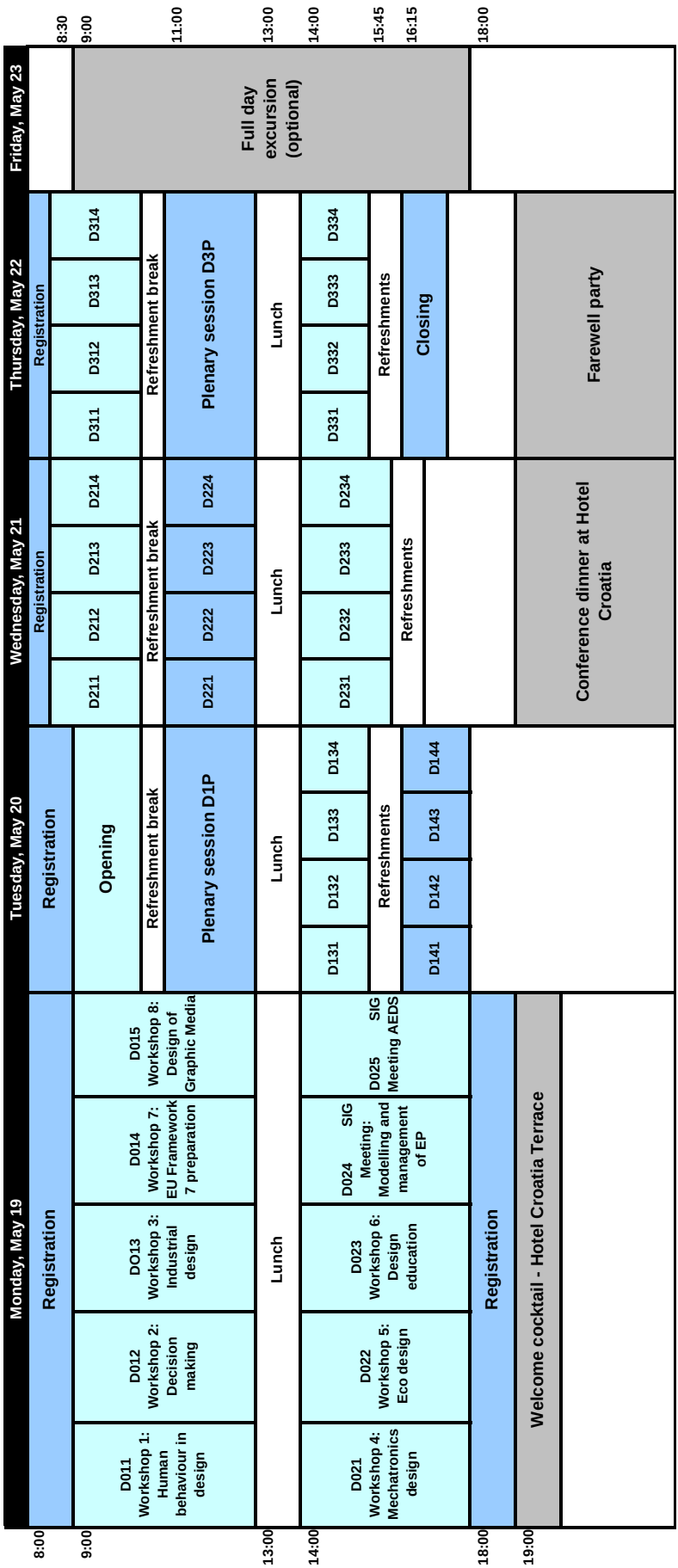
DESIGN 2008

May 19-22, 2008
CAVTAT – DUBROVNIK – CROATIA

Final Schedule and Abstracts



DESIGN 2008 is the 10th successive meeting of professional designers, design researchers and members of the academic community.

Twenty seven years after the first conference the basic rationale of gathering remained the same: to bring together researchers and practitioners who have worked on or thought about design from a variety of perspectives, disciplines, and fields: engineering, aesthetics, ergonomics, psychology, sociology, and others.

The **DESIGN 2008** conference is a result of policy of continuity and continuous learning process. The structure of the **DESIGN 2008** conference has been influenced by the discussion and outcome of the workshop **"Engineering Design Science – Consolidation and Perspectives"** that took place at the previous **DESIGN 2006** conference. The diversity of technology changes and the richness of design research achievements in the past 27 years encouraged us to organise the **DESIGN 2008** event under the challenging motto: Excellence in design. Excellence could be achieved only by synergic effort of all parties involved: authors, reviewers and organisers. The preparations are over, and the conference is now given on you, the participants. Research findings will be reported in 165 papers presented at 8 workshops, 2 plenary and 28 topic oriented sessions. The workshops will mark the first and the last day of the conference. At the beginning we believe the workshop format will allow participants more discussion and deeper insight into a topic and on the Thursday plenary session workshop chairs would share the results with all the participants. The organizers intended to provide stimulating environment for exchanging ideas, lecturing, auditing, discussing, analysing and inventing. We hope that you will remember some ideas you will gather here, contacts you are going to make, our warm welcome and the high spirit of the conference we expect to achieve.

Our thanks to all the parties that took part in the preparations of the conference: authors, referees, researchers and practitioners who were willing to share their knowledge, theoretical and practical experience representing multidisciplinary aspects of design and product development.

Welcome to DESIGN 2008! We hope that the conference and its proceedings will help to enrich your research insight and international network.

M.M. Andreasen, H. Birkhofer, S.J. Culley, U. Lindemann, D. Marjanović

GENERAL INFORMATION

CONFERENCE VENUE:

The conference will take place at the Hotel Croatia CAVTAT.

Registration desk working hours are:

Sunday, *18th May*	18:00-19:30
Monday to Thursday, *19th-22nd May*	08:00-18:00

REFRESHMENTS AND LUNCHES:

Refreshments and lunches will be served in the Hotel Croatia from *19th – 22nd May*

SOCIAL EVENTS:

MONDAY, 19th May

19:00 – 20:00 Welcome cocktail - Hotel Croatia Terrace

WEDNESDAY, 21st May

19:00 Conference dinner - Hotel Croatia

THURSDAY, 22nd May

19:00 Farewell party

FRIDAY, May 23rd

09:00 Optional full day excursion. Rate per person EUR 65. 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 ATLAS desk

OPENING SESSION - Tuesday, May 20, 2008. – 09:30

- **WELCOME ADDRESS**
- **THE DESIGN SOCIETY WELCOME ADDRESS**

Udo Lindemann – President of the Design Society

CLOSING SESSION – Thursday, May 22, 2008. – 16:15

Monday – May 19, 2008, morning sessions

D011 WORKSHOP 1: HUMAN BEHAVIOUR IN DESIGN

09:00 – 13:00 | Congress Hall Bobara, Chairmen: Petra Badke-Schaub (NDL), Udo Lindemann (DEU)

The workshop Human Behaviour in Design at the DESIGN 2008 conference focuses this year on different dimensions of team behaviour in design. The choice for this subject doesn't come as a big surprise, referring to Bucciarelli (1994) who stated that designing is a basic social activity, and the final outcome is the result of negotiation and compromise. Furthermore a way of structuring team processes and finally we will discuss a holistic approach which aims to cope with the challenges presented before such as knowledge sharing distortion in interdisciplinary design teams.
See list of contributions on page 3.

D012 WORKSHOP 2: DECISION MAKING IN RESEARCH AND PRACTICE

09:00 – 13:00 | Salon Orlando, Chairmen: Harald Meerkamm (DEU), Claus T. Hansen (DNK)

Decision Makers are principally responsible for their company's future. Approving the introduction of new products, processes or technologies often means to deal with hardly manageable risks. Helping developers and designers to find the best answers and to keep risks at a minimum is the goal of all efforts in scientific and applied decision making research. This workshop will provide a platform to discuss different approaches trying to achieve this goal.
See list of contributions on page 5.

D013 WORKSHOP 3: INDUSTRIAL DESIGN

09:00 – 13:00 | Salon Šipun, Chairman: John Restrepo (DNK)

This new expanded scope of design stimulated the use of knowledge generated in other disciplines like engineering, chemistry, computer science, electronics or physics, and more recently, biology, social studies, psychology etc. Industrial Design has shifted from a practice to a discipline. This shift brings along challenges to industrial designers, educators and researches alike. In this workshop, we would like to address some of these challenges by exploring the questions related to industrial design.
See list of contributions on page 7.

D014 WORKSHOP 7: EU FRAMEWORK 7 - HOW TO DEVELOP COMPETITIVE FP7 PROJECT PROPOSAL

09:00 – 13:00 | Salon 5, Chairman: Gordana Prutki Pečnik (HRV)

This workshop explains how research proposals are developed, how consortia are formed and topics chosen, as well as outlining the FP7 rules and procedures. The workshop is aimed at researchers preparing their first proposal for EU funding for a collaborative research project. It is also suitable for research managers and advisors familiar with previous FPs, lacking recent involvement in EU research and looking to update their knowledge.

D015 WORKSHOP 8: DESIGN OF GRAPHIC MEDIA

09:00 – 13:00 | Salon 6, Chairman: Vilko Žiljak (HRV)

This workshop puts stress on planning the printing of securities, documents and applying such graphics in the security area. A new research area has been introduced through implementation of colours, design and infrared area programming. Up till now this subject was unknown to the public because it was applied only in producing securities. Design is extended to producing and designing a dynamic image, stochastic graphics, and video. The designer covers new areas known from previous times. Integration of a series of methods is the basis for creating e-books. Visualization and design quality become even key elements for content presentation.

D021 WORKSHOP 4: ENGINEERING DESIGN IN MECHATRONICS – HOW TO MANAGE COMPLEXITY

14:00 – 18:00 | Congress Hall Bobara, Chairman: Stephan Moehringer (DEU)

Mechatronics - the synergetic integration of different engineering domains such as mechanics, electronics and information technology can create new products and stimulate innovative solutions. Due to the interaction of domains the complexity of mechatronic products is usually very high. There exist methods how to deal with complexity but a lot of questions are still unsolved.
See list of contributions on page 9.

D022 WORKSHOP 5: ECO DESIGN

14:00 – 18:00 | Salon Orlando, Chairmen: Tim McAloone (DNK), Wolfgang Wimmer (AUT)

What is the role of eco design in the community of the Design Society, in ensuring that this third wave of environmentalism comes, stays and grows into a sustained activity that actually makes change? In this workshop we have a change in approach this year, by turning our attention away from actual product improvements, and looking towards ecodesign application experiences and education competencies and planning, on which we will facilitate a debate.
See list of contributions on page 11.

D023 WORKSHOP 6: DESIGN EDUCATION

14:00 – 18:00 | Salon Šipun, Chairman: John Malmquist (SWE)

Design is a key part of any engineering education, due not only to that design is a central professional skill for any engineering discipline, but also due to that design projects re-inforce learning of disciplinary knowledge and provide a platform for training generic professional skills such as communication. Current industrial trends challenge design education by strengthening the need to teach design in a multidisciplinary and global context. In the workshop, we will discuss the key outcomes of design education along with innovative approaches to reach them.
See list of contributions on page 13.

D024 SIG MEETING: MODELLING AND MANAGEMENT OF ENGINEERING PROCESSES

14:00 – 18:00 | Salon 5, Chairman: Peter Heisig (GBR)

Product design is a complex task involving different disciplines with different views and responsibilities. Models provide a comprehensive means towards the integration of these different views and knowledge. Therefore the modelling task is a crucial management technique in order to achieve alignment across the different disciplines involved in the product design processes.

D025 SIG MEETING: APPLIED ENGINEERING DESIGN SCIENCE

13:00 – 18:00 | Salon 6, Chairman: Stanislav Hosnedl (CZE)

We would like to discuss the following and other relevant, seemingly simple questions, which, however, can have many different, but nevertheless, correct answers, in the hope of achieving a broader understanding in this essential field for designing: product and technical product as an entity and a system; and description of a technical product and requirements on it.

DS SUMMER SCHOOL 3rd ANNUAL MEETING

20:00 - | Restaurant Leut, Cavtat, Kilian Gericke (DEU)

The Design Society organises since ten years the Summer School on Engineering Design Research to make the participants better qualified and equipped for research on topics related to design science. After a second annual meeting at the ICED 2007, there will be a third meeting at the DESIGN 2008 conference in Cavtat. The former participants will organize an informal dinner in one of the Cavtat restaurants.

THE IMPACT OF TRUST AND POWER ON KNOWLEDGE SHARING IN DESIGN PROJECTS: SOME EMPIRICAL EVIDENCE FROM THE AEROSPACE INDUSTRY

Cloonan J., Matheus T., Sellini F. - *Airbus CIMPA* (*GBR*) 1071

It is acknowledged by aerospace engineers that relationships between partners are influenced by topics such as trust and that they enable or inhibit knowledge flow. This paper presents findings from interviews with engineers in the aerospace industry on how trust and power within supply chain teams impact knowledge sharing and integration. From a trust perspective, the results of the paper indicate that individually, engineers are aware of its importance but that there is little organisational awareness and consequently no framework or support exists for managing it. With regards to power, we show that there are positive as well as negative impacts on knowledge sharing to be considered.

EMOTIONAL ALIGNMENT IN TEAMS: HOW EMOTIONS SUPPORT THE DESIGN PROCESS

de Boer R. J., Badke-Schaub P. - *Delft University of Technology* (*NLD*) 1079

We propose as central theme of this paper that design team performance is affected primarily by a simultaneous occurrence of emotion in individual team members. That is, a design team will perform better (all other things being equal) if the emotional arousal of one team member is transferred to the other team members, for instance through heated debate. We have defined the term Emotional Alignment to describe the state of simultaneous emotional arousal in a team. To support this thesis, we first discuss evidence from design literature and literature case studies. We then demonstrate the likelihood of such a relation through recent exploratory research.

DESIGNING IN A GROUP - HOW CAN KNOWING EACH OTHER INFLUENCE DESIGN PROJECTS?

Hayes J. P., Knight L. A., Newnes L. B. - *University of Bath* (*GBR*) 1087

This paper presents a study of engineering design groups that seeks to explain how knowing other participants can influence processes and outcomes in design projects. Literature on the role of individuals and groups in design projects is reviewed, identifying an increasing current interest in collaborative design work. This research focuses on understanding how interpersonal relationships influence group processes and outcomes in design. From a pilot study, a framework for analysis is developed with a temporal perspective and introduces the concept of identity with rationale for case selection and case propositions. Both individuals and groups are considered where influences in group interaction and development can be captured.

DESIGNING BASED ON THE EVOKED METAPHOR - CASE STUDY

Levy P., Yamanaka T. - *Chiba University* (*JPN*) 1095

This paper introduces a course on Methods in Kansei Design started in 2007 at the University of Tsukuba, and one of the student projects. After providing a comprehensive description of Kansei, a design method based on the construction and the use of a metaphor (namely the Evoked Metaphor - EM), and on the use of intuitional processes for knowledge sharing, is introduced. This method intends to help knowledge sharing by minimizing distortions due to interdisciplinary environment. The method and the teaching structure are detailed. The final part presents a design project on car navigation system, using foxhunting as an EM, which has not only improved communication and knowledge sharing, but also imagination, and therefore creativity.

TEAM COHESION AND PROCESS ASPECTS OF TEAMWORK IN DESIGN

Neumann A., Badke-Schaub P., Lauche K. - *Delft University of Technology* (*NLD*) 1105

The authors discuss the importance of shared representations in design teams, describing a theoretical model of group coordination in design. A coding scheme is formulated to derive the development of shared representations based on verbal utterances. The data from an experiment, in which eleven groups developed a conceptual product design, is coded accordingly. Results indicate that well functioning teams, in contrast to poorly functioning ones, put more effort into structuring the process as well as maintaining the group coherence early in their design activity. Well functioning teams also show a decrease of those utterances during the design process. Theoretical and practical implications of the findings are discussed.

GUIDING TEAM SELECTION AND THE USE OF THE BELBIN APPROACH

Wasiak J. O., Newnes L. B., Mileham A. R., Hicks B. J., Outram G. - *University of Bath* (*GBR*) 1113

A collection of successful individuals does not necessarily make a successful team. A comprehensive review of existing methods for forming teams was undertaken, identifying important aspects to consider. In an experiment following fourteen teams, each member's Belbin roles, academic profiles, skill disciplines and aspects of their tasks were evaluated against team ability. Findings showed the importance of selecting the correct leader and achieving a balance of roles amongst the team. Evidence that different team profiles could be suited to different tasks was also found. Implications for developing a more holistic team selection model are discussed.

DECISION MAKING IN DESIGN TEAMS: ANALYSIS OF USED AND REJECTED DECISIONS

Ensici A., Bayazit N., Badke-Schaub P., Lauche K. - *Istanbul Technical University* (*TUR*) 1121

Nowadays, the majority of designers work as part of a team. During product development designers have to make countless decisions. Design decisions have a tremendous impact on the quality of the design solution, costs and on the company's success on the market. This study analyses decisions that impacted the final outcome against those that were not persued further revealed a major influence on how designers configured the solution space within rejected decisions. In an experimental study a cognitive coding system has been developed which assessed socalled design decision components. The analysis of decisions can be seen as a promising approach to analyse the contribution of the individual to the decision making process in design teams.

EVALUATION OF THE POTENTIAL PERFORMANCE OF INNOVATIVE CONCEPTS IN THE EARLY STAGES OF THE NEW PRODUCT DEVELOPMENT PROCESS (NPDP)

Ferioli M., Roussel B., Renaud J., Truchot P. - *INPL-ERPI* (*FRA*) 1139

Innovation is incontestably one of the big responsible of companies' growth and a crucial element for competitiveness. It is proven that without a precise procedure, structured and based on defined criteria, the possibility of making an unsuccessful evaluation of the innovative ideas increases considerably. In this paper we present a first approach of an evaluation method that aims to support the early stage in the NPDP, particularly the ideas selection. Considering the importance of these decisions and their consequences, the use of an effective methodology is justified. The selection method suggested by our research is able to change the evaluation subjectivity, by formalizing the procedure and fixing precise criteria.

METHOD OF DESIGN EVALUATION FOCUSED ON RELATIONS OF MEANINGS FOR A SUCCESSFUL DESIGN

Georgiev G., Nagai Y., Taura T. - *Japan Advanced Institute of Science and Technology* (*JPN*) 1149

This research proposes a methodology of analysis of design factors, based on meanings. The originally described factors of meanings are based on the idea for summarizing and representing relations between meanings. The analysis of results of a survey of design factors was used to evaluate the influence of introduced factors of meanings on the design evaluation. The resulting model clearly shows the effect of the proposed WordNet-based factors of meanings on the evaluation of design. Understanding the role of meanings in design assessment factors is a step in the development of a meaning-based support method of designing. This methodology of analysis bridges the gap to supportable process of synthesis of meanings in design methodology.

DEPENDENCIES IN CONCEPT DECISIONS IN COMPLEX PRODUCT DEVELOPMENT

Kihlander I., Janhager J., Ritzén S. - *KTH, Royal Institute of Technology* (*SWE*) 1159

The paper presents results from a retrospective case study in the automotive industry with the purpose to identify dependencies in product concept decisions taking into consideration social aspects, decision structures and technology. Interviews and document reviews, such as gate reports and design reviews, formed the empirical base. The company in question has a documented and mandatory product development process with defined instructions, process maps and a basic chain of command. In spite of the operational support, the company still suffers from a certain amount of rework based on incorrect concept decisions. Results from the empirical study show how both formal and informal factors did affect the concept decision in the studied case.

EVALUATION AND RE-DESIGN METHOD OF MANUFACTURING PROCESSES

Kondoh S., Mishima N., Hotta Y., Watari K., Kurita T., Masui K. - *AIST* (*JPN*) 1167

To establish sustainable manufacturing, it is necessary to evaluate manufacturing quality. We have proposed a new product efficiency indicator; total performance indicator (TPI). In this paper, we try to apply TPI to manufacturing processes. By calculating TPI of each segment process, bottleneck segment process can be clarified. This paper takes ceramic diesel particulate filter as an example. The method quantifies the contribution of each segment process in creating the product value. A segment process which doesn't contribute much to create value and have large environmental impact, should be improved. By the approach, a designer can evaluate and redesign environmentally benign manufacturing processes.

DECISION AIDING TOOLS IN PRODUCT DEVELOPMENT: A CASE STUDY

Montagna F., Vittone R. - *Politecnico di Torino* (*ITA*) 1181

The elements of complexity and uncertainty present in the process of New Product Development (NPD) require a comprehensive approach to deal with a problem that involves people, technology and organization. An effective approach should integrate tools that facilitate communication on organizational knowledge and collective problem structuring with others that can analytically study and simulate the process activities that characterize the work context and support the decisions of the NPD process. The paper presents the results of a research that started from an observation of the phenomena involved in the NPD process and the application of this approach in a intervention for the NPD management in a Franco-Italian aerospace company.

SUPPORTING DECISION MAKING WITH AGENT BASED MODELLING AND SIMULATION

Nergard H., Johansson C., Larsson T. - *Lulea University of Technology* (*SWE*) 1191

The presented paper discusses using an agent based modelling and simulation approach to create dynamic models of actual product development activities. The modelled activities are created with the purpose to realise a decision support tool used in a Functional Product Development scenario. The decision support tool is called a Total Offer Readiness Level (TORL) and is used to assess whether the product development process is mature enough to be used in the development of a Total Offer providing only the function to the end user. The area of application and an example implementation has been developed and is shown with the purpose to highlight opportunities.

THE "OLD MASTERS" OF ENGINEERING DESIGN AND THE MODERN FORM DEVELOPMENT PROCESS OF AUTOMOBILES

Abidin S. Z., Sigurjónsson J., Liem A. - *Norwegian University of Science and Technology* (*NOR*) 1199

A comparative study was made between the "Old Masters" of engineering design and the modern form development process of automobiles with focus on the quantified structure as a common element. The study found that although the modern form development of automobiles uses different approaches, it follows a pattern similar to the strategies adopted by the "Old Masters." In the product synthesis, design approaches from the two parties are similar as far as the development allows us to move gradually from one solution to another. However, the "Old Masters" approach is based on quantified structure while the modern form development process of automobiles is additionally related to aesthetics but can be analyzed with help of product semantics.

THE SKETCH POWER TO SUPPORT PRODUCT DESIGN

Elsen C., Leclercq P. - *University of Liege* (*BEL*) 1207

This paper is interested in the extent to which sketches and 3D representations are important in today's design process, particularly during the preliminary creative phases of product design. We question the relevance of sketches within systems of external representations and amongst the infinite possibilities offered by CAD tools. This exploratory research is conducted through 3 steps: an information gathering step where we assess the current state of art, a direct contact with designers through interviews and the testing of the existing theories through pragmatic experimentation. The project's goal is to objectivize a Human Machine Interaction that could effectively and efficiently support the product designers in their creative phases.

TECHNOLOGICAL PARADOXES IN INDUSTRIAL DESIGN

Gajewski C. - *University of Alberta* (*CAN*) 1219

Through a case-study of the design of a large-scale interactive kiosk, I will explore the design process of the modern Industrial Designer and the ways in which VR technology can make it possible to minimize potential problems associated with traditional prototyping of large objects and improve communication between designers and their clients.

APPLYING TRENDS TO DESIGN: A THEORETICAL FRAMEWORK

Muir Wood A. P., Moultrie J., Eckert C. M. - *University of Cambridge* (*GBR*) 1235

When technology and functionality are not enough to differentiate a product from its competitors, the product's visual appearance becomes a major driver of consumer preference. But how do designers identify what is and will be attractive to the consumer, and how do they apply this to the styling of their products? It is evident that physical products are increasingly becoming fashion based items. There is a substantial body of theory, built over the last 50 years, as applied to fashion. However, to date, little of this understanding has been applied to the design of physical consumer products. This paper seeks to address this gap, by synthesising seminal literature from fashion theory, taste, consumer behaviour, and product design.

COOPERATION OF ENGINEERING & INDUSTRIAL DESIGNERS ON INDUSTRIAL PROJECTS

Hosnedl S., Srp Z., Dvorak J. - *University of West Bohemia* (*CZE*) 1227

The paper introduces theory and methodology developed on the basis of a "map" of Engineering Design Science, which proved to be a powerfull tool for efficient and effective cooperation for the two "competing" professions like engineering and industrial designers. This approach has been validated during education design projects carried out for and evaluated by industrial partners. The projects have been carried out at the University of West Bohemia in Pilsen over the last few years. Students worked in "competing" teams consisting of engineering and industrial design students. The following topics were undertaken last year: Dentist's working place, Assembly line for gluing hinges on mirror doors, and Parking facilities for "Coupe Vehicles".

INDIRECT ENCODING OF THE GENES OF A CLOSED CURVE FOR INTERACTIVELY CREATE INNOVATIVE CAR SILHOUETTES

Yannou B., Dilhman M., Cluzel F. - *Ecole Centrale Paris* (*FRA*) 1243

An Interactive Genetic Algorithm system is proposed for designing a car silhouette while involving the style designer in the evaluation process of a population of individuals. This IGA is based on the principle of an indirect encoding of a closed curve genome using a primary Fourier decomposition. A crossing over operator is proposed for mixing the parents' genes by a random weighted average into a new child's genome. A perceived similarity index between two genomes is built. It allows to check that our IGA is able to converge toward a targeted individual which was not present within the initial population and, consequently, that any silhouette in a style designer's mind could be revealed by our system.

TRANSPARENT 3D VISUALIZATION OF MECHATRONIC SYSTEM STRUCTURES

Diehl H., Hellenbrand D., Lindemann U. - *Technical University Munich* (*DEU*) 1255

Within this paper an interactive tool for the transparent visualization of cross discipline and cross domain dependencies in the context of the development of mechatronic systems is presented. The visualization technique is designed to support the engineers in their daily work within the development process of mechatronic products. We describe how the necessary dependency data can be acquired and how a transparent visualization of these dependencies helps to better handle complexity.

SYSTEMATIC DEVELOPMENT OF CONTROLLERS BASED ON THE PRINCIPLE SOLUTION OF SELF-OPTIMIZING SYSTEMS

Gausemeier J., Kahl S., Low C., Schulz B. - *Universtiy of Paderborn* (*DEU*) 1263

The conceivable development of information technology will enable mechatronic systems with inherent partial intelligence. They will be able to learn, to communicate, and to optimize their behavior autonomously in response to environmental changes. These systems are called self-optimizing systems. The development of such systems starts with the conceptual design phase. The result of the conceptual design is the domain-spanning principle solution. On the basis of this principle solution, further design concretization will take place in the technical domains involved. This paper addresses how controller design can be started based on the principle solution of self-optimizing systems. The method is exemplified by a self-optimizing motor drive.

PROCEEDING FOR THE CONCEPTUAL DESIGN OF SELF-OPTIMIZING MECHATRONIC SYSTEMS

Gausemeier J., Zimmer D., Donoth J., Pook S., Schmidt A. - *Heinz Nixdorf Institute* (*DEU*) 1277

The conceivable development of information technology will enable self-optimizing mechatronic systems with inherent partial intelligence, which are able to react autonomously and flexible to changing environmental conditions at run-time. The design of such systems requires a domain-spanning principle solution for a smooth cooperation of the involved engineers. This principle solution is developed within the early design phase "conceptual design" and describes the fundamental structure as well as the system’s action mode. The paper presents the proceeding during the conceptual design and describes the synthesis of the principle solution exemplary; a self-optimizing air gap adjustment system for a linear drive points out the approach.

A PROPOSAL FOR THE USE OF DIAGRAMS OF UML FOR MECHATRONICS ENGINEERING

Johar A., Stetter R. - *Hochschule Ravensburg-Weingarten* (*DEU*) 1287

The paper intends to explore the use of the diagrams of UML (unified modeling language) in the product development process of mechatronical products. The analyzed product development process concerns the development of a brake for a mobile robot. The patented steering principle of the robot is based on torque differences. This kind of steering system can by enhanced by equipping the steering axles with brakes. The developed brake uses a smart material - a ferromagnetic shape memory alloy (FSMA) - and had the unique characteristic to compensate wear and tear. The embodiment of the brake has already been registered as a patent. The experience during this development was used to reflect on an appropriate methodology for mechatronical design.

MECHATRONIC-ORIENTED DESIGN OF AUTOMATED MANUFACTURING SYSTEMS IN THE AUTOMOTIVE BODY SHOP

Kiefer J., Baer T., Bley H. - *Daimler AG* (*DEU*) 1295

Accelerated and more robust ramp-up processes of highly complex automated manufacturing systems based on shorter design cycles are a key demand in the automotive industry. To cope with these market- and/or cost-driven challenges, new solutions for production design and ramp-up processes are required. Thus, a mechatronic-oriented design methodology is introduced, taking the example of the development process of automated manufacturing cells in the automotive body shop. Apart from the presentation of the most important characteristics of the newly developed methodology, its software-technical implementation as well as some practice-relevant introduction aspects are also illustrated.

APPROACH ON THE CONTROL OF ITERATIONS IN THE MULTIDISCIPLINARY DEVELOPMENT OF TECHNICAL SYSTEMS

Krehmer H., Stöber C., Meerkamm H. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 1303

Due to the increasing complexity of products as well as the product development the course of the product development process is not foreseeable in detail; it develops iteratively in its progression. To help the developer to distinguish unnecessary iterations from helpful ones and to avoid time-consuming and cost-intensive detours, a classification of iterations and based on this a practical method of accomplishment for each identified class of iterations is shown in this paper. An approach on the control of iterations in the multidisciplinary development is depicted and shown by an example. By the presented procedure, the developer is aided in the accomplishment of inevitable iterations and unnecessary iterations can be avoided.

TO THE DEVELOPMENT OF A SYSTEM ARCHITECTURE OF COGNITIVE TECHNICAL SYSTEMS

Paetzold K., Schmid U. - *University Erlangen-Nuremberg* (*DEU*) 1311

Today increasingly intelligence is expected by technical systems with which they should be enable to operate autonomously. Therewith technical systems are to be put in the position to react flexible in terms of system purpose to various environmental conditions. Both descriptions of system tectonics and system dynamics are elementary preconditions to develop cognitive abilities in a technical system. It is crucial that cognitive abilities can not be implemented per se, rather it must be ensured that these can develop themselves. Hereunto further work for the refinement of the approach is necessary, because the idea is in principle helpful for the development of interdisciplinary products.

ENVIRONMENTAL KNOWLEDGE ACQUISITION DURING THE FUZZY FRONT END OF INNOVATION – STATE OF USE OF TOOLS, METHODS AND TECHNIQUES IN THE ...

Val-Jauregi E., Justel D., Beitia A. - *Mondragon Unibertsitatea* (*ESP*) 1319

This paper presents the state of use of different Tools, Methods and Techniques (TM&T) for environmental information acquisition during the Fuzzy Front End of innovation (FFE) in the Basque Country. The FFE, activities undertaken before the innovation process, is highly influenced by external environmental factors. Different TM&T could be used by companies to support and improve the proficiency of environmental information acquisition during the FFE. This study highlights the low frequency of use of TM&T for environmental information acquisition during the FFE. Firms primarily focus on both industry environment and technological factors from the lens of the present state of those environments, leaving aside possible future evolutions.

PARAMETRIC ECODESIGN – AN INTEGRATIVE APPROACH FOR IMPLEMENTING ECODESIGN INTO DECISIVE EARLY DESIGN STAGES

Ostad-Ahmad-Ghorabi H., Bey N., Wimmer W. - *Vienna University of Technology* (*AUT*) 1327

The methodology of parametric Ecodesign incorporates proposing reference products for environmental evaluation systematically and will help using life cycle assessment data to optimize product designs and to implement Ecodesign strategies already in the early stages of product development. The parametric description of the reference product correlates technical and environmental data. A comparison of the resulting environmental impacts of a certain design with an appropriate reference of this product is facilitated then. By knowing the potential environmental impacts and by being aware whether selected impacts become higher or lower due to design changes, an optimization of design and environmental performance can be achieved.

A NEW APPROACH TO IMPLEMENT THE REACH DIRECTIVE IN ENGINEERING DESIGN

Brissaud D., Lemagnen M., Mathieux F. - *University of Grenoble* (*FRA*) 1335

The REACh regulation (Registration, Evaluation and Authorization of Chemicals) has to be applied since 01/06/2007 (mandatory from 01/06/2009) by all the companies in Europe. It gives a new framework to better manage substances used in production, but also to design new products and to upgrade current products. Companies have to react quickly to adapt their industrial procedures to this regulation and their products to the evolving market without waiting for the deadlines in order secure their business. The paper aims at proposing a new engineering design approach to support the regulation and throughout the whole product development. A specific tool has been developed to support it and is implemented in a French company.

ECO-DESIGN DIRECTIONS: EVOLUTIONS OF THE AESTHETIC DIMENSION

La Rocca F. - *Seconda Universita Napoli* (*ITA*) 1341

The aim of the paper is to take into consideration the diverse approaches to the issue of sustainable design, focusing in particular on some of the major problems rising from the relation of the ecological aspects with a new aesthetic sensitivity on one hand, and with social and ethical reflections on the other. New ecological-industrial aesthetics may be born only out of a critical approach which stresses the distance which however exists between nature and strictly human values. The specific purpose of the paper is to analyse whether and how eco-design has paved the way to a new aesthetic dimension, and which is the role played by the aesthetic factor within the different eco-design-related issues.

ECODESIGN STRATEGIES USING CLASSIFICATION OF ENVIRONMENTAL CHARACTERISTICS

Sakao T. - *Linkoping University* (*SWE*) 1351

This paper proposes a framework for classification of environmental characteristics of offers, utilizing Kano Model and willingness to pay. The framework is connected to some design management, i.e. design itself and external-communication, strategies for companies which are also proposed in this paper. The integration of the classification and the strategies is applied to several typical environmental characteristics against Japanese markets. The results include that plant-based plastics in a chassis of a notebook-typed PC for businessmen over 50 years old cannot be recommended to be adopted within the development team. However, the company could also focus on the positive effect on its corporate branding.

CHANGING ENERGY CONSUMPTION BEHAVIOUR THROUGH SUSTAINABLE PRODUCT DESIGN

Tang T., Bhamra T. - *Loughborough Univeristy* (*GBR*) 1359

Energy consumption during the use phase of electrical products' lifecycle has a significant environmental impact, mainly determined by the user behaviour. Product designers are in a position to shape the way in which consumption occurs and to bridge the gap between environmental values and user everyday action. This paper analyzes the barriers to sustainable energy use and by linking the design strategy research with the psychological theories, the breakthrough points that potentially enable design to influence the user behaviour and habits are identified. Employing a user-centred approach, the results of a pilot study are presented that provide an understanding of user perceptions of environmental issues.

SUSTAINABLE COMMUNITY DESIGN – BENNY FARM / MONTREAL AS A SAMPLE

Yilmaz M. - *Hacettepe University* (*TUR*) 1367

Since the middle of the 1980's the concept of sustainability has become a guiding principle for human settlements at all levels of governance. The design decisions that are made without regard to the environment, are potentially devastating. Therefore, a design approach should be maintained for creating the buildings that have to be responsive to environmental forces by investigating problems in different contexts and at different scales. Within this context, Benny Farm Settlement in Montreal is searched as a case study which houses low and middle income people*.
*This research is funded by Turkish Scientific Institution TUBITAK.

(RE)DESIGNING THE DESIGN EDUCATION IN A KNOWLEDGE-BASED ECONOMY

Fain N., Moes C. C. M., van Doorn E., Duhovnik J. - *University of Ljubljana* (*SVN*) 1375

Several global trends in new product development, such as increased global competition, flux of boundaries between institutions and intensiveness of knowledge in the management of consumers and their needs, have changed the traditional work of industrial design engineers, so that they must now be closely involved in the entire product development process, and interact and intensively communicate with other disciplines. Their competences need to be adjusted and updated. this should start with the design education. In the presented paper we propose an approach in design education, that covers the emerging trends in NPD and educates studens in such a manner that their transition from study to practice is carried out effectively and smoothly.

COMPETENCE DEVELOPMENT IN AN INTERNATIONAL PRODUCT DESIGN COURSE

Kovacevic A. - *City University London* (*GBR*) 1383

The European Global Product Realisation course brings innovation to engineering education by adopting a holistic approach to the development of student competences. The students from five European countries and the UK based company were involved in the project forming an academic virtual enterprise. The main aspects of such an international project are reviewed and impact on educational goals at City University to meet UK industrial requirements was evaluated. The paper outlines how undergraduate students from different backgrounds combined theory and practice to make a product that brought a new approach to industry. The use of e-learning and video conferencing systems is discussed and measures for further improvements are proposed.

PERMANENT PROFESSIONAL EDUCATION FOR INTEGRAL DESIGN COLLABORATION

Savanovic P., Zeiler W. - *Technical University Eindhoven* (*NLD*) 1393

Multi disciplinary building design aims at integrating all aspects from the different disciplines involved. To support this complex process an Integral Building Design method is developed based on the combination of a prescriptive approach, Methodical Design, and a descriptive approach, Reflective practice: Integral Design with a functional structuring tool Morphological Overviews to structure the communication between the design team members. This forms a basis for reflection on the design results by the design team members. This method was tested in workshops for professionals in which nearly 90 professionals participated from the Royal Institute of Dutch Architects and the Dutch Association of Consulting Engineers.

TEACHING AN INTEGRATED NEW PRODUCT DEVELOPMENT SEMINAR ON COGNITIVE PRODUCTS

Shea K., Engelhard M., Helms B., Merz M. - *Technical University Munich* (*DEU*) 1401

This paper describes a new interdisciplinary, project-based seminar at TU Munich, where mechanical engineering, electrical engineering and computer science students create cognitive consumer products. The main goal is educational and aims to provide students with experience in artificial cognitive systems and related technology, conceiving new products, prototyping and working in multidisciplinary teams. Due to the high technology and multi-domain nature of cognitive products, project-focused, technical lectures and a software and hardware prototyping toolkit are integrated into a new product development process that is supported by process and technical coaches. Results from running the seminar two semesters are presented and discussed.

ACHIEVING COST-EFFECTIVE DESIGN EDUCATION: HIGHEST QUALITY GRADUATES FOR LEAST RESOURCES AND COST

Cowdroy R., Williams A. - *University of Newcastle* (*AUS*) 1409

Design education takes many forms across the range of design disciplines but principally design education to mean development of ability to design. The purpose of this paper is to show how results of recent empirical research into the mental processes of various types of creativity apply to design education. The paper shows how the various combinations of creative thinking processes are directly relevant to all design, then goes on to show how these creative thinking processes can be assessed transparently and can make innovative and significant contributions to increasing design ability in students and graduates, and to meeting educational objectives of best practice, and institutional objectives of accountability and efficiency.

WAYS OF KNOWING IN ENGINEERING

Wengenroth U. - *Munich Center for the History of Science and Technology (DEU)*

Unlike science, engineering has to deliver products that cannot be represented by one coherent theory, nor can they be designed using one coherent methodology. Even worse, many steps in the design process withstand all efforts to be represented by any coherent theory or methodology. Nevertheless, the final product has to work and has to be taken responsibility for. The wide gaps between the islands of theoretical and mathematical certainty have to be closed by a variety of ways of knowing that need to combine to the cognitive mastery of the problem at hand. Engineering knowledge is about the ability to integrate fundamentally different ways of knowing into one process.

INDUSTRIAL DESIGNS PROTECTION – A VITAL TOOL FOR BUSINESS COMPETITIVENESS

Mpazi S. - *World Intellectual Property Organization - WIPO (CHE)*

Industrial design is a vital part of modern-day living for virtually every human being. Every day of our lives we encounter products designed and manufactured with the intention of making our lives more pleasant and easier. In today's global market, industrial design is recognised as powerful tool and it plays an increasing critical role in competitiveness. In a number of recent design studies, the link between design activity and the competitive performance of companies is widely acknowledged, especially in the industrialised market economies. In this connection, one of WIPO's important role is to successfully meet the challenge of making all the design Community, and especially SME's, fully aware of the importance of industrial designs protection as a vital tool for business competitiveness.

DESIGNING TODAY WITHOUT TROUBLE TOMORROW

Hales C. - *Hales & Gooch Ltd. (USA)*

When a selected concept is being developed into a practicable and durable final design, it is crucial to consider the possible effects of overloads, upset conditions and abusive treatment during the service life of the product or equipment. Many designs appear excellent on first sight, and indeed may perform well within the specified operating conditions, but prove disastrous when overload excursions or upset conditions occur in practice. Systematic guidelines for embodiment design, covering such issues as force transmission paths, allocation of functions to specific components and application of the safety hierarchy are most helpful in making sure that a design will perform reliably within the agreed specifications. However, it is still necessary to think creatively when working through these guidelines in order to avoid failures in practice due to unanticipated operating conditions or situations.

TIDYING UP DESIGN METHODS – AN APPROACH USING ELEMENTARY DESIGN METHODS

Birkhofer H. - *Technical University Darmstadt* (*DEU*) 1

This contribution presents an innovative approach to defining elementary design methods to “tidy up” the obscure body of prescriptive procedures for design work. The key concept to overcome this was the analogy to the system of chemical elements. Adapting this concept to design methods it reduces them to elementary ones, which cannot be divided further semantically. These elementary methods are traced back to elements like objects, functions or properties linked with operations like assign, merge or connect. Analysing about 100 design methods only 8 elements and 5 operations were found. First tests demonstrate fascinating perspectives for a convincing structuring of design methods and for improved performance in teaching and learning.

THE ISSUES AND BENEFITS OF AN INTELLIGENT DESIGN OBSERVATORY

Hicks B. J., McAlpine H. C., Torlind P., Štorga M., Dong A., Blanco E. - *University of Bath* (*GBR*) 31

In order to support today’s digital, knowledge-driven and highly distributed design activities there is a fundamental requirement to improve the means by which design researchers observe industry practice, evaluate tools and methods, and assesses the state-of-the-art. A prerequisite for this is the ability to undertake more holistic investigation, perform controlled experiments, and capture, analyse and organise experimental data. To begin to address these issues the creation of an intelligent design observatory is proposed and the issues associated with designing the environment, monitoring and recording design activities, data processing and analysis, observation and measurement, and an appropriate experimental methodology are discussed.

HOW TO DERIVE APPLICATION-SPECIFIC DESIGN METHODOLOGIES

Weber C. - *Technical University Ilmenau* (*DEU*) 69

Engineering Design Theory and Methodology is often criticised as being too general, too broad, too rigid/inflexible, too time-consuming for industrial practice. Not all of the criticism is justified, but the basic message must be taken serious. The aim of this paper is to introduce a novel approach of how to transform a “general” Design Theory and Methodology into an application-specific methodology for a particular branch of industry or even company. Base is the author’s general approach of Characteristics-Properties Modelling (CPM) and Property-Driven Development (PDD). The concept is then illustrated by a small example and conclusions are drawn.

METHODICAL DESIGN 1972 – INTEGRAL DESIGN METHODOLOGY 2007: MORPHOLOGIC REFLECTION

Zeiler W., Savanovic P. - *Technical University Eindhoven* (*NLD*) 81

To support multidisciplinary building design an Integral Design method is developed by combining a prescriptive approach, Methodical Design, with a descriptive approach, Reflective practice. The use of Integral Design within the design process results in transparency of the design steps and the design decisions. Within the design process, the prescriptive methodology of Integral Design is used as a framework for reflection on the design process itself. To ensure good information exchange between different disciplines during the conceptual phase of design a functional structuring technique can be used for reflecting: Morphological Overviews, to give an overview of the functions and aspects considered and their alternative solutions.

INFLUENCE OF FEATURE CHANGE PROPAGATION ON PRODUCT ATTRIBUTES IN CONCEPT SELECTION

Koh E. C. Y., Keller R., Eckert C. M., Clarkson P. J. - *University of Cambridge* (*GBR*) 157

This paper introduces an approach which uses a modified House of Quality (HoQ) and the Change Prediction Method (CPM) to consider change propagation during the concept selection phase. The key idea is to capture the influence of unintended feature changes on product attributes which arises due to component change propagation, and present this information as an aggregate performance rating for each product attribute. The results from the case example indicate that the performance rating of product attributes can be different once change propagation is taken into account. The findings in this paper also provide an indication that ignoring change propagation in concept selection can result in project delays due to unexpected changes.

VETUSNET - A SOCIAL NETWORK FOR THE THIRD AGE

Medeiros A. P., Ferreira B. S., Da Fonte C. C., Fernandes A. A. - *University of Porto* (*POR*) 191

This paper reports the work carried out by a team, to develop an innovative product that addresses the needs of aged people, using systematic methodologies of product design and development. The importance of networking in different contexts led the team to think of a product that could act as a vehicle of communication among elderly people, thus increasing their social networks. In order to identify the customer needs (elderly people) a total of 55 interviews were carried out. The sample comprised 69% females and 31% males with ages up to 85 years. The analysis of the answers to the questionnaires revealed that main needs were not only a lack of material goods but specially loneliness, with a clear need for communication. The product selected for development was an electronic device to support a communication network aimed at aged people, the VetusNet.

"PRODUCT IN-USE" INFORMATION FOR ENGINEERING DESIGN ACTIVITIES

McSorley G., Huet G., Culley S. J., Fortin C. - *École Polytechnique de Montréal* (*CAN*) 183

Within the emerging "extended product" paradigm, manufacturers are increasingly involved in the later stages of the product lifecycle to ensure long-term customer satisfaction. Substantial savings can be made by identifying possible performance issues at the design stage, rather than correcting them once the product is in-service. To support designers, it is proposed to create a framework through which they can take advantage of "product in-use" information, defined as all information collected throughout the lifecycle concerning product performance during use. This paper examines the issues with the creation of such a framework, such as the appropriate content of this information, the necessary format and its transfer to designers.

LESSONS LEARNED FROM A WANT BASED NPD PROJECT

Björk E., Ottosson S. - *TERVIX AB* (*SWE*) 115

Incremental innovations often are based on satisfying a "want". Radical innovations often are based on satisfying a "wish". The conditions for want and wish based PD differ much from "need" based PD for which well-known PD models are designed. As want and wish based PD projects are not much described a want based project has been investigated with Insider Action Research. Some findings are that the want based project showed to be impossible to long term plan both what regards development time and cost, that the use of the DPD principles - and especially BAD-PAD-MAD - was needed, that an S-shaped curve did not show up, that milestones were "taken" and "lost" before a stable situation was reached, and that Time-to-Market was not critical.

A RADICAL IMPROVEMENT OF SOFTWARE BUGS DETECTION WHEN AUTOMATING THE TEST GENERATION PROCESS

Awedikian R., Yannou B., Lebreton P., Bouclier L., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 571

Software bugs are a direct indicator of software quality. Whereas competition and globalisation are fierce, introducing fewer bugs and detecting bugs earlier in the development process become one of the prior objectives of software organisations and particularly of automotive suppliers of car-embedded electronic modules. In this paper, we propose to improve the software testing process of an automotive electronics suppliers. Indeed, test cases are presently designed manually and depend on the experience of the testers. As software complexity grows, it becomes difficult for testers to imagine all possible combinations to be tested. Therefore, we propose to automatically generate relevant test cases for functional software testing.

TERMINOLOGY USED FOR SHAPE IDEATION

Wiegers T. - *Delft University of Technology* (*NLD*) 721

For successfully supporting shape ideation, the support software should match the way the designer thinks about shape and shape modification. Thoughts of designers cannot directly be observed. Therefore we performed experiments in which one subject had to explain a shape modification to another subject. The results show a frequent use of vernacular shape characteristics, shape metaphores and fuzzy values'. If a shape ideation system will be developed, it should be able to understand shape metaphors and fuzzy values. Moreover, such a system must be able to assign different parameter models to the same shape and apply the one that matches best the current operation of the designer.

IDENTIFYING FEATURES IN CAD MODELS FOR POWDER METALLURGY COMPONENT EVALUATION

Stolt R. - *University of Jonkoping* (*SWE*) 689

This paper presents a newly developed CAD-integrated system for the manufacturability evaluation of designs of powder metallurgy (PM) pressed and sintered parts. The contribution of the paper is the automated reconstruction of a specialized construction history tree from any CAD-model directly in the receiving CAD-system. The reconstruction is based on the geometrical restrictions of the shapes that can be manufactured by the PM process. This facilitates the creation of a transparent and user revisable rule-base to evaluate the parts manufacturability, which is shown. It will enable designers to get feedback on their designs, reducing the number of design loops with the PM-parts supplier needed before the parts geometry can be established.

A SIMULATED MODEL OF SOFTWARE SPECIFICATIONS FOR AUTOMATING FUNCTIONAL TESTS DESIGN

Awedikian R., Yannou B., Lebreton P., Bouclier L., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 561

Nowadays, it becomes crucial to carmakers and automotive electronics suppliers to ensure a high software quality. Although many methods have been proposed in software engineering, they are, most of the time, not adapted to embedded software. Since there is no unified format to specify a software in automotive industry, we propose through this paper a representation model for most of functional software specifications, that is able to simulate the expected input-output functions. This model is the core component of a global approach for automatically generating test cases for functional testing of the software. Indeed, a simulated specification model is the foundation of automating test generation.

SUPPORT OF SYSTEM ANALYSES AND IMPROVEMENT IN INDUSTRIAL DESIGN TROUGH THE CONTACT & CHANNEL MODEL

Albers A., Alink T., Matthiesen S., Thau S. - *University of Karlsruhe* (*DEU*) 245

The Contact and Channel Model (C&CM) through a clear set of model building blocks, i.e. Working Surface Pairs (WSP) and Channel and Support Structures (CSS), provides a free and dynamic way of modelling to argue systematically about design problem. Regardless whether designers want to generate a new solution for a component, make major modifications or change a very small detail, they can approach the problem in the same way and apply the same thinking steps. This paper introduces a compendium enforcing an effective procedure of building up C&CM models through its application in a real, through time and cost pressure characterized design project. The contribution shows how the C&CM helps designers to escape a typical trap of pre-fixation.

A PLM APPROACH INTEGRATING ULM (USAGE LYFECYCLE MANAGEMENT)

Chapotot E., Merlo C., Legardeur J., Girard P. - *ESTIA* (*FRA*) 327

Nowadays, product ‘usages’ in competitive market are a rich source of knowledge for designers. This interest for ‘usages’ appears since the 90’s but today this phenomenon gaining emphasis. In this paper, usage concept is explored and situated in the PLM approach. We propose an ULM (Usage Lifecycle Management) tool for managing the usage capitalisation from both end-users and expert actors. This tool is illustrated through an industrial case study based on maintenance stakeholders’ reports. This example shows how maintenance knowledge about usage may be re-used through a PLM system by designers to improve the product. This work is an introduction to next steps which will consist in modelling usage knowledge and specifying a ULM tool.

FROM FUNCTION TO SOLUTION: A SYSTEMATIC APPROACH

Panetta F., Vigano R. - *Politecnico di Milano* (*ITA*) 475

Studies in design methods provide various procedural approaches to the design process. These methods are devoted to create a process able to aid the designer for finding suitable solutions of an engineering problem. One issue with design methods is often that such approaches prescribe what a designer should do but not how. In fact, the hazy aspects of these methods are especially how complete the route from the function to the solution and how the systematic methodologies cannot stifle the designer’s creativity. This work is devoted to explore a systematic methodology and its use in an application case. Moreover, an example in the home automation field will be presented in order to better explain the application of the methodology proposed.

WHAT IS SUCCESS AND FAILURE IN PRODUCT AND SERVICE DESIGN?

Hollins W. J. - *University of Westminster* (*GBR*) 409

Research has shown that most new products fail. When one attempts to define what actually constitutes a success or failure in the design of products and in the design process, and who is affected, the picture is not so clear. There is a general consensus that there are too many failures. This paper confronts this confusing aspect and identifies potential ‘danger areas’ in the total design process up to, and including product disposal. From this are drawn solutions and conclusions that should assist in the management of more successful design.

A FRAMEWORK TO UNDERSTAND PROJECT ROBUSTNESS

Gericke K., Schmidt-Kretschmer M., Blessing L. - *Berlin Institute of Technology* (*DEU*) 919

A multitude of projects fail the forecasts regarding costs, duration and customer requirements. Following the problem of deviations will be addressed with the focus on SMEs in the domain of mechanical engineering. Numerous methods and approaches are offered to improve this situation, but these approaches are basically reactive. This means actions will not be implemented until the project is already in a precarious situation. The concept of project robustness aims for proactive solutions. In this paper a framework will be developed to understand robustness in the context of product development projects. Based on this different generic approaches to enhance project robustness will be presented and discussed.

CURRENT INDUSTRIAL PRACTICES FOR RE-USE OF MANUFACTURING EXPERIENCE IN A MULTIDISCIPLINARY DESIGN PERSPECTIVE

Andersson P., Wolgast A., Isaksson O. - *Volvo Aero* (*SWE*) 885

To a large extent, experiences gained during manufacturing, does not appear to have enough impact on new generation products in manufacturing industry. The inherent difficulties may be explained by the multi disciplinary character of the problem together with the fact that experiences are not used in the same context as where these are captured. In an empirical survey within two manufacturing companies, feedback and re-use mechanisms are studied amongst personnel from manufacturing operations, manufacturing engineering and design engineering. Results indicate that whether or not formal processes for experience management, work methods in multi-disciplinary teams and IT systems support exist or not, the effectiveness is not as high as desired.

ENABLING FACTORS FOR MANAGING INTELLECTUAL RESOURCES IN ENGINEERING DESIGN

Mela J., Lehtonen T., Riitahuhta A., Juuti T. - *Tampere University of Technology* (*FIN*) 959

Using intellectual resources available, to produce long-term competitive advantage in engineering design, requires evolution in the ways strategies are executed. This means linking effective knowledge management methods to business strategies, and strategies to operations. Intellectual resources management should not consider only individual or organizational factors, but the forms of social coalitions between these two resources. The goal of this paper is to apply existing knowledge management models with the experience of the authors, to recognize enabling factors for managing intellectual resources in engineering design. Models discuss the form, time, place and context in which the information and knowledge is shared and exploited.

INNOVATION HUBS: WHY DO THESE INNOVATION SUPERSTARS OFTEN DIE YOUNG?

O'Hare J., Hansen P. K., Turner N., Dekoninck E. - *University of Bath* (*GBR*) 971

'Radical innovation' poses many new challenges for an organisation and requires new competencies, some of which may conflict with existing best practices for incremental innovations. 'Innovation hubs' are a type of organisational structure dedicated to radical innovation projects that have been used by companies to manage these conflicts. This paper reports on a study of six innovation hubs that attempts to discover why some have failed whilst others have flourished. Conclusions are drawn on what management practices are most conducive to a successful innovation hub; and how greater value could be derived by the mainstream organisation through the cross-fertilisation of ideas, knowledge and culture.

ENGINEERING NETWORKS: A CONCEPT FOR THE COEQUAL MODELING OF DATA AND PROCESSES IN PRODUCT ENGINEERING

Mogo Nem F., Weidlich R., Eigner M. - *Technical University of Kaiserslautern* (*DEU*) 849

Enterprises today have to deal with new arising challenges. Amongst other factors, the introduction of multidisciplinary products, the demand for more product reliability and increasing product liability and the globalisation result in direct collaboration between enterprises, suppliers and customers. The concept of Engineering Networks provides a means to associate the rising amount of information to the complex engineering processes they run through. It describes a meta-model, for the modelling of integrated and federated product data and engineering process models in enterprises. An extended view concept supports the presentation and management of the product data and the associated processes, within and throughout different companies.

THE INTEGRATION OF SYNCHRONOUS AND ASYNCHRONOUS DESIGN ACTIVITY RECORDS

Giess M. D., Conway A. P., McMahon C. A., Ion W. J. - *University of Bath* (*GBR*) 785

With many engineering companies changing their focus from product delivery towards through-life service support, the realisation is that much of the information and knowledge being generated throughout each stage of the design process can aid in both product lifecycle support and also the development of new products. To support these activities, information and knowledge capture systems and models are required, which allow the information to be stored and used thirty years or more into the future. The dichotomy of interest in this paper is that of synchronous and asynchronous working, where engineers may work as part of a group or as individuals and where different forms of record are necessary to adequately capture the processes and rationale employed in each mode. This paper looks at each mode of working in turn and proposes complimentary approaches to information and knowledge capture. The combination of information and knowledge capture performed during both asynchronous and synchronous activities has the potential to create a significantly enhanced overall design process model and record enhancing not only the through-life support of the product but also subsequent projects.

DEVELOPING PROCESS INTEGRATIVE STRUCTURING OF DOCUMENTS CONTAINING PRODUCT INFORMATION

Lauer W. M., Lindemann U. - *Technical University Munich* (*DEU*) 817

In today’s very complex product development processes, a major problem is to provide engineers with the right information at the right time. Engineers need to search for existing product information and have to evaluate its relevance. This research aims at the support of information retrieval by defining a process oriented, parameter based structuring approach of product related documents. The concept of this approach is described as dynamic linking of documents to the process. Documents are analysed and process oriented parameters are derived. An outlook is given on the definition of the value scale of the parameters, the mapping of these parameters to the product development process and the expansion of the analysed data base.

HIERARCHICAL DECOMPOSITIONS FOR COMPLEX PRODUCT REPRESENTATION

Ariyo O. O., Eckert C. M., Clarkson P. J. - *University of Cambridge* (*GBR*) 737

In many published design texts and standards, it is often advocated that hierarchical descriptions should be structured into successive levels of systems, assemblies, components and so. However, there is no one single hierarchy in a complex product. In practice, sub-units within a hierarchy are defined purely in an arbitrary manner. The lack of a structured approach to product decomposition leaves a chance of creating hierarchical decompositions with limited practical use. As a way of creating meaningful hierarchical product descriptions consistently, this paper suggests precautionary steps to aid the product decomposition process. These guidelines are based on insights gained from an assessment on decomposability of a motorcycle.

TOWARDS A DEVELOPMENT PROCESS FOR COMPUTATIONAL SYNTHESIS SYSTEMS

Schotborgh W. O., Kokkeler F. G. M., Tragter H., Röring M. H. L., van Houten F. J. A. M. - *University of Twente* (*NLD*) 665

A computational synthesis system (CSS) automates the generation phase of a design process. Development of a CSS for a new design case has not received much attention in the literature, since most computational synthesis methods are developed to solve a particular design problem [Cagan 2005]. This paper outlines a CSS development process that can be used for the class of quantitative routine design. The central notion is a definition of generative knowledge for use in knowledge acquisition, representation and automation. It unites existing concepts and techniques from cognitive design research, knowledge-based engineering and computational synthesis. Three design cases are used to demonstrate its validity.

TOWARDS KNOWLEDGE INTENSIVE DESIGN SUPPORT FOR THE MICRO SURGICAL DOMAIN

Grech A. K., Borg J. C. - *University of Malta* (*MLT*) 627

This paper, which is part of ongoing research, proposes a framework for a knowledge intensive computer aided design (KICAD) tool that will be able to aid designers working in the micro surgical domain. As the name suggests, the KICAD tool is ‘knowledge intensive’ meaning that life-cycle knowledge regarding parts and design processes is incorporated within the CAD architecture. The knowledge gathered from different stakeholders involved in the different life-cycle phases is gathered and represented in computational form as ‘rules’. The KICAD tool works as follows: a) the designer selects a number of design elements from the library such as the material, micro processing technique, product design element (part to be designed) and the required feature; b) based on the designer’s decisions, the component life model starts to be evolved within the working memory of the system and c) this is monitored by LCC knowledge from the knowledge base. LCCs are evolved informing the designer about the consequences and recommendations are also given; d) while in the meantime the performance measures of time, cost and quality are evaluated for the different life-cycle phases via performance mapping knowledge. These performance measures fluctuate depending on the consequences inferred.

DESIGN CATALOGUES FOR MECHANISM SELECTION

Singh B., Matthews J., Mullineux G., Medland A. J.. - *University of Bath* (*GBR*) 673

Linkage mechanisms have many uses in design and engineering. They can be used to generate intricate motions in assembly tasks, packaging operations, and robotics. Mechanisms are preferable to their main (mechanical) alternative which is cams. The main drawback is the fact that they are difficult to design in the first place. This paper explores a means for creating computer-based catalogues of mechanisms which store the parameters for the mechanism along with its output motion. The output path is stored using Fourier techniques and the Fourier coefficients can be given physical meaning. The paper discusses the creation and use of a catalogue, how a selection can be made more optimal, and how the local design space can be explored.

INTERACTIVE EVOLUTIONARY DESIGN FOR RECOGNICING CUSTOMER NEEDS AND WISHES

Tiainen T., Ellman A. , Syrilä A. L. - *Tampere University of Technology* (*FIN*) 705

In a product development process, designers try to understand what customers need and want. Especially in the case of personalized products, it is important that customers can describe what they want. For supporting the discussion between professional designers and customers we created a prototype of a tool based on evolutionary design and utilized with a genetic algorithm. This prototype is the Table Generator. We organized a user test in a furniture fair. The results of the test are promising. Most of the users thought that the Table Generator is a supporting tool in negotiation with professionals, furthermore, about half of the test users found that the Table Generator gave them new ideas about alternatives.

DYNAMIC AND CONCEPTUAL DMU

Gerhardt F. J., Eigner M. - *University of Kaiserslautern (DEU)* 619

In times of ever increasing mechatronical product complexity, development requires early knowledge gain. We present the concept of a dy¬namically growing Digital Mock-Up (DMU), based on the Jupiter Tes¬sel-lation (JT) data format and integrated into the early phases of product development. While our so-called Dynamic DMU is to serve as a basis for a multi-disci¬plinary analysis based on a cross-do¬main description, our focus lies on an architectural point of view, and on JT as the underlying technology to manage continuously evolving geometry.

A CONCEPT FOR INTERFACES TO GENERATE 3D CAD MODEL FROM CUSTOMER REQUIREMENTS

Chahadi Y., Rollmann T., Wu Z., Birkhofer H., Anderl R. - *Technical University Darmstadt (DEU)* 593

This paper pays particular attention to the methodical inventions in the early product development stage and the information data model intended to perform the overall data management. Interactions and interfaces between the different science disciplines will be paramount to realize a continuous product development process. In particular, after the requirements have been extracted and specified from the customer wishes, an algorithmic approach is being applied to generate concrete 3D CAD models of possible solutions of bifurcated sheet metal parts. The data exchange, interfaces and the data management shall be presented here.

WEB-BASED SOLUTION REPOSITORY IN MECHANISM THEORY TO SUPPORT THE DESIGN PROCESS

Brix T., Döring U., Reeßing M. - *Technical University Ilmenau (DEU)* 583

This paper presents a solution repository that is part of the "Digital Mechanism and Gear Library" (DMG-Lib). The aim of this project is to develop a new digital, internet-based library (www.dmg-lib.org) to collect, preserve and present the knowledge of mechanism and gear science. Using the state-of-the-art in the field of interaction, metadata and search algorithms, the digital library will support engineering designers in many aspects of product development as it helps to find possible design solutions, calculation procedures for dimensioning, etc. Combined with innovative multimedia applications and a semantic information retrieval environment, DMG-Lib provides an efficient access to this knowledge space of mechanism and gear science.

INTERACTIVE VISUALISATION OF THE CONE OF VISION AS A DESIGN TOOL

Heikkinen T. - *University of Art and Design (FIN)* 635

This paper presents a study of using a software tool for augmenting two-dimensional plan drawings with interactive graphic view cone shapes, mobile isovists. Space syntax research has shown that view cone shapes relate to experiential qualities of being in space, but little discussion exists of how the shapes could be directly used in exploring design problems, which all may not be well defined. To explore this potential, a software tool was developed and tested in a student project that relied on manipulating visibility. The results of the study suggest that using interactive plan drawings opens up design problem field in sufficiently rich way to negate the need for three-dimensional modeling and navigation in natural perspectives.

A MODEL OF CK DESIGN THEORY BASED ON TERM LOGIC: A FORMAL CK BACKGROUND FOR A CLASS OF DESIGN ASSISTANTS

Kazakci A. O., Hatchuel A., Weil B. - *Ecole des Mines Paris* (*FRA*) 43

The paper addresses concept-knowledge (C-K) design theory. C-K theory explains design as the interaction between available knowledge (K space) and concepts (C space - propositions that are neither true, nor false in K space). We give a model of K space based on a term logic, NAL, and we describe how to interpret the key notions of C-K theory within the framework of NAL. It is then discussed how NAL can be used to capture fundamental notions of C-K theory. Some related issues including design assistants based on C-K theory are discussed.

USING PARAMETAR ANALYSIS FOR INCORPORATING DESIGN PRINCIPLES DURING CONCEPTUAL DESIGN

Condoor S. S., Kroll E. - *Saint Louis University* (*USA*) 9

Design principles capture the essence of design knowledge. They can aid in synthesizing and evaluating design concepts. Opportunities to incorporate the principles often go unattended, due to the absence of methodologies for the systematic application of the principles. This paper presents parameter analysis as a tool to create configurations incorporating design principles in general, and the principle of direct and short load transmission path in particular. It places a magnifying glass over a portion of the conceptual design process of a running tool for offshore oil field drilling application. The methodology presented in the paper will enable expert and novice designers to effectively incorporate design principles in their designs.

INTEGRAL BUILDING DESIGN WORKSHOPS; COMPARING STUDENTS AND PROFESSIONALS

Savanovic P., Zeiler W. - *Technical University Eindhoven* (*NLD*) 61

Following the developments in (Dutch) building practice, where besides specialist skills a integral design approach is increasingly being asked, the Building Services chair of the Faculty of Architecture, Building and Planning of Technische Universiteit Eindhoven (TU/e) initiated a multidisciplinary masters project 'Integral Design'. As basis for this project served a learning-by-doing workshop approach, developed and tested with/on experienced practitioners from the Royal Institute of Dutch Architects (BNA) and the Dutch Association of Consulting Engineers (ONRI). In this paper the results of the first two multidisciplinary masters project editions are discussed. A comparison with BNA-ONRI workshops for practitioners is made.

PHYSICAL NATURE OF TECHNICAL SYSTEMS

Rihtaršic J., Žavbi R., Duhovnik J. - *University of Ljubljana* (*SVN*) 53

The article presents a systematic approach to synthesis of a conceptual technical system (TS). The starting point for creating the structure of conceptual TS are physical laws, which are required to fulfil the desired function. In order to enable connections between individual physical laws and TS structure, basic schemata (BS) are introduced. Basic schemata consist of geometrical elements and physical quantities. They represent the necessary structure for realization of the complementary physical laws. BS are applied for embodiment of the parts and they enable their assembly into complex TS. Connections between BS reveal physical nature of TS.

THEORY OF TECHNICAL SYSTEMS AND ENGINEERING DESIGN SCIENCE - LEGACY OF VLADIMIR HUBKA

Eder W. E. - *Royal Military College of Canada* (*CAN*) 19

The personal and professional history of Vladimir Hubka is outlined. The scope of science leads to typical research methods for design, and the triad 'theory – subject – method' connects a scientific or informal theory to a recommended method. Hubka initiated a body of formal scientific theory about technical systems, transformation processes, and engineering design processes. As a typical example, the development over time of the model of a transformation system is traced. The role of information is outlined, dividing it into object information and design process information, each with its theory and its applicable methods and heuristics. Engineering design science is placed into a hierarchy of sciences, the only developed design science.

USER SPECIFIC SUPPLY OF DOCUMENTS FOR PRODUCT DEVELOPMENT KNOWLEDGE BY MEANS OF A COMPREHENSIVE TOPIC MAP APPLICATION

Weber H., Lenhart M., Birkhofer H. - *Technical University Darmstadt* (*DEU*) 877

Current books and also computer aided tools for the transfer of product development knowledge are mostly static and do not consider the user specific needs. A modular contents basis allows the composition of different but consistent documents for different users. Thereby the selection of the modules for an appropriate composition is not a trivial task. To solve this, the presented approach contains a unified description of the three fields product development knowledge domain, modular contents and users by means of adaptive topic maps. These are compatible to each other and can be integrated in a superior system. As a consequence, the original information retrieval problem can be solved by matching the different topic maps.

CHALLENGES WITH PRODUCT DATA EXCHANGE IN PRODUCT DEVELOPMENT NETWORKS

Jokinen K., Hajda M., Borgman J. - *Helsinki University of Technology* (*FIN*) 801

Collaborative product development in company networks creates new requirements for product data management (PDM). All partners need access to correct and updated data to avoid unnecessary delays and costs, and progress with tasks should be visible to others. We conducted case studies in four company networks to identify common PDM-related challenges. The results reveal several challenges with the contents of the data exchanged, the exchange processes and the tools that were used. We suggest addressing these challenges by defining and implementing PDM processes and tools that support collaborative product development. Future research in this area should address the concepts, processes, policies, and tools used in product data exchange.

INVESTIGATIONS INTO THE DATA BASIS OF DESIGN KNOWLEDGE IN INDUSTRIAL DESIGN ENGINEERING

Uhlmann J., Schulze E. E. - *Technical University Dresden* (*DEU*) 869

The article’s main topic is design knowledge within professional knowledge in design. In order to give a theoretical classification, a scheme is derived from psychology and neurosciences. Thus design knowledge is described on basis of a model of memories content for data knowledge and the action regulation theory for design activity. An application of the theoretical scheme is presented within three exemplary investigations to differentiate data knowledge into factual- and episodic knowledge: (1) A comparison between the curricula of engineering and product design, (2) an interpretation of evaluation categories for design awards, (3) an experimental approach to investigate the content of data knowledge.

DESIGN KNOWLEDGE INDEXING IN RELATIONAL DATABASE

Rohde D., Pavkovic N., Aurisicchio M. - *University of Zagreb* (*HRV*) 857

The aim of this research is the improvement of the knowledge management process for long-lasting product development projects, which repeat themselves in cycles of 3-5 years. To find and propose appropriate ways of "navigated" (suggested) knowledge capturing that would take as less designer's time as possible, this research tries to answer following questions: What kind of design information structures should be captured?, How to organize, structure and index captured information? The main advantage of proposed approach is the usage of the same relational database structure and interfaces both for process of experimental analysis used to develop knowledge indexing taxonomy and for process of future eventual practical usage.

CLASSIFICATION OF TOOLS AND METHODS FOR KNOWLEDGE MANAGEMENT IN PRODUCT DEVELOPMENT

Kaiser J.M., Conrad J., Koehler C., Wanke S., Weber C., - *Saarland University* (*DEU*) 809

Knowledge management is a very important topic in engineering design and the application of information technologies is an important part in the implementation of knowledge management. The aim of this paper is to combine knowledge management tools and methods with product development. It considers the knowledge management tools from the area of business administration in the context of the product development process according to VDI 2221. Based on these considerations, this contribution identifies and proposes existing solutions for knowledge management in the different phases of product development.

ON DETERMINING A PRODUCT'S PROCESS RELATED TO THE DEGREE OF MATURITY

Paetzold K. - *University Erlangen-Nuremberg* (*DEU*) 211

It will be shown how the decision about the progress of processes can be supported by using appropriate information about the product's functionality. By choosing behaviour-orientated representations of specific development results and it will be possible to compare with customer requirements as a reference value. So we are able to define the degree of maturity. Interdisciplinary solution approaches and development results can be considered for the definition of the development situation. Parallel to this, it is necessary to compile operating guidelines which support the developer in deriving the characteristics from the attributes, where here different analytical approaches are to be taken into account.

UNCERTAINTY AND RISK REDUCTION IN ENGINEERING DESIGN EMBODIMENT PROCESSES

Grebici K., Goh Y. M., McMahon C. - *University of Cambridge* (*GBR*) 143

The interdependency between information requirements and lead-time reduction is a challenging issue usually addressed by collaborative and concurrent design processes. The combination of temporal issue, multi-disciplinary teams, task parallelization and fuzzy system boundaries introduces additional risks due to the need to provide and receive uncertain information. Engineers often face uncertainty. They adopt a tacit approach in assessing the quality and the maturity of information. An appreciation of both uncertainty and information maturity can influence task execution and the way tasks are solved. This paper discusses a framework that may aid robust decision-making and help in achieving smooth progress in the collaborative and concurrent engineering activities in the presence of uncertainty.

SUPPORT OF DESIGN ENGINEERING ACTIVITY – THE CONTACT AND CHANNEL MODEL (C&CM) IN THE CONTEXT OF PROBLEM SOLVING AND THE ROLE OF ...

Albers A., Deigendesch T., Alink T. - *University of Karlsruhe* (*DEU*) 97

The Contact and Channel Model (C&CM) is a means to describe design problems on any level of abstraction, in order to provide a representation of the product as the problem situation requires. With the C&CM a support is provided, which in an unstructured, through multiple goals and through different procedures characterized environment of product development makes possible a systematized but free and dynamic way of modelling. The basic systematic of the C&CM allows everybody to use the model in their own strategy of problem solving. This paper firstly briefly introduces the C&CM before the methodological background of the C&CM with special focus on “model building” and “solving design” problems is enlightened.

AN OPPORTUNITY SEARCH METHOD FOR NEW PRODUCTS DEVELOPMENT

Benedicic J., Žavbi R., Duhovnik J. - *University of Ljubljana* (*SVN*) 103

Launching of new product on the market is necessary for company growth and business development. Only 10% of launched new products are successful. How can we increase successfulness of new products? We have developed a special method for identifying opportunities for new products. A new product can mean improvements of existing products, radical innovations or services. The method is suitable for small as well as big companies. We defined social, economic, technological and legislative factors which help us to recognize opportunities while taking into account company characteristics. The method presents more systematic approach to opportunity identification process

UNCERTAINTY HANDLING IN INTEGRATED PRODUCT DEVELOPMENT

Lindemann U., Lorenz M. - *The Boston Consulting Group* (*DEU*) 175

Innovation projects have to face uncertainties resulting from lacking or imperfect information on market or technology-related issues. Common development process model do not fully support radical and thus uncertain development projects. The widely recognized integrated product development framework can be expanded through a flexible but direction setting process. The overall set-up is front-loaded, embeds options on the market and technology side, and stipulates an integrative work mode. Uncertainties are thus addressed using real options that support integrated decision making. Cases study research applied in radical innovation projects in the engineered goods sector demonstrates the positive impact of such a real options approach.

GUIDELINES FOR THE DEVELOPMENT OF FLEXIBLE PRODUCTS

Bischof A., Blessing L. - *Technical University Berlin* (*DEU*) 289

Flexibility is often suggested as a useful approach for companies in fast changing environments to stay competitive. This flexibility does not only include flexible manufacturing systems, flexible processes but also flexible products, which enable easy adaptation to the diverse and fast changing customer requirements. In this paper design guidelines are proposed that support the development of flexible products. They are derived form different DfX topics as e.g. Design for Flexibility (DfF), Design for Modularisation (DfM) and Design for Adapatability (DfA). For better understanding and memorability the guidelines are presented graphically.

ANALYSIS AND OPTIMISATION OF DISASSEMBLY DEPTH DISTRIBUTION: AN APPLICATION IN ELECTRONIC DEVICE REDESIGN TO REDUCE ENVIRONMENTAL ...

Giudice F., Kassem M. - *University Politecnica delle Marche* (*ITA*) 377

The present paper proposes the application of a structured method for the analysis and reconfiguration of the disassembly depth distribution of components making up an electronic device with the aim of obtaining a generalised improvement in ease of disassembly, in relation to the necessity of reducing their environmental impact at end-of-life. As evidenced by the results from the case study, by means of an appropriate metric to assess the effectiveness of the distribution, the method provide information regarding the criticality of a system and make it possible to direct an intervention modifying the principal design parameters in a way that improves the overall efficiency of disassembly.

DESIGN FOR VARIETY – EFFICIENT SUPPORT FOR DESIGN ENGINEERS

Kipp T., Krause D. - *Hamburg University of Technology* (*DEU*) 425

The development of products with many variants is a challenge getting increasingly important due to the trend of individualisation. Product development meets this challenge generally with specific product architectures, e.g. modular or platform architectures. However beside its architecture the design of a product affects significantly the expenses of the creation of new variants.
Therefore this contribution identifies design principles supporting the simple and cost efficient generation of product variants. To make these principles available for design engineers in an efficient way, they are compiled as helpfully illustrated design guidelines. Finally the benefit of these guidelines is discussed on the basis of a real product example.

DESIGN FOR POKA-YOKE ASSEMBLY AN APPROACH TO PREVENT ASSEMBLY ISSUES

Estrada G., Lloveras J., Riba C., - *Technical University of Catalonia* (*ESP*) 351

It is important to be aware about assembly quality issues due to they represent a significant proportion of quality defects in many companies. These issues are commonly analyzed after they occur and it is observed that best solutions to eliminate them are performing poke-yoke redesigns in the product. This research propose a Design For Poka-yoke Assembly-DFPA approach, focused in define how designers can identify since early design stages the potential assembly quality issues in order to establish, as part of the customer requirements list, the assembly design requirements that has to be complied to design a product oriented to prevent assembly quality issues. By using DFPA approach it will be reduced the need of later poka-yoke redesigns.

DESIGN TO COST: NEW IMPULSES FOR TARGET COSTING

Braun S. C., Biedermann W., Lindemann U. - *Technical University Munich* (*DEU*) 317

The authors of this contribution enrich classic target costing with a costing method developed for the cost estimation of individualized products and a multiple-domain approach considering numerical aspects. The result is an approach for the target costing of functionality improvements and/or extensions of structurally complex mechatronic products. Among others the presented approach offers special potentials regarding the deduction of cost reducing actions in consideration of different aspects such as functionality, component and process structure. Impacts of resulting cost reducing changes can be traced easily through the whole network through the consistent documentation of all relevant information in form of a multiple-domain matrix.

POST-MERGER PRODUCT DEVELOPMENT INTEGRATION: A CASE STUDY

Gries B. - *Capgemini Consulting* (*DEU*) 935

Combining different companies through mergers or acquisitions (M&A) is a common management strategy nowadays. For companies whose major business activity is focused on product development, the complexity of design processes adds another dimension to the already existing challenges of a post-merger integration (PMI). The purpose of this contribution is to discuss this impact, focusing on the question how to achieve a successful transformation of design organizations. The described case study shows that harmonizing the product development processes of different organizations needs to take the following steps: a) analyzing the “as-is”, b) defining the “to-be” and c) ensuring the successful transition from a) to b).

NETWORK ENABLED CAPABILITY AS A CHALLENGE FOR DESIGN: A CHANGE MANAGEMENT VIEW

Keller R., Atkinson S. R., Clarkson P. J. - *University of Cambridge* (*GBR*) 943

In 2002 the UK Ministry of Defence introduced Network Enabled Capability (NEC) as its response to US designs for Network Centric Warfare. NEC as a paradigm poses a number of requirements on systems in the battlefield and defence companies are expected to deliver systems that meet these requirements. Requirements such as agility or interoperability can be achieved by improved change planning. At the same time, the effects of change can be unpredictable. Scoping the effects of change before a change is made can be crucial for delivering products or services in time and in budget. This paper investigates how operational requirements of NEC impact industry tasked with designing network enabled products from a change perspective.

TOWARDS AN INTEGRATION OF SIX SIGMA, DESIGN FOR SIX SIGMA AND DESIGN METHODOLOGY

Schmidt-Kretschmer M., Warncke T. R. - *Technical University Berlin* (*DEU*) 987

The selection and interpretation of methods and workflow within the product development process are not synchronous and practice usually varies between the departments involved (e.g. development and production). This complicates the utilization of company potential. The integration of the different practices could increase corporate understanding, work-content consistency and generate synergy benefits. The paper examines the possibilities and benefits of a consolidation of up to now detached approaches for problem solving, such as Design Methodology (DM), Six Sigma and Design for Six Sigma (DFSS) and describes a possible first approach to an interdisciplinary consolidation of viewpoints and presently applied approaches, bearing the entire product development process in mind, beyond the classical boundaries of production and design.

A COMPETENCE MANAGEMENT METHODOLOGY FOR VIRTUAL TEAMS - A SYSTEMIC APPORACH TO SUPPORT INNOVATION PROCESSES IN SME'S

Schumacher M., Le Cardinal J., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 993

The changing nature of teams in a context of raising importance of innovation has brought on a need to identify the competencies that are necessary to work effectively in a virtual team environment. Our paper defines key elements and identifies interrelations between different concepts of virtual teams, competences management and innovation processes. Due to the systemic approach of the functional analysis our paper offers a holistic overview of a methodology of competence management to create competitive virtual teams for supporting innovation processes in Small and Medium-sized Enterprises. The generic nature of our proposed approach makes it applicable in any industrial fields.

A FRAMEWORK TO CLASSIFY PROCESS IMPROVEMENT PROJECTS

Kreimeyer M., Daniilidis C., Lindemann U. - *Technical University Munich* (*DEU*) 951

While process improvement projects have varying parameters (e.g. goals, timeline, etc.), there is a basic structure to planning such projects. Yet, there are few planning aids, and transferring the institutional knowledge from one project to the next one is difficult. The project classification framework proposed here aims at assisting project planners, who are faced with the task to organize a process improvement project, to categorize their projects according to the optimization goal, the process granularity and the project novelty in order to show them if relevant knowledge is available, and to assist them during the selection of appropriate activities to achieve the general goal and of adequate methods to perform these activities.

SMOOTH CURVES AND MOTIONS DEFINED AND OPTIMISED USING POINT-BASED TECHNIQUES

Edmunds R., Feldman J. A., Hicks B. J., Mullineux G. - *University of Bath* (*GBR*) 603

Smooth motions are important in many areas of engineering, including robotics and machine design. Typically there are conflicting requirements and the design task can be formulated as a constrained optimisation problem. Examples of requirements include: smooth motion, minimal time of travel, minimal peak acceleration and jerk, and obstacle avoidance. Rather deal with Bézier or B-spline control points, it can be easier to deal with actual points along the motion and use variation of these to achieve performance requirements and functional constraints. The paper investigates the applicability of point-based techniques for design optimisation. Three strategies for doing this are proposed and evaluated by means of case study examples.

TOLERANCE ANALYSIS OF GEOMETRICALLY NON-IDEAL SYSTEMS IN MOTION

Stuppy J., Meerkamm H. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 697

The functionality of technical systems in motion is influenced by small geometrical variations of their components. To quantify this influence, tolerance analysis is carried out. In this paper, tolerance and motion analysis procedures are merged together for an integrated modelling strategy. All explanations are exemplified by means of the crank mechanism of a combustion engine. Different kinds of deviation are considered – a) dimensional deviation of the mechanism links crankshaft and conrod, b) position deviation of the cylinder axis and c) clearance at the conrod big end bearing. With the results gained, understanding of the correlation between defined tolerances and the functionality of the mechanism can be improved.

RECENT ADVANCES IN AVL'S MESH GENERATION SOFTWARE - ESE-TOOLS

Juretic F., Moser W., Rainer G. - *AVL-AST d.o.o* (*HRV*) 643

The paper presents the new tools aimed at automating CFD calculations at the pre-design stage. The tools are: ESE Diesel developed for in-cylinder calculations in Diesel engines, ESE Aftertreatment is an simulation environment for after-treatment systems and ESE 3DEngine is designed to enable the users in the automotive industry generate accurate engine models quickly and reliably. The tools are easy to use even for engineers with no CFD background.

A SYSTEM FOR HAPTIC TOLERANCE ANALYSIS REGARDING NON-IDEAL GEOMETRY

Wittmann S., Stockinger A., Stoll T., Paetzold K. - *Friedrich-Alexander-University Erlangen-Nuremberg* (*DEU*) 729

Incomplete or wrong definition of tolerances can cause aesthetic and functional problems. In a virtual environment the visual representation is not precise enough to reveal small deviations. Therefore a platform for haptic tolerance analysis is presented employing the human haptic sense for this task. The requirements on the system are the precise representation of geometry, realistic simulation of physics and stereographic visualization. In addition to the systems layout, experiments to acquire data about the system accuracy for gap and flush analysis are discussed. Finally, a case study for the analysis of sheet metal parts is presented. It is shown that haptic systems offer a high accuracy and extend the immersion in VR-environments.

FEM MODEL FOR THE ANALYSIS OF ROTATIONAL SPEED INFLUENCE ON TOOTH CONTACT PRESSURE DISTRIBUTION OF THIN-RIMMED GEARS WITH ...

Vuckovic K., Ulbin M., Belšak A. - *University of Zagreb* (*HRV*) 713

Conventional procedures are limited to contact pressure calculation of a solid gear. The objective of the article is to use advanced engineering tools for a numeric calculation of tooth contact pressure of thin-rimmed gears that have a special design and operating conditions. Presented finite element method approach uses a 3D parametric model of engaged gears to evaluate the influence of rotational speed on tooth contact pressure distribution. Application is shown on a thin-rimed gear with asymmetric web arrangement engaged with a solid spur gear. Contact pressure contour lines for various rotational speeds that can be used for recommendation of gear micro-geometry modifications and for defining parameters of gear life-cycle, are presented.

KANSEI PHYSIOLOGICAL MEASUREMENTS AND CONSTRUCTIVIST PSYCHOLOGICAL EXPLORATIONS FOR APPROACHING USER SUBJECTIVE ...

Tomico O., Mizutani N., Levy P., Yokoi T., Cho Y., Yamanaka T. - *Technical University Eindhoven* (*NLD*) 529

The aim of this article is to explore the suitability of psycho-physiological measures and psychological explorations for approaching user subjective experience. For this purpose the 2-point Electroencephalogram (EEG) comfort measurement is used to gather real-time information about how a person feels during the interaction with a product and the Repertory Grid Technique (RGT) interview is used to gather information about what people's primary goals and concerns are. These two different methodologies combined allows for analyzing the exploration, usage and reflection process. Thus, it can be used for: track, compare, analyze the comfortableness level and relate it to the consumer's response.

PRIORITISATION METHODOLOGY FOR USER-CENTRED DESIGN OF ENERGY USING DOMESTIC PRODUCTS

Elias E. W. A., Dekoninck E. A., Culley S. J. - *University of Bath* (*GBR*) 343

An essential element of a user-centred design approach is to understand the differences between the intrinsic energy losses of products due to their engineering construction and technology with the losses associated with their use. This argument for using user-centred design strategies is presented which leads to a methodology for the assessment of behaviour potential and energy impact for domestic energy using devices. From this assessment procedure, the significance of user related energy losses becomes clearer and recommendations for target products requiring an energy efficient redesign can be made.

ACTIVE CUSTOMER INTEGRATION TO INNOVATION NETWORKS: A PROJECT OUTLOOK

Kirschner R., Kain A., Franke S, Dick B., Lindemann U. - *Technical University Munich* (*DEU*) 433

The actual application of customer knowledge in the new product development process (NPD) is underdeveloped, especially in the environment of SME. The project described in the paper aims to develop a new approach for the active integration of customers in the NPD process. The objective is the development of new methods and approaches for innovation processes which enable systematic and early active customer integration in the phase of generating ideas and concepts. A handbook with detailed guidelines and step-by-step suggestion making when to use which method, which departments to involve and what the trade off between possible benefits and cost is, could help to increase the implementation rate of customer integration methods.

DESIGN WITH MEDICAL INFORMATION

Langeveld L. H. - *Delft University of Technology* (*NLD*) 449

Medical aspects required a new approach because the designer and medical specialist must be on the same level of understanding about the medical information for the project. The design task is first done by a project team for Advanced Product Project which resulted in a functional prototype. In a graduation project the functional prototype is designed as far as a working prototype. In the beginning of the process the graduate student researching the medical information to evaluate the requirements and wishes for the new product design. By observation research he discovers also many unspoken wishes. In the conceptual phase the focus lays on ergonomics, user interface and perfection of parts.

A USER-CENTERED APPROACH TO DEVELOPING EMERGENT TECHNOLOGY PRODUCTS

Restrepo J., McAloone T. C., Schlegel T., Lykke J. - *Technical University of Denmark* (*DNK*) 483

Current participatory design methods do not allow designers to gain the insight required to develop products with emerging technologies. This poses challenges to the designers, as input from users cannot be used too early in the design process, given that users respond best to issues they know or can relate to. This paper presents a case study where a user-centred approach was used to determine when and how to involve users in the design of a TV-enabled mobile telephone, with the aim of identifying the main form factor drivers for its design. The paper also discusses some methodological issues related to user involvement in the implementation of emerging technologies in the consumer electronics industry.

A MODULARIZATION METHOD IN THE EARLY PHASE OF PRODUCT DEVELOPMENT

Albers A., Burkardt N., Sauter C., Sedchaicharn K. - *University of Karlsruhe* (*DEU*) 253

A modular product architecture possesses many advantages required as one of the design goals. Most of the modularization methods focus on the redesign of existing products, in which a dependency matrix is often used as a tool for an integration analysis. In this research, the modularization in the early phase of the design will be focused. Three more tasks will be added into the modularization of the guideline VDI 2223 with the applying of a dependency matrix, Contact & Channel Model and Genetic Algorithm to find out the optimal architecture. Additionally, the relation between number of modules and the degree of modularity will be emphasized. This approach is validated in the development of a robot forearm for the humanoid robot ARMAR III.

ON THE DEVELOPMENT OF MODULAR PRODUCT STRUCTURES: A DIFFERENTIATED APPROACH

Blees C., Krause D. - *Hamburg University of Technology* (*DEU*) 301

The process of modularization is influenced by a variety of factors and is therefore a very complex task. This complexity can be reduced by a separated proceeding according to different perspectives. For this reason known module drivers are assigned to the main perspectives product planning, purchase, manufacturing/assembly and after sales. Additionally the modularization from the manufacturing/assembly perspective is presented more in detail. For this purpose the module interface graph and the assembly priority chart have been integrated in the process.

MAINTAINING PRODUCT PLATFORMS IN INDUSTRIAL MACHINERY

Alblas A. A., Wortmann J. C. - *University of Groningen* (*NLD*) 261

Product platforms describe the range of products offered by a company in terms of functionality, performance and architecture. Based on an extensive case study in industrial machinery, several important elements of a platform approach are identified in this paper. The technological evolution of a platform is highly uncertain and difficult to define beforehand: therefore, a life cycle approach is needed. The paper argues that a platform life cycle requires incorporating the process aspects of platform development: product development yields continuously proposals for platform engineering change, which have to be properly managed during the whole platform life cycle.

APPLYING THE MULTIPLE DOMAIN MAPPING APPROACH TO VARIANT MANAGEMENT

Deubzer F., Braun T., Maurer M., Lindemann U. - *Technical University Munich* (*DEU*) 335

As today’s markets show an increasing individualization, dynamics and diversity concerning the customers, different authors point out the relevance and challenge of efficient variant management. Accordingly to the different domains affected by the complexity of variant management, strategies to deal with this increasing complexity exist within domains such as engineering development, production, the organizational and the process domain. Companies lack the ability to enable transparency for the involved persons and gain overview over the complex interdependencies between those domains of variant management. The paper shows the adaptation of the multiple domain mapping approach to enable this holistic view on variant management.

IMPLEMENTATION OF MODULAR ARCHITECTURE OF COOLING GENERATORS

Osman K., Bojcetic N., Marjanovic D. - *University of Zagreb* (*HRV*) 465

This paper aims to contribute to the understanding of the roles of module, modularity and modularization. This paper’s objective is to propose engineering methods for more rational engineering activities base on the idea of modularization and design for reuse. The basic goal of the research is to help the designer in the conception and design of a design solution, reduce the time of preparation of design documents, and thus reduce the overall product development costs. In this paper it is need to research possibility of development cooling generator product family based on modular architecture. For this purpose it is used Modular Function Deployment method [Erixon, 1998.], consisting of five main steps and which describe structuring products in modules. The method analyzes the functional requirements for a product and determines the technical solution and modular concept, and consists of the following steps: clarify customer requirements, technical solutions, define possible modules, evaluate concepts and improve each module.

INVESTIGATING THE STRUCTURE AND ORGANISATION OF ENGINEERING LOGBOOKS FOR MORE EFFECTIVE REUSE

McAlpine H., Hicks B. J., Culley S. J. - *University of Bath* (*GBR*) 841

Engineering logbooks are an important but often overlooked source of design information and knowledge, partly because their structure and organisation makes re-use difficult or impossible. To address this, a methodology for characterising the structure of logbook entries is discussed and the results of its application to a set of logbooks is presented. These findings are used to inform the development of a strategy for improving the recording and subsequent re-use of logbook information. The strategy is discussed in detail and examples are given of how the strategy facilitates more effective management of logbook information, for both the individual and the wider organisation.

MODULARISATION OF PRODUCT DEVELOPMENT CONTENT – PROVIDING USER-SUITABLE DOCUMENTS

Lenhart M., Weber H., Birkhofer H. - *Technical University Darmstadt* (*DEU*) 825

This paper introduces a procedural model for the configuration of modular content. The model helps to decrease the amount of effort necessary to generate individual documents for learning and application. It provides precise instructions and a standardised procedure for implementing user requirements as well as situation-specific document requirements. By considering a set of scenario-specific design recommendations, the described procedure enables the author to generate individual documents, even when he is not familiar with the underlying cognitive conditions. Finally, the configuration model and the modularisation approach are key prerequisites to generating user-specific documents within a reasonable amount of effort.

THE ROLE OF NARRATIVE IN EVOLVING ENGINEERING DESIGN DOCUMENTATION

Eng N. L., Bracewell R. H., Clarkson P. J. - *University of Cambridge* (*GBR*) 769

Graph representations are emerging to replace more traditional narrative forms of knowledge capture. These seem to be a better fit for work with modern hyperlinked, non-linear computerized systems and design problems. The old forms, however, possessed important characteristics for effective knowledge capture. It is not exactly clear what is lost and gained in the transition. This paper explores narrative theories and examines them using the cognitive dimensions framework. A review of literature finds that deliberately constructed narrative structure is key to affording meaningful experience of representations. This suggests flaws in current documentation practice. Proposed concepts situate many new questions that will require further study.

TOWARDS REPRESENTING, EVOLVING AND NETWORKING ENGINEERING KNOWLEDGE FOR COMPUTATIONAL DESIGN SYNTHESIS

Hoisl F., Shea K., Helms B. - *Technical University Munich* (*DEU*) 793

Current computational design synthesis methods are often based on static knowledge and restricted to limited scope tasks focusing on specialized engineering knowledge only. Based on a review of research in engineering knowledge representations, knowledge-based engineering and engineering design grammars, this paper presents an extended model for formal engineering design synthesis and defines new requirements for the knowledge representations used within to enable the integration of multi-domain knowledge that can be networked, exchanged and dynamically evolved throughout the innovation process. The paper discusses through examples the advantages of the approach for creating computational synthesis methods that support innovation processes.

COMPARING ACTIONS OF CREATIVE DESIGNING

Englisch U., Sachse P., Uhlmann J. - *University Erfurt* (*DEU*) 1009

General principles of constructive design actions – based on the qualitative analysis of established conceptions and experts' statements of technical and non-technical (artistic) design processes – are presented and discussed. On the basis of the derived continuum of design processes the discipline "Technisches Design" (Technical Design) is categorized. Individual design processes in this discipline are regarded as multiple and complex problem solving processes (consisting of so called sub-problems). These sub-problems are characterized as belonging rather to the technical or the artistic pole of the continuum. Finally, a preview with regard to the consequences of the results – e.g. the support of design processes– is given.

THE INLFUENCE OF THE DESIGNER'S GENDER

Stilma M. D. C. - *University of Twente* (*NLD*) 1065

Product design from a gender perspective is a rather new and important area to focus on. Current product design is divers and often adjusted to the needs and wants of the consumers. A differentiating aspect in the design could be the way products are designed as every designer has influence on their designs. Distinct differences have already been found in two dimensional designs such as business cards and websites. This study analyses whether these criteria are present in three dimensional designs, such as consumer products, as well. The positive indication of the results and possible options for further research are discussed.

EXPERIENCE WITH CULTURAL INFLUENCES IN DISTRIBUTED GERMAN-CHINESE DEVELOPMENT PROJECT COOPERATIONS

Meyer-Eschenbach A., Gautam V., Wildung W., Schüler P. - *Hamburg University of Applied Sciences* (*DEU*) 1049

In international development cooperation, project members come from various countries and continents, from different cultures, educational backgrounds, and native languages. It is helpful to be aware of the profiles of the various cultures and the different processes during the planning of the project teams. In this paper, the experience of project managers and engineering designers who have worked on international projects is discussed and characterised to clarify the cultural influence in German-Chinese project cooperation. The conclusions can be helpful for engineering designers and project managers working on international product development projects with German and Chinese members.

IDEA GENERATION IN CONCEPTUAL DESIGN

Howard T. J., Culley S. J., Dekoninck E. - *University of Bath* (*GBR*) 1025

Creative idea generation is a vital part of the engineering and the new product development process. This paper is based on a number of studies which have analysed idea production during brainstorm sessions and has led to the provision of a new method by which to analyse the ideas produced. Real engineers, design tasks and design processes are analysed for ideas and evaluated objectively in terms of the actual concepts formed by the ideas. It was found that the rate of idea production appeared to be constant throughout each session until roughly 60mins. The results showed that over half the appropriate ideas of the session are produced within the first 10 minutes and the majority of the ideas behind each concept are provided by 20mins.

RELIABILITY OF EMOTIONAL RESPONSES TO MATERIAL TEXTURES

Hilton K. H. - *Northumbria* (*GBR*) 1017

There has been much discussion around the value and impact of designing emotional influences. Nevertheless, a fundamental question not well addressed has been 'just how reliable are emotions as a consideration within the design process?' Texture stimuli were presented to participants in a decontextualised form to reduce the number of additional emotional cues and simplify the test procedure. It was found that reliability of emotional responses to material textures was low, but that there was greater reliability for those textures identified at the extremes of positive or negative emotional experience.

EARLY PROTOTYPES: A STRATEGY FOR EXPLICATING TACIT KNOWLEDGE IN DESIGN ACTIVITIES

Marxt C., Link P., Inganäs M. - *ETH Zurich* (*CHE*) 1043

The globalization of design activities has been an ongoing trend in industry for many years and at the same time sparked several research initiatives. One of the major reasons for globalizing design activities lies in accessing the global knowledge pool. Knowledge exchange within this pool is difficult as a large part is only available in implicit form und hence not easily accessible. This paper identifies some of the barriers in explicating knowledge, describes a framework and shows a strategy to overcome these barriers for successful sharing of knowledge and hence development of products or services in global design networks.

THE PRACTISE OF KNOWLEDGE MANAGEMENT WITHIN THE INNOVATION PROCESS OF A COMPANY MAKING LUXURY WATCH

Alberti P. - *Université de Technologie de Compiogne* (*FRA*) 1001

The present evolution of the industrial environment is characterised by a high level of uncertainty concerning the effective expectations of the market, the available technologies, the abilities to integrate the pressure placed upon companies and the increasing role of information and knowledge on the economic activity. The industrial company's competitiveness and the efficiency of its strategy are largely depending on its ability to control the main technologies linked to its activity area, the relevance of its strategy and of its management of the global process of creation, production and marketing. After laying down the theoretical concepts of KM, this article shall present the organisation that was chosen by a company from the top quality watch-making area. We shall detail the implemented techno-centred approach and the interaction with the organisation chosen by the actors of the company.

ERROR IN ARCHITECTURAL DESIGN PROCESS: TOWARDS A COGNITIVE MODEL

Safin S., Leclercq P., Blavier A. - *University of Liege* (*BEL*) 1057

In architectural design process, the human error has a particular status. The later it is detected, the more expensive it is. Moreover, some errors can not be detected given the current state of the design process and object definition. In this paper, we propose a model based on cognitive theories about human errors, applied to architectural preliminary design. In this model we classify the consequences of a design decision (direct, indirect, detected and undetected), we describe the steps of decision in architecture in relation to the process of errors detection and we introduce the concept of evolutive context.

USING SIMULATION TO SUPPORT INTEGRATION OF LIFE-CYCLE ENGINEERING ACTIVITIES INTO AN EXISTING DESIGN PROCESS: A CASE STUDY

Kerley W. P., Wynn D. C., Moss M. A., Eckert C. M., Clarkson P. J. - *University of Cambridge* (*GBR*) 1033

This paper discusses a case study in which process simulation was applied to support the integration of life-cycle engineering activities into the existing design process at a major UK manufacturer of capital equipment. we demonstrate the practical value of process simulation as a tool to support the specification of changes to a complex, concurrent engineering design process. The paper also liilustrates how development of a design process simulation model can provide significant benefit to companies, not just in terms of the numerical results of simulation analysis, but through the understanding of process behaviour which is gained through validating the behaviour of the model in different iteration scenarios.

PROPOSAL OF A SYSTEM OF INDICATORS TO MEASURE PERFORMANCE OF PROBLEM SOLVING PROCESS IN DESIGN

Maranzana N., Dubois S., Gartiser N., Caillaud E. - *INSA de Strasbourg* (*FRA*) 1175

Evaluation of performance is of great interests for companies wishing to increase their competitiveness. There can be several ways to evaluate performance, globally on the company level, or individually for each of the company processes. Problem solving is one of the key stakes in inventive design, and presents as particularity to be hardly manageable. Due to its particularities, the question of evaluation of performance for problem resolution in design remains. In this article, a proposal is done to understand the role of different inductors on this performance.

ANALYSIS AND IDENTIFICATION OF RESEARCH OPPORTUNITIES IN PRODUCT DESIGN USING THE MULTIDIMENSIONAL PROJECT MODEL

Aguilar-Zambrano J. A., Prada-Molina M., Gómez-Senent E., González-Cruz M. C. - *Universidad Politécnica de Valencia* (*ESP*) 89

This paper shows a comparative analysis of classical product design theories with Gomez-Senent multidimensional model, identifying dimensions absent from such theories and detecting research opportunities. The Dimensions identified as absent were Factors (context) and Metaproject (project team organization). Currently in Factors Dimension, there is a transition from a technological point of view to a point of view focused on the human being and the systematization of contextual qualitative information. In Metaproject Dimension there is research about negotiating processes, design team organization and communication. Research opportunities are detected with multidisciplinary teams and in emotional, sensory, perceptive evaluation methods.

DESIGN FOR NOVELTY – A FRAMEWORK?

Srinivasan V., Chakrabarti A. - *Indian Institute of Science* (*IND*) 237

A model of designing and a framework for design for novelty in conceptual design are presented. The model integrates essential elements of activity, outcome and requirement-solution from literature; it is empirically validated using design protocols. As constructs for activities, Generate, Evaluate, Modify and Select (GEMS constructs) are used; for outcomes, State change, Action, Part, Phenomenon, Input, oRgan and Effect (SAPPhIRE constructs) are used; for requirement-solution, co-evolving relations are used. Analysis of protocols reveals weaknesses in usage of phenomena and effects. To alleviate this, usage of GEMS of SAPPhIRE for requirements and solutions at all levels of the outcome is proposed as a framework for design for novelty.

A REVIEW OF THE FUNDAMENTALS OF SYSTEMATIC ENGINEERING DESIGN PROCESS MODELS

Motte D. - *Lund University* (*SWE*) 199

In this paper it is shown that the central features of systematic engineering design process models: a step-by-step concretisation of the product with a systematic variation of subsolutions and recombination are not absolutely necessary. Current models are neither generic nor ideal. Instead of using product characteristics as a basis for design process models, the focus should be on the concrete goals of product development in industry. As these goals are manifold, the design process needs to be flexible, giving the engineering designer more freedom . Finally it is recommended to separate the feasibility study (term to be preferred to conceptual design) from more routine-like product development.

PRODUCT DEVELOPMENT PROCESS OPTIMISATION WITH HEURISTICS METHODS

Rick T., Groma I., Bercsey T. - *Budapest University of Technology and Economics* (*HUN*) 229

Product development processes are specified as bounded work tasks. It is advised to use design structure matrices for process representation, through which the relationships between tasks during the development can be revealed. This approach supports modeling of iterations, which are quintessential in practice. With a genetic algorithm a semi optimal task schedule (in both: cost and duration) can be found. Another important problem of development process planning is to assign resources fairly to tasks in order to get a fine parallelization. For solving this, a heuristic algorithm was introduced where the resource planning is done by combining various strategies in order to minimize the duration of the development project.

MODELLING DECISION-MAKING IN COMPLEX PRODUCT DEVELOPMENT

Eriksson J., Johnsson S., Olsson R. - *Malardalen University* (*SWE*) 1129

One challenge today for companies lies in finding the right approach to measuring and continuously improving the current state of a company's product development process. The task of continuously improving the performance demands the successful management of information, communication, cooperation and decision-making in a context of uncertainty, which is a highly complex task in itself. To be able to manage a complex product development system in an appropriate way, the authors have identified three important interdependent aspects of product development. The aspects are decision-making, uncertainty and performance. These aspects form the foundation for the suggested model which is intended to be used by engineering design researchers.

OPPORTUNITIES AND BARRIERS IN THE DEVELOPMENT OF SUSTAINABLE PACKAGING FOR THE AUSTRALIAN FOOD INDUSTRY

Collado-Ruiz D., Avendano A. - *Universidad Politacnica de Valencia* (*ESP*) 911

For more than three decades packaging has been considered as principal user of material resources, as well as a waste generator. The Australian packaging industry is particularly concerned about how to address these environmental issues. This paper presents a study consisting of a series of interviews with people involved in the packaging development process of some leading food and beverage packaging companies. The study comprises an assessment of the development processes currently undertaken by companies, as well as the ways in which they incorporate sustainability into it. We include a description of the different roles in this process, as well as recommendations for good practices to consider sustainability in a more efficient way.

CO-DESIGNING BROAD SCOPE OF TECHNOLOGY-BASED APPLICATIONS IN AN EXPLORATORY PARTNERSHIP

Gillier T., Piat G. - *Minatec Ideas Laboratory* (*FRA*) 927

A relatively new type of innovation partnership is emerging : exploratory partnership. This partnership concerns the identification and exploration of innovation fields from emerging technologies. Generally, these partnerships concern few partners (2 or 3) on similar or complementary business. In MINATEC IDEAs Laboratory®, 6 industrial partners have decided to explore the potential of micro-nanotechnologies for their 6 different business. In order to manage efficiently this partnership, we have experimented a method, the D4 method, which is both a creativity technology-oriented tool for designing innovative concepts and a mean to evolve from "community based co-operation" to a more reduced development cooperation (3 partners max).

IMPACTS OF DESIGN PROCESS CHARACTERISTICS ON THE SELECTION OF PLM ARCHITECTURES

Bitzer M., Eigner M., Vielhaber M. - *University of Kaiserslautern* (*DEU*) 901

This paper discusses the correlation between characteristics of the design process and the determination of PLM architectures. Based on first results from ongoing research activities with industrial partners, a process-oriented approach to the determination of PLM architectures is presented. This approach helps to analyze processes - especially design processes - and to develop - based on the results of this analysis - suitable PLM architectures. Future work will focus mainly on a transfer of the concept to a more abstract process level and on the formalization of the presented approach.

FROM WORKFLOW SPECIFICATION TO IMPLEMENTATION: AN INDUSTRIAL USE CASE

Aymar Nkondo Dika A., Ducellier G., Eynard B., Lafon P., Deneux D. - *University of Technology Troyes* (*FRA*) 893

In the domain of project management, PLM offers functionalities for enabling process definition and execution through the use of Workflow Management Systems (WMS). This paper presents the implementation of workflow module in a PLM application. We highlight the limits of workflow in a context of product development and the necessary difference between the processes identified and the workflow implemented. The research context, the workflow specification and the analysis of the results are presented. The specification is set using interviews and a process reference model is developed to enable the communication between the users and the IT-Support. The analysis describes the benefits of existing WMS in a context of product development.

FACTORS INFLUENCING THE VULNERABILITY OF MANUFACTURERS TO PRODUCT IMITATIONS

Petermann M., Meiwald T., Lindemann U. - *Technical University Munich* (*DEU*) 979

This paper describes the first step in a research project visioning towards an approach of “know-how protective product design“. Companies threatened or affected by product imitations increasingly dispose of technical measures against product imitation, supporting common measures of jurisdiction like patents and brands. Technical measures are possible in the fields of product design, manufacturing processes, logistics, and IT security. The effectiveness of such measures has not been investigated yet and shall be clarified in later steps of this research. In this paper, factors and possible values for these factors are identified that influence the vulnerability of technical goods developers and manufacturers to imitation of their products.

WHAT IS DESIGN KNOWLEDGE FROM THE VIEWPOINT OF CPM/PDD?

Conrad J., Köhler C., Wanke S., Weber C. - *Saarland University* (*DEU*) 745

Knowledge is a very common term in engineering design and also extensively discussed. Even if it is not an explicit matter, it plays implicitly a role in the background. The Characteristics-Properties Modelling / Property-Driven Development (CPM/PDD) approach is one possibility to illustrate the product development process. This paper provides a closer look on design knowledge in the context of CPM/PDD. The description of product knowledge in CPM/PDD is thereby straightforward. The more complicated part is the description of process knowledge. Therefore, the method of reduction is transferred from theoretical computer science into the context of engineering design. The result indicates what design knowledge is, especially in CPM/PDD.

USER KNOWLEDGE IN A CONCEPT DEVELOPMENT PROJECT OF A BUSINESS-TO-BUSINESS DIRECTORY SERVICE

Mannonen P., Runonen M. - *Helsinki University of Technology* (*FIN*) 833

Existing process descriptions and methods of user-centred design emphasize the understanding of users and context of use and evaluating the usability of designed products. The descriptions of user research methods and usability evaluation techniques are rich and large in numbers. There however seems to be a lack of analysis and descriptions of what kind of role the gathered user knowledge plays in designing and what kind of impact does it have. This paper describes a concept development project of a business-to-business directory service and presents an analysis of the amount and characteristics of user related information gathered and utilized during the concept development process.

KNOWLEDGE ORIENTED PROCESS MANAGEMENT FOR DFX

Faerber M., Jochaud F., Stöber C., Jablonski S., Meerkamm H. - *University of Bayreuth* (*DEU*) 777

The development of innovative products has become crucial for companies nowadays. Engineers are facing many challenges while transforming requirements specifications into working products. Both target processes to structure the design process and the DfX approach with specific instructions help engineers with this task. However both are usually treated as separate aspects. In this paper we propose a data model to combine both the process model and the DfX approach into a single integrated data model. This data model, based on ontologies and semantic web technologies, is the basis for a knowledge base that can be used by a workflow management system to support product developers during all phases of the design process.

A NEW KNOWLEDGE BASED APPROACH THE REVERSE ENGINEERING OF A PRODUCT

Durupt A., Remy S., Ducellier G., Derigent W. - *Université de Technologie de Troyes* (*FRA*) 753

Current (RE) approaches are based on frozen models (parametric surface approaches) and are hardly re-usable. Consequently, the possibility of re-engineering or re-design does not exist. This paper proposes a new research direction taking into account product lifecycle knowledge. The research direction combines a geometric approach to a functional approach for formalizing and semi-automating the rebuilding methodology. This methodology is presented and the geometrical recognition and the knowledge identification phases are set and data are organised in a functional and structural skeleton. Finally, a use case of the journal cross of a Peugeot 403 is presented for illustrating the approach.

AN INTEGRATED CONTEXT MODEL FOR THE PRODUCT DEVELOPMENT DOMAIN AND ITS IMPLICATIONS ON DESIGN REUSE

Eckstein R., Henrich A. - *University of Bamberg* (*DEU*) 761

Todays product development is characterized by cutting down product development costs and times which can be accomplished by leveraging reuse of existing knowledge in an enterprise. We propose a search approach, that incorporates a comprehensive description of the user and the document context. This description of the user leads to a better understanding of the information need. We suggest the consideration of domain specific measures to enable a higher precision in searching. The perspective behind this idea is that a user's information need is characterized by a user query and his current context. The retrieved documents are represented by their content and the document context – the creation phase or the degree of maturity for example.

CONCEPTUAL DESIGN OF INDUSTRIAL PRODUCT SERVICE SYSTEMS (IPSS) BASED ON THE EXTENDED HETEROGENEOUS MODELLING APPROACH

Welp E. G., Sadek T. - *Ruhr-University Bochum* (*DEU*) 545

Industrial Product-Service Systems (IPSS) are proposed as a solution to meet individual customer requirements. Thereby, high-investment capital goods are offered in customized business models which highly include services. This paper proposes an IPSS concept model based on an extension of the heterogeneous modelling approach in mechatronics. To integrated product and service modelling in early phases of development established and mostly diffuse distinctions between the both are abolished. An integrated and formalized modelling spaces constitutes the basis to integrate IPSS-functions, IPSS-objects and IPSS-processes to IPSS systems behaviour.

IMPLEMENTING A SERVICE ORIENTED PLM ARCHITECTURE USING PLM SERVICES 2.0

Bergsjö D., Catic A., Malmqvist J. - *Chalmers University of Technology* (*SWE*) 271

This paper regards the implementation of a service oriented PLM architecture in the automotive industry. To test this, a demonstrator that implements the standard PLM services 2.0 has been developed. The demonstrator supports the change management process of a diesel engine and accesses information from distributed databases across organizations and technology domains. Findings regard issues related to the benefits and limitations of the standard as well as implications of a service oriented PLM architecture experienced from business and user perspectives. In order to manage a shift towards SOA it is also needed to invest in PLM management and support capabilities. SOA contributes to take better control of the business logic, than competing PLM architectures as well as it offers good engineering support.

INNOVATION CYCLES CONCERNING STRATEGIC PLANNING OF PRODUCT-SERVICE-SYSTEMS

Hepperle C., Mörtl M., Lindemann U. - *Technical University Munich* (*DEU*) 401

Managing the innovation process of complex product-service-systems (PSS) becomes increasingly difficult. This can be attributed to characteristics such as higher product and process complexity, increasing dynamics and a higher degree of uncertainty in the innovation process. To face these challenges, this paper proposes an approach in identifying and describing innovation cycles concerning strategic planning of PSS. Thereby, innovation cycles can be seen as recurring processes within and in-between the PSS-lifecycle-stages as well as the recurring process of strategic planning of PSS itself. Further, an approach is proposed how data gained from cycle-oriented strategic planning of PSS can be structured within a product-service-spectrum.

CONCEPTUALISATION OF PRODUCT/SERVICE-SYSTEMS THROUGH STRUCTURAL CHARACTERISTICS

Tan A., Andreasen M. M., Matzen D. - *Technical University of Denmark* (*DNK*) 517

Many manufacturers today are shifting from a product to service-orientation, where instead of the product, the activity and knowledge associated with the use is considered to be more valuable to the customer. This approach has been dubbed product/service-systems (PSS). It appears that no theories have crystallised about PSS's structural and behavioural attributes, and no mindset exists for conceptualisation based upon the nature of service in design. Starting with Hubka's Transformation Model, service-oriented models are reviewed. Based on this an understanding of the conceptual aspects of PSS are outlined. An account is given of how this is applied when teaching PSS design. Directions for research in systematic PSS design are also given.

A COMMON DENOMINATOR FOR PRODUCT SERVICE SYSTEM DEVELOPMENT

Schindler S. O., Schendel C., Matzen D. - *Technical University Darmstadt* (*DEU*) 493

Products and services have long been combined into integrated offers, referred to as Product Service Systems. The question of how best to design PSS in an integrated process is currently under discussion. The material in this paper is the outcome of a joint project in which the prerequisites for PSS development at a manufacturer of office furniture were explored. The objective is to identify a common denominator in products and services suitable for design purposes and discuss its applicability in the design process of a company. Models of the product life cycle and customer activities are combined and similarities are determined. This conceptual view of the design elements in PSS is compared to findings of the industrial case study.

SPECIFICATION RISK ANALYSIS: INTRODUCING A RISK MANAGEMENT METHOD FOR PRODUCT ARCHITECTURES

Wagner C., Graebsch M., Seering W., Lindemann U. - *Technical University Munich* (*DEU*) 537

This paper presents an adaptation of the FMEA as a risk management tool for embodiment design. The development of the approach and important decisions are described. By means of three dimensions, risks of not meeting specifications can be assessed and prioritized. Furthermore the method enhances the development and follow-up of mitigation measures. The method has been tested by product development teams of a university course. The field study identified the Specification Risk Analysis as a useful tool to mitigate potential deficiencies of a product architecture. Additionally, it was shown that the highly matured procedure of the FMEA can be adopted for various purposes and is not limited to quality issues.

ROBUST DESIGN METHOD FOR PRODUCT LIFE CYCLE CONSIDERING THE FUTURE UNCERTAINTIES

Kondoh S., Masui K., Mishima N., Matsumoto M. - *National Institute of Advanced Industrial Science and Technology* (*JPN*) 439

Product life cycle design has gained more interest in recent years due to growing concern about environmental problems. In general, there exist significant uncertainties (e.g., operating condition, user preference, collection rate etc.) in product life cycle and a design method that is robust and tolerant against these uncertainties should be established. To this end, this paper discusses the uncertainties in product life cycle and evaluates their impact on total performance throughout a whole product life cycle. Based on this discussion, a design method for product life cycle that maximizes its total performance handling these uncertainties is proposed.

ENHANCING SUPPLIER'S QUALITY BY PREVENTIVE QUALITY ASSESSMENTS DURING DESIGN OF AUTOMOTIVE ELECTRONICS

Graessler I. - *Robert Bosch GmbH* (*DEU*) 395

Proceeding and results of a strategic improvement project at Bosch Automotive Electronics aiming at enhancing quality of mechanical vendor parts are presented in this contribution. In contrast to electronics, quality problems with mechanical vendor parts in high level series production sometimes follow no pattern. Analyzing weak points of past development projects lead to the following solution approach. Milestone reference plan of product development was supplemented by preventive quality assessments (QA-M). As tooling knowledge was identified as key success factor, company-internal tooling experts were set up. The new procedure was defined in a new development guideline and globally rolled out. Implementation progress is since then measured by QA-M application rate in development projects and feedback about applied technical expertise.

PREVENTIVE COST AND RISK MANAGEMENT IN THE EARLY PRODUCT DEVELOPMENT PHASE

Szeghõ K., Bercsey T., Eigner M. - *Budapest University of Technology and Economic* (*HUN*) 509

Today, it is very important for managers of the engineering process to define inno¬vative products in a complex and globalised environment. Each time they have to proceed more rapidly, more low-cost and usually with less capacity in order to be able to exist successfully on the market. The well-known question is at the beginning of the product develop¬ment process: How can I develop a “good product” in less time and with low cost? A new method for optimising the development process to reduce product costs in the early product development phase has to be found. The new to be developed method should include all important factors (costs, risks) whose modifi¬cation and optimisation will have a positive influence on the development process.

THE RELATION BETWEEN PROJECT RISKS AND ROBUSTNESS OF DESIGN – A CRUCIAL FACTOR OF SUCCESS IN PLANT ENGINEERING

Moehringer S., - *Simon Moehringer Anlagenbau GmbH* (*DEU*) 457

In competitive markets with global sourcing the acquisition phase in plant engineering is essential. It is the aim of the contractor to quote a project with the best price possible in order to compete but a considerable risk is involved. A new approach is presented using the experience of error situations to valuate the risk in the acquisition phase. The risk areas and the risk specification of a potential project are identified and individually valuated. In addition to this the design robustness of the project is configured. In order to achieve a configuration as accurate as possible a matrix correlating the project risk and the project design is established. The matrix helps to identify the critical design areas and their specifications.

Plenary session - WORKSHOP OUTCOME PRESENTATIONS
Session: D3-P Chairman: Udo Lindemann (DEU)

Thursday - May 22, 2008. 11:00 – 13:00 | Congress hall Ragusa

HUMAN BEHAVIOUR IN DESIGN

Petra Badke-Schaub - *Delft University of Technology (NDL)*

DECISION MAKING IN RESEARCH AND PRACTICE

Harald Meerkamm - *Friedrich-Alexander University Erlangen (DEU)*
Claus T. Hansen - *Technical University of Denmark (DNK)*

INDUSTRIAL DESIGN

John Restrepo - *Technical University of Denmark (DNK)*

ENGINEERING DESIGN IN MECHATRONICS – HOW TO MANAGE COMPLEXITY

Stephan Moehringer - *Simon Moehringer Anlagenbau GmbH (DEU)*

ECO DESIGN

Tim McAloone - *Technical University of Denmark (DNK)*
Wolfgang Wimmer - *Technical University of Vienna (AUT)*

DESIGN EDUCATION

John Malmquist - *Chalmers University of Technology (SWE)*

NEEDS AS A BASIS FOR DESIGN RATIONALE

Bergström M., Ericson A., Larsson M., Nergard H., Larsson T., Renström B. - *Lulea University of Technology* (*SWE*) 281

This study is based on data from a Swedish real-life industrial product development project for e-health care of elderly. The purpose in the paper is to discuss identification of user needs. Information about the elderly is transferred in recurrent meetings. Besides the perception that these meetings occupy time which could be spent giving care, the nurses find it problematic to convey such information to substitutes, as well as they have to rely on their memory. In this case, a Dictaphone device was a solution. Reports on practical activities of identifying user needs and how they affect decisions in product development are limited; one contribution of this paper is insights into such a case.

REQUIREMENTS MANAGEMENT IN EARLY STAGES OF MECHATRONIC DESIGN BY VISUALISATION OF INTERDEPENDENCIES

Stechert C., Bauer S., Franke H. J., Meerkamm H. - *University Erlangen-Nuremberg* (*DEU*) 501

In this contribution, applications of a new Decision Making (DM) tool based on a qualitative modeling and visualization of interdependencies between requirements are shown and discussed. Concretely, DM tasks occuring when designing parallel robots are qualitatively modeled by a pairwise comparision of interactions between requirements. The resulting interaction matrix is the input model required by the visualization method. Based on that interaction matrix, the tool calculates and shows an easily understandable visualization of the entirety of all requirements based on their interactions in a three-dimensional space. Such visualization is shown for two DM tasks from different development stages in the field of parallel robots.

A SYSTEMIC ANALYSIS OF OLDER DRIVERS REQUIREMENTS TO GATHER KNOWLEDGE TO BE USED BY DESIGN ENGINEERS

Flöck C., Le Cardinal J., Mekhilef M. - *Ecole Centrale Paris* (*FRA*) 361

The challenge of our very next future is to design cars that face the specific needs of the growing number of older drivers. We suggest an approach that takes into account the whole system. Beside different expert groups we include the enduser in our research and propose using inclusive design to assure usability for a wide range of users. The functional analysis conducted in this study allowed us, to gain a better picture about the key elements, stakeholders and approaches in the research field. It gives insights into the complex system, shows interrelations and will help us to advance in the development of coherent research aiming at the multidisciplinary delivery of sets of requirements to be considered by car designers and constructors.

ON THE DESIGN OF MANUAL WHEELCHAIRS FOR PEOPLE WITH SPINAL CORD INJURIES

Gooch S. D., Woodfield T., Hollingsworth L., Rothwell A. G., Medland A. J., Yao F. - *University of Canterbury* (*NZL*) 387

Manual wheelchair propulsion is an important part of daily living for people with tetraplegia. New surgical procedures, such as the posterior deltoids to triceps transfer surgery (known as TRIODS), better enable people with tetraplegia to propel their wheelchairs. 22 people with tetraplegia participated in this study. Their power output was measured using a wheelchair dynamometer. Wheelchair propulsion technique was captured using a video and analysed. Distinctly different wheelchair propulsion techniques were observed. Post TROIDS subjects were found to have changed their wheelchair propulsion technique. Results obtained in this study pose new requirements for the design of wheelchairs for people with tetraplegia.

THE EVALUATION OF THE ABILITY OF A CONSTRAINT-BASED MANIKIN TO REPRESENT NORMAL HUMAN TASKS

Medland A. J., Gooch S. - *University of Bath* (*GBR*) 649

The health and safety of the operators of machines is an important consideration during the design of such products. A human modelling program has been created within a constraint environment that can interact with the products and models of the environment. Real restrictions are imposed by the use of constraint rules and the incorporation of anthropomorphic data. With this representation natural postures of humans can be generated and their interaction with objects such, as process machinery, can be evaluated during the early stages of design.

DIGITAL RECONSTRUCTION OF A HUMAN SKULL

Etxaniz O., Minguez R., Arias A., Barrenetxea L., Solaberrieta E. - *The University of the Basque Country* (*ESP*) 611

This paper describes the process to obtain a high quality digital model of a human skull, by reverse engineering techniques. This development was made in the Product Design Laboratory (PDL), in the Faculty of Engineering of Bilbao (The University of the Basque Country). The digitalization of the skull is the first stage of a project that PDL is developing together with a research group at the University of Cordoba. In this first step, the digitization process and the quality of the achieved digital model have been evaluated. The next stage is to scan a human jaw and to digitally reproduce the real motion of both elements (skull and jaw). A thorough analysis of this movement will allow improving the design and placement of the prostheses.

GAP AND FLUSH VISUALIZATION OF VIRTUAL NONIDEAL PROTOTYPES

Stoll T., Paetzold K. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 681

When a product is manufactured, it always has deviations from the ideal CAD-geometry. Therefore, tolerances are assigned to each part. In this paper a method is presented where a designer can generate different nonideal prototypes independently from the proposed tolerances. This is done by defining gap and flush measurements at selected points. The designer can then evaluate whether the product meets the desired aesthetic quality. This information is given to the product developer or tolerance specialist, who assures that the requirements are met. All visualizations that are generated can be viewed in virtual reality, so that the scenes are more realistic, and the interpretations made by the designer are even more reliable.

VISUAL ANALYSIS METHODS FOR NON-IDEAL ASSEMBLIES

Penzkofer F., Wittmann S., Winter M. - *Friedrich-Alexander University Erlangen-Nuremberg* (*DEU*) 657

We follow the “generate and test” approach to analyse tolerance specifications: Based on toleranced CAD data, non-ideal parts are generated. For these non-ideal parts we propose several visualization methods to reveal the geometric consequences of the defined tolerances on the resulting product. One set of methods is used to reveal the geometric properties of individual assemblies, like surface quality and progress of gaps. The other set is intended for visualizing the spatial relations between multiple assemblies, like collision probabilities, based on a statistical analysis of these assemblies. The intention of these methods is to provide an intuitive view of the complex relations between tolerances and resulting geometry.

THE RELATIONSHIP BETWEEN FUNCTIONS AND REQUIREMENTS FOR AN IMPROVED DETECTION OF COMPONENT LINKAGES

Boersting P., Keller R., Alink T., Eckert C. M., Albers A., Clarkson P. J. - *University of Karlsruhe (DEU)* 309

Functional product models in design so far were built up by asking for the main function of a product first and then breaking the main function down into sub-functions, until an appropriate level of granularity was reached. A problem of this approach is that a product often provides even more functions which are not subordinate to the main function. This paper presents an approach how these functions can be captured in a reliable and structured way, using the requirements of a product as a superstructure. The improvements of this new approach are demonstrated by predicting change propagation based on an improved functional product model and comparing it to the results of a change prediction using the conventional functional product model.

MANUFACTURING SYSTEM DESIGN BASED ON REAL-LIFE DEMANDS - A METHOD DESCRIPTION

Karlsson A. - *SWEREA IVF (SWE)* 417

Manufacturing system design is a process that often results in sub-optimized systems with less than intended performance. It is therefore of outmost importance to base the design on factors originating from a defined interested party and then translate them into performance shaping factors of a manufacturing system. Sometimes the complexity of the factors affecting the system takes over in the design process, making the designers, system builders and even the buyers forget about the initial requirements – customer demands. The manufacturing system design method presented in this paper is aimed at being simple enough to use, though providing accurate enough results by taking into account relevant system demands.

FLEXIBLE SUSTAINABLE PROCESS INNOVATION: INTEGRAL BUILDING DESIGN METHODOLOGY

Zeiler W., Quanjel E. - *Technical University Eindhoven (NLD)* 553

There is a growing awareness of sustainability that leads towards knowledge transfer and research between companies and the Dutch knowledge and research institutes within the building industry. The principles of the IFD (Industrial Flexible Dismountable) concept aim at an integrated approach within the design process to reach a maximum level of integration between designers from different disciplines. A newly developed methodology for structuring integral design processes enables design team support during designing and further stimulates exchange of ideas and concepts. This approach is tested within a professional context of a building design project.

METHODS IN PRACTICE – A STUDY ON REQUIREMENTS FOR DEVELOPMENT AND TRANSFER OF DESIGN METHODS

Geis C., Bierhals R., Schuster I., Badke-Schaub P., Birkhofer H. - *Technical University Darmstadt (DEU)* 369

Nowadays, methods play an important role in supporting design processes and activities. Nevertheless, many potentially useful methods are seldom applied, not carried out in the intended way or poorly adapted. This paper analyses reasons for deficient method usage in daily industrial job routines and also names requirements for development, transfer and implementation of methods in the industry. It shows the potential of new methods, gives an overview of necessary measures for better method usage, and sets up a model that shows how all these measures (like simplification of adaptation of methods, promotion of methods in companies or specific training of methods) interconnect to allow successful implementation of methods in the industry.

A CLASSIFICATION SCHEMA FOR PROCESS AND METHOD ADAPTATION IN SOFTWARE DESIGN PROJECTS

Ploskonos A., Uflacker M. - *Hasso Plattner Institute for IT Systems Engineering* (*DEU*) 219

Aligning generic methodologies in human-centered design with the very specific demands of individual software projects presents a challenge during project planning and execution. Generally discussed in isolation of a particular context, many design process theories and methods need to be tailored to fit particular project needs. This work presents a classification schema to support in the project-specific adaptation of design processes. Based on design project observations, we identify four major project types 'Usability', 'Capability', 'Extension', and 'Innovation'. The distinct process characteristics and commonalities for each category are discussed, qualifying the schema to support in the design project planning process.

MOBILISING CRITERIA IN ARGUING ABOUT PRODUCT SOLUTIONS: A MOTOR FOR DESIGNER CONVERGENCE DURING A PROJECT REVIEW?

Cassier J. L ., Prudhomme G., Lund K. - *Université de Grenoble* (*FRA*) 123

In the context of market globalization, companies are now collaborating; concurrent engineering has taken the place of sequential engineering and therefore is generating many changes in designers' work. Inspired by studies in argumentation, our objective in this article is to model the dynamics of human interactions by which designers construct a common ground, allowing them to converge during the decision process. Our ultimate goal is to propose methods and tools that support designers during the decision process. Through two original representations, we analyze a project review meeting at AB Volvo and show how in their quest to satisfy criteria, designers are led to propose new solution elements and thus to come to agreement.

ANALYSING THE RELATIONSHIP BETWEEN DESIGN PROCESS COMPOSITION AND ROBUSTNESS TO TASK DELAYS

Chalupnik M. J., Wynn D. C., Eckert C. M., Clarkson P. J. - *University of Cambridge* (*GBR*) 131

In this paper, Monte-Carlo simulation is used to investigate how the robustness of hypothetical process fragments is influenced by the number of dependencies between tasks and the resource constraints within the cluster. We show how aggregation of these results on a graphical 'robustness profile' allows conclusions to be drawn about the factors which govern process robustness, and argue that this can provide insight to support the improvement of more complex, realistic processes.

A MATRIX REPRESENTATION OF THE CPM/PDD APPROACH AS A MEANS FOR CHANGE IMPACT ANALYSIS

Köhler C., Conrad J., Wanke S., Weber C. - *Saarland University* (*DEU*) 167

This contribution describes an approach to analyse the impacts of engineering changes using a new form of representing the Characteristics-Properties Modelling/Property-Driven Development (CPM/PDD) approach. First, some general remarks about Engineering Change Management (ECM) as well as the ECM process will be made. Then, the CPM/PDD approach will be introduced. In the main part, inspired by the Design-Structure Matrix (DSM) and Matrix-FMEA, the authors introduce the matrix-representation of CPM/PDD (Matrix-CPM/PDD) which enables them to analyse the impacts of engineering changes with a lower perceived complexity.

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