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Instructions

Research in Interactive Design - Volume 2 enhances the last successful implementations related to Interactive Methods dedicated to Design and Manufacturing processes. The discussion is detailed and highlighted within:

1. a book: it provides an overview of 200 high-detailed articles,
2. a CD-Rom: it includes 200 articles defining recent achievements in research related to Numerical and mechanical Engineering, Design and industrial studies, High-Realistic Multi-Sensorial Virtual Prototyping and computing technics applied to the development of Interactive Design and Manufacturing methods.

The book provides an abstract of each article referenced and identified according to the following presentation:

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Research in Interactive Design integrates the best articles selected by the International Scientific Committee of the International Conference *Virtual Concept 2006*.



Virtual Concept is an International Conference organized and implemented by ESTIA, Ecole Supérieure des Technologies Industrielles Avancées, France.

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The present book results from a scientific association with the well-known society AIP PRIMECA having international visibility and recognized in the domain of design and manufacturing sciences, partners of Virtual Concept 2006.

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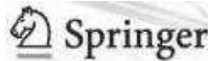
Virtual Concept 2006 is also scientifically and technically associated to the famous international institution Design Society certifying the relevance of the full articles presented in this book:

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Research in Interactive Design - Volume 2 has been also supported by Renaud Briand, Christophe Merlo, Patrick Sébastian; as guest co-editors, they have managed the technical publications related to interactive methods respectively developed with Mechatronics, Product Life Cycle and Numerical Modelling techniques.

The present book has been produced by Anaïs Bruzaud.

Foreword

Pr. Daniel Coutellier has started his career as an engineer in charge of CAE analysis software at DATAID AS&I company. In January 1989, he joined the French engineering institute ENSIAME. After being director of studies in ENSIAME, Pr. Daniel Coutellier took his actual post as deputy head and director of International Relations.

Professor in Mechanical Engineering at ENSIAME, Pr. Coutellier is also the general director of the network AIP-PRIMECA that aims to promote the use and the development of integrated design approach in Mechanics and Productics. Chairman of several international congress about design and manufacturing, Daniel Coutellier is quite involved in research close to crash simulation development, and its use as a supporting tool in product design.

Xavier Fischer is an engineer in mechanical engineering and applied Mathematics, qualified by a great French engineering school. After his involvement in Aeronautics industry (SOCATA EADS and Turbomeca) he obtained his PhD in the French engineering school Ecole Nationale Supérieure des Arts et Métiers (centre of research LEPT CNRS UMR 8508).

Author of more than 40 major publications, author and editor of the 2 volumes of the book research in interactive design implemented with Springer Verlag, and invited speaker in around 10 meetings each year, Xavier Fischer intends to regard the problematic of high-realistic multi-sensorial virtual prototyping development for fostering innovation. Since 1997, he focuses on the development of a new perspective of engineering support approach named the Interactive design.

In 2000, he developed the Inverted Integrated Design approach (IDD) that aims to support decision making during the embodiment design stage.

Since 2001, he has extended the concept of IID towards the idea of Interactive Methods. By combining sensorial approach, creativity tools, Virtual Reality Techniques and high-advanced modelling tech-

niques, Xavier Fischer mainly regards how to create new ways for obtaining high-qualified models being able handled in real time for rapid-exploration of design space or for developing human centred design approach based on the use of Virtual Reality techniques. The provided contributions intend to foster creativity by positioning human (design actors or users) in the centre of the design process.

Today researcher in the engineering institute ESTIA, Xavier Fischer manages the Interactive Design research Group. He is also the general chair of the international conference Virtual Concept and the editor in chief of the Springer Verlag International journal IJIDeM (International Journal for Interactive Design and Manufacturing). In charge of international development of research and industrial activities in the new domain of Interactive Design, he supervised a lot of mixed and transversal consortium aiming to strengthen the innovation support tools.

Xavier Fischer maintains relationships with several companies (Dassault Aviation, Ski Rossignol, .etc.) and he is involved in European or French projects, as workpackage leader.

Pr. Daniel Coutellier and Dr. Xavier Fischer are the general Co-Chairs of Virtual Concept 2006. They propose in this book the last discussions about Interactive Design and Manufacturing methods.

Acknowledgement

We wish to start this section by sincerely thanking all the authors for their high-quality contributions integrated within the present manuscript. The scientific and technological survey of *Research in Interactive Design* immediately displays a high-level of maturity of activities that are highlighted through 200 relevant full articles.

Nevertheless, the recognized quality of the proposed discussions is also due to the presence of an International Scientific Committee composed of prestigious researchers. For this, each member of the scientific committee of Virtual Concept 2006 must be gratefully and thankfully highlighted for their involvement.

Moreover, Pr. Georges Fadel, Pr. Grier Lin, Pr. Brian Prasad and Pr. Jannick Roland have also contributed to the visibility of this book. The whole Virtual Concept 2006 organisation gathers itself in order to thank them for their important contributions and support.

We benefit this short section in order to highlight the great involvement of Pr. Bartolo, Dr. Briand, Pr. Cugini, Pr. Di Gironimo, Dr. Merlo, Pr. Moreau, Pr. Ramirez, Dr. P. Sébastian, Pr. Sol and Pr. Kesavadas who have participated to the enhancement of this book by building high-quality special sections focused on in-depth recent studies.

We take advantage of this section to recall the fundamental support of, in order:

- Mr. Jean-Marie Berckmans, Chair of Chamber of Commerce and Industry of Bayonne Pays Basque,
- Mr. Bernard Darretche, General Manager of Chamber of Commerce and Industry of Bayonne Pays Basque,
- Mr. Jean-Roch Guiresse, Manager of ESTIA.

Thanks to their confidence, Virtual Concept 2006 still exists, through this paragraph, we would like to sincerely thank them for their aid, management and support.

Finally, we would want to highlight the efficient and essential involvement of:

- Nadine Pehau: she has allowed the whole scientific organization to implement high-performance review processes with her high-performance review process management extended tool,
- Anais Bruzaud who ensure the promotion, the logistic procedures and the whole comfort of the whole Virtual Concept 2006 event.

We would want to conclude this part of the book by thanking each scientific and institutional partner of Virtual Concept 2006.

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The Interaction: a New Way of Designing

1.1 The context of evolution

An obvious fact of the present industrial epoch is the advancement of computing techniques that has strongly contributed to the emergence of engineering processes becoming more and more efficient, rapid and high-powerful. Computing Science has allowed constructive engineering support systems to emerge. Today, it is a common idea in Industry to search the support of software based on huge fields of knowledge, information and data being modelled, structured and capitalized being processed for assisting, fostering engineering activities and ensuring to lead to innovative solutions.

In the domain of Manufacturing and Product Design, most of the usual support systems rely on the notion of simulation. In this way, all engineering activities organize themselves around intermediate virtual versions of products, production line or manufacturing process that constitute alternative possible solutions to a design or manufacturing problem. The virtual representations are useful for anticipating engineering defaults, instigating new ideas, fostering work meetings and allowing the sharing of ideas in an extended enterprise.

Today, engineers make live a virtual object: virtual object behaviour, being static or dynamic, may be simulated. Although the virtue of Engineering Support Systems is apparent, their manipulation requires a good transversal knowledge.

As a matter of fact, the provided virtual representation necessarily comes from:

- complex numerical behavioural model coming from multi-scale physical analysis and understanding,
- structured model of engineering skills resulting from identified, extracted and capitalized knowledge,
- some concepts of solution that only can emerge from the creativity of the group of actors involved in a project.

Finally, the industrial experience shows that the ideal engineering support system would be a tool being able to:

- incubate and reinforce the interrelations within engineers by highlighting the creative power of the group: creativity and innovative solutions result from the harmonious association of knowledge born from human interactions,
- provide extended simulation where the regarded virtual solution is really immersed in its future environment and being able of pure physical interactions with other elements: often, the right solution appears because engineer have correctly anticipated the problem of possible noisily physical interactions with other components, this effect may be reinforced with the all virtual where simulation of global environments may really highlight the problem of global organization that can not being visible on only isolated simulation of components,
- allow a human to feel and to act on a virtual product as in the real life, it consists in guaranteeing the perceptual relations between a user and its future product through high realistic simulation.

Recently, some efficient Computer Aided Engineering tools have proposed some functionalities allowing engineers to combine technical point of views with more qualitative information coming from engineers know-how, skills and professional habits. These knowledge expert systems, often linked to classical CAD systems, intend to enlarge the sharing of knowledge in an extended enterprise as companies exchange virtual representations.

Nevertheless, such software is not sufficiently resourceful because it is

impossible to share knowledge as it is the case for a virtual representation of a product, and to replace human presence is not possible.

The virtual leadership of engineering process can become possible if the system incubates and fosters interaction between actors. Innovative ideas are the consequence of cognitive interactions between industrial actors: the swap of different knowledge, cultures, ideas, skills, know-how and point-of views forms the innovation.

At last, the future engineering support tool must reinforce, lead, manage and structure the cognitive interaction within the enterprise by leading to the rapid emergence of innovative ideas.

The previous consideration imposes three main questions:

- would it be possible to simulate cognitive interactions for incubating ideas and making rapider the emergence of always more innovative solutions?
- what are the techniques being able to be used for identifying and modelling experts knowledge?
- how to combine remote virtual meeting for making closer engineers in the extended enterprise, bigger the creative power of a group and more important the cognitive interactions by exploring virtual representations of solutions?

First, our approach is based on a detailed definition of the concept of cognitive interaction. From this definition, we provide an overview of a specific technique combining creativity methods and Multi-Agent System in order to structure and represent a distributed representation of useful knowledge. Our interactive approach assists the description, the analysis and the modelling of an industrial problem.

In another hand, if the strengthening of cognitive interaction makes easier the engineering problem solving, the research of solutions is more effective if we regard the problem of solution integration in an environment instead of only considering one only component.

As a matter of fact, it rapidly becomes obvious that, in a same way, a simulation highlighting the interactions between a virtual product and the elements of its future environment would be able to considerably redirect the design of solutions since all functionalities are developed for assuming pure physical interactions.

More and more, usual simulation methods like Finite Element Analysis are under competition with extended simulation techniques. As a

matter of fact, usual techniques commonly focus on the behaviour of one single component whereas Virtual Reality proposes to immerse the component in a virtual environment. Such approach aims to allow engineers to simultaneously regard in virtual simulations the pure physical interactions and behaviour of objects that will sooner constitute a real environment of life.

The concept of high-realistic virtual prototyping, involving adaptive simulations, becomes more and more expected by industry, but it implies some questions and adaptations:

- how to develop behavioural model of a global environment organization being reduced (for suiting a real time simulation), high realistic and sufficiently exhaustive?
- how to implement distributed model based on the physical interaction between virtual elements within Virtual Reality instruments?
- how to value the significance of the simulation?

We highlight the concept of pure physical interaction by providing some efficient solutions related to:

- the description and the characterisation of models: it is based on adapted used of functional analysis and creativity methods,
- the non-intrusive analysis of real environments: it implies the handling of specific micro-systems and wireless electronic systems,
- the reduced modelling of behaviours developed from a combination of Fuzzy, connexionist, evolutionary and stochastic approach.

But the best solutions in term of Virtual Prototyping would be that it would include a multi-sensorial character. As a matter of fact, most of the defeats of design come from a wrong satisfaction of product-end-users. This failure could be avoided by confronting as soon as possible a user to intermediate solutions and analyzing its reaction: a user centred design method may be implemented.

Virtual Reality offers strong possibilities as regards sensorial interactions. As a matter of fact, recent instruments allow a user to interact, to feel and to act on virtual elements with all its senses.

The Virtual Reality simulators become more and more industry. But, such recent approach provides some questions:

- how to develop efficient human centred design methods based on multi-sensorial virtual prototypes?
- how to ensure the links between real and virtual environments?
- is it possible to have adaptative simulations fitting the action of the user?

Our research lead to some solutions supporting the preparation of models being able to send sensations to a user. This approach combines modelling tools to real analysis whose the aim consists in integrating in the models some variables related to the sensations. The models link functional to sensorial aspects and represent the sensorial interactions.

All previous argumentations are essentially related to the problem of description, analysis and modelling of behaviours and interactions.

We use the virtual prototyping, mainly based on the concept of interaction, for supporting decision making in design and manufacturing. As a matter of fact, we handle all models for:

- exploring solutions spaces and rapidly identifying best and most innovative solutions,
- navigating within virtual environments and offering high realistic representations of intermediate industrial solutions.

Finally, the joint simulation of interactions and behaviours constitute a way for:

- making closer the industrial actors,
- having high realistic global and extended simulation,
- integrating the user in the process and fostering industrial innovation.

The presentation of Interactive Design and Manufacturing approach is detailed in the following sections by highlighting the concept of interaction.

1.2 A Basic Problematic in Design: the Dimensioning step

1.2.1 The classical Design Process

Classical design process is commonly presented as a sequential and iterative approach: it includes 4 main stages:

- the specification definition step: it aims to accurately define the ideal goals of the project as form of specifications,
- the conceptual design step: being the first phase of the dimensioning activities, it does lead to the organic definition of the future solution as form of concept, by precisely highlighting the main technical function chosen,
- the embodiment design step: pursuing the dimensioning actions, it aims to decide about fundamental components that compose the architecture studied by pre-defining fields of suitable shapes, sizes, powers, materials, configurations (etc.),
- the detailed design step: it achieves the dimensioning phase by confirming the aptness of architecture previously designed thanks to virtual representations (CAD/CAM/CAE) simulation tools (like Finite Element Methods) and eventually, to improve it by developing optimization studies.

The dimensioning activities occur all along the preliminary design phases. They have the basic objective to build a consistent architecture that matches the specifications related to behavioural feature.

Dimensioning in design strongly depends on engineers:

- expertise, knowledge, culture and experience that lead to the determination of an efficient architecture: this approach is mainly implemented for pre-dimensioning (conceptual and embodiment design steps),
- ability to use CAD/CAM/CAE and simulation systems transforming dimensioning actions in computing and mathematical activities.

On one hand, dimensioning phases engages the whole design team: result quality is really dependant on engineers aptitude to work together. The challenge of the project manager is to guarantee the consideration of most of know-how, knowledge, ideas and experiences coming from all the extended enterprise without accurate and global representations of a solution before the end of the process. Finally, collective engineering achievement depends on the efficient organization developed the leader project.

Actually, virtual representations only intervene on the last step of the process, when most of the fundamental decisions are made. As a matter of fact, CAD/CAM/CAE and Simulation tools require an accurate and exhaustive definition of the product for virtually representing solutions: they are only constructive for validating engineering ways. Unfortunately, today, there is no practicable instrument based on virtual principle and useful for supporting the synthesis of engineering choices during the early stages of the process.

In order to support collective engineering in the extended enterprise, we propose a new approach that intends to extend the CAD and simulation systems to the preliminary stages of the process: we provide new instruments allowing virtual exploration of solution spaces as soon as possible, even if engineering choices are not fully defined.

Our proposal consists in supporting collective engineering by fostering the consideration of market expectations and enlarging the manipulation of extended virtual representation all along the dimensioning activity.

1.2.2 Problematic 1: Collective Engineering

A quite innovative product is a well-dimensioned solution assuming the major behaviours specified during the first process stage. Such objective is achieved only if every project participant is listened. The quality of the final solution strongly depends on the quantity of ideas, opinions and knowledge arriving to the project manager.

Finally, the dimensioning activity organization determines the issue of the project. Numerous works intend to foster the sharing of knowledge, ideas and experiences. Concurrent, integrated or simultaneous engineering, for instance, are efficient in well-organizing human resources. However, they are not well-adapted to dimensioning activities and they do not naturally take into account virtual representations because, during early design phases, only non-accurate draft solutions are brought,

generally incompatible with CAD requirements.

From previous analysis, we refer to the foundation of collective engineering (at the stage of dimensioning) that would have to:

- be managed from shared virtual representations under perpetual evolution but having the virtue to bring closer project experts during dimensioning phases,
- be implemented from and around alternative and intermediate virtual representations representing engineering ideas,
- be link to specific instruments allowing solution spaces to be rapidly virtually explore by satisfying every experts points of view.

Our first fundamental objective consists in making easier the description and the modelling of knowledge for better virtually exploring solution spaces.

1.2.3 Problematic 2: Functional and Marketing Integration

An efficient collective engineering necessarily takes into account market tendencies. It is the reason for why marketing departments have a strong presence in the preliminary design phases.

The integration of marketing to functional and technical point of view is an evidence for the modern industry that aims to:

- rapidly fit market demands,
- anticipate non-satisfaction of end-user expectations,
- identify wrong orientation of engineering as soon as possible and avoid mistaken investment.

The aim the perceptual and sensorial design methods suits previous statement: they provide some ways that enable marketing experts and designers to have more interactions. The techniques ensure to identify the reason of satisfaction or non-satisfaction of product end-users. However, they remain under construction when it is a matter of modelling end-user expectations and support decision making by providing to technical activities a marketing view.

The ideal approach where end-user expectations are considered as technical functions would be a Human-Centred Design method handled by designers and:

- dedicated to the preliminary stages of the process by aiding the synthesize of suitable solutions instead of validating existing complete products,
- manipulated in a virtual environment where the virtual product under construction is totally immersed,
- guaranteeing good interactions between marketing and design departments.

Our second fundamental objective consists in aiding to the determination of design solutions from the expectations of future customers. Our proposal is to guide such approach by the use of virtual prototyping, being multi-sensorial.

1.2.4 Problematic 3: Adaptive Extended Simulations

Finally, the virtual become more and more the base of engineering studies. For cost reasons and facilities of rapid re-design and decision-making, engineers replace the real by the virtual. Virtual simulation has become a common instrument in industry for:

- obtaining a global pre-view of engineering choices,
- anticipating technical defaults,
- confirming certifications.

But, moreover, it turns out to be a tremendous tool for bringing closer engineers because a virtual representation always offers a global view of project achievement and allow the whole project team to exchange and to cooperate, even if it is physically distributed in the extended enterprise.

Classical instruments like CAD/CAM and Finite Element Analysis (FEA) based simulation systems that contribute to the development of virtual prototyping are unfortunately non-adapted to a support during the early stages of the design process.

As a matter of fact, these instruments:

- are high-specialized in term of model: they only represent products totally being defined, and then they only occur on last process steps,
- are mono-behaviour in term of simulation: simulations focus on one typology of functioning, for instance a FEA based simulation is implemented in elasticity or in plasticity or in crash or etc.: the behaviour can not be adapted by itself according to the form of applied constraints,
- are expensive in term of time computing and model creation: their manipulation required high level of knowledge,
- rather regard mono-component behaviour in term of simulation: FEA based simulation requires evolvment for ensuring the behavioural reproduction of multi-component product where interactions respect complex physical laws.

Today, for more efficiency, virtual simulation would:

- consider a set of possible behaviours model by a collection of models being able to be launch according specific conditions of simulation,
- rapidly simulate multi-component systems,
- be integrated in the preliminary phases of the design process by providing facilities of development even if the product is not totally defined.

Our third fundamental objective consists in supporting the development of virtual prototyping at the different stages of the design process even if simulation can be approached.

1.3 The Three Main Interactions: a Reply to the Problematic

1.3.1 Towards Interactive Design Method

The Interactive Design Method is based on the principle of virtual exploration of solution spaces. For supporting decision-making during earlier

phases of the design process, this approach regards evolutionary virtual representations and simulations related to engineering studies.

As one part of the overall objective, Interactive Design approach sustains collective engineering during preliminary stages of the process. From knowledge implicated in the project, it permits virtual exploration of solution spaces implemented from the simulation of cognitive operations.

The previous service is next extended by the handling of high-realistic multi-sensorial virtual prototyping techniques. The advanced simulations are handled in order to confront a user with intermediate sketches of the product. Combined to specific design methodologies, virtual prototyping becomes a resourceful instrument to simply analyze the interactions between the user and the future product.

However, the simulation must be exhaustive by not focusing only on the product but immersing the product in a virtual reproduction of its future physical environment. This functionality intends to provide a large view of all the interactions received by the future product.

Finally, Interactive Design Method strongly regard the design from the concept of interaction. On one hand, design choices come from the interactions between knowledge: we refer to cognitive interactions.

On the other hand, design choices are necessarily realized for assuming a specific behaviour occurring from:

- an interaction occurring between it and the user: they are sensorial interactions,
- interactions happening between it and the other physical element of its environment: they are pure physical interactions.

The three kinds of interactions are modelled, and combined to component behavioural models under simulation. Each has specific characteristics presented in the following sections.

1.3.2 On Cognitive Interaction

In decision-making, the basic component is the individual knowledge of experts: they are skills, know-how and technical information extracted from experiences and scientific cultures. Launched within a team of industrial experts, the individual knowledge is necessarily transferred and shared. But the dynamic of project implies that this basic component is principally combined to all other suggested rules.

During engineering studies, the transfer and the sharing of knowledge is managed by the project manager who intends to identify the rules being able the most effective, productive and relevant.

However, it is really the combination of the whole collection of rules that produce the creative idea. According to a development adapted at each project step, individual knowledge collection being simultaneously processed necessarily leads to a solution. The engine of the creativity is the cognitive interaction that, under certain situation, guarantees innovative solutions.

1.3.3 On Sensorial Interaction

Under situation of using, a product is necessarily in contact with a human. Therefore, the core of design is to developing solutions that necessarily satisfy end-users.

In this way, in order to accomplish the project, the main challenge of engineers consists in mixing technical points of view to marketing sights. The product is designed as:

- a transmitter of energy that is received by the user feeling a sensation,
- a receptor of energy coming from the users action that results from the perception perceived by the user

Whereas the sensation received by a user under specific conditions is always the same for all users, the perception differs. As a matter of fact, the sensation corresponds to a flow of energy consequential to a particular behaviour of the product. But the perception is the own interpretation of a sensation depending from the personal experiences of the user.

In design, only sensation can be handled since it entails an objective character.

Finally, human swaps energy with the product and Interactive Design approach strongly revises this interaction. The Sensorial Interaction is considered as fundamental in preliminary design by having the power to re-direct the engineering studies.

1.3.4 On Pure Physical Interaction

A physical behaviour of a material component is inevitably due to solicitations with other elements of its environment.

Within an environment, the energetic fluxes go through the components composing the system. This energy may be:

- completely transmitted,
- operated,
- controlled,

by a component that exploits it for upholding its own behaviour. The behaviour is next received by other components under contact as form of energy for launching behaviour.

In design, decision-making strongly takes into account the future presence of the product in its future environment. Decision-making in design consists in determining dimensions that ensure a consistent behaviour maintaining harmony in the environment where it will be immerse. The study of Pure Physical Interactions between environment elements, where the product is, are fundamental

1.4 From Modelling to Simulation in Interactive Design

1.4.1 To Describe, to Analyze and to Model

Interactive Design Approach consists in regarding, analyzing, modelling:

- the three interactions: the cognitive, sensorial and pure physical interactions,
- the corresponding material element and human behaviour.

The Modern Physics and Mechanics provide numerous studies, description and models of material element behaviour. But we have less works related to the definition and modelling of interactions.

Interaction is commonly independently modelled as form of boundary conditions, an approximation of the Physics, allowing also simulations to be focused on the product regarded.

Interactive method aims to consider global environment established by a set of elements under interaction. Therefore, in design, the product is one element of two different environments being under balance:

- the industrial process,
- the future physical environment where it will be immerse for achieving its function.

The industrial process and the product future physical environment are named systems.

We define a system as:

- a collection of individuals: an individual being a material element, a user or an engineer,
- each individual has several possible behaviours being intrinsic to own character,
- own behaviour being launch by an interaction received from another individual,
- the form of the interaction determining the type of individual behaviour.

And the product links together the elements of the system where it is integrated.

The design problem consists finally in:

- determining the important variables that chacarterize the exchange between the product and its environment,
- eventually analyzing the existing interactions, being purely physical, sensorial or cognitive,
- modelling the interactions by simultaneously considering the behaviours of the system elements.

In order to lead engineers to an accurate model of the interactions, and so of the design problem, we classically integrate in the interactive methods some toolsbased on:

- Design, Manufacturing and Innovation sciences rapidly allowing experts to identify significant variables and knowledge involved in the design problem (in the way of interactions),

- Mechatronics enabling users to analyze real behaviours through the variables analysis, in a non intrusive way by using embedded micro-systems,
- advanced Numerical Engineering and Artificial Intelligence techniques permitting experts to simply obtaining a reduced, explicit and high-qualified model of interaction.

The mixing of transversal research leads to efficient tools strongly supporting the modelling of an industrial problem.

1.4.2 Advanced Simulations

From the models, Interactive Methods suggest to implement to kind of simulations:

- the rapid virtual exploration of solution spaces: they consist in rapidly simulating cognitive interactions by simultaneously processing all interaction and behavioural models with new combinatorial numerical techniques, they are an extension of classical optimization methods,
- the Multi-sensorial high-realistic virtual prototyping: from the interaction model, Interactive approach propose the Virtual Reality instruments use for developping advanced adaptive simulations where the end-user may feel, interact with and handle the product in a virtual way. Such approach allow engineers to implement a user centred design method.

The advanced simulations developed in interactive approach may be implemented soon in the industrial process, and strongly support the decision making by fostering innovation.

1.5 Conclusion

The present book is the second volume of the serie. *Research in Interactive Design (Vol. 2)* clearly considers the earlier most significant transversal contributions related to interactive methods, models, instruments and techniques. Addressed to researchers or industrialists, it provides some efficient solutions for supporting decision-making in innovation by accurately highlighting the relevance of this new transversal domain under growing and beginning its integration in industrial processes.

Tutorials and Reflexions

2.1 Innovation and Creativity

Title: Problem Solving Using BTIPS-Learning and Applying in Conceptual Design

Authors: M. Bzymek Zbigniew

Key Words: Problem Solving, BTIPS-Learning, Conceptual Design

The Brief Theory of Inventive Problem Solving (BTIPS) is a compact, to certain degree formalized and somewhat changed version of TRIZ and TIPS. It can serve as a unique tool for problem solving in engineering research, design, practice and education. The list of principles contains 43 items. The number of effects is enlarged and prediction techniques are simplified. All the modules of BTIPS may be used with computer. With the tutorial the readers can learn the method and study examples of its application using IM or TechOptimizer. The author's experience in research, teaching and applying BTIPS will be sheared.

2.2 Haptic Interaction in Kinematics

Title: A Framework to Illustrate Kinematic Behavior of Mechanisms by Haptic Feedback.

Authors: Damien Chablat, Fouad Bennis, Qinqin Zhang, Wei Zhang

Key Words: haptic feedback, mechanism, singularity, e-learning.

The kinematic properties of mechanisms are well known by the researchers and teachers. The theory based on the study of Jacobian matrices permits us to explain, for example, the singular configuration. However, in many cases, the physical sense of such properties is difficult to explain to students. The aim of this article is to use haptic feedback to render to the user the signification of different kinematic indices. The framework uses a Phantom Omni to move a two-dof serial and parallel mechanism. The end-effector of the both mechanism can be moved either by classical mouse, or Phantom Omni.

Full Text: 183IDEW

2.3 Mirror Based Stereographics and Immersion

Title: Obtaining Stereographics Using a Two-Monitor System and a Set of Mirrors.

Authors: Antonio Aguilera

Key Words: stereoscopy, immersion, mirror.

Nowadays is quite common to find personal computers with two monitors, all they need is a video card with outputs to (at least) two monitors, which should be as identical as possible and show each image in the stereo pair through each monitor. This paper shows first how to build a simple set of mirrors so that each eye will look at a different monitor, and second, how to write an OpenGL code that computes correct stereo pairs of a moving scene and displays them each on its own monitor, enabling us to see it in real 3D.

Full Text: 183IDEW

2.4 Mixed Reality for Human Centred Design

Title: Possibility of applying Virtual Reality and Mixed Reality to the Human Centered Design and Prototyping for Information Appliances.

Authors: Satoshi Kanai, Hideki Aoyama, Jouke Verlinden, Tek-Jin Nam

Key Words: human centered design, information appliances, digital prototype, user interface software, usability assessment, virtual reality, mixed reality.

As functions of digital information appliances such as mobile phones is rapidly increasing, human centered product design including the assessment of usability and ergonomics is necessity at early design phases. In this situation, user test, which implies direct involvement of users, is becoming of great importance. The concept of virtual reality and mixed reality offers designers potential means to substitute the interactive digital mockups of the information appliances for the physical mockups. In this workshop, several case studies to solve these problems will be presented, and impacts on the rapid development and technical limitations of them will be discussed.

Full Text: 188WoIM

2.5 Mechatronics in Interactive Design

Contribution 1

Title: Towards New Maintenance and Product Design Processes With Embedded Technology.

Authors: Emilie Chapotot, Jérémy Legardeur, Philippe Girard

Key Words: maintenance, design, RFID, collaboration platform.

We aim to focus on the next challenges concerning the integration of electronic technologies in mechanical products. Especially, the question of the maintenance and design processes are here addressed taking into account of the innovation proposed by the use of RFID (Radio Frequency Identification) technology. This article presents this problem in the context of an IP European project that gathers different stakeholders in the aeronautic and transport industry. This first work highlights the need of development of collaboration platform in order to promote interactions among specialists in design, maintenance and electronic technology.

Full Article: 262MECAID

Contribution 2

Title: Mechatronics: from the Idea to the Product, a Global Challenge.

Authors: aziz Naamane, Nacer Msirdi

Key Words: mechatronics driven projects, innovation management, transversal technologies.

This paper gives the examples of the different projects ran with industrialist, by considering new ways of designing and producing, to create new powerful products and new machines. The design of these elements is achieved by the integration of components of different technologies. This new way of designing requires from the very start of the study harmonious integration of various technologies in order to carry out a competitive industrial product . These resulting products or processes present performances which are not possible to reach by considering these various techniques separately.

Full Article: 194MECAID

The previous exploratory argumentations are detailed in order to initiate original exploratory reflexions.

2.6 Concurrent Engineering and Interactive Approach

Title: Supporting Concurrent Engineering in JPL's Advanced Project Design Team using a System Engineering Development Environment

Authors: Leila Meshkat, Kathryn Weiss, Michael Luna, Nancy Leveson

Key Words: TeamX, Design Rationale, systems engineering, concurrent design.

We present an approach to facilitating concurrent engineering trades and knowledge capture through the use of a systems engineering development environment called SpecTRM (Specification Tool and Requirements Methodology). SpecTRM was compared to the concurrent engineering design team (TeamX)s traditional approach to capturing and organizing trade-space data between multiple disciplines during conceptual design. Analysis of the study results shows that the tools are most effective when used simultaneously, because their benefits complement each other, the former providing a structured requirements and knowledge capture environment, and the latter providing quick recording and organization of system trade information and action items.

Full Text: 75WoIM

2.7 Design Review and Mixed Reality

Title: IMPROVE: an Innovative Application for Collaborative Mobile Mixed Reality Design Review.

Authors: Pedro Santos, Andre Stork, Thomas Gierlinger, Alain Pagani, Celine Paloc, Inigo Barandarian, Giuseppe Conti, Raffaele De Amicis, Martin Witzel, Oliver Machui, Jose Manuel Jimenez, Bruno Araujo, Joaquim Jorge, Georg Bodammer

Key Words: outdoor mixed reality, collaborative design review, head mounted displays, colour calibration, video transmission.

IMPROVE is a European IST project targeting the architectural and automotive domain allowing users collaborative mobile mixed reality design review and developing: lightweight stereoscopic optical see-through HMDs using OLEDs sensor fusion combining markerless tracking algorithms, inertial sensors and GPS mixed reality rendering techniques based on precomputed radiance transfer (PRT) color and image calibration techniques for improved image rendering and perception collaborative interaction techniques for sketching design changes and annotations high quality video streaming to mobile devices The final paper will give insights into research and development activities and present usage scenarios as well as the first results of user tests.

Full Text: 163WoIM

In-Depth Tools and Techniques

3.1 Desktop and Collaborative Engineering

Title: Beyond Desktop: Emerging Technologies for Supporting 2D Collaborative Teams.

Authors: Jannick Rolland

Key Words: optics, interactive design, collaboration, 3D immersion.

Emergence of several trends such as the increased availability of wireless networks, miniaturization of electronics and sensing technologies, and novel input and output devices is giving rise to user interfaces suitable for use across a wide range of applications, including collaborative environments. In this talk, we will present emerging visualization methods, particularly as it relates to deployable displays and displays worn on the body to support mobile users. State of the Art large field of view head worn displays will be presented. Low field of view designs, suitable for integration into the eyeglasses form factor will also be discussed. Eyeglasses based displays are particularly interesting because they are well suited for mobile applications and they are more likely to enjoy higher social acceptance..

3.2 Taxonomy and Evaluation in Design

- Title:** A Taxonomy for the Design and Evaluation of Networked Virtual Environments.
- Authors:** Miranda Baladi, Henry Vitali, Georges Fadel, Joshua Summers, Andrew Duchowski
- Key Words:** networked virtual environments (NVEs), taxonomy, virtual reality.

Networked Virtual Environments (NVEs) are virtual environments that are distributed across two or more physical locations and connected over a network, thereby forming one virtual shared workspace. In the past decade, research in the field of networked virtual environments has become active, quickly growing out of infancy into a diversity of applications. As is common in any new field, this growing assortment of applications lacks an overall classification, making the design of NVEs cumbersome and the comparison of existing environments difficult at best. Our goal is to provide a means of classification through the development of a taxonomy of NVEs. First, an extensive literature review is conducted investigating the characteristics of virtual environments in general, as well as issues specific to networked virtual environments. This search leads to the development of a taxonomy for describing NVEs, which is used to compare current NVE systems and applications and find weak areas in which future work might be most beneficial. Finally, the taxonomy is used for the development of networked virtual environments for collaborative mechanical engineering design.

3.3 Knowledge and Classification

- Title:** On Applying Knowledge-based Engineering to Configure Best of Class Product.
- Authors:** Brian Prasad

Key Words: knowledge-based engineering, PLM, product design.

Designing and developing highly engineered products requires direct (and more dynamic) associations between customers specifications and product characteristics (or its behaviors). In order to meet the specified customer performance, cost, and integrity goals, a multitude of specialized analyses, heuristics, shortcuts, look-up tables, equations, algorithms, finite elements, and material substitution at multiple levels (system, subsystems, components and parts) are ought to be performed. The product geometries of such engineered product are often complex and many parts are designed interactively from scratch using a 3D commercial computer-aided design (CAD) – lately often referred as Product Life-cycle Management (PLM) system. Today, this very PLM-based engineered product-design process is often static, very feature or geometry-dependent, knowledgeintensive, and therefore, engineers often takes considerable time (months) to complete this manual process. Today, more and more companies want to quickly reengineer a product from a multitude of family solutions (corresponding to various design trade-off studies). They are interested in some dynamic form of a decision-based system that could automatically filter through a multitude of historical product solutions and quickly reconfigure one that meets the customer requirements with the least cost, weight, and time investment. Such decision-based product automation is not an easy task by any means. Product definitions without knowing specific geometry are hard to conceive, capture generically, and reuse widely (via any generative tool). A typical product development process by its nature is highly dynamic, nonlinear, discrete, feature-dependent, and partdependent. The solution is not easy, since problem formulation is time-bound, has numerous discrete inputs, topologies, and several mathematical discontinuities. This talk discusses the system architecture of the Knowledge-driven Automation (KDA) program – establishedn 2002. It addresses many of the above product development issues and problems. In particular, authors describe a Knowledge-based System Engineering Process for Obtaining Engineering Design Solutions in a Commercial PLM Setting. The architecture and solutions use a number of innovative knowledge-based engineering (KBE) concepts and procedures. Through strategic use of generative modeling, spreadsheet tables, part and assembly templates, system engineering concepts, and our proprietary smart part concepts, authors were able to engineer-to-configure a family of hydraulic actua-

tors automatically from their customer specifications using a set of PLM (CATIA V5 and its underlying knowledgware) tools.

3.4 Virtuality and Designers' Thinking

Title: Making Beautiful Dream Come True.

Authors: Grier Lin

Key Words: leadership, virtuality, industrial organization, vision in design

In the past history, we saw many leaders who were determined and confident in their sense of direction, unafraid to take risks, bold and courageous, inspiring and uplifting. However, leadership is a much more difficult matter these days than it once was. The world is much more complex and confusing, continually reshaping and renewing itself, changing before our very eyes in endless and complex variations. Even as it gets tougher to be a leader, it becomes more necessary, for only capable leaders will enable an organization to survive in such difficult and demanding time. Without leadership, an organization is like a boat adrift in turbulent seas with no oars, no compass, no maps, and no hope.

Our vision presents practical steps that a leader can take to greatly improve her-his leadingeffectiveness. Making beautiful dreams come true virtually starts with the assumption that you already are a leader of an organization or aspire to become one. The organization may be large or small, new or old. It may be in the private sector, the public sector, or the nonprofit sector. You may hold a position at the very top of the organization, or you may head a department within a larger organization. Your unit may be the local office of a public agency, a project in a research center. The practical steps include: design a vision that will serve your organization well, finding the right vision, taking vision stock, choosing the right vision, making dreams come true, and taking charge.

3.5 PLM, Collaborative Engineering and Education

Contribution 1

Title: Industrial Applications of PLM: Automotive and Aerospace sector.

Authors: David A. Guerra-Zubiaga, Manuel Contero, Pedro Orta, Arturo Molina

Key Words: PLM tools, advanced tools at collaborative product development, information and knowledge integration in PLM.

Manufacturing companies require advanced methods and digital tools to develop new products. In the majority of the cases, new tools are needed to develop a product in a cross functional business process with too many activities, while the people involved work in a collaborative environment because they are at long distance away. As a consequence, it is important to define a product life cycle suitable to each product and manufacturing company. Then apply advanced tools to develop new products. The life-cycle of a product encompasses the holistic view of its entire development. During the last 20 years significant advances has been done at each phase individually, for example using CAD, CAM and CAE application. Product Lifecycle Management (PLM) tools represent a key platform providing effective communication between collaborative team members. The present work gives an idea of industrial applications of PLM, using automotive and aerospace sectors as case studies

Contribution 2

Title: Digital Manufacturing for Aerospace industry: Experimental Aircraft.

Authors: David A. Guerra-Zubiaga, Ricardo A. Ramírez-Mendoza, Laurent Donato, Arturo Molina

Key Words: digital manufacturing tools in PLM, collaborative manufacturing, assembly process.

The aerospace manufacturing process is characterized by complex scenarios that need to be validated in order to determine manufacturability and low cost production. Key manufacturing knowledge traduced to best practices is required to produce successful manufacturing scenarios. New technologies such as Digital manufacturing tools used through PLM, are able to access and reuse the best practices, as well as evaluate 3D manufacturing scenarios. This paper shows how to reuse collective expertise and intelligence using manufacturing scenarios to support key decisions through PLM. This paper contributes to the exploration of digital manufacturing tools using key manufacturing knowledge at PLM environment to the field of assembly engineering applications. The present research encompasses multidisciplinary engineering work teams defining the assembly process of an airplane part. This paper argues that digital manufacturing tools enable complex manufacturing scenarios analysis virtually, exchanging expertise at collaborative work and increasing value added between collaborators. A case study is presented as a validation to this idea

Contribution 3

Title: Virtual Prototyping for Vehicle Dynamics and Control.

Authors: R. A. Ramírez-Mendoza, A. Drivet, R. Morales-Menéndez, C. Poussot Vassal, O. Sename, L. Dugard

Key Words: virtual prototype, modelling, simulation, multi-body dynamic software, active suspension.

Virtual prototypes (VP) are becoming very important in research and development of automotive industry. VP is considered to improve some of the steps in the product design process. A virtual prototype can indeed make a change in the way products are designed, tested and manufactured, because it may sometimes replace the physical prototype saving both time and money. Using a virtual model, different operation

conditions can be stated, prove some design constraints and mostly test different designs to ultimately refine the vehicle. In this paper a study case of a Renault Scenic's suspension is presented. This model is developed in multi-body dynamic modeling software. Furthermore, in this research, some automotive control systems are tested. Extensive simulation results are reported to prove the feasibility of this approach, in particular for the case of a semi active suspension system

Contribution 4

Title: Virtual Teams: Engineering and Education.

Authors: Rubén Morales-Menéndez, Ricardo A. Ramírez-Mendoza, Pedro Orta, Hugo Elizalde

Key Words: active learning, collaborative engineering, collaborative education, PACE automotive project, Virtual teams.

Based on a multidisciplinary global automobile design sponsored by PACE (Partners for the Advancement of Collaborative Engineering and Education), active learning techniques are used in virtual environments. The challenge implies design, modelling, analysis and integration of multiple working components of a new automobile design. The PACE team involves thirteen different schools in eight different countries, so a virtual environment is mandatory. Exploiting active learning techniques several skills are promoted (communication, working-team, innovation, problem-solving) in a collaborative engineering framework.

3.6 Spatial Information on Interactive Design

Title: Spatial Information on Interactive Design.

Authors: David Sol

Key Words: information system, spatial location, interactive systems, virtual reality.

We propose new trends to use spatial information on interactive design. The problems will be taken from the automotive industry, mainly Volkswagen Company in Mexico. The infrastructure to discover the new trends includes the creation of new organizations charged to implement the new ideas. In this context, spatial information plays an important role to improve interactive design.

3.7 The Role of Simulation in Virtual Prototyping

Contribution 1

Title: Comfort Assessment of Motorcycle Saddles: a Methodology Based on Virtual Prototype.

Authors: Monica Carfagni, Lapo Governi, Yary Volpe

Key Words: comfort assessment, virtual prototyping, saddle design, FEA, reverse engineering.

We illustrate a research work carried out in order to allow a comfort-oriented optimization of motorcycle saddles. The aim of the work is to develop a numerical tool (CAD/FEM) to assist the designer willing to take comfort into account as a primary requirement for saddle design. This paper briefly illustrates the basic steps of the methodology. The authors, after obtaining a set of parametric CAD models of both saddle and rider, simulated the contact occurring between these components by means of a FE solver, thereby obtaining a comfort level estimate. The results, validated by a set of experimental tests, can be used both to evaluate the comfort level of an existing saddle and to improve the saddle design. The work demonstrated the feasibility of the proposed approach, capable of providing useful hints for a comfort-oriented design, already from the early stage of stylistic design of motorcycle saddles and, possibly, of other products.

Contribution 2

Title: A Computer-Assisted Methodology to Innovate the Development Process of Prosthesis Socket.

Authors: Giorgio Colombo, Stefano Filippi, Caterina Rizzi, Federico Rotini

Key Words: product customisation, virtual prototyping, reverse engineering, rapid manufacturing, physically-based modelling and simulation.

We propose a computer-assisted methodology to improve prosthesis development process. We consider the case of the socket (interface between the residual limb and the mechanical part of the prosthesis) both for trans-femoral or trans-tibial amputee since it requires a high level of customisation. The new paradigm forecasts the integration of following techniques: reverse engineering and medical imaging for the acquisition patients morphology and bony-muscular structure, virtual prototyping to model the limb and the socket, physics-based simulation to reproduce the real movement of the patient and the interaction between the socket and stump and, finally, rapid prototyping tools for the physical realization of the product. The paper describes problems related to the implementation of each step within a real socket development process; in particular, first results regarding the reconstruction of the stump virtual model and physics-based simulation will be presented and discussed.

Contribution 3

Title: Digital Hand and Virtual Ergonomic Assessment Simulator for Styling Design.

Authors: Satoshi Kanai, Yui Endo, Natsuki Miyata, Makiko Kouchi, Masaaki Mochimaru

Key Words: digital human, digital hand, ergonomic assessment, CAD.

We present an ergonomic assessment simulator where stability and

ease of grasp of product exteriors can be evaluated using 3D CAD models and "digital hand" models. The digital hand models have a very precise 3D hand link structure and deformable external skins. The hand models also have a rich dimensional variation of Japanese adults based on real measurements. By inputting a 3D CAD model of an external housing of the product, the simulator automatically find one of the possible grasp postures of the digital hand. In the grasp postures, the system also quantitatively evaluates the stability of the grasp based on the force-closure theory and ease of the grasp based on a database of range of finger joint angles. The effectiveness and accuracy of the simulator was verified through measurements on real human grasps.

Contribution 4

Title: The Role of Virtual Prototyping and Simulation in the Fashion Sector.

Authors: U. Cugini, M. Bordegoni, R. Mana

Key Words: virtual prototyping, simulation, non-rigid material simulation, fashion sector, virtual atelier.

Virtual Prototyping practice and technologies are developing fast and moving from the traditional industrial sectors that have pushed their development (automotive, aeronautical) to new sectors, like the fashion sector, that is far from them, but anyway economically important. The concept of Virtual Prototyping has been built upon a bottom up approach. Tools oriented to different phases of the product development process (CAD, CAM, CAE, etc.) have been developed separately, without any intersection or anything in common among them, except for the idea that the geometrical model of the object is the reference point for the all phases. Actually, each of these tools simulates a single aspect/characteristic of the future product: the shape, the appearance, the manufacturability, the strain, the physical behaviour, etc. On top of them, Virtual Prototyping has developed with multiple aims. First, it aimed at integrating into a unique object all the characteristics that are uniquely formalised, and that can be uniquely simulated, so allowing an integration of all the interrelations among the all product aspects.

Another characteristic of Virtual Prototyping concerns its use and validation. This has raised the need to make compatible the context where the prototype can or could be virtually operating, in terms of digital modelling. Therefore, the Virtual Prototype can be seen as a correlated set of dedicated models able to simulate specific aspects and models of interaction modalities. The paper presents the key aspects of Virtual Prototyping and the enabling technologies in the fashion sector, presenting their benefits and the shortcomings that still require research and development.

3.8 Modelling, Simulation and Virtual Reality Supporting Design

Contribution 1

Title: Design Validation and Certification of Playground Equipments in Virtual Environment.

Authors: Giuseppe Di Gironimo, Antonio Lanzotti

Key Words: design validation, virtual reality, certification, grasping techniques, playground equipments.

The use of Virtual Reality (VR) laboratory to validate design and to certify industrial product is proposed, pointing out limits and potentiality. The ISO 9001: 2000 requires the phase of design validation in order to demonstrate that the design output are able to satisfy specified or forecasted user requirements, for this reason, generally, physical prototype are realized in order to evaluate real product performances and their correlation with simulated ones. The VR environment can improve the performance evaluation on virtual prototypes, thanks to the interaction between products, functional gauges, test templates, probes and testers. A case study about playground equipments for public use is shown in

order to illustrate the applicability and the limits of the proposed procedure. An original virtual grasping technique was developed in order to improve the realism of the interaction between real human and virtual functional gauges. Finally, two testing techniques were compared and

first results of virtual trials are presented

Contribution 2

Title: Re-design of Railway Locomotive in Virtual Environment for Ergonomic Equipment.

Authors: Giuseppe Di Gironimo, Stanislao Patalano

Key Words: collaborative design, top-down approach, ergonomics, virtual reality.

The present work deals with the re-designing of a locomotive, according to the in force European standards, in the field of active and passive safety. The paper illustrates the use and the management of heterogeneous product information (2D drawings, technical documentation, photos), Virtual Reality tools and digital human models, for the re-designing of a locomotive, using a collaborative approach with a total absence of the reference digital models. The project development has been organised using a top-down approach in a collaborative environment. Finally, by means of the digital prototype of locomotive, a series of aesthetic, functional and ergonomic analyses, in virtual environment, has been performed.

Contribution 3

Title: Design of a Virtual Reality Architecture for Robotic Work Cell Simulation.

Authors: Raffaele De Amicis, Giuseppe Di Gironimo, Adelaide Marzano

Key Words: virtual manufacturing, robotic work cell simulations, virtual reality architecture.

A methodology for developing robotic work cell simulation models via virtual reality technology is introduced.

The development of the method is based on applications of the EON reality simulation software in designing real robotic work cells.

With the methodology presented in this paper, designers in the field of engineering design and automation are able to easily understand the state-of-the-art technologies of robotic work cell simulation, and integrate these technologies with their knowledge and experience about CAD, robotics, and robotic work cell design

Contribution 4

Title: Maintainability Tests of Complex Assemblies in Virtual Reality.

Authors: Giuseppe Di Gironimo, Stefano Papa

Key Words: virtual reality, direct manual interaction, complex assemblies, maintainability tests.

In the present work we relate a methodology developed to execute maintainability tests of complex assemblies in Virtual Reality. Different approaches have been analyzed, described and compared in the paper.

The main goal of the work was to draw up a methodical approach in order to perform disassembly, accessibility and manipulability analyses in semi-immersive virtual environment of complex mechanical systems.

The method is based on a direct manual interaction: user in charge of the maintenance task can interact directly with the virtual model of the product by means of special devices. The tests were carried out in three complete Virtual Reality environments, realized by the authors, characterized by originals VR architectures.

3.9 Co-Design of Products, Processes and Network of Firms

Contribution 1

Title: Product and Project Co-design: What Do System Engineering Standards Recommend?

Authors: Claude Baron, Manrc Zolghadri, Daniel Estève, Laurent Geneste, Michel Aldanondo, Elise Vareilles.

Key Words: co-design, system engineering, model driven engineering, product design, project organization.

Industries have to design and produce performing and reliable systems. Nevertheless, designers suffer from the diversity of methods, which are not really adequate to their needs.

We highlight the interactions between product and project design, often treated either independently or sequentially. They study the organisation of the exchanges between these two processes and propose a methodology with regard to the standards of System Engineering and the recommendations of Model Driven Engineering (MDE), in the context of what is called the co-design paradigm

Contribution 2

Title: Modelling and Performance Evaluation of the Decision-Making Processes in the Product Life Cycle in Extended Environment.

Authors: Radhouane DJjeridi, Aline Cauvin, Guillaume Poncelin

Key Words: extended enterprise, decision making, collaborative environment, enterprise modelling, supply chain, GRAI-GIM methodology.

In the context of concurrent engineering, few works deal with collaborative decision-making processes in the context of extended enterprises. Our issue concerns the modelling of decision-making all along the product life cycle in supply chains. The main interest consists in improving the coordination of their activities. We study the process and operational aspects of the supply chains. Our work deals with the modelling of the decisional aspects using an analysis methodology of the decisional structure of industrial organizations (GRAI-GIM methodology). We propose a reference GRAI grid of supply chains which can be used to support the development of decisional grids of a logistic organization. These decisional grids will make it possible to assess the coherence of decisions in order to improve the organization.

Contribution 3

Title: Innovative Product and Value Network Co-Design: Context, Problematic and some Exploratory Result.

Authors: Marc Zolghadri, Claude Baron, Philippe Girard

Key Words: value network design, collaborative innovation, innovative product design, co-design.

Innovative product development and in-house process design have been largely studied and methods such as Concurrent Engineering, Integrated Product Development or Dynamic Product Development were set up to answer real needs of industrialists. However, no innovative product can be put on the market without a well-structured and well-organized network of firms. This simple idea influences deeply various aspects of collaborative enterprises. This paradigm, called here Co-Design, is studied by providing its most important context elements that managers should take into account. In this paper, we define basic concepts and also provide some exploratory results related to the co-design control primitives

Contribution 4

Title: Study on Product Configuration Process and Modelling Technology.

Authors: Chen Zhigu, Han Xiaojian

Key Words: product configuration, configuration process, product model, configurable product.

On the bases of summarizing the primary aspects of research of the product configuration and analyzing the configuration problems which may occur in product lifecycle, integrated product configuration level model is put forward .The functions and relations of product configuration, process configuration and resource configuration which are three parts of the integrated product configuration level model are explained. Importantly, product model and its corresponding configuration process model are established for integrated product configuration process. Finally, application case on product configuration process model is given

3.10 Sensation and Simulation

Title: Virtual Modelling Through Human Vision Sense.

Authors: Alves, N.M.F., Bártolo, P.J.

Key Words: architectural design, BioCAD, human vision, reverse design, virtual modelling.

The restoration-renovation of historic buildings has become an important facet of the construction industry, which can generate large economic benefits, drawn from the increased commercial value of these buildings and its surrounding area in terms of tourism and investment, apart from other non-priced benefits associated with user satisfaction. In this context, the rapid generation of tridimensional computer models from existent large objects like historic buildings can be particularly

important either for building re-use, virtual museums or others patrimonial applications. This paper proposes a new biologically based computer tool, called BioCAD that mimics the human vision process. This system was specifically designed for the rapid and accurate generation of 3D computer models from existing large objects and can be integrated with other computer-based technologies. Two case studies were chosen to validate the system and to demonstrate its integration with rapid prototyping and Haptic CAD systems.

3.11 Model and Tools for Collaborative Design

Contribution 1

Title: New Model and Tool for Ideas Management During Early Phases of Innovation Process.

Authors: Olivier Pialot, Jérémy Legardeur, Jean-François Boujut

Key Words: new idea management, knowledge management, early product design phases.

We aim to focus on the early informal design phase of innovative projects that is one of the challenges for industrial companies. More precisely, the question of the ideas management during innovative projects processes is here addressed with a model and tool perspectives. The model is based on three dimensions (concept, technology and potential) and highlights the need of interactions between them regarding strategic and operational levels. The paper presents also a tool dedicated to structure the preliminary exchanges among all stakeholders. This tool is mainly oriented towards the consolidation and the diffusion of new ideas

Contribution 2

Title: A Solution for Actors Viewpoints Representation with Collaborative Product Development.

Authors: Hichem M. Geryville 1, Abdelaziz Bouras 1, Yacine Ouzrout 1, Nikolaos S. Sapidis

Key Words: viewpoints, multidisciplinary collaboration, exchange information, product and process information, product lifecycle management.

As product complexity and marketing competition increase, a collaborative product development is necessary for companies which develop high quality products in short lead-times. To support product actors from different fields, disciplines, and locations, wishing to exchange and share information, the representation of the actors viewpoints is the underlying requirement of the collaborative product development. The actors viewpoints approach was designed to provide an organisational framework following the actors perspectives in the collaboration, and their relationships, could be explicitly gathered and formatted. The approach acknowledges the inevitability of multiple integration of product information as different views, promotes gathering of actors interests, and encourages retrieved adequate information while providing support for integration through PLM and-or SCM collaboration. In this paper, a solution for neutral viewpoints representation is proposed. The product, process, and organisation information models are seriatim discussed. A series of issues referring to the viewpoints representation are discussed in detail. Based on XML standard, taking cyclone vessel as an example, an application case of part of product information modelling is stated

Contribution 3

Title: Assistance to Agent-Based μ -Tools Development for a Co-operative Design Platform.

Authors: Alain-Jérôme Fougères

Key Words: μ -tools, assistance design, natural language processing, cooperative work.

We report the assistance design of applications to actors of design process whom we call microtools (μ -tools). The μ -tools are well adapted to instrument the co-operative activities integrated in virtual spaces of the

design. Those can be integrated on a software-agent platform (PLACID) adapted to the innovating and distributed design mechanical systems. The development of these μ -tools is a collaborative activity bringing together the future users and the developers. This collaboration is not always easy. Also, we try to propose possibilities of assistance throughout the development of the μ -tools, starting from the interactions and the natural expression of the various actors

Industrial Aspects

4.1 Desktops in Industry

Title: Moving the Cat to Desktops.

Authors: J.B. De La Rivière - Immersion SAS Company (France)

Key Words: 6dof interaction, navigation, manipulation, dof separation.

We present the first experimentations that take place in the CRIMSON project in order to design an innovative 6dof device dedicated to 3D manipulation and navigation, even in the context of critical situations such as crisis management. It is a 6dof device intended to facilitate interaction in large display environments. By trying to bring the main advantages of the Cat device to desktop workstations, we have developed an intuitive and efficient alternative to the classical SpaceMouse. Indeed, our device makes use of both isotonic and isometric sensor modes, separated dofs, passive haptic feedback and an auto-supported structure. While they show ways of improvements, the experimentations we conducted, in the frame of crisis management and massive geo-information visualisation, tend to confirm the ease of use and efficiency of the prototype.

4.2 Virtual Object Manipulation from the Real World

Title: Hands-Free Techniques for Interaction of 3D Objects with a Digital Environment.

Authors: V. J. Vincent - GestureTek Inc Company (Canada)

Key Words: video gesture control, interactive large screen displays, camera enabled computer control, interactive walls, stereo camera.

We will be presenting the use of cameras as interfaces of hands free control of computing devices in immersive environments by referencing real-world installation examples. This includes but is not limited to, full body immersion in 3D computer-generated worlds, for large screens and interactive walls (NASA). Other scenarios include, the users seeing their computer generated image in the digital environment where they can interact with and control the 3D objects and content at will by making simple gestures with their hands and feet, in Minority-Report fashion.

Full Text: 254MECAID

Interactive Techniques

5.1 Virtual Ergonomics

Contribution 1

Title: Ergonomic Tests in Mixed Environments: Integration of VR and Physical Control Devices.

Authors: Umberto Giraudo, Monica Bordegni, Giandomenico Caruso, Francesco Ferrise

Key Words: virtual mannequin, ergonomic validation, mixed reality, motion capture.

VR is becoming a common practice in automotive industry. It fosters the reduction of the time-to-market and the costs for PMU. Ergonomics tests based on VR tools are able to influence the design of products. We present a methodology based on a mixed reality environment integrating VR and tangible objects used for performing ergonomic tests of control devices and the results of testing sessions where the tester interacts with a virtual model and receives a feedback. . The environment includes a virtual human controlled by a motion tracking system, and a physical object consisting of a rotatory haptic device.

Full Article: 78InCo

Contribution 2

Title: Display Technology Application Assessment for Virtual Systems.

Authors: Omar Khan, Paul Huang

Key Words: virtual systems, virtual environment, computer display systems.

Computer-generated virtual systems and virtual environments provide researchers, engineers, game/entertainment developers, designers, and many other professions with powerful tools to perform jobs that were unimaginable a few years ago. For virtual systems, visualization is only one of the five senses used by humans, so by combining sounds, motion, and other sensory stimulus, it is possible to digitally re-create objects, events and environment to completely emulate real objects, events, and environment in which they occur with high fidelity. This paper reports the research and findings on various tools, equipment, and settings that can be used to create high-fidelity virtual systems.

Full Article: 83InCo

Contribution 3

Title: Vehicle Validation Visualization.

Authors: Mikael Nybacka, Tomas Karlsson, Tobias Larsson

Key Words: virtual environment, distributed simulation, collaborative environment, real-time visualization, automotive validation.

Increasing complexity of embedded systems in automotive industry calls for more efficient testing and verification processes. This paper presents a visualization application for distributed real-time vehicle validation. Real-time data from vehicles are transmitted via wireless network from the test track to a simulation framework. The processed data from the simulation are distributed to multiple web based visualization clients. The Java based client presents data in a rich 3D environment thus enabling non-expert to understand behaviors of complex vehicle systems. The application will contribute to enhanced validation data presentation and the ability to collaborate in a distributed real-time virtual environment.

Full Article: 56InCo

5.2 Interactive Simulation for Risk Prevention

Contribution 1

Title: Training Simulator to the Handling of Fire Extinguisher.

Authors: Damien Paillot, Frédéric Rivet, Frederic Mérienne, Michel Bonnet

Key Words: learning application, immersive, stereoscopic, fire extinguisher.

This paper is focused on the use of virtual reality dedicated to technical gesture learning. In the context of the manipulation of fire extinguisher, the technical gesture is critical and necessitates several trials to be learnt. Fear, heat, stress make this shot very complicated. However, the pollution norms and the cost of each trial do not allow a large number of trials. Thus, virtual reality techniques constitute a learning tool complementary to the real trial. The aim of this work to propose an alternative tool to learn the technical gesture for the use of fire extinguisher. The proposal method is based on the integration of a real extinguisher, associated to a tracking system, into a virtual scene of fire case. A phenomenological model of fire has been developed and implemented so as to take into account the interaction with the powder, the temperature of flame, the direction and the force of wind, A first system was implemented with a stereoscopic rendering and in the scenario of a puddle pool of hydrocarbon. This prototype has been tested by firemen of French military school on hydrocarbon management. First results have shown a good equivalence between virtual shot and real shot according to the criteria of the technical gesture.

Full Article: 3InCo

Contribution 2

Title: Developing a Virtual Environment for Offshore Safety Training.

Authors: Benjamin Zayas, Evelyn Vega

Key Words: virtual reality training, safety training, Internet2.

The Virtual Reality Group at the Instituto de Investigaciones Eléctricas has been working on a number of projects involving research and development of instructional systems for the energy realm. Such systems aim to complement conventional training methods for maintenance and visualization process. An area recently explored is related to safety training through interactive scenarios, where trainees can experiment emergency situations and interrogate offshore-oil platform components while roaming around the virtual facility. Fundamental concepts of virtual reality training and visualization over Internet2 are discussed along with the design process for developing a large-scale virtual environment prototype based on a video-game engine.

Full Article: 174InCo

Contribution 3

Title: Multi-Agents Approach for Modelling Safety Interventions on a SEVESO Site through Virtual Reality.

Authors: Lydie Edward, Domitile Lourdeaux, Dominique Lenne, Jean-Paul Barthes

Key Words: virtual reality, safety intervention, risk management, multi-agent system, artificial intelligence.

In the V3S (Virtual Reality for Safe Seveso Substractors) project, we design a tool allowing storyboarding hazardous working situations on Seveso sites for risk prevention and decision making. This tool interprets a high level task and a related risks model. It is meant for a manager to help him/her to make decisions. The manager plays the scenario of an intervention and manages a team of virtual operators (associated with autonomous agents). Depending on his/her decisions, the incurred risks are displayed in the virtual environment. We will present our project and the multi-agent architecture on which it relies.

Full Article: 127InCo

5.3 Interactive Simulation for Improving Industrial Operations

Contribution 1

Title: Virtual Maintenance based Maintainability Analysis System.

Authors: Jianping Hao

Key Words: maintainability analysis, virtual maintenance, maintenance action, virtual maintenance prototype.

It is a new challenge maintainability engineers faced how to conduct maintainability analysis and find potential design deficiencies in time without building physical mock-up. Virtual reality is an effective way to this problem. This paper introduces a virtual maintenance based maintainability analysis system (VMMAS) and several key technologies solved during the development of this system. The paper consists of six parts, including introduction, VMMAS architecture, virtual maintenance prototyping, maintenance action modeling, simulation based maintainability analysis and evaluation, system implementation and application case.

Full Article: 256InCo

Contribution 2

Title: Improvement of Re-Process with the Rapid Surfacing Technology.

Authors: Francisco Anaya Bravo, Carlos Acosta

Key Words: reverse engineering, rapid surfacing technology, software bechmarking, virtual surface recovery, 3D data acquisition and recognition.

Rapid Surfacing Technology (RST) is a new concept in RE that involves techniques that speeds up and gives flexibility to the process. At Volkswagen AG RE process, different software packages are involved and the data exchange among the many packages used restricts flexibil-

ity and costs. To evaluate the best RST tool, testing the data recovery of three characteristic parts, was the approach. The required precision and geometrical constraints were parameters. A suitable RST software was recommended to VW AG as a result. Recommendations to RST developers are pointed out as well.

Full Article: 31InCo

Contribution 3

Title: Enabled Dynamic Tasks Planning in Virtual Manufacturing Environments.

Authors: Qingjin Peng

Key Words: virtual manufacturing, dynamic tasks planning, 3D visualization.

This paper discusses dynamic tasks planning enabled by virtual manufacturing environments. Applications developed are presented including process planning for the shop floor fabrication, assembly planning for the product completion, and disassembly planning for the product end-life management. A 3D visualized interface is implemented using Java and VRML-EAI, which provides an interaction between human and virtual objects. It can perform a precise time-dependant simulation and real-time data acquisition. The acquired data can then be used to calculate other useful information in manufacturing. The proposed method provides a solution of cost-effective, platform independent, and sharing visualized information over the Internet for virtual reality applications.

Full Article: 50InCo

5.4 Interactive Method for Supporting Preliminary Design

Contribution 1

Title: Dynamic Product Structure Configuration of Superimposed Part Structure Solutions.

Authors: Niko Salonen, Niko Salonen

Key Words: product configuration, modular product platforms, relation Mmdels.

There is a need to enable different superimposed part structure solutions as part of the design process and identify these solution options to support configuration of life-cycle phases. This requirement is one of the important needs of integrated product structure configuration in modular product architectures in commercial marine product platforms. The solution of this study is the sub model definition of dynamic product structure. This sub model enables superimposed solution structure definition in away that parts and documents are managed through change process effectively in product data management systems.

Full Article: 176InCo

Contribution 2

Title: The Quest for the Ideal Solution.

Authors: Zbigniew M. Bzymek

Key Words: problem solving, engineering design, BTIPS theorems, BTIPS corollaries, principles, effects, prediction, problem solving algorithms, degree of isolation, preliminary solution, trimming, solution test, ideal solution, teaching BTIPS.

The challenge of 21 century is to develop a tool that would satisfactorily support the most uncontrollable phase of design - the problem solving and concept generation. The Brief Theory of Inventive Problem Solving (BTIPS) may be used to perform such task. It is a compact, to certain degree formalized and somewhat changed version of TRIZ and TIPS that can be more effective in application. BTIPS is a unique tool for problem solving in engineering research, design, practice and education. The paper describes authors experience in research, teaching and applying the theory for solution of engineering problems.

Full Article: 32InCo

Contribution 3

Title: VR-DeMo: a Tool-Supported Approach Facilitating Flexible Development of Virtual Environments using Conceptual Modelling.

Authors: Karin Coninx, Olga De Troyer, Chris Raymaekers, Frederic Kleinermann

Key Words: high level modelling, conceptual modeling, model-based development.

To improve the design of virtual environments, we have developed an approach, called "VR-DeMo", which allows virtual environments to be defined using conceptual modelling. The design of virtual objects with their behaviour is realized through domain concepts. Exploratory interaction design, with attention for usability, is facilitated through model-based development of interaction techniques and metaphors. This paper describes the development process and the tools supporting the integration of this approach in order to ease the developers task. The realization of an interactive tool to model a park in its urban environment is presented as a case study.

Full Article: 88InCo

5.5 From CAD to Virtual Reality

Contribution 1

Title: Interfacing Product Views through a Mixed Shape Representation. Part 1: Data Structures and Operators.

Authors: Jean-Claude Léon, Okba Hamri, Antoine Poulat, Franca Giannini, Bianca Falcidieno

Key Words: digital mock-up (DMU), mixed representation, HLT-Rep, polyhedral-Rep, CAD-CAE link.

Currently, the product development process being collaborative and distributed, it relies on multiple skills and representations of the prod-

uct. Obtaining the digital representation of the product model required for each product view is time consuming because component shapes and their associated data need to be adapted. Considered here as a first part, an analysis of the requirements for this adaptation process is performed that leads to the concepts and organization of the corresponding data structures and operators. Among the product views, the design simulation interface is addressed through various examples.

Full Article: 72InCo

Contribution 2

Title: Interfacing Product Views through a Mixed Shape Representation. Part 2: Model Processing Description.

Authors: Jean-Claude Léon, Guillaume Drieux, Antoine Poulat

Key Words: digital mock-up (DMU), mixed representation , HLT-Rep , polyhedral-Rep , downstream digital mock-up , adaptation process.

Obtaining the digital representation of the product model required for each product view is time consuming because component shapes and their associated data need to be adapted. Considered here as a second part, issues related to operators addressing the associative modification of models, the product description, are described as a complement of the first part. Among the product views, the concept of downstream digital mock-up serves as basis to illustrate the properties of the proposed approach. The product adaptation phase is here considered as a process and the corresponding model is described.

Full Article: 74InCo

Contribution 3

Title: Towards a Fully Integrated CAD System in Virtual Reality Environment.

Authors: Tommaso Ingrassia, Marco La Cascia, Francesco Cappello, Massimiliano Romano

Key Words: virtual reality, CAD modelling, tracking system.

Nowadays, in the industrial field, it is very felt the need of improving the design process by using the virtual reality. In this context there is a great demand, by the mechanical designers, for a fully integrated CAD (Computer Aided Design) - virtual reality system. In this paper a software application, that is still being developed, to create three-dimensional CAD models, constituted both of surfaces and solid geometries, is presented. This application, moreover, makes use of an optical tracking system, that allows the user to create the models by freely moving his hands in the three-dimensional space.

Full Article: 87InCo

5.6 Virtuality for Interactive Manufacturing

Contribution 1

Title: Automated Process Planning and Simulation Based Manufacturing of Space Instruments.

Authors: Kauko Lappalainen, Mika Ihatsu

Key Words: CAPP, automated process planing, machining simulation.

Manufacturing of space instruments represents high quality and low quantity production of specialized parts. By using the 3D CAD/CAM system with libraries of machine tools, cutting tools, fixtures and machining data NC programming can be done effectively. Tool path generation of routine features can be done automatically by using feature recognition and method files. In order to improve the machine utilization and to shorten the machining lead-time the simulation of NC program is necessary. The procedure was tested in machining parts of space instruments. The results showed that one-of-a-kind manufacturing can be implemented even in a flexible manufacturing system.

Full Article: 65InCo

Contribution 2

Title: Virtual Reality Simulation Applied on a Numerical Control Milling Machine.

Authors: A. Pérez Acal, A. Sanz Lobera

Key Words: manufacturing, simulation, virtual reality, machine-tools, numerical control.

Simulation of Numerical Control Machine-Tools based on Virtual Reality allows a previous visualization of the different processes performed on a manufactured part. Moreover, simulation allows inexperienced workers to learn how to control the Machine-Tool in a safe way even through the web. The development of a 3-axis NC milling machine commonly used in the aeronautical industry is presented here. The machine architecture and its environment are based on Object Oriented Programming, which makes possible upgrade and modularity. Each machine element is represented by a C++ class, as well as the compiler that interprets the NC program code lines.

Full Article: 63InCo

Contribution 3

Title: Virtual Reality for NC Machining Improvement.

Authors: Pierre Lagarrigue, Roland Maranzana, Tibor Szalay, Alain Brail, Jean Max Reconnet, Raquel Beceril, Guillaume Cohen

Key Words: NC machining simulation, virtual machine tool.

In the field of manufacturing by chip removal and more especially NC machining, there is a clear need to develop a tool capable of accurately simulate the CNC machining operation. This tool will take into account all static and dynamic parameters including sources of inaccuracies and errors. This tool will provide a perfect representation of the machined part all along the machining process and will enable corrective actions thanks to an optimisation capability. The research teams of Budapest, Montréal and Toulouse have decided to associate their skills to develop a virtual machine tool that will fit to these needs.

Full Article: 128InCo

5.7 High Realistic Rendering

Contribution 1

Title: Live 3D Scenography System and Tangible 3D Vision.

Authors: Shiro Ozawa, Takao Abe, Noriyuki Naruto, Itaru Kamiya, Atsunobu Narita, Mitsunori Hirano, Ichiro Kase, Takuya Ogawa

Key Words: 3D, haptic, network, collaboration.

We have developed the "Live 3D Scenography System and Touchable 3D Vision." The system has created a new virtual experience such as visual haptic communication. And we are developing a 3D touchable video-phone system and some industrial collaboration applications based on this system.

Full Article: 13InCo

Contribution 2

Title: Rendering: Radicalising the Film Industry.

Authors: David Preston, Jocelyn Deborne

Key Words: rendering, film, strategy, project management.

The authors have recently become involved in several projects utilising virtual concepts within the film industry, notably Mirrormask [2005] In particular the uses of rendering has been categorised and assessed and the film industry found wanting yet enthusiastic [Deborne, 2006]. This paper demonstrates how rendering together with worldwide digitalisation has the potential to radically alter the film industry at large. We present a study of one particular project that we have been leading via virtual means and offers a strategy on how to film render based on lessons we have learnt from the multiple projects we have been engaged in globally.

Full Article: 39InCo

Contribution 3

Title: Representation of Complex Facades using Typed Graphs.

Authors: Dieter Finkenzeller, Alfred Schmitt

Key Words: virtual architecture, procedural modeling, computer graphics.

In this paper we present a method for representing complex facades. For this purpose we developed a hierarchical decomposition for the facade. The steps of the decomposition are represented as nodes in a typed graph where the leaves are the atomic facade elements. Every node includes necessary attributes for its facade structure. The edges in the graph depict adjacent facade elements providing spatial information. With this approach complex architectural structures can be defined easily. A geometry engine traverses the graph in order to generate the detailed facade geometry but can stop at any given depth to produce exactly fitting geometry.

Full Article: 93InCo

5.8 Interactive Conceptual Design

Contribution 1

Title: Functionally Efficient Conceptual Design and Innovation Tools.

Authors: Martin E. Baltazar-Lopez, Eric F. Zenteno-Cardoso, Jorge D. Flores-Porras

Key Words: design methodology, functional structure, abstraction, innovation.

A design methodology founded on the research work done at the Institute for Innovation and Design in Engineering, has been applied to enhance the ability to design and innovate of neophyte engineers. This methodology is based on the cognitive skills of abstraction, critical parameter identification, and questioning in order to obtain a functionally

efficient conceptual design. Besides of teaching the design process to novice designers, the methodology inspires in them a design philosophy which enables them to perform engineering effectively and innovatively in any area of specialty. As examples of this design philosophy two study cases are presented.

Full Article: 95InCo

Contribution 2

Title: Conceptual Configuration in 3D.

Authors: Bent Larsen

Key Words: 3D, 2D, configuration, design, usability.

Designing 3D models is a complex task and requires skilled users. We demonstrate that many 3D modelling tasks can be accomplished by using 2D techniques and configuration, enabling common users the ability of designing complex 3D models. We demonstrate the usability of our techniques by showing a case where it is used to conceptually design a pharmaceutical plant.

Full Article: 238InCo

5.9 Image in Design: Creation, Improvement and Using

Contribution 1

Title: Tangible Image Studio for Digital Imaging in Product Design.

Authors: Tek-Jin Nam, Jungha Hwang

Key Words: tangible user interface, digital imaging, lighting, CAD.

We introduce a system for supporting digital imaging tasks in product design, called Tangible Image Studio. Tangible Image Studio helps industrial designers intuitively control parameters for digital imaging, such as camera location, target location, type and property of light sources in

3D CAD tools by employing tangible user interface techniques. It can improve the user interface of digital imaging tasks in CAD. It is also useful as a teaching aid for photographic studio lighting.

Full Article: 259InCo

Contribution 2

Title: Edge-Based Markerless 3D Tracking of Rigid Objects.

Authors: Javier Barandiaran, Diego Borro, Luis Matey

Key Words: augmented reality, 3D tracking, edge-based, computer vision, real-time.

We present a real-time object 3D tracking algorithm. The algorithm is continuously projecting the 3D model by using the pose estimated in the previous frame. Moreover, control points are generated along the visible edges of the object. The next pose is estimated by minimizing the distances between the control points and the edge detected in the image. This tracking technique requires an initial pose estimation to start. So, a review of different marker and marker less based pose estimation methods is presented. The whole system can be used for helping workers in Augmented Reality assisted environments like mechanical maintenance.

Full Article: 126InCo

5.10 Virtual Sketching

Contribution 1

Title: Virtual Sketching in Mechanical Design.

Authors: Christophe Bascoul, Pascal Ray

Key Words: sketch, constraint dynamics, haptic, conceptual design.

The importance of the design phase leads us to develop a virtual sketch tool making it possible to any person to handle a mechanical system. The simplicity of the geometrical model makes it possible to run simplified analyses. Our objective is thus to understand how the

introduction of this new tool can make it possible to improve industrial products design. We work now on a new module of constraint dynamics. We use the principle of Gauss of least constraint. The geometries are limited to simple forms: segment, circle, plan, sphere, etc.

Full Article: 179InCo

Contribution 2

Title: Learning How to Sketch in Three Dimensions.

Authors: Holger Diehl, Max Bremer, Lindemann Udo

Key Words: conceptual design, CAD, 3D-Sketching.

At the institute for product development an AR-based 3D-Sketching tool has been developed. The quality of the 3D-Sketches created by persons who use the 3D-Sketcher for the first time are very low. The main reason therefore is the difficult task of coordinating in three dimensions and the use of two unknown input devices. In several tests rules for good 3D-Sketching have been identified. The result is a catalogue with several little sketching tasks that can be used to improve 3D-Sketching skills. In this paper the training catalogue as well as its application in a test with five persons will be described.

Full Article: 228InCo

Contribution 3

Title: Content-Based 3D Mesh Model Retrieval from Hand-Written Sketch.

Authors: Satoshi Kanai

Key Words: content-based retrieval, shape retrieval, shape similarity, mesh model, CAD, search engine, hand-written image, non-photorealistic rendering, generic fourier descriptor, local binary pattern.

A content-based 3D mesh model retrieval system from hand-written sketch is proposed. The user can put a query in the form of a 2D hand-written sketch to 3D mesh model database, and the system automatically returns a set of 3D mesh models having 2D views similar to the input sketch from the database. Generic Fourier Descriptor and Local Binary

Pattern which are invariant to rotation, translation and scaling of 2D images are used to measure dissimilarity between a query sketch and an image generated from 3D model in the database.

Full Article: 236InCo

5.11 Geometric Modelling

Contribution 1

Title: Characteristic Lines Modeling in Interactive Design.

Authors: Mai Ohno, Hideki Aoyama

Key Words: modeling, CAD, style design, characteristic Line.

Designers embody ones idea by drawing sketches at the early stage of design process. Because characteristic lines are important factors to express products external features, concretizing and determining characteristic lines are extremely important. Designers repeatedly draw characteristic lines for working on design to sophisticate shapes. Therefore, a 3D-CAD system having the function to construct and adjust characteristic lines by easy operations becomes strong support for the style design. The objective of this research is to develop a 3D-CAD system which can create surfaces with the characteristic lines interactively and modify the shapes by changing the parameters defining the lines.

Full Article: 85InCo

Contribution 2

Title: 3D Polygonal Models from CT Data.

Authors: Felix Hamza-Lup

Key Words: 2D-3D conversion, radiation therapy, planning, X3D.

As radiation treatment/surgery becomes increasingly available at various medical centers around the world, it becomes also the preferred choice for tumors treatment. Planning is a crucial part of the process and requires 3D models extracted 2D CT (Coherent Tomography) scans.

Our focus is the design and implementation of an on-the-fly conversion system of the patient 2D CT into 3D polygonal models. This work is complementary to the goal of creating a real-time 3D graphical simulator for an advanced radiation therapy/surgery system that improves the planning process showing how virtual reality can be used to support the decision making process as well as innovation.

Full Article: 253InCo

Contribution 3

Title: Octree Based Production of Near Net Shape Components.

Authors: Hugo Medellin, Jonathan Corney, J.B.C. Davies, Theodore Lim, J.M. Ritchie

Key Words: near net shape (NNS), RPNNS, octree decomposition, octree model, octree assembly cell, NNS component.

We present an integrated system for the production of near net shape components based on an Octree decomposition of a 3D model. Not only is the system capable of producing shapes of variable precision and complexity (including overhanging or re-entrant shapes) from a variety of materials, but it also does not require the design of production tooling (e.g. moulds, dies, jigs or fixtures). Several Octree algorithms for subdivision, neighbour finding and tree traversal have been modified to support this novel application. The construction of two mechanical components in the proposed system is presented and discussed.

Full Article: 27InCo

5.12 Virtual Assembly

Contribution 1

Title: New Media and Technology Support in Manual Assembly.

Authors: Mathey Wiesbeck, Michael F. Zaeh, Henning Rudolf, Wolfgang Vogl

Key Words: assembly, augmented reality, ar, digital tools, provisioning, radio frequency identification, rfid, expert system, system integration.

An obstacle in the assembly process of complex and highly customized products is the execution of the strongly different work steps for every product. Furthermore the provisioning of the large number of components proves challenging, as it can neither be done order-related nor consumption-related. In automated storage systems concepts for chaotic allocation of storage place to cope with this issue are widely known. This approach has found hardly any realization in manual provisioning, since the resulting search and pick times would be raised drastically by such a chaotic arrangement. Pick-To-Light systems have been used in manual picking to address this issue for some time. However, in assembly of highly customized products not only the storage information but also detailed assembly information is necessary. The data needed for visualizing such necessary information, e.g. storage place of certain components can be generated using Auto-ID-Systems, like RFID. Making use of rule-based expert systems the data resulting from the work surrounding can be provided situation-adapted and context-based through Augmented Reality -Technology to the worker. The paper to be submitted derives the necessity of the above systems from the changed situation in manual assembly, e.g. higher number of customized products and the increasing share of individual assembly content per worker, and presents a prototypical workplace with chaotic component provisioning showing the integration of the technologies Augmented Reality, Auto-ID-Systems and expert systems to achieve a solution for the prior mentioned issues.

Full Article: 2InCo

Contribution 2

Title: Virtual Reality Aided Design of Parts and Assemblies.

Authors: Torsten Polzin, Holger Zickner, Dieter Weidlich, Reimund Neugebauer

Key Words: virtual reality, immersive modeling, interaction,.

Current virtual reality systems provide an enormous potential for enhancing the visualization of 3D-design drafts. Based on new navigation

techniques the designer is able to interact, model in a more intuitive and efficient way. In our contribution we present a novel interaction metaphor that facilitates the synthesis of efficient virtual reality interaction and visualization techniques with modern feature based CAD systems. We present NAVIMODE, an alternative approach for navigation, manipulation and selection, to combine the advantages of VR and CAD systems. The design engineer has the chance to design in there habitual environment using the advantage of Virtual Reality concurrently.

Full Article: 42InCo

Contribution 3

Title: Design of an Innovative Assembly Process of a Modular Train in Virtual Environment.

Authors: Giuseppe Di Gironimo, Adelaide Marzano

Key Words: virtual manufacturing, train design, assembly analysis.

We have conceived an innovative assembly cycle of railway vehicles that can improve the manufacturing process. The study has been carry out using Virtual Reality (VR) technologies in the VR Laboratory of the Competence Regional Center for the qualification of transportation systems founded by Campania Region. The developed simulation environment has allowed to evaluate different workplaces layout configurations of the train assembly cycle. The best workplace layout configuration has been detected in order to minimize the lead time in the production line and to optimize the automation level and the human component for each workplace.

Full Article: 209InCo

5.13 Interactive Decision Support System

Contribution 1

Title: Quick-Response Decision Making in Volatile Systems.

Authors: Siamak Tavakoli, Ali Mousavi

Key Words: production management, key performance factors, real-time data, decision support.

We propose a quick-response decision modeller to help managers deal with the demands of volatile environments. It argues the need for a focused, real-time, high quality information apparatus to support holistic decisions made by line managers in dealing with daily situations. This can be achieved by creating the proper information environment and equipping the system with suitable prediction platforms. In the sections to be followed we propose an outline for a quick response decision-making tool where line managers monitor and control the behaviour of the system and are able to assess the gains and losses behind each option.

Full Article: 201InCo

Contribution 2

Title: An Intelligent System for the Interactions Analysis in a Collaborative Design Process.

Authors: Alain-Jérôme Fougères, Egon Ostrosi, Michel Ferney

Key Words: collaborative design process, interactions analysis, multi-agent system.

During the collaborative design process, the co-operation between actors is variable and fluctuating. This paper proposes a multi-agent system for analyzing those interactions. The system reacts graphically according to the verbal exchanges between various actors. From this point of view, the system makes it possible to follow the privileged relations in a group and to make simulation of the self-organization inside this group. Our objectives are to provide each agent with some capacities of interpretation of the exchanges. In that case, we could be able to refine the deductions on the interactions between actors, by adjusting the functions of interpretations.

Full Article: 158MODEL

5.14 Cognition for Virtual Exploration

Contribution 1

Title: Influence Analysis of Similarity Cognition by Environmental Factor.

Authors: takami hamamoto

Key Words: similarity, cognitive psychology, cognitive science.

In styling design, similarity is an important index in differentiation with the product of the other company. However, in curve design using CAD for styling, similarity is not evaluated quantitatively. This study was designed to analyze the similarity cognitive structure considering environmental factors that influence the cognitive structure. First, the experiment that presentation time and size of samples were controlled was conducted. With the multidimensional scaling, complexity in momentary sight and volume in continuous sight were extracted for principal shape feature. Moreover, it was confirmed that complexity tends to be influenced by presentation time.

Full Article: 113HUCEID

Contribution 2

Title: Design and Implementation of a Knowledge-Based Software for Feasibility Checks of Spot Welds within a CAD System.

Authors: Frank Mantwill, Andreas Lucko, Henrich Brockmeyer

Key Words: knowledge-based engineering, design process, manufacturing planning, CATIA V5, spot-welding.

Requirements from manufacturing should be taken into account as early as possible in the development process. This can be supported by knowledge-based software that ideally is integrated into the CAD system used by the development department. As an example for such software an application was created that enhances the widely used CAD system CATIA V5 with functionalities for automatic feasibility checks of spot

welds. The results of the simulation are displayed in a graphical user interface. Using the software helps improving the development process by making iterations less complex or eliminating them altogether.

Full Article: 22InCo

Contribution 2

Title: Reducing the Information Gap Between Synchronous and Asynchronous Co-operative Design Phases.

Authors: Onur Hisarciklilar, Jean-François Boujut

Key Words: semantic annotations, asynchronous communication, design collaboration.

This paper discusses the usage of semantic annotations to support communication in design teams. We make distinction between two concurrent design situations. In synchronous situations, annotations may support the oral discussion and solution evaluation. In asynchronous ones, they may support constraint elicitation, help to capitalise and record non-geometric information, and support decision-making process. In our field study, we focus on design review process and design minutes recording and structuring. After making a short definition of semantic annotations, we describe a design scenario of an effective usage of annotations. We conclude by proposing a tool for a better communication through annotations.

Full Article: 125InCo

5.15 Interactive Creativity Methods

Contribution 1

Title: A Substance-Field Ontology to Support TRIZ Thinking Approach.

Authors: Alexis Bultey, François , François Rousselot

Key Words: TRIZ, substance-field modelling, ontology, description logics knowledge representation system (DL-KRS).

An ideal TRIZ reasoning environment should support TRIZ fundamental concepts and simulate its process of thinking. An advanced TRIZ methodology is modeled in this perspective : the substance-field analysis. It has been found that none of existing TRIZ software support all the requirements of the substance-field analysis. Meanwhile, according to the researches of the LGECO team, it has been shown that TRIZ knowledge could be modelled and managed in an oriented object ontology for a computer aided problem formulation. A new ontological model based on this previous work improved by the concepts of the substance-field analysis and by the Description Logics reasoning is proposed in order to simulate the TRIZ problem solving stage: from the generation of a general solution to the interpretation phase linking the abstract field of general solution to the real field of physic and physical effects.

Full Article: 17MODEL

Contribution 2

Title: On the Creativity in Case Based Reasoning for Application in Product Design.

Authors: Zhiqiang Zhu, Hung-Yao Hsu, Sev Nagalingam, Grier Lin

Key Words: case based reasoning, creativity, product design.

Case Based Reasoning (CBR) methodology is to solve new problems by reusing previous designs in similar context and adapting them to generate new solutions. In this situation, solutions obtained through the CBR system may become mundane if the creativity aspect of the CBR system hasnt been addressed properly. Here, creativity is considered as expressing new and useful designs by using CBR as a building block. In this paper, the importance of acquiring creativity feature for CBR methodology to facilitate innovative product design is highlighted. Potential creativity and related methodologies that can be embodied in CBR systems are also discussed.

Full Article: 117InCo

5.16 Human Centred Design Method

Contribution 1

Title: Virtual Organization Space.

Authors: Mark Mobach

Key Words: agent-based modeling, organizational change, physical architecture, systems science, virtual reality, visualization.

Although virtual reality has become increasingly important for architectural science, applications combined with organizational science and agent technology remain scarce, but very promising. The current richness of virtual reality allows stakeholders of organizations to glance at various possible future states of the organization, in terms of a virtual building and agent behavior within it, and decide where interventions in their plans for the future may be appropriate. Therefore, virtual organization space can be regarded as a vehicle for improving the real world of users in all sorts of organizations which are confronted with construction and reconstruction of their premises.

Full Article: 37HUCEID

Contribution 2

Title: Digital Style Design Systems From Concept to Sophisticated Shape .

Authors: Hideki Aoyama, Andreas Nordgren, Hiroki Yamaguchi, Yusuke Komatsu, Mai Ohno

Key Words: interactive style design, digital style design, concept, Kansei word, high light line, characteristic line.

This paper reports four digital style design systems to construct a sophisticated shape from a concept or a rough sketch. First one is a system to automatically construct a 3D digital model form key words expressing the product concept. Second one is a system to automatically construct a 3D digital model from a rough sketch drawn by a designer. Third one is a system to automatically sophisticate a 3D digital model according

to the high light lines designated by a designer. Fourth one is a system to sophisticate a 3D digital model by forming characteristic lines designated by a designer.

Full Article: 187InCo

5.17 Virtual Prototyping in Interactive Design

Contribution 1

Title: Interactive Augmented Prototyping as a Design Means: a case-based approach.

Authors: Jouke Verlinden, Imre Horvath

Key Words: augmented reality, empirical research, case study, tool validation, design support.

Although much has been hypothesized on radical nature and the usefulness of either virtual or augmented prototyping support, little is known on the actual impact and adoption of such concepts. This paper reports on a forerunning empirical study on bottlenecks in conceptualization and how these can be solved by employing Virtual or Augmented Reality techniques. We chose the method of case studies to produce a deep and accurate account of all prototyping and modeling activities. A range of industrial design companies are currently followed while performing design projects, the approach and early results will be presented in this paper.

Full Article: 129InCo

Contribution 2

Title: Simulation of the Shoe Upper Materials Deformation in Gait Using FEM.

Authors: M. Jose Ruperez, M. José Rupérez, Mariano Alcaniz

Key Words: shoe model, simulation, uppers, force distribution, finite elements.

We provide a model which simulates the shoe upper materials defor-

mation in gait as well as quantifying the forces distribution on the foot surface. It was achieved a computational model which allows to simulate the uppers deformation in a complete step and to provide the areas of increased pressure on the foot surface for different feet of the same size, for different sizes of the same design and for materials with different elastic parameters. The aim of this model is to allow the functional and aesthetic valuation in the CAD footwear design. The developed application will be the first known tool with which the footwear manufacturer will be able to virtually value the functional features of a design, without making prototypes nor using footwearers. In this way, this application will minimize the time and the costs that a new shoe collection generates.

Full Article: 8HUCEID

Contribution 3

Title: Integration of Virtual Reality Technologies in Industrial Design Processes: a Structured Approach.

Authors: Maura Mengoni, Maura Germani

Key Words: virtual reality, industrial design process integration, benchmarking criteria, protocol analysis.

Virtual Reality technologies provide novel modes of human computer interaction that can be used to support industrial design processes. The integration can be successful if supported by a structured approach. They should be customized on the specific tasks of the company in order to improve collaboration in extended enterprises and time savings. The work aim is the definition of a structured methodology to identify the design phases to be managed by VRs, to assess them by drawing benchmarking criteria, to define metrics to estimate and monitor their performance. This research has been developed in collaboration with a big Italian company.

Full Article: 80InCo

5.18 Interactive Simulation for Design Improvement

Contribution 1

Title: Modelling, Design and Construction of a Solar Space Conditioning System.

Authors: Martin E. Baltazar-Lopez, Rafael Castillo-Rincon, J. Jasson Flores-Prieto, David Perez-Salmeron, Juan Carlos Bahena-Bustos

Key Words: design methodology, solar space conditioning abstraction.

A design methodology based on abstraction, critical parameter identification, and questioning was used for the conceptual design of a virtual prototype of a solar space conditioning system. It was implemented in order to have a fine control on space conditioning variables such as temperature and relative humidity. Two case studies are presented for space conditioning for drying, where the virtual prototypes obtained were tested and the information obtained was successfully implemented in the construction of the real prototypes.

Full Article: 171InCo

Contribution 2

Title: Wear Prediction: A Methodical Approach.

Authors: Muhammad Azeem Ashraf, Bijan Sobhi Najafabadi, Hung-yao Hsu

Key Words: tribo-system, running-in wear, steady-state wear, FE wear model.

Due to the complex and dynamic nature of wear phenomena, there is no general methodology that can be applied to all wear problems. This paper presents a methodical approach for predicting sliding wear. The major stages of the approach are: tribo-system examination, experimentation, experimental wear coefficient determination and model formation. Analytical time domain and finite element (FE) models are

employed for wear calculations. Analytical models can predict the wear volume only, whereas FE model can give worn geometry as well. Comparing predicted and experimental results demonstrates the validity of the approach.

Full Article: 60InCo

Contribution 3

Title: PsychoDriving: a System for Virtual Automotive Route Creation in Driving Phobia Treatment.

Authors: Jose Gustavo Paiva, Alexandre Cardoso, Edgard Lamounier, Ederaldo José Lopes

Key Words: virtual reality, driving phobia, psychologist, interface, virtual automotive routes.

We present a virtual route creation system to be used on driving phobia treatment. In this system, the psychologist can organize a set of traffic elements on a drawing area representing the route, and configures its external aspects. This system is capable of transform this draw in a 3D route, to be covered by the patient during the treatment. An analysis with psychologists showed that the system provides greater flexibility in the creation of routes and a simple and intuitive route creation interface, without necessity of knowledge on techniques of Computer Graphics, Virtual Reality and Computational programming.

Full Article: 81InCo

5.19 Simulation of Complex Physical Behaviour

Contribution 1

Title: Simulation of Polymer Flow Behavior in Molding Carbon Reinforced Composites.

Authors: A. Sherif El-Gizawy, Ahmed Khattab

Key Words: flow behavior, molding, composites, simulation, geometric reconstruction, GIF.

A simulation model for flow behavior in molding operations for car-

bon reinforced composites is developed. It uses a control volume methodology to characterize flow behavior during resin infusion in molding woven fiber composite structures. In order to enhance the visual capability of the developed virtual model, a geometric reconstruction scheme is used to present the resin flow front at fixed time increment. The Graphic Interchange Format (GIF) is used to combine images into a single file to create animation. This model provides capabilities for prediction of flow pattern, pressure distribution inside the mold, and evolved defects.

Full Article: 239InCo

Contribution 2

Title: Development of Virtual Model for Process Design of Friction Stir Welding Operations.

Authors: A. Sherif El-Gizawy, Surendra Chitti Babu

Key Words: friction stir welding, finite element, deformation behavior, temperature distribution, GIF.

A virtual solid mechanics model for process design of friction stir welding operations is developed. It uses a non linear finite element techniques to characterize thermal and deformation behavior during friction stir welding high strength aluminum alloys. In order to enhance the visual capability of the developed virtual model, the Graphic Interchange Format (GIF) is used to combine images into a single file to create animation. This model provides capabilities for prediction of deformation pattern, temperature, plastic strain, and stresses distribution along the welded structure. Several case studies were conducted to evaluate the effectiveness of the developed model.

Full Article: 242InCo

Contribution 3

Title: CCAT: Collision Checking Analysis Tool - Discovering Dynamic Collisions in a Modeling and Simulation Environment.

Authors: Luke Ludwig, John Haurykiewicz

Key Words: collision checking, interference checking.

To discover dynamic collisions in military vehicles with automated ammunition handling capabilities, we developed CCAT, an automated toolset that detects dynamic collisions in the virtual world. CCAT reduces development costs while increasing the accuracy and speed that collisions are detected within a model in motion. CCAT can be plugged into 3D-immersive CAD modeling and visualization tools that detect collisions. We present examples of collisions CCAT detected in real time on automated ammunition handling systems using PTC's dvMockup. Collisions and motion commands are recorded, so that we can playback any scenario and interactively examine and classify collisions in the 3D world.

Full Article: 68InCo

5.20 Large Overview on Interactive Methods and Tools

Contribution 1

Title: Enhancing Real-Time Engineering Based Simulations with the General Purpose of Graphics Hardware.

Authors: Alecio Binotto, Carlos Eduardo Pereira

Key Words: real-time simulations, graphics hardware.

Real-time scientific simulations usually require high performance platforms to deal with the massive numerical calculations. Graphics and physics hardware and the CPUs multitask evolution are the main elements that can provide the real-time. This work presents the use of graphics hardware as co-processor for engineering based simulations. These applications can successfully be benefited from the general purpose using graphics hardware to achieve the simulation and visualization in real-time. Mathematical case studies are shown to map the hardware features with the application needs, like in basic linear algebra subprograms. Future directions load balancing the application instructions in available hardware are introduced.

Full Article: 170InCo

Contribution 2

Title: Qubit Neural Network According to Quantum Circuit for Logical Operation.

Authors: Michiharu Maeda

Key Words: neural network, quantum computing, logical operation.

We describe a learning model of qubit neural network according to quantum circuit for logical operation and describes the influence to learning by changing the number of neurons. Our approach has a 3-qubit neuron including a work qubit in the input layer, which employs gradient descent for learning. For improving the learning efficiency, furthermore, a momentum term is added to gradient descent. For the number of neurons in the output layer, the convergence rate and the average iteration for learning are examined. Especially it is exhibited that our model can learn for one neuron in the output layer.

Full Article: 211InCo

Contribution 3

Title: Virtual Reality in Design.

Authors: Jiménez Homero

Key Words: virtual reality, design, puncture carrier pneumatic, Collective Transport System METRO- of México City, service.

In this work the virtual reality in design allowed the practical and innovator solution to problem of service affected because puncture carrier pneumatic in some line of the net of Collective Transport System METRO- of México City. One top-quality device for quickly re-establish the normal service was designed. The electronic files of parts, assemblies and views for three-dimensional and dynamics to feign the behaviour of the device was carried.

Full Article: 108InCo

6

Mechatronics and Interaction

6.1 Haptic Interfaces

Contribution 1

Title: Haptic Loop Frequency and Computational Demanding Applications.

Authors: Monica Bordegoni, Franco De Angelis, Luca Formentini

Key Words: haptic devices, haptic loop, haptic interaction.

Proper functioning of haptic devices relies on an application supplying data at a sufficient frequency. Hence, the issue of establishing how much is the required frequency is often debated among the haptic community. This paper has a twofold objective: to defeat a few commonplaces regarding this matter by clarifying the issue via an analogy to the way graphic systems work, and to propose a method for integrating haptic devices with computational demanding applications.

Full Article: 180MECAID

Contribution 2

Title: A New 11 DOF haptic Device Based on Wires for Large Scale Immersive Environment.

Authors: Daniel Tiberiu Butnaru, Florin Gîrbacia, Csaba Antonya, Doru Talaba

Key Words: haptic devices, virtual reality, virtual interaction, force feedback.

We present a new 11 DOF haptic device based on wires. The design of the haptic device developed here is presented and its advantages are highlighted. The implementation of the haptic device within a multi-wall large scale immersive virtual environment is presented. An application scenario within virtual reality immersive theatre for manipulation of a virtual mechanism is presented. Finally, the results obtained with the prototype are discussed.

Full Article: 157MECAID

Contribution 2

Title: Design of an Adaptable Haptic Device for an Arthroscopy Training Environment.

Authors: Jose San Martin, David Miraut, carolina gomez, Sofia Bayona

Key Words: haptic design, virtual reality, arthroscopy simulator, ergonomics.

Learning process of Minimal Invasive Surgery (MIS) will be strongly based on surgical simulators. However, general medical simulators do not take into account all the requirements, such as surgeons position or possible intervention angles. Our MIS adaptable new simulator incorporates two additional degrees of freedom: a displacement of every actuator set allows flexibility to adapt the inter-trocar distance and portal angle adjustment makes possible rotating these sets around the device symmetry axis. The design allows an ergonomic disposition of the surgical instruments according to the trainee features and permits software developers to overcome the constraints of general purpose simulators.

Full Article: 49MECAID

6.2 Multi-Sensor Applications: Design and Simulations

Contribution 1

Title: A Multi-Disciplinary Distributed Simulation Environment for Mechatronic System Design Enabling Hardware-in-the-Loop Simulation Based on HLA.

Authors: Satoshi Kanai, Taku Miyashita, Tatsumi Tada

Key Words: Multi-disciplinary simulation, mechatronic system, hardware-in-the-Loop simulation, 3D kinematic simulator, embedded system, Matlab, CATIA.

Multi-disciplinary distributed simulation including the mechanical, electronic and software disciplines is a key to improve design quality of mechatronic systems. In this paper, we propose an HLA (High-Level-Architecture)-based multi-disciplinary distributed simulation environment for designing mechatronic systems. In this system, off-the-shelf simulators such as CATIA, VRML and Matlab/Simulink can communicate each other through the RTI middleware. Moreover, even hardware prototypes can also participate in the part of the distributed simulation environment, which enables us hardware-in-the-loop simulation. An effectiveness of the environment were verified through case studies of an automotive power-window control and omni-directional wheel chair control systems design.

Full Article: 237InCo

Contribution 2

Title: Nanorobot for Treatment of Patients with Artery Occlusion.

Authors: Adriano Cavalcanti

Key Words: coronary stenosis, mobile nanorobot, multi-sensorial simulators, nanomanufacturing design, nanomechatronics, nanomedicine, nanotubes, nanowires, photonics, virtual reality.

We present the study of nanorobots control activation for stenosed coronary occlusion, with the practical use of chemical and thermal gradients for biomedical problems. The recent developments on nanotechnology new materials allied with electronics device miniaturization may enable nanorobots for the next few years. New possibilities for medicine are expected with the development of nanorobots. It may help to advance the treatment of a wide number of diseases: cardiovascular problems, neurosurgery, cancer, diabetes and new cell therapies. The implementation of new methodologies to help on manufacturing analyses and control system design for the development of nanoscale molecular machine is one of the most important fields for research. The use of 3D physically based simulation in conjunction with clinical data may provide ways to design practical approaches for control and transducers development.

Full Article: 9MECAID

Human Centered Techniques

7.1 Improving Design Quality from Human Cognition

Contribution 1

Title: HCD Method Using VR and Related Techniques for Designing Complex System.

Authors: Sébastien Delarue

Key Words: human centered design, complex system, assistive robotics, technical aid, virtual reality, augmented reality, augmented virtuality.

Human Centered Design (HCD) considers the users and their needs throughout the process of design of a software application. In the case of the design of a mixed product (including software, and mechanical and electronic equipments), difficulty resides in the production of an object that can be evaluated at each iteration of the design cycle. The use of Virtual Reality and related techniques as Augmented Virtuality and Augmented Reality bring an affordable solution to allow iterative evaluation as defined in HCD. We propose an adaptation of HCD which simplifies the transition from the concept to the end product. We apply this approach to innovating assistive robotics.

Contribution 2

Title: Robust design of Car Packaging in Virtual Environment.

Authors: Antonio Lanzotti

Key Words: virtual ergonomics, robust design, human variability modelling.

We present a statistical methodology for designing a driving seat of a new city car. The dimensioning of seat settings and the positioning of the steering wheel were chosen on the basis of experimental results obtained through virtual manikins (Jack) and ergonomics evaluations. Significant improvements of seat comfort and available space for driver population were obtained by using robust design methodologies. Once fixed a target population and adequate comfort indexes, the proposed methodology allows defining a car packaging which is, in average, more comfortable than that obtainable by applying the posture prediction algorithms proposed by the UMTRI (UMI-USA).

Full Article: 138HUCEID

Contribution 3

Title: Use of a Human Centred Approach and Virtual Environments in Mobile Working Machine User Interface Design.

Authors: Teemu Evila, Kaj Helin, Tuomo Kujala, Susanna Aromaa, Juhani Viitaniemi, Harshada Patel, Roope Raisamo

Key Words: user interface, virtual reality, human centred design, human-machine interaction, design method, industrial, mobile working machine.

New design methods are needed to improve the usability, safety and ergonomics of mobile working machines. Our objective has been to develop a novel information platform for human centred machine design. The approach follows a 4-step design method combined with Virtual Reality applications which provide the user with a new instrument for data

collection. The advantage of using Virtual Reality applications is that they can simulate easy-to-use and modifiable models for different stages of the design process and can also be used as an instrument for design evaluation. The method has been tested in an industrial case in design workshops.

Full Article: 30HUCEID

7.2 Human Integration in Virtuality

Contribution 1

Title: Full Body Motion Capture in CAD Environment.

Authors: Christian Pere, Nicolas Meylaender, Frédéric Mérienne

Key Words: virtual reality, digital mock-up, user-centred design, ergonomics, maintainability, virtual metaphors.

Within CAD software, the interactivity between the user and the DMU is still mainly performed by standard devices. Some new systems like haptic devices allow giving force feedback to the user but it is only dedicated to the arm. On the other hand, motion capture systems are available but not used in engineering. We propose a full body motion capture in CatiaV5 using virtual metaphors in order to animate in real time the virtual manikin. The benefit of this application will permit to check the accessibility of an area during the design phase and also to validate the maintenance operations.

Full Article: 204HUCEID

Contribution 2

Title: A Simple Video Tracking Tool for Interactive Product Designers and Artists Using Flash.

Authors: jinyung Park, Jidong Yim, Tek-Jin Nam

Key Words: video tracking, macromedia flash, tangible interaction design, media art development, authoring environment.

We present a designer-friendly video tracking toolkit that can be used in Macromedia Flash, which is the most favourite multimedia authoring tool for designers. It helps designers and artists simply display video images, track specific colors, and detect motion changes with standard digital video capturing devices like USB webcams.

Full Article: 260HUCEID

Contribution 3

Title: Postural Empathy Tests for the Measure of Immersion in Virtual Environments.

Authors: Marc Chevaldonné, Arnaud Saimpont, Frédéric Mérienne, Thierry Pozzo

Key Words: postural empathy, cognitive tests, virtual reality, sense of immersion, instrumentation and measurement.

As a first step in the study of what cause a good sense of immersion, we have led tests on postural empathy in virtual environment, in partnership between computer and cognitive scientists. While the participants are observing human movements, some parameters are measured on them in order to evaluate their reaction. In this paper, we present the test and its results which show the influence of a human body in postural instability on the participant stability. It helps us to determine what can provide better immersion. The paper ends with future works about studying the influence of more sensory effects.

Full Article: 98InCo

7.3 Virtual Assessment and Testing

Contribution 1

Title: A Virtual Container Terminal Simulator for the Design of Terminal Operation.

Authors: Henry Lau, Leith Chan

Key Words: distributed virtual environment, terminal simulator, CAVE.

Port container terminal operation requires a skill workforce who participates in performing a number major operation including planning, scheduling of resources, operating of crane systems, etc. in a highly coordinated manner. To facilitate the optimal design of terminal operation for both management and operators a real-time distributed virtual environment that simulates container terminal operation is developed. The system includes an imseCAVE, which is a low cost fully immersive virtual reality system together with network computers that are linked to the imseCAVE for remote monitoring of terminal operations and providing user interfaces that simulate the planning systems for terminal operations.

Full Article: 175HUCEID

Contribution 2

Title: Digital Usability Assessment for Information Appliances using User-interface operable 3D Digital Mockups.

Authors: Satoshi Kanai, So Horiuchi, Yukiaki Kikuta, Yoshiyuki Shiroma

Key Words: usability assessment, web3D, user interface, information appliances, interactive simulation, human-in-the-loop, 3D CAD, digital mockup.

Manufactures of information appliances recently have to pay attention to the human centered design, and usability assessment is becoming of great importance. But the tests for usability assessment needs time and cost due to prototyping physical mock-ups and analyzing the test results. To solve the problem, this paper proposes a 3D virtual environment where we can interactively operate user interface on the Web 3D digital mockup. The environment also offers functions of setting task of usability test, execution of test, logging of operations and automatically analyzing the test result to clarify issues in the UI design specifications.

Full Article: 235HUCEID

Contribution 3

Title: Ergonomic Design Structured through Activity Theory.

Authors: Denis Coelho

Key Words: cognitive engineering, pleasure, comfort, methods, approach, conceptualizations.

Compatibility between theoretical structures of comfort, pleasure and cognitive engineering (themes of ergonomic design) is demonstrable. Pleasure pursues adding gains, comfort and cognitive engineering struggle with relieving pain and minimising loss. The psychological human aspect is common to all three. Commonalties were found between comfort and pleasure and between cognitive engineering and pleasure. A common underlying structure of activity-goal-user-artefact was demonstrated for empirical studies. This showed that deriving measurable variables and identifying operatives could be done from the operation level of activity theory. Activity theory enabled structuring and organising a research-design process underlying the conduction of specific design studies.

Full Article: 53HUCEID

7.4 Users Through Virtual-Real World Interaction

Contribution 1

Title: Personality and Emotions in Agent Simulation: Fuzzy Rules and an Implementation

Authors: Latifeh PourMohammadBagher

Key Words: personality, personality and emotion update, fuzzy agent.

This is a sequel to articles where the authors gleaned the personality knowledge based on the five personality traits and six facets for each trait for fuzzy agents with personality, promoted concepts of dy-

dynamic personality for fuzzy agents, emotions have been shown to have a significant influence on the decision-making process. a fuzzy emotional model has been implemented with Java, inserted to the fuzzy agent with personality . This model, uses the personality factors and provides the intensity of four emotions of stress, sadness, anger and joviality, after agent encounters an accident. this Results used in agent decision making process.

Full Article: 122HUCEID

Contribution 2

Title: Designed to Be Used, not Used as Designed.

Authors: Marissa Diaz, Isaac Rudomin, Sandra Diaz

Key Words: HCI, sensorial design, perceptual design, virtual reality, user centered design.

VR applications are usually designed with a practical approach and so are constrained by usability rules that ensure the correct usage of the application. However, they tend to neglect the user as part of the system. An interface is a connection between two separate worlds. By definition the collection of capabilities of the interface are the only means of communication between those worlds. In order to conceptualize an interface that uses the capabilities of the user as part of the application, this paper reviews some aspects of human perception that have been overlooked in other user centered designing approaches.

Full Article: 35HUCEID

Contribution 3

Title: Graphical Password with Haptics.

Authors: Mauricio Orozco Trujillo, Abdulmotaieb El-Saddik, Behzad Malek

Key Words: haptics, biometrics, virtual environment, graphical password, authentication.

The process of identifying an individual is referred as authentication which plays a critical role on security systems. Graphical password schemes are believed to be more secure and resilient to dictionary at-

tacks than textual passwords. We designed graphical password based on the addition of haptics. Using haptics, we integrated the pressure as key feature to increase the resiliency. The initial testing showed that the users do not follow the conventional passwords guidelines. We tackled it by proposing two solutions to ensure a hack-proof scenario, we adapted the pressure recording of the system based on two-class classification of neural networks.

Full Article: 106HUCEID

Modelling Techniques

8.1 Simulation of Continuous Structure

Contribution 1

Title: Deformable Object Simulation with Reaction-Diffusion.

Authors: Yongmin Zhong, Bijan Shirinzadeh

Key Words: deformation, soft objects, reaction-diffusion, and analogy systems.

Currently, most of the existing deformation methods are fully built on an elastic model. However, the behaviours of soft objects such as human tissues are extremely nonlinear. The common deformation methods, such as mass-spring methods, finite element methods and boundary element methods, are mainly based on linear elastic models because of the simplicity of linear elastic models and also because linear elastic models permit to reduce runtime computation. However, linear elastic models cannot accommodate large-range geometric deformations. Although the few methods which can handle the large-range deformations, the use of quadric strains generally causes a very expensive computation for real-time simulation. In addition, extra work often needs to be performed for anisotropic deformations. This paper presents a new methodology for deformable object simulation by drawing an analogy between reaction-diffusion and elastic deformation. The potential energy stored in an elastic body as a result of a deformation caused by an external force is propagated among mass points by the principle of reaction-diffusion.

An improved reaction-diffusion model is developed for propagating the energy generated by the external force among mass points. A method is presented to derive the internal forces from the potential energy distribution. This methodology can not only deal with large-range deformation, but it can also accommodate isotropic, anisotropic and inhomogeneous materials easily through simply changing diffusion constants. Examples are presented to demonstrate the efficiency of the proposed methodology.

Full Article: 6InCo

Contribution 2

Title: Surface-surface contact wear prediction using FEA.

Authors: Muhammad Azeem Ashraf, Bijan Sobhi Najafabadi, Hung-yao Hsu

Key Words: virtual life testing, FEA, wear coefficients, transient wear, steady-state wear.

This paper presents, virtual life testing of a dry surface-surface sliding contact for wear. Finite element analysis (FEA) is used as a tool to calculate nodal pressures at the contact area for small sliding steps. These pressures are then inputted to a customized wear calculating routine. The routine uses averaged steady-state and transient wear coefficients, which are obtained from experiments on the prototypes. The FE contact geometry is modified after each sliding step to account for the contact height decay thus determining wear volume loss over usage time.

Full Article: 57InCo

8.2 Model Efficiency

Contribution 1

Title: Distance-Based Attribute Value Recombining Algorithm.

Authors: Fuzhong Nian

Key Words: distance, VPRS, reduction.

In classical rough set, the attribute must be kept, as long as one of its value need to keep. There is some intrinsic relation between some values which belongs to different attributes. Those values can be combined to a new on. This paper, first unfold all of attributes according to their values, then based on distance in VPRS, recombining them which belongs to different attributes, and make all of new attributes become Boolean-valued attributes. Therefore, the process of reduction be simplified, another, some redundant attribute values ,even some redundant attributes that be kept in classical rough set, also be eliminated.

Full Article: 130MODEL

Contribution 2

Title: Merging Models with Different Perspectives on Product Configuration Knowledge.

Authors: Anders Haug, Lars Hvam

Key Words: product configuration, knowledge representation, knowledge engineering.

Product configuration systems can be defined as product-oriented expert systems that allow users to specify products by selecting components and properties under restriction of valid combinations, i.e. an interactive design process. The application of configuration technology has for several years produced benefits, such as reduction of lead times, resources and errors. A major challenge in product configuration projects is to document configurations systems in a way that satisfies the needs of different users. This paper proposes a concept that allows models with different perspectives on product configuration knowledge to be maintained without having to ensure coherency between models.

Full Article: 196MODEL

Contribution 3

Title: A Model Reduction Approach for Real Time Part Deformation with Non Linear Mechanical Behavior.

Authors: Jean-Luc Dulong, Frederic Druesne, Pierre Villon

Key Words: real-time, non-linear mechanical behavior, model reduction, Karhunen-Loeve expansion, hyperreduction, enrichment.

Interaction between a designer and a virtual prototype is a promising way to optimise the parts design in mechanical industries. This can induce deformation of flexible parts. The analysis in real-time of non-linear mechanical model by finite element method (FEM) is impossible. Our approach is based on two phases: 1-some load cases, characteristic of possible manipulations, are pre-calculated by FEM, 2-results of this campaign are interpolated during the real-time immersion. This paper compares 4 approaches to calculate the campaign as fast as possible: the classical FEM, an enrichment method, an enrichment method with model reduction technique and the hyperreduction method.

Full Article: 52MODEL

8.3 Model Quality and Realism

Contribution 1

Title: Properties of External Field in Statistical Fluctuation for Image Restoration.

Authors: Michiharu MAEDA

Key Words: image restoration, statistical physics, external field.

We present properties of external field in statistical fluctuation for image restoration, in which the external field is extended in statistical physics. For inferring the original image, neighboring pixels as well as a notice pixel are prepared as the external field and the degraded image is restored according to the statistical fluctuation of stochastic model. The properties of external field are described and the validity of them is confirmed through numerical experiments.

Full Article: 212InCo

Contribution 2

Title: FE Meshes Preparation for Interactive Analysis in Virtual Reality.

Authors: Georges Dumont, Jean-Marie Souffez

Key Words: virtual reality, FE meshes, multiresolution data, Interactive analysis.

Finte Element computations become too large to be straightforwardly handled by graphics hardware, because the mesh and the results are huge and do not fit in-core. We propose a multi-resolution representation to provide an interactive handling and analysis of these meshes in Virtual Reality. Our method is an extension of the existing methods and relies on a model-based segmentation of the initial mesh. The sub-meshes are under-sampled to ensure interactive manipulation of the whole model which structure is given by a dual graph. At run-time, the user can focus her attention on specific sub-meshes that she can access at initial resolution.

Full Article: 34InCo

Contribution 3

Title: Real-Time Visualization: Bio/Chemical Plume Propagation and Evacuation Modeling Approach.

Authors: Paul Huang, Jeffrey Wolff, Chris Holmes

Key Words: virtual tool, computer simulation, real-time visualization.

With the increased terrorism alertness today, the question of "how to handle the public safety problem effectively and efficiently" needs to be resolved urgently. Computer simulation can "duplicate", study and analyze what might happen in real-life when under the terrorist attack in a harmless environment. We report the use of a new virtual tool to accurately depict terrorist scenarios and evacuation strategies by a public safety related agency. Using this, we can try out different strategies and schemes to manage those extreme scenarios so that the outcome from the wrong doings by terrorists can be minimized or foiled completely.

Full Article: 69MODEL

Product Life Cycle Aspects

9.1 Collaborative Design

Contribution 1

Title: Is Parametric CAD Sufficient? Industrial Evidence of the Use of Coupled PLM/KM Solutions in Collaborative Design.

Authors: Bertrand Rose, Emmanuel Caillaud

Key Words: collaborative design, parametric CAD, collaborative design solution deployment.

Parametric CAD is today an established way of leading routine design in a lot of companies, including SME. Nevertheless, a gap is still existing before switching to this design method. A lot of questions arise regarding the way of selecting the right parameters, the right values to be set or their scales of variation. This article presents the empowerment that a CAD solution can gain when coupled with a PLM tool (namely ACSP) and a KM solution. Practical real life examples of the deployment of such a solution will be given.

Full Article: 241PLEDM

Contribution 2

Title: Collaborative and Distributed Design for Product Configuration with Intelligent Agents.

Authors: Egon Ostrosi, Alain-Jérôme Fougères, Eugeniu Deciu, Michel Ferney

Key Words: product configuration, intelligent agent, collaborative design, distributed design.

Design for product variety is a relatively new research field, but it has received considerable attention in engineering. Design for product variety is an inherent distributed and complex process. Aiming to the computerization of product family design, this paper tackles the development of a Multiagent System assisted Collaborative and Distributed Design for Product Configuration. Three problems interrelated are considered: 1. How to enable agents to decompose their goals; 2. How to enable agents to recognize, reconcile and find the consensus, insight the disparate and conflict views; 3. How to realize intelligent configuration through learning in Collaborative and Distributed Design.

Full Article: 160PLEDM

Contribution 3

Title: IT Applications Enabling Product Data Exchange in Collaborative Product Development.

Authors: Benoit Eynard

Key Words: PLM, DMU, collaborative engineering, exchange, XML.

Regarding the reduction needs of turbomachine development cycle, the SNECMA company works in partnership with other engine manufacturers. In order to improve this collaborative product development, Snecma uses a digital mock-up that manage, store and merge own and partners 3D data. This leads to intensive product data exchange and sharing. We aim to describe the IT architecture and mechanisms implemented by SNECMA that ensure data exchange with partners. Those architecture and mechanisms are based on a PDM system and XML data processing. Their implementation consists in encapsulate several generic functionalities and features that can be re-used during other engine project.

Full Article: 54PLEDM

Contribution 4

Title: Collaborative Practices Analysis in Design Teams.

Authors: Christophe Merlo, Guillaume Pol, Graham Jared, Jérémy Legardeur

Key Words: mechanical engineering, design, co-ordination, co-operation, decision, human factors, process identification, project management, software tools.

The subject of our argumentation is the collaborative practices used in the product development process in SMEs. The background and industrial case study and the theoretical basis are described. A new tool named CoCa is proposed to analyse collaborative practices in situ in order to track all the collaborative events and the project context. Finally, from first experimentation results, some indication is given of its potential use in gaining understanding of complex collaborative processes.

Full Article: 120PLEDM

9.2 Product Lifecycle Management: Industrial and Educational Issues

Contribution 1

Title: Between Heritage and Industrial Engineering, a New Life for Old Products: Virtuality.

Authors: Florent Laroche, Alain Bernard, Michel Cotte

Key Words: industrial engineering, virtual reality, product lifecycle management, heritage, technical history.

All along history, humans have always invented, created to improve their standard of living. Many machines have been built, sometimes simple and others very complex. In order to achieve the best results for customers, machines, industrial plants and humans are moved, displaced and replaced. It is the global humanity technical knowledge that disappears. Our approach proposes a new kind of finality: as saving

and maintaining physical object cost a lot for museums, and sometimes dismantling is impossible as the machine falls in ruin, we propose to preserve it as a numerical object. The aim of this research is to define the global process and technologies that have to be used for conserving this heritage: from the digitalization of the physical object to its valorization thanks to virtual reality technologies (for museums, experts or didactic engineering). We will detail the interoperability chain that must be followed for creating the Digital Heritage Reference Model (a new reference model for museum conservatives); moreover, thanks to many examples, we will explain the object lifecycle concept associated to the anthropological know-how at the intersection of Industrial Engineering Sciences and Social Sciences.

Full Article: 149PLEDM

Contribution 2

Title: Design to Maintenance Cost by the Control of the Product Environment

Authors: Guillaume Poncelin, Aline Cauvin, Mathieu Glade, Denis Dufrene, Patrick Lyonnet

Key Words: design to cost, reliability, maintenance, Cost control, life cycle.

Among helicopterists, the maintenance costs representing on average 30 percent of the total cost, the competition is played on a new level: the one of the reliability cost control. The issue in 2005 of the new standard in electronic component reliability forecasts, FIDES allows today to identify and quantify the sources of the equipment non reliability taking into account the machine and human environment as well as the product development process. It then becomes possible to integrate in the decision-making process at the first helicopter design phases the reliability parameter, being able from now to be integrated in the cost-benefit analyses.

Full Article: 79PLEDM

Contribution 3

Title: Sustainability Analysis of the Product Development Life Cycle Using a Metric Based on Exergy.

Authors: Harri Nordlund, Markku Kuuva

Key Words: exergy, environmental metrics, general design theory, dimensional analysis theory.

Environmental accountancy and environmental impacts analysis are characterized by fragmented approaches encompassing a number of different perspectives and analytical techniques. Although Life Cycle Assessment method (LCA) is the most commonly used tool by which environmentally conscious design is carried out, LCA techniques have been criticized as unreliable scientific tools. Its identified limitations include a lack of adequate inventory data, disparate underlying assumptions, and environmental assessment made in terms that are not directly comparable. Those limitations make LCA technique ineffective during the early design stage. This paper addresses this shortcoming by outlining antecedent researches in thermodynamic field. It is argued herein that the concept of exergy may be a promising basis for the development of a uniform, broad-based measure of environmental impact, and that such a measure can significantly advance a scientific approach to early environmentally design.

Full Article: 29PLEDM

Contribution 4

Title: Industrial and Designed-for-Learning Products: Analogies and Differences.

Authors: Stephane Brunel, Marc Zolghadri, Philippe Girard

Key Words: education, learning situation, knowledge lifecycle, designed-for-learning product.

A product is more than an item just used by customers; it is also a linchpin of knowledge lifecycle. Students and their teachers use products to learn or teach concepts and knowledge of various scientific and

management fields. Products are at the heart of knowledge creation and (re)usage within the firms too. The purpose of this paper is to study, from the knowledge lifecycle and learning points of view, analogies and differences between industrial and designed-for-learning products usable in learning situations with trainees.

Full Article: 100PLEDM

9.3 PLM Tools and Engineering Knowledge

Contribution 1

Title: Knowledge Capture and Representation for KBE Application Specification.

Authors: Samar Ammar-khodja, Nicolas Perry

Key Words: knowledge integration, knowledge capitalization, MOKA, knowledge project management.

During design phase, engineering problem solving typically involves large groups of people from different engineering disciplines. Engineers who must set up new product cycles deal with important information flow that makes difficult the decision-making. To face these difficulties, a knowledge engineering process is necessary to structure the information and its rush. This paper presents a knowledge capitalization process deployment based on the enrichment of MOKA methodology. Our goal is to help different actors to work collaboratively by proposing them one referential view of the domain, the context and the objectives assuming that it will help them for a better decision-making.

Full Article: 92PLEDM

Contribution 2

Title: A Multi-Agent Architecture to Synthesize Industrial Knowledge from a PLM.

Authors: Davy Monticolo, Samuel Gomes, Vincent Hilaire, Patrick Serraféro

Key Words: PLM, knowledge engineering, multi agents system, collaborative design.

We present a knowledge management experiment realized in a industrial company. Our research concerns the development of a knowledge engineering module integrated in a PLM system which is based on a multi-domain scheme (project, product, process and use) considering several viewpoints (structural, functional, dynamic, etc.). This PLM system enables us to capture technical data and information throughout design projects. The evolution of this PLM system concerns the realization of knowledge engineering features, using multi-agents technology. This approach allows to model the engineering collaborative activities and synthesize industrial knowledge during projects (vocabulary, rules, experiences, etc.) using technical information.

Full Article: 249PLEDM

Contribution 3

Title: Functional Design through a PLM System for Automatic Creation of Optimized 3D Models.

Authors: Jean-Bernard Bluntzer

Key Words: PLM, functional design, collaborative design, knowledge based engineering, parametric CAD.

The main purpose of this paper is to present our approach of generating automatically 3D CAD models, integrating all the known expert design rules, by changing only functional requirements, for a same product architecture. Through the requirements specifications integrated in our self-developed web-based PLM platform, and particularly the functional specifications and the product architecture parameters, we are able to generate and drive automatically, in a commercial CAD software, a parametric product architecture and its geometric skeleton. Designers can after, complete this 3D skeleton by using generic parts templates, stored in a shared database.

Full Article: 167PLEDM

Contribution 4

Title: Enterprise Integration Engineering and Action Research to implement PLM Tools.

Authors: Arturo Molina, Nicolas Peñaranda, Joaquin Aca

Key Words: PLM, enterprise integration engineering, action research, industrial application.

We describe how Enterprise Integration Engineering (EIE) and Action Research (AR) are used to support the implementation of PLM Tools. The concept of EIE is used to align the enterprise strategies to the use of PLM software in order to impact key performance indicators in the company. A EIE reference framework helps to define strategies, evaluate performance measures, design and re-design processes and establish the enabling tools and technologies. Action Research is used to guide the implementation of PLM tools at various stages of the product development process. An industrial application is described to demonstrate the benefits of both concepts.

Full Article: 33PLEDM

9.4 Product and Process Modelling Applications

Contribution 1

Title: Using Constraint Databases to Express 3D Geometrical Data.

Authors: William Derigent, Zoe Lacroix

Key Words: STEP, geometric data management, constraint databases.

A 1994 survey reported that designers spend about 60 percent of their time searching for the right information. As a result, efficient retrieval systems ease the designer work and help companies to save money. Actual design archival and retrieval system often consider the geometric data as black boxes on which no queries could be execute. In this paper, we develop a solution to solve this problem, by using constraint

databases, which could handle geometric data, and detail the algorithm used for the transformation of a standard STEP file into constraints.

Full Article: 164PLEDM

Contribution 2

Title: Mechanical Analysis to Create Product-Process Knowledge for DFM Design Approach. Application to Peen Forming process.

Authors: Florent Cochenec, Lionel Roucoules, Emmanuelle Rouhaud

Key Words: DFM, peen forming, process simulation, manufacturing knowledge.

A specific application of shot-peening process consists in using the residual stresses state induced to form large metallic panels. Therefore, that process strongly modifies the mechanical characteristics of the product. This paper aims to show how mechanical analysis for process simulation is used to understand product-process knowledge that are then managed to be used in a DFM approach at the earliest stage of design. Indeed, mechanical characteristics modifications induced by the process can be taken into account for process selection and be integrated in product modelling to be shared with structural analysis for example.

Full Article: 153PLEDM

Contribution 3

Title: Light-Weight Representations in Product Lifecycle Management.

Authors: Lian Ding, Wei Dong Li, Chris McMahon, Manjula Patel

Key Words: light-weight representation, product lifecycle management (PLM), mark-up language.

Product Lifecycle Management (PLM) aims to address the increasing requirements of companies to support multi-viewpoint representations and information transmission between users. Conventional product representations, e.g. CAD models, cannot meet such requirements due to

the platform-application-dependency, bulky files, technical restriction in the design-engineering applications, etc. To overcome these problems, a major recent research topic in PLM is to develop light-weight representation to support users at different stages of the product lifecycle in rapidly browsing and retrieving product information. This paper presents a survey of light-weight representations in PLM, including light-weight 3D visualisations, desiccated formats and mark-up languages.

Full Article: 156PLEDM

Contribution 4

Title: PIFA: a Modelling Approach to Combine Process and Knowledge Management: Case Study STMicroelectronics.

Authors: Hendrik BUSCH, Mickael Gardoni, Michel Tolenaere

Key Words: knowledge management, dynamic business process management, information retrieval, ontology, requirement engineering, human behaviour and resistance.

Workflow and Knowledge Management became more and more important in the recent years. Nevertheless, both of the domains have still problems to resolve: Knowledge Management has to handle the problems of human resistance to capitalize knowledge. Workflow Management has to deal with changes in the process model and in process instances. Especially, in a knowledge intensive dynamic process environment, it is primordial to understand and to satisfy these two requirements to guarantee the user acceptance. We developed therefore PIFA an analyze method to capture the requirements of both domains that helps to design a knowledge management system based on the analysis results to support workflow and information management. Our PIFA-approach is especially applicable on knowledge intensive dynamic processes. Therefore, the process level helps capturing requirements for the process flow, the information level helps capturing the information flow to improve the information sharing within a process and between processes and the functionality level guarantees that the involved actor have an immediate surplus value and will accept the changes caused to the defined process flow, the higher information capitalization and the new IT tool. There-

fore, PIFA combines the process actions with the knowledge capitalization and the surplus value.

Full Article: 11InCo

9.5 Large Overview on Product Development Tools

Contribution 1

Title: Formal Modelling of an Extended Enterprise to Intergrate Express Data Models.

Authors: Omar Lopez-Ortega, Moramay Ramírez-Hernandez, Abdelaziz Bouras

Key Words: extended enterprise, STEP, MANDATE and PLIB standards, EXPRESS models, formal framework, data sharing and exchanging.

An Extended Enterprise is formed when individual firms decide to join and share their core competences, and they are obliged to share data. Product Lifecycle Management benefits when individual firms cooperate in an Extended Enterprise. Up to day no formal model neither a technological development exist, to boost integration of firms. We propose a formal framework to integrate EXPRESS models to improve sharing and exchanging of data in an Extended Enterprise. We model and implement a neutral data repository, based on formal modelization of the Extended Enterprise. By using the proposed framework, firms cooperation is enhanced.

Full Article: 28PLEDM

Contribution 2

Title: PLM Implementation at the Academic Environment - Case Study.

Authors: Jacek Diakun

Key Words: PLM, collaborative engineering.

We describe the case study of PLM Implementation at the academic environment. The special organisational unit called The Virtual Design and Automation Centre VIDa was established at the Poznań University of Technology in order to propagate the virtual techniques in engineering design and transferring them into industry. Units working within the framework of VIDa (originally distributed amongst the various units of the Faculty) were previously involved in research which was related to particular stages of product lifecycle. However, these activities were highly dispersed. The scope of research encompassed the following areas: CAD, CAD/CAM, CAE, CAQ, CAPP, Rapid Prototyping and Rapid Tooling. In order to create common project platform it was decided to implement the PLM system. The implementation started at the beginning of 2003. Actually the implementation encompasses the following modules: document management, workflow management and Web access. The implementation was tested based on the real product models from Polish industry. These projects encompassed geometrical modelling, Virtual Reality modelling and recycling assessment of products. Based on these experiences the classes on PLM was started at Poznań University of Technology - the way of PLM teaching will be also included in the article .

Full Article: 257PLEDM

Contribution 3

Title: A Collaborative Environment for Product Development Using Standards.

Authors: Michel Martinez, Joel Favrel

Key Words: virtual enterprise, product data, data exchange, STEP, information infrastructure, enterprise integration.

Collaboration between multiple organizations and companies becomes an interesting way for design and manufacture of large, complex, industrial systems. Virtual Enterprise is a term often used to describe such collaborations. As a part of the collaboration, the members of a Virtual Enterprise share their expertise, software tools, and product data. The development of an Information Infrastructure is necessary for the Virtual Enterprise to manage efficiently its resources. The objective of this paper is to provide an Information Infrastructure to share product

models in a collaborative environment. Firstly, we describe the virtual organization approach and the problems of sharing data. Then we explain our Information Infrastructure based on STEP standard and the web technology. At last, we conclude and give the perspectives of our work.

Full Article: 261PLEDM

Focused Interactive Design Topics

Virtual Concept has labelled some Workshops and Schools in the whole world. Mexico, China, Australia, Brazil and USA have welcomed some Virtual Concept International Preliminary Workshops. From these dynamic organizations, some authors have decided to publish in-depth articles. This section is the report of these focused sights.

Contribution 1

Title: 3D User Interfaces: from Pragmatics to Formal Description.

Authors: Luciana P. Nedel, Carla M.D.S. Freitas

Key Words: 3D user interfaces, virtual reality, human-computer interaction.

A good matching between input device, interaction technique, the interactive task to be accomplished and system output can help the development of more comfortable, efficient and usable graphics applications. In this article, the process of developing and validating 3D interaction techniques is presented, addressing the selection of devices, the specification of interaction through the use of formalisms, implementation issues and validation. We start reviewing basic concepts of virtual reality, with special attention to 3D interaction techniques. Human-computer interaction concepts needed to develop virtual reality interactive techniques

are also reviewed. Then, the whole process of designing and evaluating a 3D interactive technique is thoroughly analyzed.

Full Article: B1

Contribution 2

Title: A Service Oriented Architecture for a Collaborative Engineering Environment in Petroleum Engineering.

Authors: Ismael H. F. Santos, Alberto B. Raposo, Marcelo Gattass

Key Words: collaborative problem solving environment, SOA, enterprise service bus, scientific workflows.

We discuss the scenario of Petroleum Engineering projects at Petrobras, a large Brazilian governmental oil and gas company. Based on this scenario, we propose an Service Oriented Architecture (SOA) for a Collaborative Problem Solving Environments (CPSE) that we call Collaborative Engineering Environment (CEE) responsible for controlling and executing specialized engineering projects in oil and gas industry. The environment is composed by the integration of three different technologies for distributed group work: Scientific Workflow Management System (ScWfMS), Multimedia Collaborative System (MMCS) and Collaborative Virtual Environments (CVE)

Full Article: B2

Contribution 3

Title: Increasing Reality in Virtual Reality Applications through Physical and Behavioural Simulation.

Authors: Fernando S. Osório, Soraia R. Musse, Renata Vieira,
Milton R. Heinen, Daniel C. de Paiva

Key Words: agent, modelling, Physics, knowledge.

We aim to present new trends, methods and applications related with the interaction of agents and objects present in a Virtual Reality (VR) Environment. In the first part of this tutorial we will discuss about the

introduction of interaction based on physics, including concepts related to perception, action, kinematics and dynamics (including rigid body dynamics, flexible/deformable objects and particles systems). After this discussion about physical interaction between VR agents and elements, then the second part of the tutorial will focus on the behavioural simulation of virtual autonomous agents. We will discuss about different simulation techniques of agent behaviour control, including autonomous agent control architectures (e.g. deliberative, reactive and hybrid architectures). The introduction of knowledge about the agents (e.g. emotional states, personality, personal profile) and about the environment (e.g. special places, functioning rules, place profile), will be also addressed. The knowledge introduced is then used to improve aspects related to the agents autonomy, the interaction within the VR environment, and the degree of reality in the VR simulations. We conclude this tutorial with some examples of practical applications, including recently developed VR applications implemented by our research group.

Full Article: B3

Contribution 4

Title: Computer Graphics Applications in Virtual Engineering.

Authors: Alécio Pedro Delazari Binotto, Gino Brunetti, Carlos Eduardo Pereira, Pedro Santos.

Key Words: virtual engineering, rapid product development, cross-domain engineering, real-time graphics systems.

The application of computer graphics and communication technology in the product development process leads to virtual engineering that, besides excellence in engineering, is becoming a key factor for successful multidisciplinary rapid product development. Virtual engineering tools address the support of cross-domain engineering to integrate the different engineering disciplines and provide a fruitful environment for innovation in products and processes. The advances in virtual engineering are motivated by the global economic competitiveness and, at the same time, by the global alliances built to meet this competition with innovation, collaboration, excellence, quality and shorter development times. In this work, the authors give an overview of the basic concepts of collaborative

virtual engineering present in all phases of innovative product development (from design, to simulation, to maintenance), providing examples for virtual engineering tools and focusing on the importance of real-time systems.

Full Article: B4

Contribution 5

Title: RPD - Rapid Product Development.

Authors: L. Lincoln

Key Words: creativity, rapid design.

Rapid Product Development (RPD) defines an industrial culture that promotes the development of new products and design for production, in scales of time more abbreviated possible. This culture uses new technologies to promote the time reduction, besides the use of 3D, CAD-CAM, Rapid Prototyping, Rapid Tooling, Simulation and the use of Administration Techniques that activate the industrial process.

Full Article: B5

Contribution 6

Title: Virtual Maintenance based Maintainability Analysis System.

Authors: Jianping Hao, Songshan Wang, Liu Hui

Key Words: maintainability analysis, virtual maintenance, maintenance action, virtual maintenance prototype, virtual reality.

It is a challenge for maintainability engineers how to conduct maintainability analysis and find potential design deficiencies in time without building physical mock-up. Virtual reality is an effective way to this problem. We introduce a virtual maintenance based maintainability analysis system (VMMAS) and several key technologies solved during the development of this system such as virtual maintenance prototyping, maintenance action modeling, simulation based maintainability defect analysis and evaluation. Discuss the system implementation and application case.

Full Article: B6

ID³: a Virtual Research Center on Interactive Design

The fundamental principle of industrial innovation consists in the mutualisation and the crossing of cultures, knowledge and experiences. Since 2000, on the initiative of ESTIA, a strong relationship has been developed between Mexican and French Institutions. The main goal of this cooperation is the creation of new innovation support approaches: they are the interactive design and manufacturing methods. Based on the multi-sensorial high-realistic virtual prototyping, this techniques require high-transversal activities combining studies of industrial, mechanical, numerical engineering and Virtual Reality. This transversality has led to the management of an international network, implying today industrialists.

Finally, the basic principle of industrial innovation regarded and studied through the transnational operations has been also implemented for fostering scientific and technological actions on the network: to cross, collaborate, cooperate and mutualize resources.

In order to reinforce the international cooperation between Mexico and France, the Mexican University of Guadalajara, and the French engineering institute ENSAM and ESTIA, supported by the French embassy in Mexico (represented by Annie Marchegay) jointly develop specific tools:

- a virtual center in network ensuring the virtual cooperation and fostering the development of transnational technological and research activities: facilities for virtual dynamic visits and presentations (research centers, bibliotheca, results, etc.), immersive meeting of people being physically separated (teleportation) and virtual lead-

ership of projects; they are the basic functionalities of the virtual and distributed lab,

- transnational shared PhD (capitalized both by Mexico and France) and the supported mobility of post-graduate students or researchers (in the context of short seminars),
- specific dissemination tools as 4 annual workshops/Schools (2 in Mexico, 1 in Brazil, 1 in France in 2006/2007), the international well-known Conference Virtual Concept (2005 in France and 2006 in Mexico), an international journal and books, all being jointly developed with virtual instruments specially created and adapted,
- technical actions having industrial soundness and jointly launched by French and Mexican institutions.

Today, the transnational research network ID³ intends to open itself to other countries in the world. The Interactive design and manufacturing will be improved in the context in an international transversal mixed community having its own dissemination tools.

Key Words :

Virtual Meeting, Virtual Leadership of transnational project, PhD and Master mutualization, virtual cooperation on technical/scientific actions, virtual and shared organization of the dissemination.

Project Leaders :

Xavier Fischer, Renaud Briand - ESTIA (France),

Jean-Pierre Nadeau - ENSAM (France),

Victor Larios Rosillo - Universidad de Guadalajara (Mexico).