting diverse context elements. Also business model aspects of PSS are considered using the category of the business model canvas together with strategies and protocols obtained from various real world cases. To illustrate the PSS design method with business model strategy integrated, a case of urban umbrella rental service system is presented.

TOWARDS VALUE DRIVEN SIMULATION OF PRODUCT-SERVICE SYSTEMS: A CONCEPTUAL SCENARIO

Panarotto M., Larsson T. C. / Blekinge Institute of Technology (SWE)

279

Bringing into the debate current challenges when developing a Product Service System offering; i.e the increased uncertainties and wider design space that such a business model implies, the paper discusses a Value Simulation approach as a means to successfully deal with the underlined challenges in order to find during the preliminary design stages the best combination of products and services that maximize stakeholders' and customers' value. Furthermore, a conceptual scenario based on a case is presented in order to strengthen the paper and provide a base for further development.

Congress Hall Konavle

SESSION D324

21 May 2012
Monday

22 May 2012
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Thursday

REAL PRODUCT EYE TRACKING

Badni K. S. / Loughborough University (GBR)

1275

Eye tracking methods are often used to review virtual products. This generally requires users to keep their head still and focus on a screen producing an unnatural situation for evaluating real products. The aim of this pilot study was to create a more realistic and natural 3D eye tracking methodology. The data produced was compared to traditional 2D eye tracking showing a number of differences in dwell times, fixation points and clustering within areas of interest. The results of this study could help to develop virtual product analysis to reflect how a real product is actually reviewed.

NATURE-INSPIRED DESIGN STRATEGIES IN SUSTAINABLE PRODUCT DEVELOPMENT: A CASE-STUDY OF STUDENT PROJECTS

de Pauw I. C., Karana E., Kandachar P. V. / Delft University of Technology (NLD)

787

In design practice, Nature-Inspired Design Strategies (NIDS) can be applied when developing sustainable products. However, knowledge on how this actually helps designers is lacking. This study explores the effects of applying Cradle to Cradle and Biomimicry in student projects, as compared to using Ecodesign. The findings indicate that NIDS inspire the students, encourage out-of-the-box thinking, and provide absolute - instead of relative- design principles to guide the concept development. Furthermore, the use of examples from nature seems to benefit effective communication of their work.

AN APPROACH TO SUPPORT SEARCHING FOR BIOMIMETIC SOLUTIONS BASED ON SYSTEM CHARACTERISTICS AND ITS ENVIRONMENTAL INTERACTIONS

Kaiser M. K., Hashemi Farzaneh H., Lindemann U. / Technical University Munich (DEU)

969

Biology recovers promising solutions for all kinds of technical challenges. Finding exceptional solutions is crucial for innovative designs. This paper presents an approach to support the designer in searching for extraordinary biological solutions for a technical problem and the biologist in finding an application for an interesting phenomenon. The search is based on matching terms in technical and biological documents in four term categories: system functions, descriptions of the system itself, its characteristics and its environmental interactions. The approach is illustrated by an example.

AUTOMATED CLASSIFICATION INTO THE BIOMIMICRY TAXONOMY

Vandevenne D., Verhaegen P. -A., Dewulf S., Dufloy J. R. / Katholieke Universiteit Leuven (BEL)

1161

Ask Nature is a publicly available tool that provides relevant bio-inspiration in the early design stage. The tool's main limitation is the manual work required to expand its biological strategy database. This paper demonstrates the feasibility of automatically classifying descriptions of biological strategies into Ask Nature's classification scheme. This contribution is a first step towards a scalable system enabling the generation of biologically-inspired design ideas drawn from a representative database which reflects the current available human knowledge of the natural world.

CAUSAL MODELS FOR BIO-INSPIRED DESIGN: A COMPARISON

Baldussu A., Cascini G., Rosa F., Rovida E. / Politecnico di Milano (ITA)

717

Models supporting Biologically Inspired Design (BID) are receiving a growing interest by the scientific community. Among the others, SAPPhIRE and DANE are the most acknowledged frameworks in literature. After showing with a practical example their complementarity, the paper presents a formal comparison of their ontologies with the aim of investigating the possibility to develop an integrated model. The study revealed that the two frameworks do not present contradictory features and the different content of their representation is clearly outlined.

ASSESSMENT OF ANTHROPOMETRIC METHODS IN HEADSET DESIGN

Stavrakos S. -K., Ahmed-Kristensen S. / Technical University of Denmark (DNK)

1123

Assessing consumer products for usability and comfort often involve expensive user trials. This paper examines the incorporation of anthropometry in the design of external-ear devices. Two studies were carried out: one to compare anthropometric methods and a smaller study to identify comfort factors. The instrument and photographic method were time and cost effective, hence appropriate for larger data sets whereas the 3D method produced accurate images aiming in a deep analysis of data, hence ideal for qualitative understanding. Finally, a mathematical model was developed to predict ear data.

SESSION D325

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TRACEABILITY CASE STUDY ON RAIL VEHICLE CONTROL UNIT DEVELOPMENT PROJECT

Pavković N., Tečec Ribarić Z., Sviličić T. / *University of Zagreb (HRV)*

1567

Paper presents results of implementation of traceability methodology and tool proposed in TRENIN project (<http://www.trenin.org>). A case study was conducted at industrial partner which produce complex power electronics and control equipment. Proposed approach suggests the definition of context for tracing by "extracting" and extending the subsets of product development ontology. The focus of paper is on possible utilization scenarios - how developed functionalities could lead towards the shared understanding and knowledge integration in multidisciplinary product development process.

DISTRIBUTION OF ENGINEERING DESIGN KNOWLEDGE WITHIN THE DEVELOPMENT OF MULTI-AGENT DESIGN SYSTEMS

Kratzer M., Crostack A., Binz H., Roth D. / *University of Stuttgart (DEU)*

1495

In this contribution, a generic distribution of engineering design knowledge is presented. By means of this generic distribution and a step-by-step procedure, knowledge engineers are guided starting from a consistent semantic network and are finally able to obtain a structured overview about the knowledge domain within the development of multi-agent design systems (MADS). Additionally, this knowledge distribution could also be adapted for the development of common KBE systems. The functionality of the distribution is shown on the example of the knowledge domain interference fits.

A GAUSSIAN MODEL OF EXPERT OPINIONS FOR SUPPORTING DESIGN DECISIONS

Rajabalinejad M., Spitas C. / *Delft University of Technology (NLD)*

1579

The focus of this paper is on development of a novel method for decision making process. Decisions play a major role at all stages of the design process. Here we propose to use a new decision making tool for the design process. This method helps designers to account for all uncertainties (Hatchuel and Weil, 2009) involved by appropriately factoring them into the decision making process. Because this method is rather new, numerical This method with a uniform probability distribution function has been applied to the Cold Facts project (Rajabalinejad and Spitas, 2011a) and further developments are presented in this paper.

SUPPORTING TRACEABILITY OF DESIGN RATIONALE IN AN AUTOMATED ENGINEER-TO-ORDER BUSINESS MODEL

Elgh F., Poorkiany M. / *Jönköping University (SWE)*

1425

This work focuses on structuring product knowledge, including the design rationale, and knowledge traceability across sub-areas in the development process. The objective is to support reuse, expansion and maintenance of generic product family objects embedded in design automation systems. The result is a framework and a system enabling design rationale with high level of granularity to be stored and structured. Traceability to other domains and supporting documents and the possibility to query the stored knowledge are also supported together with means for history and authorization control.

DSM MADE EASY

Halonen N., Juuti T., Luostarinen P. / *Tampere University of Technology (FIN)*

1445

The world of product design and manufacture is becoming increasingly complex due to escalating competition in global markets. However, there is a lack of adequate tools available to provide the right starting blocks for organisations and groups to harness complexity management. This paper introduces a design structure matrix based systems modelling tool, DiMo, which is especially developed for a facilitation process in product development. Initial testing of DiMo indicates that the tool is capable of improving systems modelling processes and enables easy and effective information acquisition.

INTERDISCIPLINARY ANALOGICAL INFORMATION TRANSFER IN DESIGN: DIFFERENCES BETWEEN KNOWLEDGE LEVELS

Özkan Ö. H., Dogan F. / *Izmir Institute of Technology (TUR)*

1545

We aimed to understand analogical transfers in cognition as a more holistic view to support design education. 40 source domains were manipulated in experiment in four categories: bus stop, architecture, artifacts, nature. 373 students and 22 expert designers attended to the experiment. Findings lead us to understand relation between expertise, the acquisition of knowledge and creative thought. Results showed that novice designers generally selected long-distant domain for creativity and originality and expert designers generally selected local domain for practicality and efficiency.

Congress Hall Ragusa

SESSION D331

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HANDLING PRODUCT INFORMATION - TOWARDS AN IMPROVED USE OF PRODUCT MODELS IN ENGINEERING DESIGN

Kohn A., Lutter-Günther M., Hagg M., Maurer M. / *Technical University Munich (DEU)* 1719

The choice of adequate product models for specific needs occurring in the product development process is challenging as the number of product model types steadily increases. This paper provides an overview of the current application and scope of product models in engineering design in order to enable a more targeted choice. We provide the necessary theoretical background and discuss the applicability of different classification possibilities in terms of our objectives. Product models are identified within two literature researches and classified according to three main classification criteria.

EVALUATING THE STRUCTURAL COMPLEXITY OF A PRODUCT FAMILY

Rissanen N. E., Malmqvist J., Pulkkinen A. J. / *Tampere University of Technology (FIN)* 1597

Complexity of different systems is often seen as a negative issue in companies because it generates costs. Therefore, the reduction and avoidance of complexity are design strategies for coping with the complexity in product development. This paper presents a method to evaluate structural complexity of a product family at an early phase of the design process. The method is based on Pugh's concept evaluation matrix. In this paper, the criteria for structural complexity evaluation of a product family are defined and the applicability, benefits and limitations of the used method were evaluated.

MODULARITY, VARIANT AND VERSION MANAGEMENT IN PLANT AUTOMATION - FUTURE CHALLENGES AND STATE OF THE ART

Feldmann S., Fuchs J., Vogel-Heuser B. / *Technical University Munich (DEU)* 1689

The software created in plant engineering is modified many times during operation; hence, modularity plays an enormous role for successful engineering and maintenance of automation software. This paper provides a survey on the state of the art, industrial practise and resulting challenges focussing especially on modularity as prerequisite for reuse. Two analyses show the differences between modularity structures in mechanical, electrical and software engineering as well as resulting problems and challenges that need to be solved to prepare a solution for module, variant and version management.

DESIGN METHOD FOR MODULAR PRODUCT-SERVICE SYSTEM ARCHITECTURE

Kimita K., Shimomura Y. / *Tokyo Metropolitan University (JPN)* 979

For achieving a successful product-service system (PSS), stakeholders have to cope with dynamic changes, such as resources, market demands and so on. However, addressing the changes requires much more complex interactions among relevant stakeholders. This study assumes that the modular PSS architecture enables relevant stakeholders to address the complex interactions among them. This paper, therefore, proposes a design method for the determination of PSS modules. The effectiveness of the method is demonstrated by the application, where an e-learning service is used as an example.

INTEGRATING SYSTEMS AND MECHANICAL / ELECTRICAL ENGINEERING - HOW MODEL-BASED INTERFACE MANAGEMENT SUPPORTS MULTI-DOMAIN COLLABORATION

Tristl C., Karcher A. / *Bundeswehr University Munich (DEU)* 1811

By looking at complex systems and their development process within the context of distinct development phases, domains and interacting system elements, Interface Management is a key success factor to avoid system integration issues. Therefore, this paper presents an approach to develop a model-based Interface Management Framework to enhance collaboration between different processes like Systems Engineering and Mechanical/Electrical Engineering on the dimensions Communication, Process, Tool and Product Data, using the emerging methods of Model-based Engineering and Product Lifecycle Management.

VALIDATION OF PRODUCT PROPERTIES CONSIDERING A HIGH VARIETY OF COMPLEX PRODUCTS

Kortler S., Kohn A., Lindemann U. / *Technical University Munich (DEU)* 1731

Validation processes are becoming more and more complex. Due to rising technical capabilities and a wide variety of customer requirements, OEMs are increasing their product variety in order to increase profits. According to the various characteristics of subcontracted components involved in complex products, the product variety can be very high. The impacts of the involved subcontracted components on the composed product variety during the product's application are difficult to predict. This paper presents an approach to help evaluate product properties according to the product's application.

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LIGHTWEIGHT MECHATRONICS DESIGN: AN INTEGRATED APPROACH

Luedeke T., Vielhaber M. / *Saarland University (DEU)*

999

On the first sight, the increasing usage of mechatronics seems to be contrary to the idea of weight reduction. A detailed consideration shows that there are some innovative solutions to lead to a weight optimum with the application of mechatronic components and systems. For this purpose, it is essential to point out the possibility of an integrated product development to create light mechatronic products successfully. In this paper, a first approach for the framework "lightweight mechatronics design" is proposed.

DESIGN FOR INNOVATION

Cantamessa M., Cascini G., Montagna F. / *Politecnico di Torino (ITA)*

747

The paper proposes "Design for Innovation" as a new perspective for design aimed at addressing the multi-actor contexts of the innovation adoption and diffusion processes. Four areas should characterize Needs Identification and Requirements Definition: "Design for Purchasing" (by buyers), "Design for Adoption" (by users), "Design for Impact" (on beneficiaries) and Design for Externalities (on outsiders); neglecting them can kill innovation processes even with promising products. An approach for representing inter-actorial influences on needs and for structuring requirements is hence proposed.

DESIGN FOR MOBILITY - A METHODOICAL APPROACH

Schmidt J., Krüger D., Eilmus S., Paetzold K., Wartzack S., Krause D. / *Bundeswehr University Munich (DEU)*

1101

This contribution describes a framework for the development of mobility supporting products. The holistic approach combines known methods for user integration, digital human modeling and handling variety. By linking these methods together both users' needs and technical aspects can be considered continuously in the design process. As the methods are adjusted to each other, the input and output parameters provide the data necessary for the next step. This improves the acceptance of products, as the individual users' needs are fulfilled more exactly.

THE FOUNDATION FOR ROBUST DESIGN: ENABLING ROBUSTNESS THROUGH KINEMATIC DESIGN AND DESIGN CLARITY

Ebro M., Howard T. J., Rasmussen J. J. / *Technical University of Denmark (DNK)*

817

This contribution argues that prior to using traditional Robust Design Methods, it is essential that attempts have been made to obtain an ideally constrained and unambiguous design, which are both correlated with the robustness of a design. Two methods, Kinematic Design and Design Clarity are described, that quantify the mobility and ambiguity of a design in a simple way, allowing for the methods to be used during early-stage design where design iterations are fast and hence do not allow for more elaborate methods.

NON-PROBABILISTIC UNCERTAINTY ANALYSIS IN EARLY DESIGN STAGES

Eifler T., Wiebel M., Haydn M., Hauer T., Birkhofer H., Bohn A. / *Technical University Darmstadt (DEU)*

827

For the development of robust products, acting disturbances within the product life cycle must be considered. However, well known methods of probabilistic uncertainty analysis often cannot be applied adequately during early design stages. Consequently, appropriate strategies for the analysis of uncertainty are necessary. In this contribution, opportunities for the application of non-probabilistic analysis methods based on structured visualization of life cycle processes and simplified models are shown. Thereby, the contribution focuses on the uncertainty of used models and available data.

MANUFACTURABILITY AND VALIDATION METHODS IN PASSENGER CAR DEVELOPMENT – AN INDUSTRIAL CASE STUDY

Hesse M., Weber C. / *Technical University Ilmenau (DEU)*

929

Through the late advancements in visualisation, simulation and Rapid Prototyping technologies, the field of application of Virtual and Rapid Prototyping techniques for verification and validation has expanded and many different methods have been developed and applied besides the build of physical prototypes. In order to gain better understanding of the validation of manufacturability, this paper introduces a model of validation methods and provides an industrial case study examining problem types occurring throughout automotive product development and production.

Congress Hall Orlando

SESSION D333

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A REVIEW OF STATE OF THE ART AND EMERGING INTERACTION TECHNOLOGIES AND THEIR IMPACT ON DESIGN AND DESIGNING IN THE FUTURE

Boa D., Cash P. J., Hicks B. J. / University of Bath (GBR)

381

Engineering design generates a large quantity of digital and physical information in a wide variety of formats, which can be challenging to manage effectively. Issues with fragmented information, integrating physical and digital information and productivity all contribute to these difficulties. Emerging and state of the art interaction technologies, such as gesture control with the Kinect, offer new ways of interacting with design information. This paper reviews these technologies giving examples of how they are currently used and how they could be introduced into the design process.

3D EXHAUST SYSTEM (MUFFLER) DESIGN TOOL FOR 1D CFD SIMULATION PURPOSES

Tonković D., Putz N., Juretić F. / AVL-AST d.o.o. (HRV)

697

The paper presents a new CFD mesh generation tool, aiming at early stages of automotive muffler design. The design modeling workflow consists of two stages. The sketching stage utilizes a template-based CAD tool optimized for generating muffler geometries while simultaneously setting up additional physical properties. The meshing stage is completely automatic and transfers 3D geometry to a network of 1D cells, by using a polyhedral based cut- cell approach. The tool is designed to be user friendly and interactive, as the targeted users are not experts in modeling complex 3D systems.

CAN COMPUTER GRAPHIC SYSTEM BE USED TO INFORM DESIGNERS ABOUT INCLUSIVITY?

Zitkus E., Langdon P., Clarkson P. J. / University of Cambridge (GBR)

599

The majority of methods currently available to inform designers about accessibility and usability problems is underused in industrial context. This paper analyses an alternative way to advise designers about the features of a new design through Computer Graphic Systems (CGS). However, the use of CGS very early in design activity is not clear. Most cited literature acknowledges its use only at advanced stages of the process. The design activity was investigated to understand the use of these tools by industrial designers and how CGS could be used to inform designers about inclusivity.

PARAMETER-DRIVEN MECHANISM SYNTHESIS IN CAD

Lonij G., Kurtenbach S., Corves B. / RWTH Aachen University (DEU)

523

In this paper we show the design procedures for a six bar linkage of a bottle handling mechanism. The approach provides an interactive model, which includes reusable partial models. Through the CAD system's programming interface parameters are transferred between the partial models. The result is an interactive model, in which dimensions can be changed using simple mouse gestures and results of changes can be reviewed virtually instantaneously. By manipulating adjustable design parameters, required dimensions can be met.

A NEW TOOL FOR IMMERSIVE 3D FREE-FORM SURFACE MODELLING AND REFINING

Arqueros N. J., Prieto P. A., Zúñiga M. D. / Universidad Técnica Federico Santa María (CLE)

365

A new tool for 3D visualization, modelling and refining free-form surfaces is presented. The tool is based on a plug-in developed to exploit the advantages of two commercial products: Autodesk Maya and Leonar3Do Virtual Reality Kit. The stereoscopic visualization feature of Maya and its 3D curve and surface editing functionalities are leveraged by the 3D input that can be delivered by using the 6 degree-of-freedom device provided by Leonar3Do kit. We have used a prototype system to model and modify freeform-based geometries, either constructed in Maya or imported from another CAD package.

A SPINNING-HULL APPROACH PROVIDING RAPID BALANCE CALCULATIONS WHEN MODELLING HUMAN POSTURES

Medland A. J. / University of Bath (GBR)

533

Modeling of the posture of humans may require a search for balance. This is obtained by ensuring that the CofG lies within the convex hull created about the feet. Balance and the shape of the convex hull will change as body parts move. The posture needs thus to be sought by iteration that can require extensive calculation depending on the method used. A new approach has been developed that takes advantage of a constraint modeler to allow a bounding box construction to be spun about its axis to form the hull. This is shown through its geometric construction and a set of manikin examples.

SESSION D334

Congress Hall Konavle

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DESIGN FOR GENDER – A NEW PERSPECTIVE FOR THE DEVELOPMENT OF MACHINES

Hehenberger P., Cojocaru E., Ernst W. / Johannes Kepler University Linz (AUT)

1997

As we know, in most European countries design people from the industrial sector are predominantly male and consequently, the requirements for a new product are defined by men during the design process, even if more women than men will operate the designed machine. In order to identify and define more precisely gender specific requirements of the users the paper shows, where the existence of gender differences in operating the laser cutting and engraving machines will be investigated by means of different methods.

DESIGNING A MODEL OF THE UNKNOWN: ARTISTIC IMPACT IN A CHAIN OF SKILLED DECISIONS

Florin U., Eriksson Y., Orre I. / Mälardalen University (SWE)

1977

This is an investigation of design with informative and explanatory ambitions. The problem area involves possibilities and obstacles that accompany the involvement of artistic knowledge-in-practice in a collaborative design process. A design process in a societal context is explored in this paper. Theoretically this study draws on ideas of the philosopher Hans-Georg Gadamer and also on the analytical concept boundary object developed by the sociologist Susan Star. This investigation displays how sketches and models are functioning as tools for negotiation during a collaborative design process.

FEASIBILITY OF BUILDING LEN LYE'S KINETIC SCULPTURE "SUN, LAND AND SEA"

O'Keefe A. N., Gooch S. D. / University of Canterbury (NZL)

2025

"Sun, Land and Sea" is a kinetic sculpture proposed by world-renowned artist, Len Lye (1901-1980). Lye constructed a model what of he perceived should be built at a much larger size. The sculpture includes long metal strips with induced travelling and static waves. While analysis of the travelling wave is an important part of predicting the shape of the sculpture, it is also vital for establishing 'artistic integrity'. Scaling rules were evolved to determine the structural properties of full size sculpture. The paper concludes that it will be feasible to build a full size "Sun, Land and Sea".

DESIGN RE-THINKING: FROM ITALIAN RENAISSANCE TO STRATEGIC DESIGN ARCHITECTURE

Faroughi A., Faroughi R. / Cologne University of Applied Sciences (DEU)

1967

In this work a new strategic design concept, which organizes and manages complexity and change, is presented. Along the lines of the Italian composer Giuseppe Verdi, the paper first analyzes the past in order to understand the original meaning of design. Based on these findings, it builds a possible system focusing on the basic processes in the past. Finally, the paper combines the past with the current challenges of design and develops the 'Strategic Design Architecture' which aims to manage the current complex design activities.

READY TO USE, EASY TO EVOLVE

McConnell A. F., Spinelli G. / Brunel University (GBR)

2007

Unquestionably age affects a person's ability to use technology, however, older people should not be bound by impairment. Mobile technology can help facilitate the independence of older people; unfortunately, designers often fail to understand their diverse needs and instead develop 'toy phones' for those deemed incapable. This paper offers a view that aims to inform phone design that recognises the diverse desires and capabilities of older users and encourages them to become active users of technology and gain better access to a society, which is increasingly technology driven and dependent.

DESIGNING FOR THE AGEING EXPERIENCE: FRAMEWORK OF INFLUENCES ON ADOPTION AND USE OF TECHNOLOGY PRODUCTS BY USERS IN DIFFERENT LIFE STAGES

Medeiros A. C. B., Mieczakowski A., Clarkson P. J. / University of Cambridge (GBR)

2015

The world population is ageing. At both the individual and collective levels, ageing causes several changes in people's lives that influence their needs, capabilities and attitudes towards technology products. In today's context of technology use, limited functionality is not always an answer to solve all accessibility and usability issues. This paper provides designers and researchers with a framework of seven factors of influence on user experience to help them better understand users' needs, capabilities and attitudes in different life stages and design more inclusive products and services.

Congress Hall Štipun

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THURSDAY, MAY 24					Hours	
REGISTRATION					08:00	
D411 METHODS IN SYSTEMS ENGINEERING	D412 SIMULATION BASED DESIGN	D413 PRODUCT ARCHITECTURE AND FAMILIES	D414 CASE STUDIES ON DESIGN METHODS	D415 DESIGN EDUCATION	08:15	CONGRESS HALL RAGUSA
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					10:00	CONGRESS HALL BOBARA
REFRESHMENT BREAK					10:15	
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D4-P PLENARY SESSION II					10:45	
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LUNCH					12:45	
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D431 ENGINEERING CHANGES AND RISK MANAGEMENT	D432 KNOWLEDGE EXTRACTION	D433 SYSTEMS ARCHITECTURE	D434 FUNCTIONAL REASONING	D435 LIFE SCIENCE AND DESIGN FOR HEALTHCARE	14:30	
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REFRESHMENT BREAK					16:15	
					16:30	
CLOSING					16:45	
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FAREWELL PARTY					19:30	



CORRELATION OF STRUCTURAL CHARACTERISTICS OF PRODUCT DESIGN STRUCTURE MATRICES

Biedermann W., Lindemann U. / Technical University Munich (DEU) 1657

Structural analyses are widely accepted as a major tool in early design phases. However, due to recent advances in graph theory such as motif analysis an almost infinite number of analysis criteria is available. In this paper we show that the number of criteria can be drastically reduced when taking the modelled system into account. We perform a comprehensive analyse of 35 product structures using 26 analysis criteria. Using correlation analysis and data clustering we show that the set of analysis criteria can be reduced to eight criteria which possess the same analytical capabilities.

DEVELOPMENT OF SYSTEMS THINKING IN MULTI-DISCIPLINARY TEAM INTERACTION: TWO CASES FROM SPACE INDUSTRY

Moser H. A., Ziegler G. D. S., Blessing L., Braukhane A. / LuxSpace (LUX) 1929

Systems thinking of individuals and collectives is a prerequisite for systems engineering. Requiring a team of specialists from multiple disciplines, such as mechanics, software, radio-frequency, electronics, and finance, interactions in systems engineering are multi-disciplinary. Within an activity theoretical framework a content analysis of two multi-disciplinary interactions in different lifecycle phases of two space missions is presented. It is shown that interaction with extra-disciplinary team members results in improved systems thinking.

PROPOSAL FOR FUNCTIONAL PRODUCT DESCRIPTION AS PART OF A PLM SOLUTION IN INTERDISCIPLINARY PRODUCT DEVELOPMENT

Eigner M., Gilz T., Zafirov R. / Technical University Kaiserslautern (DEU) 1667

The transparency between disciplines in engineering is not sufficient. Within modern products interdisciplinary collaboration is important. This paper presents a concept that addresses this problem on two fronts. On the one hand, the concept of model-based Systems Engineering has been used to define a so called Functional Product Description which is suited for discipline-independent product specification. On the other hand a data schema has been defined, which enables the integration of Functional Product Description models in PDM in order to properly support the engineering process.

A FRAMEWORK FOR MODEL-BASED SAFETY ANALYSIS OF COMPLEX ENGINEERED SYSTEMS

Mehrpouyan H., Kurtoglu T., Bunus P. / Palo Alto Research Center (USA) 1753

Identifying detrimental effects of environmental factors and system component interactions are historically one of the most challenging aspects of early hazard assessment in the design of complex systems. This paper introduces a model-based technique that is developed to help designers and systems engineers perform safety analysis in the early stages of the design process in order to identify and mitigate hazardous interactions between system components. Application of the presented method to a SUV Power subsystem demonstrates the capabilities of the proposed method.

MANAGEMENT OF CROSS-DOMAIN MODEL CONSISTENCY FOR BEHAVIORAL MODELS OF MECHATRONIC SYSTEMS

Rieke J., Dorociak R., Sudmann O., Gausemeier J., Schäfer W. / University of Paderborn (DEU) 1781

Mechatronic system development requires a close collaboration of different domains. After the system's conceptual design is created, the domains work in parallel using domain-specific models. Later changes to a domain-specific model may or may not affect other domains. To allow synchronizing these models, we present an improved synchronization technique that can distinguish between domain-spanning relevant changes and non-relevant, domain-specific refinements. We illustrate the technique using behavioral models of the innovative railway transport system RailCab.

DELIMITING STRUCTURAL AND DYNAMICAL SYSTEM ANALYSIS IN ENGINEERING MANAGEMENT

Biedermann W., Diepold K. J., Lindemann U., Lohmann B. / Technical University Munich (DEU) 1649

Modelling the dynamic behaviour of products is one of the key issues in engineering management. As the modelling requires lots of data and effort ways to predict the behaviour a priori are sought. In this paper we test if structural analyses allow for predicting product behaviour in change management. We use an simulation approach and compare the simulation results to structural analysis. Our results show that some product components behave very variable. Yet, the structural analyses do not allow for identifying these a priori. They allow for identifying components with predictable behaviour.

Congress Hall Ragusa

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APPLICATION OF SENSITIVITIES ON SIMULATION-DATA-BASED METAMODELS DURING THE PRODUCT SYNTHESIS

Ziegler P., Breitsprecher T., Walter M., Westphal C., Wartzack S. / Friedrich-Alexander University Erlangen (DEU)

589

This research work focusses on a methodology to support the product developer at the product synthesis, which can be implemented in a design support tool. The method uses metamodels, which can predict product properties from combinations of characteristics. Calculating the metamodels bases on simulation data. The method uses sensitivity analysis due to SOBOL, as well as derivation-based sensitivity. The sensitivity analysis can be used for optimization and robustness analysis. The specific feature is that for the robustness analysis no distributions of the characteristics are necessary.

SIMULATION BASED AUTOMATED DESIGN TO COST OF STRUCTURALLY COMPLEX PRODUCTS

Frank G., Hillbrand C., Schwarz M. / V-Research GmbH (AUT)

435

For enterprises that operate in markets, where customer needs can only be fulfilled with highly individual and therefore with a high variety of products, it is important to find ways of reducing the designing and manufacturing costs. This paper presents a Knowledge Based Engineering approach to help solving such challenges. By automating the creation of new and the adaption of existing assemblies, including their structural analysis, the complexity of design processes is decreased and speeded up significantly. The development of a standardized part set reduces manufacturing costs considerably.

TOWARD SIMULATION-BASED MECHATRONIC DESIGN

Dohr F., Vielhaber M. / Saarland University (DEU)

411

The paper deals with model- and simulation-based mechatronic design, which is seen as a key factor in coping with future challenges in design. Different design methodologies from mechanics, electronics, computer science and mechatronics itself are analyzed with regard to their applicability for model- and simulation-based design. Based on this analysis a basic framework is derived, consisting of six viewpoints on mechatronic design. One of these viewpoints, the process view, is described in more detail based on the common V-model, which is extended by simulation phases.

CAD BASED SIMULATION OF ULTRASONIC SHOT PEENING PROCESS

Badreddine J., Remy S., Micoulaut M., Rouhaud E., Desfontaine V., Chateau F., Doubre-Baboeuf G., Renaud P. / Sonats (Europe Technologies Group) (FRA)

373

The paper presents a CAD based model for UltraSonic Shot Peening (USSP) that allows conducting an accurate simulation of the process for complex mechanical parts. The analytical model, on which the CAD model is based, is also presented. The purpose of such models is to provide a tool for the choice of ultrasonic shot peening process parameters and chamber designs. At this day, there are no tools for this purpose, other than the designer's experience. Such models can also provide a visual feedback for the designer, arising from the USSP model calculations, directly onto the CAD geometry.

GENERATING SIMULINK AND STATEFLOW MODELS FROM SOFTWARE SPECIFICATIONS

Heinzemann C., Pohlmann U., Rieke J., Schäfer W., Sudmann O., Tichy M. / University of Paderborn (DEU)

475

Much of the innovation in today's technical systems is only possible by the use of embedded software. This is especially true in the case of system of systems where autonomous systems coordinate using complex message- based communication protocols. MechatronicUML is a modeling language for these systems that exploits formal methods to verify that safety requirements are always satisfied. In this paper, we present how we integrate MechatronicUML in the Simulink tool chain by means of model generation. We specifically discuss how the verified behavior is preserved in the generated models.

USE OF METHODS OF SENSITIVITY ANALYSIS FOR SIMULATION PLANNING

Reitmeier J., Paetzold K. / University of the Bundeswehr Munich (DEU)

551

Sensitivity analyses focus the parameter sensitivity of a solution providing both quantitative and qualitative conclusions. They aim to increase the confidence in a model and associated statements and analyse the extent to which model results are dependent on changing input parameters. This is an adequate way to show the designer how to effectively improve his solution. The objective of this contribution is to describe and discuss the ability to integrate sensitivity analyses closer into the development process based on the categorisation of product data in characteristics and properties.

SESSION D412

Congress Hall Bobara

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EVALUATING A METHODOICAL APPROACH FOR DEVELOPING MODULAR PRODUCT FAMILIES IN INDUSTRIAL PROJECTS

Eilmus S., Gebhardt N., Rettberg R., Krause D. / *Hamburg University of Technology (DEU)* 837

The Integrated PKT-Approach for Developing modular Product Families aims at reducing internal variety by offering support through the method units Design for Variety and Life Phases Modularization. In 10 industrial case studies this approach was evaluated in terms of applicability, usefulness and usability. The evaluation procedure includes results derived by experienced as well as unexperienced method users. Showing that the approach serves the reduction of internal variety in both cases, still need for further research concerning a broader applicability and higher usability is derived.

OPTIMIZING SYSTEM ARCHITECTURE FOR ADAPTABILITY

Engel A., Reich Y., Browning T. R., Schmidt D. M. / *Texas Christian University (USA)* 1677

System architecture decisions such as the assignment of components to modules can have a large impact on the System's adaptability. We broaden systems architecting theory by considering components' option values and interface costs when making the assignment decision. We build and test an analytical model to identify the tradeoffs between an inexpensive but unadaptable system and an expensive but adaptable one. We demonstrate the model with a realistic example of an Unmanned Air Vehicle (UAV) and use a genetic algorithm to identify an architecture that optimally balances cost and adaptability.

METHODOLOGIES TOWARD PRODUCT ARCHITECTURE IMPROVEMENT IN THEORY AND PRACTICE

Heilemann M., Schlüter M., Culley S. J., Haase H. -J. / *Bosch GmbH / University of Bath (DEU)* 919

The purpose of this paper is to show the aspects to consider and on which aspects to focus during product architecture optimization. Aspects which are considered as important for industrial practitioners were collected and compared to implemented measures in industrial organizations. The identified aspects and implemented measures in industry were cross-compared to approaches in literature. The study shows that practice and literature have the same focus aspect. However, it also reveals that there is a large difference in the coverage of all other aspects.

OPTIMAL DESIGN OF MODULAR CONFIGURATION CONSIDERING HIERARCHY OF A PRODUCT FUNCTION STRUCTURE

Kobayashi M., Matsumoto Y., Higashi M. / *Toyota Technological Institute (JPN)* 989

This paper proposes a new optimal design method of a modular configuration considering hierarchy of a product function structure. In the proposed method, modules are configured based on a product function structure unlike existing method and their configurations are optimized by using hierarchical genetic algorithm. As for the objective function, contribution of each module to improvement of recyclability, reusability and maintainability is evaluated. Using the proposed method, optimal and feasible modular configuration considering whole product lifecycle can be obtained.

PLANNING DESIGN AUTOMATION SYSTEMS FOR PRODUCT FAMILIES - A COHERENT, TOP DOWN APPROACH

Sunnersjö S. / *Jönköping University (SWE)* 123

Design automation, DA, is a computer based method to solve tasks in engineering design. The method can be applied to original design work, but is much more widespread for use in variant design. The purpose of this paper is to present a coherent path through the critical points when planning a DA system. The approach is top-down with the requirements and problem characteristics first being clarified, whereupon selection of methods of implementation follows. By applying the methods described much of the uncertainty associated with building complex DA-systems can be eliminated.

PRODUCT STRUCTURE MANAGEMENT AS THE BACKBONE OF ENGINEERING DESIGN: EXPLORATION OF A REFERENCE MODEL

Kissel M., Bradford N., Kreimeyer M., Lindemann U. / *Technical University Munich (DEU)* 1709

In automotive industry, systems engineering - especially product architecture design- gain in prominence in order to cope with challenges of today's markets. Complexity of portfolios and customization are drivers for this development. To keep a product portfolio manageable high effort is required to adapt the organization, roles, responsibilities, tools and methodologies. In this paper, an approach of integrating architectural design activities using a product structure model as backbone for engineering design processes is proposed. A case study was conducted and results are discussed.

Congress Hall Orlando

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DESIGNING MATERIAL STANDARDS

Stolt R. / Jönköping University (SWE)

1133

Material standards are currently developed though building consensus and voting in organisations like ISO and ASME. If these organisations adopted methods from design in the development process of standards, the user perspective could be added greatly improving the usefulness of the standards. This paper attempts to find the user requirements on material standards and evaluates how well it has been met in four different existing standards. The result is that the end user perspective has been forgotten to a varying extent, leaving plenty of room for improvements which is discussed in the paper.

CREATING AWARENESS ON NATURAL FIBRE COMPOSITES IN DESIGN

Taekema J., Karana E. / Delft University of Technology (NLD)

1141

Natural Fibre Composites (NFCs) have noteworthy environmental, cost and performance related superiorities for products. However they are not widely recognised and applied in product design. Delft University of Technology, with a support from Dutch Government (AgentSchap NL), has initiated a foundation of a knowledge platform for creating awareness on NFCs among Dutch designers to increase the application possibilities of NFCs. This paper presents the development and application of NFC Design Tool Kit as a part of the platform activities to provide product designers with variety of information regarding different types of NFCs and to inspire them to consider NFC materials in their designs.

ACCESSABILITY TO MATERIAL INFORMATION BY USING STANDARDIZED MATERIAL NOTATIONS

Janus A., Kirdar C., Staeves J., Tartler D., Wartzack S. / BMW Group (DEU)

647

New challenges in the automotive industry require new, detailed and complete material information along the product life cycle. Several facts complicate the finding of the required information. The main reasons are the distributed information sources and the heterogeneous material notation systems. This work presents an industry study on the biggest difficulties in collecting the required information. In addition two different approaches are presented: Creating a master data base according to VDA 231-200 and standardization of the material notations without changing the original data.

APPLICATION OF THE MECHATRONIC-SYSTEM-MODEL-APPROACH FOR THE DEVELOPMENT OF AN INDUSTRIAL ANNEALING SIMULATOR

Follmer M., Hehenberger P., Zeman K. / Johannes Kepler University Linz (AUT)

637

Currently, there is a critical lack of methods as well as software-tools supporting the inter-disciplinary aspects of the development process of mechatronic products, especially in the conceptual design phase. Mechatronic System Models (MSM) can improve this unsatisfactory situation and allow for a holistic view on complex mechatronic systems. Additionally, they should provide the possibility to execute several simulations on the system-level. In this paper the MSM-Approach was applied to an already finished industrial project that involves the further development of an annealing simulator.

A REVERSE ENGINEERING APPROACH TO ENHANCE MACHINERY DESIGN FOR SAFETY

Fargnoli M., Vita L., Gattamelata D., Laurendi V., Tronci M. / Ministry of Agriculture (ITA)

627

Awareness of the importance of safety in the agriculture and forestry fields has been growing both among equipment manufacturers and users due to the always large number of accidents. A research work was carried out in order to design and develop a non foldable ROPS for narrow-track tractors, i.e. a novel model of non foldable ROPS, called CROPS (Compact Roll-Over Protective Structure), which provides rollover protection all the time without making agricultural works more difficult. For this purpose, a reverse engineering methodology was adapted to design for safety traditional procedures.

CASE EXAMPLE IN SYSTEMATIC DESIGN ENGINEERING - PROPELLER SHAFT BEARING ARRANGEMENT

Eder W. E. / Royal Military College of Canada (CAN)

617

Engineering Design Science enables prescription of a systematic method for the design process, followed in this case example. The creative search for solutions can be helped by this systematic and methodical approach, which encourages full documentation of the thoughts, alternatives and decisions. This case example applies the recommended method, and shows the scope of the output, with emphasis on conceptualizing. The novel design problem is an unconventional propeller drive shaft and thrust bearing arrangement for a motorized replica sailing barge.

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CREATING A RESEARCH ENVIRONMENT FOR THE EVALUATION OF DESIGN EDUCATION IN EMBODIMENT DESIGN

Spitas C., Badke-Schaub P., Spitas V., Rajabalinejad M., Karana E. / *Delft University of Technology (NLD)*

2075

In this paper we present a theoretically motivated and evaluation-centred research approach which aims to analyse behaviour patterns of students when dealing with complex problems in embodiment design. In the following sections some basic propositions are presented which are seen as determinants for deciding where to start from, what to prioritise and underlying the design activity. Rather than to make claims or generalise the findings to a real design process, we focus on the proposition of a more comprehensive measurement method for the evaluation of design education than what is currently the state of the art.

LEARNING ACTIVITIES THAT IMPROVE THE DESIGNERS SOCIAL SKILLS?

Holmqvist J., Ericson Å., Wenngren J. / *Lulea University of Technology (SWE)*

2059

Engineers have to develop their social skills due to being exposed to new types of problems and situations as a result of manufacturing companies' movement towards providing systematic solutions e.g., product-service systems. The authors assume that PSS-development relies on engineers' capability to explore the users context and identify their goals. Collaborative design activities are difficult experiences that need to be practiced. The paper suggest to offering students in engineering education new learning activities and assigning them to new types of teamwork, solving open-ended problems.

PROJECT ORIENTED LEARNING ENVIRONMENT, BRIDGING ACADEMIA AND INDUSTRY

Holliger C., Flores R. I., Monterrubio C., Stroschein S. / *University of Applied Sciences (CHE)*

2053

The Project Oriented Learning Environment (POLE) is an educational paradigm which brings together students and faculty of an international network to work on real industrial tasks. The heterogeneous teams not only differ in cultural background but are also mixed with respect to their disciplines. The paper describes the POLE platform, discusses insights gained during the ten years of its existence and some methodological improvements. Furthermore, a web-accessible data base (Library for Advanced Knowledge Environments, LAKE) is described which allows for analyses of decision taking processes.

JOINED-UP DESIGN: UNDERGRADUATE TECHNICAL SKILLS AQUISION

Porobic S., Schaber F. / *The University of Northampton (GBR)*

2067

The "Joinedupdesign for Academies" programme aims to promote a collaboration between design students and secondary school pupils, leading to regeneration of school campus and surrounding community in the United Kingdom. This paper is reporting on the engagement of the University of Northampton with the programme and details the reflections of the participating mentor, a chartered architect, in view of technical skills acquisition, CAD competencies. Students greatly benefit from the opportunity to take their current skills and develop them further within a practical and realistic setting.

THE AMBIGUOUS ROLE OF METHODS IN DESIGN EDUCATION: INITIAL FINDINGS FROM THE DELFT METHOD STUDY

Daalhuizen J., Person O., Gattol V. / *Delft University of Technology (NLD)*

2035

A design method is often portrayed as something a designer can follow—like a road—to reach a predetermined outcome. This view raises the expectation that any designer is able to successfully apply a method in the intended way (and favors to do so), regardless of the problem at hand. But is this expectation realistic? In the present study, we analyzed method usage of 213 design students taking part in a design exercise. We present four distinct profiles in terms of students' process experiences: individual differences in method usage are vital in understanding the role methods play in design.

REVISITING PROTOTYPING - LEARNING IN EARLY DESIGN

Ericson Å., Håkansson A., Öhrling D. / *Lulea University of Technology (SWE)*

2045

The vision for manufacturing firms to provide more services certainly include more intangible and tacit parameters for engineers to handle. Hence, the early development stages describe a learning process where knowledge and solution progress in parallel. The purpose of this paper is to discuss how designer's learning in practice could be supported by applying rough prototyping methods. The paper suggests that sketching techniques like novel visualization should be trained more often, that is the designer transforms a verbal description into a sketch, for example to visualize a user statement or need. Also, the paper exemplifies how rapid prototyping has been used to communicate with users.

Congress Hall Šipun

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LEAN IN PRODUCT DEVELOPMENT

Nilsson C. / *SCANIA (SWE)*

Scania has taken another step in becoming a lean product development organization. The aim is to be able to meet the customers' demands even faster and continuously improve the quality and secure innovations at an early stage. To succeed with this, high emphasis is put on an active and present leadership every day. The Scania Product Development Process has main areas: Concept Development, Product Development and Product Follow-up. Our Concept Development is characterized by being iterative with the aim to secure a technical concept. The work is done in small experienced teams and is focused on finding the right concept solution. By working in this way we are able to create an environment that inspires innovation. Our Product Development is characterized by delivering quality on time, the aim is that 9 out of 10 projects finalize on time. Our Product Follow-up is focused on quickly solving unexpected problems that occur in the field. Visual and every day management is an essential part of our strive to become successful. Principles guide the organization. Empowerment and involvement of every individual are in focus and our leaders are actively involved in the every day work. In practice, our engineering teams meet every morning to follow-up yesterday's deliveries and to plan today's work. Clear objectives are important so everyone knows what to do and at the same time we empower individuals to make decisions within their own area of competence. A clear and solid escalation routine applies when we are not able to meet our daily commitments. A well integrated work with continuous improvements puts the basis for further improving the quality. Scania does not have a quality department, but better everyone is responsible for the quality and to make improvements. This way we proudly can see that every truck that leaves the production line is a little bit better than the previous.

SYSTEMS ENGINEERING VS. DESIGN - DIFFERENCES, COMMONALITY AND OPPORTUNITIES

Schulze S. -O. / *German Chapter of INCOSE (DEU)*

The Engineering society and profession is undergoing changes and is more and more influenced by market needs, wishes and going global. This is independent of branches and industries and further driven by the internal company and enterprise history and strategy as well. The presentation will give a short overview about the Systems Engineering approach and definition and will compare it with the authors understanding of design and product development based on the practical experience from different industries. It has to cover the life-cycle from market need until disposal and taking into account the processes, methods and tools including the human factor within this time frame. It will show the commonalities and differences as well as the opportunities for our engineering future to satisfy the changes and drive them instead of following the program and product managers' directives. The presentation will provide a proposal to bridge the methods and all other mentioned technics to handle complexity and the model based Systems Engineering approach.

THE DESIGN DEBATE

Moderators: Professor Steve Culley (GBR)/Dr. Tom Howard (DNK)

This is a new innovation for DESIGN 2012. Organizers and debaters expect the audience will actively and lively participate in this event that is organized for the first time and hopefully not the last time at DESIGN conference. The purpose of the debate is to investigate in a forensic manner some key topics that affect the engineering design research community. This will be achieved by key players in the community presenting evidence for or against a particular topic.

Topic: "Design Research should be about developing new products, technologies and services, not theories, models and methods"

Format: The topic will be proposed and then opposed in detail by eminent members of the Engineering design research community (8 minutes each), Supporting statements, seconding the two viewpoints will then be given (4 minutes each). The floor (the audience) will then be asked to question the proposers and opposers. There will also be an opportunity to present additional viewpoints and positions on the topic. Preference will be given to those who have submitted to the moderators in advance. A vote will then be taken to see which side has "won" the debate.

Congress Hall Ragusa

SESSION D4-P

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CHARACTERISTICS OF SUCCESSFUL RISK MANAGEMENT IN PRODUCT DESIGN**Olechowski A., Oehmen J., Seering W., Ben-Daya M. /***Massachusetts Institute of Technology (USA)***269**

The paper reports results of one of the largest empirical studies to-date on the impact of design risk management practices on product design success. Through a survey of 224 practices, 38 (in 7 categories) were found to be statistically significant for at least 3 out of 4 performance metrics. The categories are: 1. Organizational Design Experience; 2. Risk Management Personnel and Resources; 3. Tailoring and Integration of Risk Management Process; 4. Risk-Based Decision Making; 5. Specific Mitigation Actions; 6. Monitoring and Review; and 7. Other ISO Risk Management Principles.

INTEGRATING STRUCTURE AND UNCERTAINTY MODELING USING MULTIPLE-DOMAIN-MATRICES**Neumann M., Sadek T., Labenda P., Herzog M. / Ruhr-University of Bochum (DEU)****1771**

New product development is characterized by uncertainties that are the result of insufficient experience and incomplete information, finally leading to risks. With increasing product complexity, uncertainties are often not restricted to the point of their occurrence. Instead, the appearance of uncertainties causes new uncertainties that are explainable by the existence of interdependencies between product and process elements. In order to analyse uncertainty propagation, the concept for an integrated uncertainty and structure model is presented that is based on Multiple-Domain Matrices.

MULTI-LAYERED CHANGE: ENGINEERING CHANGE IN BUILDING REFURBISHMENT**Garthwaite P. M., Eckert C. M. / The Open University (GBR)****161**

This paper adopts an engineering change approach to the investigation of a hospital refurbishment case-study and examines how change unfolds under the varied constraints of a one-off project. The research identifies specific change mechanisms and finds that constraints are negotiated in ways not necessarily possible in engineering. The paper develops a multi-layered model ("use", "building", "process" and "governance") to show how changes can be initiated, propagated or mitigated within or between layers, making building refurbishment change a more malleable challenge than engineering change.

MAPPING RISKS IN PRODUCT DEVELOPMENT**Škec S., Štorga M., Stanković T., Marjanović D. / University of Zagreb (HRV)****311**

Paper introduces Risk breakdown structure created by concerning different internal and external sources of risks during product development. The identified risks are mapped to PD process models in order to provide insight in frequency and understanding of certain risk categories as the basis for a valid comparison of different types of PD process. To validate mappings, questionnaire was sent to product/service development companies and results were analyzed based on the risk type occurrences.

EXPLORING DIFFERENCES BETWEEN AVERAGE AND CRITICAL ENGINEERING CHANGES: SURVEY RESULTS FROM DENMARK**Langer S., Maier A. M., Wilberg J., Münch T. J., Lindemann U. /***Technical University of Denmark (DNK)***223**

Engineering change management plays a vital role in product development and innovation processes. This paper explores potential differences between average and critical changes. Data was elicited through an industry survey conducted with more than 90 engineering firms in Denmark. Results cover occurrence, objectives, initiators, causes, and effects of ECs on product, process, people, and cost. Where appropriate, we differentiate between firms with a higher and lower amount of critical changes. Results show, for example, that critical changes have a high affiliation to change propagation.

DETERMINING THE DRIVERS FOR LONG LEAD TIMES OF ENGINEERING CHANGE ORDERS: A DATA MINING APPROACH**Sharafi A., Elezi F., Zuber F., Wolf P., Krcmar H., Lindemann U. /***Technical University Munich (DEU)***299**

In the automotive industry engineering change orders (ECOs) are responsible for a high proportion of development costs. An inefficient handling of them prolongs the time to market, which is widely regarded to be a key competitive factor and a cost driver. This paper points out which drivers are causing high process times by applying knowledge discovery and data mining methods using data of a European car manufacturer and comparing the outcome with theoretical drivers derived from literature. In addition the impact of product complexity and dependencies between different products is explored.

SESSION D431

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PROCEDURE FOR DERIVING A TARGET KNOWLEDGE-BASE FOR COMPANIES TO EVALUATE KNOWLEDGE FOR PRODUCT DEVELOPMENT

Roth D., Binz H. / *University of Stuttgart (DEU)*

1605

The long-term objective is to offer a method for the evaluation of knowledge within the product development. The intention of this paper is to propose a procedure for deriving a target-oriented knowledge base, related to a formerly developed general structuring model (GSM). For this, knowledge types have been identified with respect to their capability of being represented in semantic networks. Receiving a semantic network for those knowledge types allows the reduction of the GSM by taking constraints of companies into consideration.

KEY ISSUES IN THE TAKE-UP OF KNOWLEDGE MANAGEMENT INTERVENTIONS IN ENGINEERING DESIGN

Carey E., Culley S., McAlpine H., Weber F., Xie Z. / *University of Bath (GBR)*

1405

Engineering Design (ED) projects are typically large, encompass transnational multi discipline teams, spanning many years, developing complex products. Thus Knowledge Management (KM) information systems for ED face additional issues. These factors contribute to difficulty in user take-up of support systems. Key issues from literature are first ranked, then a case study of a KM intervention within an aerospace company is used to validate a list of key requirements for IS development within this domain. Further work to develop a model for standard requirements for KM support systems for ED follows.

REQUIREMENT ANALYSIS FOR CONTEXTUAL MANAGEMENT AND SUPPLY OF PROCESS- AND DESIGN KNOWLEDGE – A CASE STUDY

Luft T., Wartzack S. / *Friedrich-Alexander University Erlangen (DEU)*

1515

This paper provides a methodology for analysing requirements for a knowledge management system that consists basically of a management and search functionality. On basis of a theoretical developed methodology, a requirement analysis for a knowledge management system in an industrial case study is presented. Therefore an analysis of the knowledge and information basis as well as of the needs and mentalities of employees is conducted. As a result all requirements for the management functionality and the search functionality of a holistic knowledge management system are identified and described.

A CONCEPTUAL FRAMEWORK TO SUPPORT ENGINEERING DESIGNERS IN USING IN-SERVICE INFORMATION

Jagtap S., Johnson A., Larsson A. / *Lund University (SWE)*

1465

In the global market of air transport, the integration of products and services is seen as being necessary for the long-term success of engine manufacturers. A flow of in-service information to designers is crucial for minimising in- service issues. A literature review showed that there are no studies that have proposed or developed methods or tools to support designers in using in-service information in a design task. The work presented in this paper aims at proposing a framework to support designers in using in-service information in a design task.

CAPTURING THE FLOWS OF THE PRODUCT PROCESS

Pakkanen J., Becker I., Lehtonen T., Juuti T. / *Tampere University of Technology (FIN)*

1557

Research question of the paper is: How to analyse the information completeness in the product process? This paper represents an approach to connecting information flow thinking with maturity analysing of the information. Approach was discussed in a car manufacturing case context. The issues which are important in information flow modelling were identified: information elements, tasks and their relations. Information flow modelling was tested in the case company. Concept that would facilitate the analysing of maturity of information elements using measuring agents was drafted.

MULTIDIMENSIONAL SYSTEMS OF CONCEPTS – AN APPROACH FOR A BETTER COMMUNICATION IN THE PROCESS OF REQUIREMENT ACQUISITION

Röder B., Dietrich C., Birkhofer H., Bohn A. / *Technical University Darmstadt (DEU)*

1091

Requirement acquisition is one of the most important, but also the most difficult processes in the entire product development. Many errors in the process of requirement acquisition do not arise out of technical orientated wrong decision or due to a lack of expertise, but because of communication problems between customers and developers or between several developers. The aim of this paper is to expand the basic idea of systems of concepts and to integrate it into the process of requirement acquisition by using the idea of OLAP data cubes and expanding it to "Term Cubes".

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EVALUATION OF ARCHITECTURE OPTIONS IN SYSTEMS ENGINEERING

Schrieverhoff P., Bender T., Kissel M., Lindemann U. / *Technical University Munich (DEU)* 1791

All systems and products are designed to fulfil the needs of their stakeholders. Those needs evolve over time, though, and thus products that can be adapted to altered demands and boundary conditions most flexibly will have an increased life cycle value to the stakeholder. On the other hand alterations in product architecture lead both to engineering effort as well as to cost associated with physical changes in the design. This paper examines the valuation of adaptability options in order to support the engineering decision towards or against their inclusion on a product architecture level.

PRODUCT ARCHITECTURE GENERATION AND EXPLORATION USING BAYESIAN NETWORKS

Moullec M. -L., Bouissou M., Jankovic M., Bocquet J. -C. / *Ecole Centrale Paris (FRA)* 1761

Conceptual design of complex product begins with generation and exploration of possible architectures. This process starts from a large set of potential solutions that is progressively focused towards the most promising solutions. In practice, there is not enough time and resources to envisage all solutions. The purpose of this paper is to propose an architecture generation and exploration method that is based on Bayesian nets in order to automatically generate a large set of solutions, taking into account various constraints: components compatibility, required performances and uncertainty.

A PRODUCT MODEL TO SUPPORT PLM-BASED VARIANT PLANNING AND MANAGEMENT

Kreimeyer M. / *MAN Truck & Bus AG (DEU)* 1741

This paper presents an industrial approach for a consistent product structure intended to support variant planning and variant management in commercial vehicle design. It was developed to serve three main purposes: To support the planning and documentation of all activities in engineering design in a consistent and traceable manner, to define – step by step variants as part of new design projects, and to help harmonize the different development processes of the company's different divisions (truck, bus, and engine design). The model is illustrated with an example from these processes.

TOWARDS A STRATEGIC DEVELOPMENT OF MODULAR PRODUCT PROGRAMS

Jonas H., Gebhardt N., Krause D. / *Hamburg University of Technology (DEU)* 959

In product development, balancing individual customer requirements and reducing internal product variety is crucial for the producing company. Common methods like Design for Variety and Modularization are mostly applicable to small product families. This is a barrier towards program-wide carryover components. Also, a successful product development should point at the future structure of the product program, since meanwhile the market requirements might change. In this paper, a new method for Product Program Development consisting of a product planning- and structuring phase is presented.

ON THE MARKET ASPECT OF PRODUCT PROGRAM DESIGN: TOWARDS A DEFINITION OF AN ARCHITECTURE OF THE MARKET

Hansen C. L., Mortensen N. H., Hvam L. / *Technical University of Denmark (DNK)* 1699

This paper will propose to expand the existing notion of coordinating product and production architectures as a means to develop profitable architectures by including an architecture of the market. This is to be interpreted as the 'market perspective' of the product family referring to the design of the product family from the market's point of view. The main result of this paper is the suggestion of a definition of a market architecture with an articulation of its elements, relations, hierarchical nature and raison d'être.

A NEW INTEGRATED APPROACH TO IMPROVE THE ROBUSTNESS OF COMPLEX MULTI-DISCIPLINARY SYSTEMS

Sop Njindam T., Paetzold K. / *Bundeswehr University Munich (DEU)* 1803

As technology evolves, the integration of information processing and other software components into our daily products is becoming common place, turning them into multidisciplinary systems. These technological advances probably impact the susceptibility of these products to fail. The approach we present to improve the robustness of complex multidisciplinary systems is based on the integrated modeling architecture which covers system viewpoints such as requirements, structure, function, behaviour with the objective of detecting and fixing design flaws which may worsen the system robustness.

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Wednesday

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Thursday

14:15-16:15

OPTIMIZATION APPROACH FOR FUNCTION-PARTITIONING IN AN AUTOMOTIVE ELECTRIC ELECTRONIC SYSTEM ARCHITECTURE

Brandt L. S., Krämer N., Metzger J., Lindemann U. / *BMW AG (DEU)*

737

The objective of this article is the development of a cost optimization approach for function-partitioning of an EE- system-architecture (EE-SA) taking technical and economic factors into account. Next to cost-reduction, the optimization approach aims at reducing the existing EE-SA complexity. Its result forms the basis for structuring the future EE modular construction set development and its integration into an EE-SA. The article is an intermediary result. The approach and its findings are open for discussion to achieve further improvement and validation within the scientific environment.

FBS LINKAGE MODEL – TOWARDS AN INTEGRATED ENGINEERING CHANGE PREDICTION AND ANALYSIS METHOD

Hamraz B., Caldwell N. H. M., Clarkson P. J. / *University of Cambridge (GBR)*

901

Engineering changes are unavoidable and cause severe problems through propagation. This paper presents a framework aimed at improving engineering change management through integration of product and process domains. The framework suggests modelling of engineering changes by using the FBS model in the product domain, the Applied Signposting Model in the process domain, and parameters to integrate both. Subsequently, this paper elaborates the first building block of the framework – a novel, multi-layered change prediction and analysis method in the product domain based on the FBS model.

NEW INSIGHTS ON THE CONTACT&CHANNEL-APPROACH - MODELLING OF SYSTEMS WITH SEVERAL LOGICAL STATES

Matthiesen S., Ruckpaul A. / *Karlsruhe Institute for Technology (DEU)*

1019

The paper is about the description of logical states with the Contact&Channel-Approach. The approach supports designer during the product development process by enabling to model the connection between functions and embodiment design. Up to now, it was only possible to describe technical systems which were either static or dynamic but with chronological sequences of states. It is presented how the Contact&Channel-Approach can be extended for systems with different logical states in theory and an industrial application of the new extension shows the necessity and the resulting advantages.

EMBODIMENT DESIGN BASED ON BASIC SCHEMATA

Žavbi R., Fain N., Duhovnik J. / *University of Ljubljana (SVN)*

1225

A series of experiments to shed light on usefulness of a computer tool was started. The first experiment showed that there is statistical significance in variety of design concepts generated by the control group and the experimental group. But, industrial designers (not only engineering designers) might generate different solutions and should also be taken into consideration. A partial experiment was designed and performed to obtain solutions generated by (student) industrial designers and compare them with the solutions generated by the experimental group during the first experiment.

FUNCTIONAL MODELLING PERSPECTIVES ACROSS DISCIPLINES: A LITERATURE REVIEW

Eisenbart B., Blessing L., Gericke K. / *University of Luxembourg (LUX)*

847

The research presented in this paper discusses the different understandings of function which hamper shared functional modelling. Function models proposed in literature from various disciplines are then analysed, in order to identify the different inherent functional modelling perspectives. The paper concludes that in order to support shared functional modelling and to support cross-disciplinary system development, these different functional modelling perspectives need to be linked.

A FRAMEWORK FOR DESCRIBING FUNCTIONS IN DESIGN

Srinivasan V., Chakrabarti A., Lindemann U. / *Technical University Munich (DEU)*

1111

Providing common views to describe function will improve its understanding and usage. The aim of this research is to develop and theoretically validate a framework comprising the different views of function. Abstraction level, requirement-solution, system-environment and intended-unintended are identified as the views based on literature review. SAPPhIRE model, requirement-solution model, system-environment model and, intended-unintended views of designers and users are used to describe the views, and comprise the framework. The framework is validated by showing it can describe the functions.

Congress Hall Konavle

SESSION D434

21 May 2012
Monday

22 May 2012
Tuesday

23 May 2012
Wednesday

24 May 2012
Thursday

14:15 - 16:15

CUSTOMIZED PRODUCT DESIGN BASED ON MEDICAL IMAGING

Harih G., Dolšak B., Kaljun J. / University of Maribor (SVN)

911

The increase of market demand for customized products and limitations within traditional design methods has led to development of new user-centered design methods based on multidisciplinary approach using medical imaging. Quality and reliability of this technique can be used for the innovative design process to develop customized products which allow high consideration rate of bio-mechanical constraints and provide best fit to the subject. Customized products developed with these methods provide increased user performance, comfort and lower the risk for task related disorders.

TELEHEALTH: TOWARDS A GLOBAL INDUSTRIAL ENGINEERING FRAMEWORK BASED ON VALUE CREATION FOR HEALTHCARE SYSTEMS DESIGN

Jean C., Stal-Le Cardinal J., Jankovic M., Bocquet J. -C., Espinoza P. / Ecole Centrale Paris (FRA) 949

Industrial Engineering tools can be used to help design new organisational processes in the healthcare context. In this article, we propose a new multi-scalar method of value creation to design processes. This method focuses on the systemic approach and the concept of value creation taking into account multi-stakeholder and multi-criteria aspects. This method is applied to a major organisational change : the increasing use of telehealth. A first application is discussed regarding the telehealth experience named Télégéria at the Georges-Pompidou European Hospital of Paris.

OPEN INNOVATION PRACTICES IN A CLUSTER CONTEXT: A MEDICON VALLEY CASE STUDY

Achiche S., Howard T. J., Ástvaldsdóttir A., Andersen O., McAloone T. C. / Technical University of Denmark (DNK)

151

Open Innovation is a paradigm promoting the use of external as well as internal ideas and paths to market. This paper explores the trends of open innovation in the Medicon Valley cluster through surveys in 28 companies and 4 in-depth interviews. The results show that the companies are increasingly adopting open innovation. The cluster has a key function of connecting with competent partners; the flow of skilled employees and attracting venture capital. The main barriers to open innovation are related to intellectual property rights, quality, knowledge and finance.

MECHANICAL STABILITY ANALYSIS OF THE EXTERNAL FIXATION SYSTEM SARAFIX

Mešić E., Muminović A., Repčić N. / University of Sarajevo (BIH)

1029

This paper presents research results of a mechanical stability of a Sarafix external fixation system, applied to an unstable tibia fracture. A stability analysis was performed using FEA and experimental testing under axial compression. Research was performed on the Sarafix fixator design controlling values and directions of interfragmentary displacements and principal stresses at the measuring points. Von Mises stress values were also analyzed. Sarafix proved to be mechanically stable, confirming good clinical results in the treatment of bone fractures.

TOWARDS EMPATHIC DESIGN IN THE IRISH MEDICAL DEVICE INDUSTRY

Morris S., Cormican K. / National University of Ireland (IRL)

1039

The goal of our research is to identify whether empathic design methods are used in the medical device industry in Ireland and to identify the challenges faced by designers when implementing empathic design tools and techniques in this space. An exploratory study incorporating sixteen semi-structured interviews with experienced individuals involved in medical device product innovation was conducted. Critical challenges are identified and these findings will inform those contemplating using empathic design techniques about the experiences of those who have navigated the process.

A KNOWLEDGE-BASED DESIGN PROCESS FOR DIABETIC SHOE LASTS

Germani M., Bernabeu J. A., Mandolini M., Mengoni M., Raffaelli R. / Università Politecnica delle Marche (ITA)

889

Diabetes is a growing health problem round the world. Doctors' experience confirms the beneficial role of customized shoes in reducing the risk of ulceration for feet of diabetic peoples. Even if shoe last design software tools have been already proposed, they can not be effectively applied in the field of diabetic shoes. The paper aims at the definition of systematic protocols for the measurement of feet and lasts, and the definition of geometrical operators to modify the last accordingly to its specific footwear parameters, optimally computed for each patient by a knowledge based system.

SESSION D435

Congress Hall Šipun

**21 May 2012
Monday**

**22 May 2012
Tuesday**

**23 May 2012
Wednesday**

**24 May 2012
Thursday**

14:15-16:15

CITATIONS AND THE DESIGN SOCIETY: INVITATION TO AN EXPERIMENT TO EXPOSE OUR COMMUNITY'S RESEARCH RESULTS

McAloon T. / *Technical University of Denmark (DNK)*

Google Scholar is quickly gaining the position of favoured academic literature search machine by many academics and universities worldwide. The Design Society has approached Google Scholar and has proposed a new service that Google Scholar could provide to their users. Such a new service concept would comprise a platform where Google Scholar made it possible to collect and promote Design Society members' profiles, their research and their papers. The Google Scholar team are excited about this idea and have agreed to carry out an experiment with the Design Society. The experiment will test a number of functions and services that could enhance our community's research promotion dramatically on the internet. All we need are 200 current DS members to sign up, so that the experiment can become a reality. In this short presentation the concept that we have proposed to Google Scholar will be described and we will appeal to Design Society members to join in the experiment. See it as a design project - it will only take you about 6 minutes of your time to join in!

CONFERENCE REFLECTION AND CLOSING

Udo Lindemann / *Technical University Munich (DEU)*

CLOSING SESSION	Congress Hall Ragusa	
	21 May 2012	Monday
	22 May 2012	Tuesday
	23 May 2012	Wednesday
	24 May 2012	Thursday
	16:45 - 17:45	



FRIDAY, MAY 25, 09:00 a.m. (OPTIONAL)

PELJEŠAC WINE TOUR

**Come and join us on this full day tour
starting at 09:00 a.m. on 25 May 2012
in front of the Croatia Hotel
(optional – not included in conference fee)**



Join us on this full day tour where you will have the unique opportunity to experience the tradition and quality of Croatian wine growing. The Pelješac peninsula has been known for its excellent wines since ancient times.

En route, we will make a few stops:

- In the picturesque town of Ston, we will visit famous salt farm. The Ston salt beds are the oldest in Europe. Today there are nine salt “pools” where sea water is drained are left to evaporate in the sun leaving only natural sea salt behind. Each of the pools is named after a saint and the salt works long history goes back to 1360 when the Republic of Dubrovnik created them. Salt was an extremely important and valuable commodity and the first production was strictly controlled.
- On our way we will visit one famous wine producer who will take you on a tour of his vineyards, wine cellars and introduce you to the wine production process. The Matuško cellars are known for the production of Dingač – the excellent red wine as well as Prošek – the sweet wine.
- On our way back we will stop at the Antunović family farm where we will have a lunch of typical home made food and drinks.



PRICE: € 67,00 per person (minimum 40 persons required)
(bus, guide, entrance fee, wine tasting and lunch – included)
Come and book your excursion no later than May 22 at the conference registration desk.



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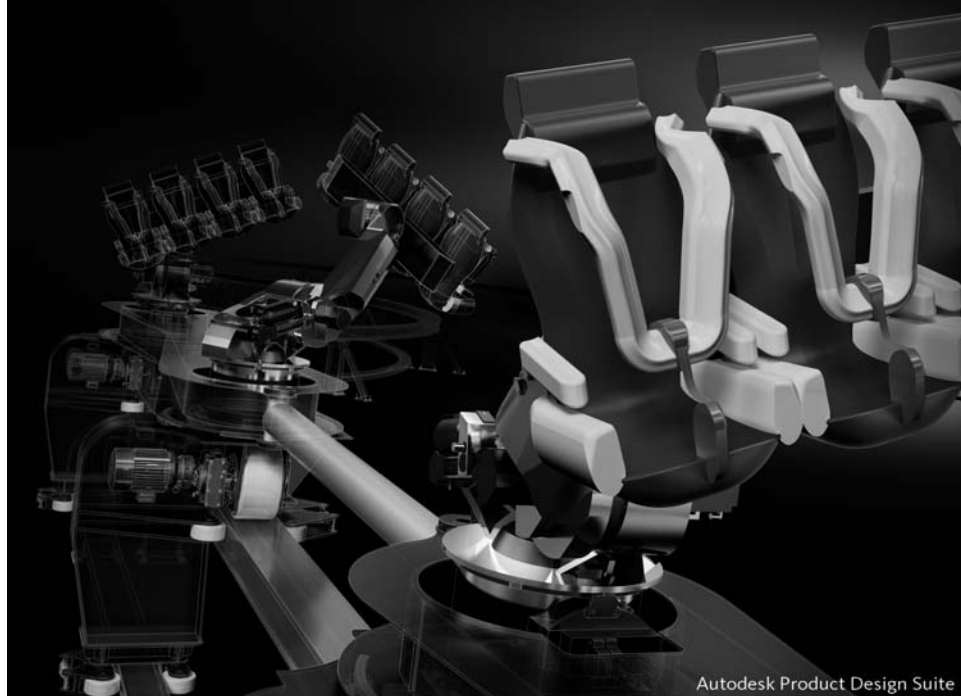
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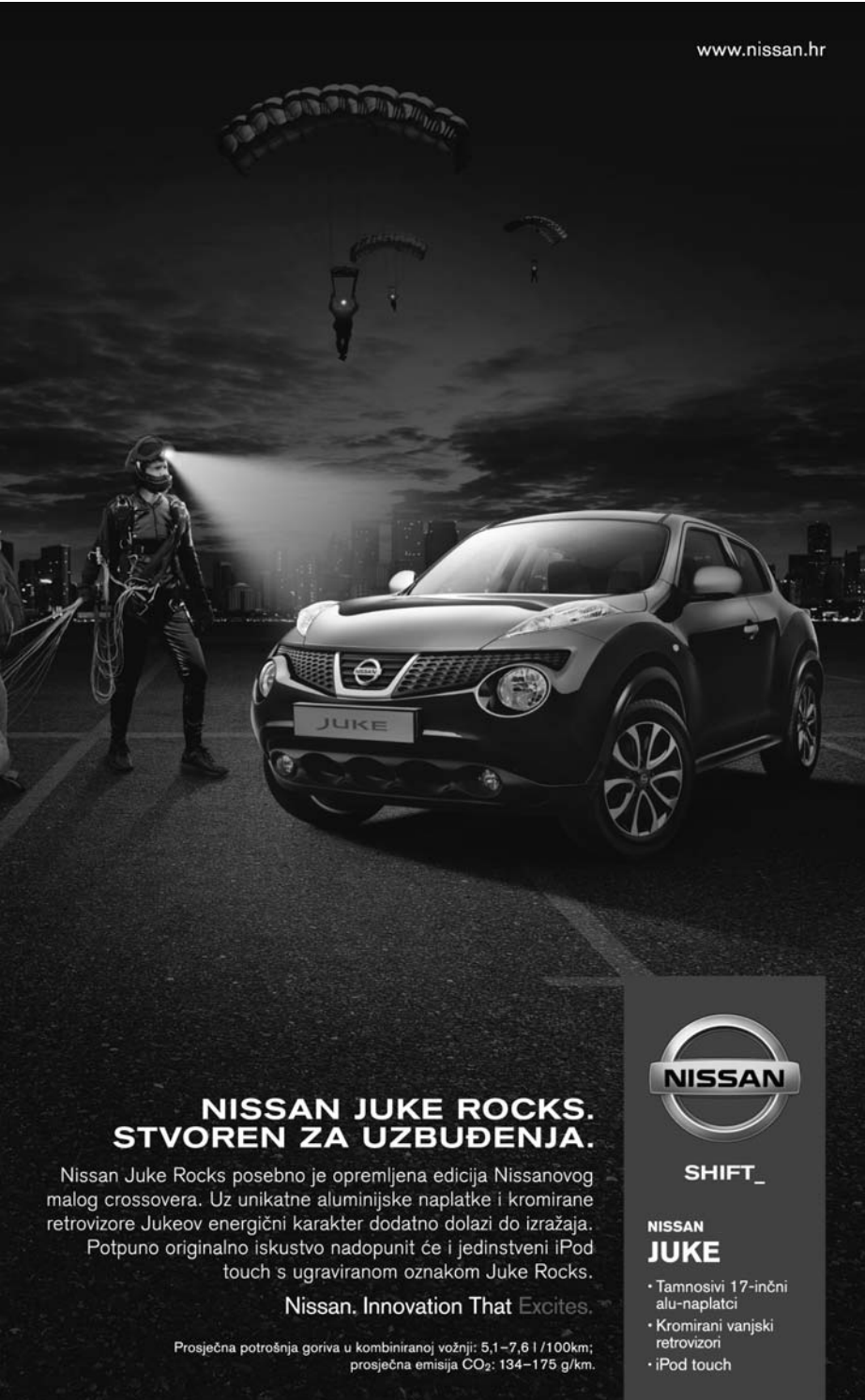
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JUKE**

- Tamnosivi 17-inčni alu-naplatci
- Kromirani vanjski retrovizori
- iPod touch

[illegible]

NOTES

This image shows a full page of blank, lined paper. It features approximately 28 horizontal blue lines spaced evenly across the page, typical of standard notebook paper. The lines are thin and light blue, set against a plain white background. There are no margins, text, or other markings on the page.