

Research in Interactive Design
Proceedings of Virtual Concept 2005

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Daniel Coutellier

**Research
in Interactive Design
Proceedings of Virtual Concept 2005**

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Instructions

Research in Interactive Design 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 130 high-detailed articles,
2. a CD-Rom: it includes 130 articles defining recent achievements in research related to Numerical and mechanical Engineering, Design and industrial studies, Virtual Reality and computing technics applied to the development of Interactive Design methods.

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

| | |
|--|--|
| Title: | Article Title |
| Authors: | list of authors |
| Key Words: | main words defining the topic of the article |
| Here, an outline of the article is provided through a detailed abstract, whole article being included in the CD-ROM. | |
| Full Text: electronic reference of Article within the CD-ROM | |

Each abstract is linked to a full article included in the CD-ROM retrievable through its electronic reference. In order to read the electronic version of the article, a PDF file reader is required.

By using Acrobat reader (product from Adobe Company), it is possible to:

- search the list of article according to a specific keyword,
- search the article written by a specific author,
- obtain a thematic structure of the discussion,
- read biographies.

The following opening pdf page automatically starts when reading the CD-ROM and allows the reader to reach the well-detailed articles: by clicking on the different titles and following the instructions, the reader can have a direct access to the electronic texts.



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Research in Interactive Design integrates the best articles selected by the International Scientific Committee of the International Conference *Virtual Concept 2005*.



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

Designer and Owner



The present book results from a scientific association with major European networks having international visibility and recognized in the domain of design and manufacturing sciences, partners of Virtual Concept 2005:

Scientific Certification



Virtual Concept 2005 is also scientifically and technically associated to famous international institutions certifying the relevance of the full articles presented in this book:

Scientific Partners



The conference Virtual Concept 2005 is linked to academic European and American institutions:

Academic Partners



Virtual Concept 2005 is developed and organized with six well-known institutions:

Partners



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.

Dr. Xavier Fischer also began his career in 1995 as mechanical engineer in the domain of Aeronautics. In the context of plane design projects, he focused on the development of complex numerical models handled to implement virtual simulations of great assemblies. Engineer from a distinguished French engineering institute, he obtained his PhD in Mechanical Engineering from the prestigious institute “Ecole Nationale Supérieure d’Arts et Métiers”.

Nowadays, researcher in the trilingual engineering school ESTIA, Dr. Xavier Fischer divides his time between his research, courses and the international promotion of activities related to the domain of Interactive Design technologies by proposing ways of promotion or mutualization at an international level. In ESTIA, a great part of his activity focuses on the enhancement and intensification of associations between industrial and research domains, particularly through French, European or international projects. Dr. Fischer currently participates also on the international promotion of ESTIA.

Pr. Daniel Coutellier and Dr. Xavier Fischer are the general Co-Chairs of Virtual Concept 2005. 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 115 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 2005 must be gratefully and thankfully highlighted for their involvement.

Moreover, Pr. John S. Gero, Pr. Grier Lin and Pr. Okay Kaynak have also contributed to the visibility of this book. The whole Virtual Concept 2005 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. A. Bernard, Pr. F. Bennis, Dr. M. Hafez, Pr. J.C. Léon, Dr. M. Mekhilef, Dr. J.F. Petiot, Dr. P. Sébastien and Pr. J.R. Villalobos 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 2005 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,
- Jean-Marc Cieutat, involved in the development of the present manuscript,
- Jose-Luis Corral, H el ene Marty, J er emy Legardeur and G eraldine Cochelin who ensure the promotion of the whole Virtual Concept 2005 event.

We would want to conclude this part of the book by thanking each scientific and institutional partner of Virtual Concept 2005.

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Introduction

Interactive Method: a Way to Support Decision Making in Design and Manufacturing

The last decades have seen the development of tools dedicated to the virtualization of the real world. The simultaneous advent of Computing Science and Applied Mathematics have contributed to the change and improvement of product engineering approaches by fostering the development of new high-performance devices based on the concept of simulation. Nowadays, Computer Aided Design, Manufacturing and Engineering systems are considered as common tools and efficient instruments for supporting decision-making in product design and manufacturing. The fundamental goal of these devices consists in avoiding as soon as possible wrong decisions by enabling design actors to virtually observe and regard the results of a joined or concurrent activity, eventually being implemented in an extended context.

The basic functioning of the previous tools implies the idea of design solution space representation. By virtually representing:

- a product: handling to the multitude of Computer Aided Design (CAD) systems,
- a process: employing specific systems dedicated to the simulation of industrial scenarios such as maintenance, manufacturing (CAM systems), etc.,
- a physical behavior: implementing numerical models on systems, for instance, based on Finite Element Methods,

the roads of engineering have quite evolved and are completely organized

around these support-systems. More recently, these instruments have acquired a new main function: an assistance dedicated to the exploration of the virtual design solution spaces. In this context, an engineer may benefit from:

- optimization tools: manipulating complex mathematical models in order to rapidly identify and store away the solutions that are mathematically the best, and obviously respecting the laws of the model,
- Computer Aided Engineering instruments: handling engineering rules in order to direct the search of solutions according to capitalized knowledge, know-how or specialized information.

Now, all the previously presented systems are often linked between them through extended management instruments (PLM systems) or methodologies (integrated, concurrent approaches) that intend not only to connect the tools, but essentially to put in touch all design actors and also to better manage the project.

The previous tools have all the same goal and philosophy: in the end, they allow engineers to handle complex mathematical models simply in order to implement virtual representation and simulation of their creation and ideas. The combination of advanced engineering methodologies and decision support systems have certainly contributed to the advent of high-tech products, particularly in Aeronautics, Aerospace, Automotive, Energetic industries, or in the field of consumer goods. On the latter, they have led to the emergence of high-customized and attractive products. Mechanical Engineering and Design Science have certainly taken advantage from the development of the support systems.

However, the manipulation of the different high-specialized tools, and in this way, the modelling and the processing of in-depth knowledge and culture, is not so easy. Although CAD, CAM, CAE and numerical simulation systems have demonstrated their efficiency, their limitations are well-known by engineers: they do not constitute the exhaustive mirror of the real world and they can not provide an accurate representation of a whole real environment, especially since it does not already exists being under creation process. Moreover, such tools turns out to be highly specialized and, sometimes, they involve the implementation of expensive processes, in particular for products or environments including great

number of components interacting between them and which study needs the involvement of several technologies. The cost may be due to:

- the difficulties appearing in the development of virtual models dedicated to the representation or the exploration of design solutions space,
- the processing of models that may rapidly require important computing power,
- the high level of knowledge required for using these specialized devices.

Moreover, the evoked devices only supply closed, defined, established and steady virtual representations avoiding every interaction between the virtual and the real worlds.

Recently, the suppliers of computing technologies have developed new instruments which enable humans to interact in different ways with virtual worlds. As a matter of fact, the development of Virtual Reality technology has implied the creation of new devices ensuring humans to have a presence in a virtual environment, to interact with it, to feel it and to act on it.

Nowadays, Virtual Reality techniques are combined with specific mathematical, computational, mechanical and industrial engineering in order to foster a Design and Manufacturing Support approach, also named Interactive Methods.

The Interactive Methods result from advanced researches combining the fields of Numerical Engineering, Mechatronics, Mechanical and Industrial Engineering, Design and Manufacturing Science.

The last successful research have led to the emergence of suited methodologies and systems that really assist decision-making and foster industrial innovation. Design problem-solving may be achieved with instruments strongly connected to classical decision-support systems, organized and built around the concept of simulation.

More and more introduced in the industry, they provide to the engineer high-performance ways to implement high-realistic virtual prototypes.

Research in Interactive Design proposes an accurate view of last discoveries in Interactive Methods. Basically, Interactive Design approach consists of differently supporting product engineering by promoting a new generation of devices allowing engineers to better implement accu-

rate and complete virtual prototypes enabling the interaction between the real and virtual world.

Alternately, *Research in Interactive Design* leads the reader to sophisticated solutions in order to answer the following questions:

1. How to model virtual world, including the interactivity concept ?
From a combination of common design methods, mechatronic techniques and numerical engineering approaches, some relevant and emergent methodologies emerge, having the purpose of aiding engineers in the making of advanced visual or behavioral models. These models, which have the characteristic being reduced, accurate and well-qualified, aim either to describe a design-problem, or to represent the organization and behavior of a virtual world by foreseeing the possible relation between the virtual and real environments (for instance, a human interacting with a virtual world). In this way, researches about Interactive Methods start with activities related to:
 - the development of techniques intending to assist the structuring of an important model; the most popular of these creativity tools,
 - the making of specific mechatronic and embedded systems, allowing engineers, upstream, to observe the behavior and organization of real worlds,
 - the implementation of complementary solutions related to the identification and the capitalization of knowledge, information and know-how, often complementing the aspects that have not been able to be regarded with mechatronic instruments,
 - the building of an extended model capable of creating virtual prototypes handled in real time or of rapidly exploring solution spaces; such mathematical representation results from the combination of Artificial Intelligence techniques and classical numerical methods.

2. How to implement interactive representations and exploration of design solution spaces ?
For handling engineering problem models, navigating within design solution spaces and representing realistic extended virtual prototypes, researchers and industrialists have mixed original and ad-

vanced numerical methods, efficient computing techniques, relevant mechatronic devices and Virtual Reality tools. The emergent exhibited solutions have the following fundamental goals:

- rapid identification of design solution sets according to capture industrial and physical laws;
this approach consists in rapidly exploring n-dimension solution spaces by simultaneously and interactively taking in account all specifications and expectations,
- virtual prototypes implementation;
the objective is to allow engineers the manipulation in real time of opened and evolved dynamic virtual representations and simulations; this enables engineers, to truly act on virtual worlds and modify their states, and also to provide a global representation of decisions situated in a complete context,
- interactions between real and virtual worlds;
with mechatronic embedded systems, the aim is to supply design actors with ways to truly have physical and multi-sensorial interactions with virtual environments, guaranteeing a connection between the real and virtual worlds.

3. How to foster industrial innovation by enhancing the concept of simulation and interactive virtual prototype ?

Interactive approach may only be efficient if it is well-integrated in an industrial process and if its use reinforces industrial innovation. By better considering humans in the design and manufacturing processes, Interactive Methods suggest some global integrated solutions in order to:

- provide efficient methodologies for capturing and re-using relevant knowledge,
- support decision-making (to enhance, to test and to validate ideas) as soon as possible by promoting the manipulation of simulation and virtual prototyping even if decisions are emerging,
- to further the ways of sensorial design.

Research in Interactive Design clearly considers the earlier most significant transversal contributions related to Interactive Design and Man-

ufacturing Methods. It provides some solutions in order to extend the capabilities of actual decision support systems and demonstrate their significance through real industrial problem-solving.

Research in Interactive Design will allow the reader to receive a clear and accurate information about Interactive Design and Manufacturing approach. This book demonstrates the relevance of this new topic, actually growing through advanced researches and beginning its integration in industrial processes.

2

Tutorials

2.1 Enactive Modelling

Title: Enactive Modelling

Authors: M. Parenthöen, J. Tisseau

Key Words: affordance, active perception, active object, enactive entity, modeling, enaction, simulation, complex system, epistemo-praxeology

This tutorial is about the modeling of natural phenomena for their participative simulation in a virtual reality system. It begins with an epistemological glance on the modeling of complex systems, which include a human being in the simulation loop, allowing experimentation of the models, throughout modeling, by their participative simulation. This approach places virtual reality as an interlink between humanities, natural sciences, exact sciences and engineering sciences. Enactive modeling is an example of such a constructive methodology for natural phenomena in virtual reality system, reconciling knowledge resulting from psychology, neurophysiology, physics and computing sciences. The method suggested "enactive modeling" is conceptualized, formalized, instrumented and illustrated by the case of a heterogeneous water plane of several square kilometres usable by sailors and oceanographers. This new constructive method for the modeling of complex systems involving multi-models and multi-scales interactions opens many perspectives.

2.2 Virtual Reality Environments

Title: Intelligent Virtual Reality Environments (IVRE): Principles, Implementation, Interaction, Examples and Practical Applications

Authors: F.S. Osorio, S.R. Musse, C.T. Santos, F. Heinen, A. Braun, A.T. Siva

Key Words: Intelligent virtual reality environments; intelligent virtual agents; adaptive environments; user modeling; content modeling; perception; interaction; simulation; e-commerce; e-learning; games

This tutorial aims to present new trends, methods and applications of Virtual Environments endowed with information/knowledge in order to provide to the user more interesting immersive interaction. We present concepts related to environment modelling, visualization and user interaction, mainly focused on some important proprieties: dynamic entities, adaptive environment, intelligent agents and behavioural models. Intelligent Virtual Reality Environments (IVRE) integrate Virtual Reality, Artificial Intelligence and Simulation tools and techniques in order to provide more realism, more dynamic environments and to improve interaction with users. This tutorial aims to present an overview of some important techniques related to IVRE implementation, for example: intelligent objects, autonomous agents control architectures, knowledge acquisition, representation and manipulation techniques, behavioural models (physically based and/or human based), etc. The IVRE have been employed in many applications, described in this tutorial, such as: e-commerce, e-learning, games, simulation of real situations (from crowd simulation to robotics) and also visualization of animations and study of specific behaviours. We conclude this tutorial with some examples of IVRE practical applications that our group developed recently: CROMOS - Crowd Modelling and Simulation (e.g. simulation of emergency situations) and ADAPTIVE - Adaptive 3D Intelligent Virtual Environment (e.g. adaptive virtual bookstore and e-learning environment).

2.3 Techniques For Modelling in Physics

Title: Physics-Based Modelling Techniques for the Virtual Simulation of Deformable Shapes
Physics-Based Modelling Techniques for the Virtual Simulation of Deformable Shapes

Authors: M. Fontana, C. Rizzi, U. Cugini

Key Words: Deformable shapes, physics-based modelling, numerical methods, virtual simulation

Many scientific and industrial sectors increasingly demand tools for the modelling of deformable objects, e.g., wires, flexible sheets, cloth, soft tissues and muscles, soft containers, and so on. Models based on mere geometrical description are not adequate to accurately predict the shape and behaviour of these objects, as it is necessary to take into account properties of materials and the effects of the external environment on the shape and motion of the objects. These effects are the static or dynamic consequence of external forces and stresses, imposed geometric or kinematic constraints on the objects, or collisions against external obstacles or between object parts. Various techniques for deformable shape modelling have been proposed in computer graphics. The purpose of this Tutorial is to present a state-of-the art of the best-known techniques, with a short mention on some geometrical approaches for shape manipulation and deformation, up to a more in-depth outline on discrete and continuous techniques based on different physical formulations, e.g., discrete dynamics, structural mechanics, elasticity theories, fluid dynamics, etc. Numerical issues, concerning time/space discretization methods of associated ODE/PDE problems, are also pointed out. Recent trends and relevant applications are shown in the area of virtual sculpting, industrial CAD, virtual surgery, computer animation, etc.

3

Invited Sessions

3.1 PLE in Interactive Design

3.1.1 Summary

Session Chair: A. Bernard

Affiliation: Ecole Centrale de Nantes, IRRCyN - France

Key Words: PLM, PLE, design, FBS-PPRE model, numerical engineering, virtual reality.

PLM (Product Life-cycle Management) concept is today widely adopted within both the academic and the industrial communities. In particular, it characterizes the actual evolutions of design methods that try to model, analyse and integrate, during the design stage, the constraints related to products and systems life-cycles.

PLM has to be understood as a set of methods and tools for the construction and the management of the different models, information and knowledge concerning processes, products, resources and external effects, integrating function-behaviour-structure concepts as the base for enterprise objects modeling. Creation actions, methods and tools are part of PLE (Product Lifecycle Engineering) components. Management actions, methods and tools relate more directly to PLM it self.

The aim of this contribution is to propose a general overview of PLE and its role in improving interactive design. Technologies, such as CAD/CAM/CAE coupled to VR environments, allow improving design efficiency, and give interesting ways of progression based on numerical (virtual) engineering methods and tools. Based on some presentations,

conceptual aspects, tools and effective applications will give the base for a constructive and productive discussion on the experience of the contributors.

Concerning the concepts, an international community has proposed an international conference on the global PLM topics and also an international journal. Its inaugural issue has been distributed during the last PLM05 conference in Lyon (July 2005). During this session, some reference elements coming from this community will allow participant analysing actual scientific views and methodologies for PLM deployment. Regarding tools, characteristic environments will be presented in a way of improving the performances of a design team in terms of analysis possibilities. New computing methods and multi-critrs, integrated or linked to CAD/CAM/CAE environments will be commented. The role of VR technologies and devices will also be introduced and some experiments and applications will allow better understand the capabilities of these new design environments. Concerning the applications, representative initiatives will be presented and results will be shown, with concrete performance indicators in terms of time and integration capabilities. A complete study based on numerical engineering will also show the interest of a global integration based on knowledge-based tools and methods, and driven by a PLE approach dedicated to casting industry.

During the last four years, some very interesting initiative were conducted at national and European levels. The first one is related to a RNTL project named PERF-RV which allowed contributing to improve the application of VR in the scope of design and more especially for PLE applications. Another one, EVEN, is a thematic network of the firth European program. The aim of these two initiatives were to let leaders, both from academia and industry, join their efforts to contribute to the improvement of virtual engineering approaches in different fields. Many workshops were organised and nowadays, most of the applicable results are exploited in industrial contexts. Such a lot actions are not only reserved for large companies but they also have impacts on SMEs. The results concern both models and methods and are applicable to all company contexts.

This session is a very interesting opportunity for a very pragmatic discussion on the opportunity and the difficulties of PLE application within the different steps of a design process, PLM-oriented. The FBS-PPRE approach, proposed by IRCCyN laboratory (IVGI team: Virtual Engineering for Industrial Engineering) will also be demonstrated and

some applications of such kind of model will be proposed for analysis and discussion. Key words: PLM, PLE, design, FBS-PPRE model, numerical engineering, virtual reality.

3.1.2 Abstracts

Contribution 1

Title: PLE in Interactive Design

Author: A. Bernard

Key Words: PLE, PLM, product life cycle management

This article aims to provide an overview about the Product Life cycle Engineering systems (PLE) and their uses within the interactive design and manufacturing processes

Full Article: VC2005IS1001

Contribution 2

Title: Some Experiences With Virtual Technique Implementation in Household Product Development

Authors: Z. Weiss, E. Weiss, R. Konieczny, M. Kasica, M. Kowalski

Key Words: product design, VRML, Virtual Reality, functional model.

This paper presents the work that has been carried out through the implementation of virtual techniques in the Virtual Design and Automation Centre (VIDA) at Poznan University of Technology (PUT). A description is given of the process of implementation and of the first experience of using the EON ICatcher VR system. Two different methods were used for the creation of the virtual environment based on the CAD data of an actual existing product. The first effort was made in VRML and the next in an immersive system with a passive stereoscopic view from the EON Reality company.

Full Article: VC2005IS1002

3.2 Perception and Sensation in Interactive Design

3.2.1 Summary

Session Chair: J.F. Petiot

Affiliation: Ecole Centrale de Nantes, IRCCyN - France

Key Words: User Centred Design (UCD), sensory analysis, perceptual design.

We propose in this session to focus on the perceptions and sensations of a user during his/her interactions with a virtual product. The aim is to show how virtual reality could be implemented for an interactive design of products. The presentations will concern both the methodological aspects of the problematic and the tools to implement. A general methodology for a user-centred design will be first described. This methodology, based on sensory analysis methods, is generalized to non-food and to virtual products. Two examples are proposed to illustrate the methodology: (1) an example in musical acoustics. It concerns a sensory study of musical instruments and the use of physical modelling simulations of tones for the design of instruments (virtual acoustics). This example will be illustrated by several audioexamples. (2) an example in industrial design. It concerns the design of forms and the use of digital prototyping for the modelling of forms user preference. A study of the aesthetics of table glasses is conducted on virtual prototypes. Next, a general method for the study of the links between user-perceptions and design variables of a product will be described. We will put particularly emphasis on the crucial role of virtual reality, and on the interesting perspectives it opens up. Finally, a presentation on the use of virtual reality for supporting the creativity in the early phase of design projects will be proposed. A virtual reality interface for the navigation in a database of images will be described. This tool leads to the building of dynamic trend maps and is relevant to enhance creativity of industrial.

3.2.2 Abstracts

Contribution 1

Title: Virtual Reality and User-Centred Design

Author: J.F. Petiot

Key Words: customer oriented design, sensory immersion.

We propose in the presentation to focus on the perceptions and sensations of a user during his/her interactions with a product. The aim is to show how virtual reality could be implemented for an interactive design of products. The study concerns both the methodology to develop and the tools to implement. First, a methodology for a user-centred design is described. Secondly, two examples are proposed to illustrate the methodology: (1) use of physical modelling simulations of musical instruments tones for the design of instruments (virtual acoustics) (2) use of digital prototyping for the modelling of forms user preference (aesthetics). Finally, a method for the study of user perceptions is described.

Full Article: VC20051S2001

Contribution 2

Title: Designing a Dynamical Interface Supporting Creativity for Designers

Authors: A. Guenand, J.F. Petiot

Key Words: Idea generation in product design, virtual reality, semantics , dynamical image search, data analysis.

There are many ways to support the creativity in the design activity, mainly using trend panels, movies or video-shows presenting the consumers trends. Nevertheless, even if these trends representations can be furnished to the designer, or be done by him, the designers activity always leads to image searching and image manipulation. This paper is about the use of virtual reality for supporting the creativity in the early phase of design process. We make the hypothesis that the manipulation of objects in virtual reality should help the perception of objects and the image generation in the early stage of the design process. In order to support the designers image seeking for idea generation, we propose

a Virtual Reality interface that enables to explore an image database through three axes representing 3 values of the product: the semantic, the emotional and the social values. This paper describes the method for achieving the tool.

Full Article: VC2005IS2002

3.3 Exploration of Solution Space in Interactive Design

3.3.1 Summary

Session Chair: M. Mekhilef

Affiliation: Ecole Centrale de Paris, LGI - France

Key Words: Optimal Design, preference modelling, decision modelling, space exploration, decision support.

This session aims to regard and discuss about available techniques allowing designers to explore the design solution spaces. These approaches combines virtual to optimization techniques. the main objective of such devices consists in aiding design actors to rapidly identify embodiment or detailed design solutions by respecting preferences, and satisfying relevant knowledge.

3.3.2 Abstracts

Contribution 1

Title: Exploration of Design Spaces by the Mean of Game of Life.

Author: M. Mekhilef

Key Words: game of life, poptimal design, Pareto solutions.

In this paper we address for the first time the potential of the Game of Life introduced by John Conway on 1970 as a tool to explore the de-

sign spaces. The main idea is that this game intrinsically handles the possibility of creation of various forms among what some have the ability to move and so when applied in optimization leads to the possibility to explore the feasible optimization domain. We use this idea on a mechanical problem in order to study the general behaviour.

Full Article: VC2005IS3001

Contribution 2

Title: Multi-Criteria Optimization

Authors: R. Filomeno Coelho, Ph. Bouillard, S. Pierret

Key Words: evolutionary algorithms, multiobjective optimization, multicriteria decision aid, preferences, approximation methods.

Since the late eighties, evolutionary algorithms (EAs) have demonstrated their robustness and efficiency in solving single-objective optimization problems in various engineering fields. Based on the Darwinian law of the survival of the fittest, EAs start with a set of potential designs and make them evolve by successive operations of selection and recombination, aiming at converging towards the global optimum at the end of the process. However, in lots of industrial applications, dealing with only one objective is generally not sufficient. Therefore, multiobjective evolutionary algorithms (MOEAs) have been developed in order to find the Pareto optimal set, i.e. the set of nondominated solutions such that there exists no other feasible individual in the search space better with respect to all criteria. Most MOEAs are a posteriori methods: a solution is chosen by the user after the search process. Nevertheless, when the user already has a clear opinion about his/her preferences, a priori techniques might give interesting results very quickly. They consist in defining preferences (through weights or via a ranking of the objectives) before the algorithm starts its search. A third approach, less used in practice, takes into account the user's preferences during the search, implying an interaction between the user and the program. It is important to stress on the fact that no approach is to be preferred systematically: it depends on the user's expertise and requirements about a given problem. For instance, when the user has a strong idea about his/her preferences, the PAMUC a priori method can be applied. It integrates PROMETHEE II in an EA and uses specific procedures to tackle the constraints. At the

opposite, when the user lacks of information about the problem, a posteriori MOEAs may be used, as the Strength Pm-2 (SPEA2) proposed by Zitzler and Thiele. However, one of the main drawbacks of a posteriori MOEAs is the large number of function evaluations they require, which can be critical when time-consuming computations have to be performed (e.g. Computational Fluid Dynamics models). Therefore, the method implemented in MAX (the optimization code developed in CENAERO) is organized as follows: first, a database is built by running the exact model on a set of initial individuals, and used to create an approximated model by means of radial basis function networks. Then, a predefined number of loops are performed, each loop consisting in: (1) executing SPEA2 on the approximated model, (2) computing a subset of the Pareto solutions found by the EA thanks to the accurate (expensive) model, (3) adding these new points to the database in order to construct a better approximation. This approach has demonstrated to give very good results while decreasing the number of function calls by a factor close to 10 (in comparison with SPEA2 without approximation), opening the path of multiobjective optimization to many areas of engineering.

Full Article: VC2005IS3002

3.4 Modelling, Simulation and Virtual Reality for Supporting Design

3.4.1 Summary

Session Chair: J.C. Léon

Affiliation: INPG-UJF, Soil, Solid, Structure Laboratory (L3S) - France

Key Words: virtual mock-up, virtual environment, modelling.

This session aims to highlight the fundamental links between modelling and simulation.

First, it provides an overview about the different recent techniques allowing design actors to develop accurate models dedicated to the representation of physical and design behaviors.

Secondly, we propose to regard how models may be employed in an industrial process for supporting design activities. We clearly show

how the detailed techniques may improve professional habits by being integrated to digital approaches.

3.4.2 Abstracts

Contribution 1

Title: Fundamental Concepts in Digital Mock-Up Modelling for Product Design Support

Author: J.C. Léon

Key Words: multiple representations, B-Rep models, 3D, polyhedral models, preparation process, shape adaptation.

Nowadays, digital mock-up is a well recognized concept to support the product development process. Most of the time, a product digital mock-up is based on CAD representation where each component of a product is defined with a shape as manufactured. As a result, a product component has only one reference shape, often managed through a PDM. However, the multiple stages of the product development process address a wide variety of topics where simulations (structural, thermal, ergonomics, assembly,) must take place to evaluate the product behaviour. Each of these simulations require specific models usually characterized by the fact that the shape of the component, sub-system, etc. studied differs from that of their reference one. In addition, the simulation models required need to be enriched with specific data for a given simulation field. The simulations performed often require a dedicated simulation environment software, which means that model exchange are mandatory to load a model into a target environment. The shape changes required are often difficult to perform because the quality of the model exchanged and modelling functions are not currently well suited to perform shape changes and handle simulation specific data attached to the shape considered. Based on this analysis, several aspects will be addressed to highlight the current needs:

- requirements to fit as flexibly as possible into the product development process chain,
- capability to describe and transform non-manifold models and corresponding topological requirements,

- fundamental mechanisms to attach, transfer, transform semantic information associated to an initial model,
- concept of criterion-driven modelling to generate one or several transformed models from a single (or multiple ?) input model for a target simulation,
- requirements to ensure the coe various models that may be needed for a given simulation,
- requirements for a specific range of operators to handle sets of components rather than isolated ones.

Full Article: VC2005IS4001

Contribution 2

Title: Virtual Mock-Up Management in Virtual Environment

Authors: F. Merienne, M. Chevaldonné

Key Words: virtual environment, progressive mesh, virtual mock-up, human factors.

Digital mock-up can be used for specific applications (like ergonomic studies, project reviews, educative projects or maintainability developments) which require the immersion of a user in a virtual environment. Interfaces used have to be adapted to the user and need a real time calculation on the digital mock-up. For instance, the visualization of the mock-up is dependent on a point of view which has to be refreshed at a frame rate of 100 Hz. For this reason and in a technological context, the mesh of the digital mock-up has to be simplified and adapted. A new mock-up, named virtual mock-up, is created for virtual reality applications. Methods and tools have to be developed in order to create the virtual mock-up from the digital one, and in order to manage the virtual mock-up during the immersive process. Of course, these methods and tools have to take into account the user in the virtual environment created for him. So, the human factors must group important criteria for the elaboration of rules in order to manage the data of digital mock-up. Some tests on users in virtual environments are necessary to obtain important factors on the perception of a virtual environment by a user. These factors are then a guide to manage the virtual mock-up (for the preparation of mock-up and real time management). Thus, the simpli-

simplification of digital mesh can be performed in function of view criterion as the visibility of the considered model in a first step. A second step consists in the preparation of different levels of details for each model. During the immersion process, the choice of the level of detail depends on different parameters as the distance between the user and model, the eye field of view, the eccentricity of the model in the users field of view. In a third step, the mesh is adapted in real time to the context of the user in the virtual environment. Use of progressive meshes. These methods can be combined themselves and with the use of textures. The management of progressive meshes with textures has to be performed with attention.

Full Article: VC2005IS4002

Contribution 3

Title: Processing of Part Interfaces in Polyhedral Assemblies to Generate Geometrical Wrapping

Authors: P. Veron, R. Chouadria

Key Words: idea DMU, product development process, numerical chain, downstream applications, model simplification and adaptation, semantic, VR and simulation applications.

In the last few years, the processes involved in the development of industrial products have been more and more supported by an increasing number of numerical tools. In aeronautic industry, as in other major industries, product development is supported by numerical tools and models such as Digital Mock-Ups (DMUs), based on Computer Aided Design (CAD) models, physical simulation models (such as Finite Element models) and Virtual Reality (VR) applications. They are used for the construction, capitalization, simulation, evaluation and visualization of alternative design proposals. Typically at EADS where the products are large and complex, the DMU used to support the concurrent engineering organizations has grown rapidly in size and complexity and the design processes involve a lot of people, who may be either collocated or located on distant sites. In this context, providing the users with significant information through PDM at the right time is a real challenge where the supervision of the numerical chain is becoming an essential requirement. The issue is not on model conversion between various software platforms and formats. Data need to be transferred,

modified, adapted and reorganized according to the targeted application needs and constraints to reach the appropriate data requirements (types of data, geometric shape, database structure,). The preparation processes of DMU data (mainly 3D models) has to be quick, efficient and as much as possible automatized in order to save time and minimize user-intervention. They must also be able to deal with semantic information linked with DMU data in order to improve their use. This communication presents the industrial context at EADS, the main requirements identified for numerical chainsw of the works currently performed to enhance applications integration. As an illustration, the major benefits expected are discussed in the context of VR and physical simulation applications.

Full Article: VC20051S4003

Contribution 4

Title: Numerical Chain Improvement for Supporting Efficient Use of Digital Mock-Up

Authors: L. Fine, N. Chevassus

Key Words: polyhedral assembly models, digital mockup, interface processing, geometrical wrapping, decimation.

Digital mock-up is now widely used to support the product design process. Current developments focus on its exploitation for various behavioral simulation processes of the product and also for different downstream processes such as industrialization and manufacturing, maintenance and support. In this context, polyhedral models are the privileged geometric representation used because of their suitability to support most of the previously cited applications. They are mainly produced by tessellation of parametric CAD models, they are easy to store, to manipulate and they allow levels of resolution for visualization. They can also be easily exchanged between CAE tools without loss of data. As a result, they enable more flexibility of the use of digital models throughout the product developments process. Previous works have focused on simplification processes applied to polyhedral models of the elementary parts describing a product. The proposed approach extends these processes to polyhedral models of the assemblies which describe a whole

product. To apply simplification techniques or other processes on polyhedral assemblies, contact surfaces between interacting objects have to be identified and specific constraints must be applied for processing. The proposed approach allows checking and preserving a global consistency of the assembly model to ensure the reliability of the future processes. Thus, contacts between parts are detected using a method working on a static configuration of the assembly. Finally, the faces involved in each contact area are precisely detected and the contact area is then remeshed using a Frontal Delaunay technique to produce locally an identical tessellation on both parts involved in the processed contact. During this remeshing process, the quality of the triangulation produced is a assembly model thus processed is the used to generate a geometrical wrapping of the assembly which is well suited for visualization purposes mainly in the case of huge digital mockup (i.e. aeronautical and automotive industries).

Full Article: VC2005IS4004

3.5 What is Interactive ?

Session Chairs: X. Fischer (1)
F. Bennis (2)

Affiliations: (1): LIPSI ESTIA - France
(2): Ecole Centrale de Nantes, IRCCyN - France

Key Words: Design support system, simulation, design process modelling, design solution space exploration, design for user, human-virtual environment interaction.

This session aims to develop a discussion about the basic concept of "Interactive Design". From short presentations, we suggest to regard fundamental fields related to "Interactive Design" topic:

1. modelling techniques: by combining mechatronics and numerical engineering approaches, some methods lead to significant models being able to represent physical behaviors, knowledge or specific design process,
2. design solution space exploration: based on rapid and interactive

numerical methods or on Virtual Reality techniques, some tools support design and allow designers to better-determine satisfying design choices,

3. interactive design process: specific process are organized around the new previous techniques and are strongly regarded in order to provide more comfort to design actors.

Interactive Design and Manufacturing methods result from transversal topics that consist in:

- well-describing a design or a manufacturing problem,
- modelling the design problem with accurate and reduced models,
- supporting the determination of most innovative design solutions,
- representing design solution space

The previous process involves new techniques that allow human to have interaction with virtual spaces and environments.

3.6 Modelling in Interactive Design

3.6.1 Summary

Session Chair: P. Sébastien

Affiliation: TREFLE UMR CNRS 8508- University of Bordeaux I

Key Words: reduced modelling, qualification of models, modelling for rapid-simulation, numerical engineering for modelling.

In the framework of innovative design processes, mechanical system interactive design is facing with a major difficulty related to decision support and real time simulation. Interactive design is currently limited by the knowledge modelling process of complex physics phenomena. A general approach of this problem still lacks. This session aims to discuss this problem and investigate recent developments in knowledge modeling and model reduction in this domain: -model approximation techniques, -analogical modeling methods -fuzzification methods -mixed approaches Applications of the session concern decision support platforms in aero-

nautics, virtual environments for tennis simulation and virtual prototyping.

3.6.2 Abstracts

Contribution 1

Title: Knowledge Modeling in Mechanical Embodiment Design for Real Time Simulation and Decision Support

Authors: P. Sébastian, J.P. Nadeau, X. Fischer, R. Chenouard

Key Words: knowledge modeling, real time simulation, decision support, embodiment design, parsimony, precision, exactness, specialization.

There has been growing interest in modelling complex mechanical or energetic systems for virtual reality applications and decision support in embodiment design. Various model reduction techniques have been developed to support this type of applications in the framework of specific scientific domains. A general approach of knowledge modelling dedicated to this problem still lacks. In this paper, some fundamental aspects of knowledge modeling for real time simulation and decision support in embodiment design are investigated. This approach is based on the management of the intrinsic precision, exactness, specialization and parsimony of models, including functional and physics models. Models are adapted to real time applications and decision support by managing the degrees of freedom related to these intrinsic parameters and by using model adaptation methods. Model adaptation methods investigated here are analytical integration or numerical approximation methods used to improve the parsimony of models.

Full Article: VC2005IS6001

Contribution 2

Title: Real-time Deformation of Structure Using Finite element and Neural Networks in Virtual Reality Applications

Authors: R. Hambli, A. Chamekh, H. Bel Hadj Salah

Key Words: virtual reality, finite element, neural network, real-time deformation, Tennis racket.

In this paper, an approach for virtual realtime deformation of complex structures is developed. The approach combines the finite element method and Neural Network calculations to allow the user to perform interactive shape changes and view the resultant deformation changes in a virtual environment. A tennis racket and ball are used to illustrate the capability of the proposed method. Because real time deformation simulation is a time consuming repeated analyses, the neural networks are employed in this investigation as numerical devices for substituting the finite element code needed for the tennis racket and ball deformation. The input data for the artificial neural network are a set of parameters generated randomly (ball impact velocity, impact angle and the zone impact). The output data are the deformation of the ball/strings and the impact force feedback value. The work contribute toward the development of real virtual simulator which uses a haptic device that feels the feedback force generated by the deformation.

Full Article: VC2005IS6002

Contribution 3

Title: Towards a Modelling Methodology for Virtual Prototyping in Interactive Design

Authors: K. Ordaz Hernandez, X. Fischer, F. Bennis

Key Words: computational mechanics, interactive design, model reduction, model qualification, virtual prototyping.

This paper introduces the recent work towards a modelling methodology for the construction of virtual prototypes within the interactive mechanical design of a product. It argues that interactive design shall be enhanced by using realistic virtual prototypes being analytical and immersive at the same time, i.e. having physically plausible models simulated in real time. From this point of view, interactive design requires real-time, reduced, realistic, and qualified models to achieve natural interaction. The qualification of models is emphasised in order to estimate the level of suitability of the models for prototyping. The accomplished

stages of the methodology are exposed, with the ski as case of study. Finally, this paper presents the ongoing work aiming to formalise the qualification of different formulations for the behaviour of a static beam under great displacements, and the backside qualification of model reduction techniques.

Full Article: VC2005IS6003

3.7 Multi-resolution in Geometric Modelling

Session Chair: P. Reuter

Affiliation: INRIA Futurs, LABRI- University of Bordeaux I

Key Words: surface modelling, 3D, rendering.

In recent years, multiresolution modeling has proved to be valuable in 3D geometric surface modeling and computer graphics. It is concerned with the generation, representation, visualization, and manipulation of surfaces at various levels of detail or accuracy in a single model. Applications include fast rendering, level of detail editing, collision detection, scientific visualization, as well as compression and progressive transmission. A widespread example for multiresolution surfaces is the subdivision surface. Starting from very simple primitives, such as cubes or spheres, the user can progressively deform and enrich the surface with tools like, for instance, extrusion, shear or twist. As soon as a coarse level is correctly modeled, the user can refine the model by applying a subdivision pass, and add finer details, tessellate the areas where more features are required, and thus model the shape more and more accurate by using the different levels of refinement of the subdivision surface. Indeed, a major advantage of the subdivision surface is flexibility: the user can modify the shape at any resolution the deformations at coarser levels are automatically propagated to the finer levels. Multiresolution is also the link between geometric modelling and rendering, providing for instance an appropriate level of detail for a given viewpoint in order to ensure real-time rendering. A simple example, introduced in the 90s, is the progressive polygonal mesh. Starting from a detailed single model, multiple coarser mesh resolutions can be generated by the successive application of an edge collapse operator. Of course, coarser mesh

resolutions can be rendered more efficiently, at the expense of lost fine details. acquired surface data, since due to the recent advances in 3D acquisition devices, the surfaces are more and more scanned from the real world rather than modeled. A challenging task is to handle the modeling amount of data usually provided by 3D scanners in real-time. For example, the significant overhead of dealing with the connectivity of polygonal meshes has motivated various researchers to seek for alternative multiresolution surface representations, as for example point-based surfaces. In this talk, we first briefly review some classical surfacedefinitions such as polygonal meshes and spline surfaces. Then, we give further insight in surface definitions that have gained much attention recently as suitable multi-resolution representations, such as subdivision surfaces, implicit surfaces, and point-based surfaces. Our special interest focuses on how these surface representations are adapted for multiresolution modeling and rendering in the abovementioned applications.

3.8 Tactile Feedback

3.8.1 Summary

Session Chair: M. Hafez

Affiliation: CEA LIST - France

Key Words: touch, human-virtual environment interaction.

Tactile interfaces are used to communicate information through the sense of touch, which is an area of growing interests from the research community. Potential applications include virtual training for surgeons, remotely touching materials via internet, automotive industry, active interfaces for blind persons, and sensory substitution devices. Different research groups have developed laboratory prototypes to study and understand the sense of touch. However, the designs and the actuator technologies used cannot satisfy mass production, as the assembling of different parts becomes time-consuming and practically impossible at the scale of these micro actuators which have a size in the millimeter range. Tactile stimulation can be accomplished in different ways. The

technologies for virtual environment systems were inspired from dot matrix printers technologies and Braille systems for blind people. Solutions based on mechanical needles actuated by electromagnetic technologies (solenoids, voice coils) and, piezoelectric crystals, Shape Memory Alloys (SMA), pneumatic systems, and heat pump systems based on Peltier modules have been proposed. Other technologies such as electrorheological fluids, which cause an apparent change in the viscosity under the application of an electric field, are under investigations. Technologies dedicated to medical applications such as electro-tactile and neuromuscular stimulators have not yet been used because of their invasive nature. This session will focus on both the technology aspects and the applications for tactile feedback. The building blocks of a new tactile language developed at CEA LIST will be presented.

3.8.2 Abstracts

Contribution 1

Title: Tactile Interfaces at CEA LIST

Author: M. Hafez

Key Words: tactile interface, industrial applications, technologies for human-virtual environment interactions.

Tactile interfaces are used to communicate information through the sense of touch, which is an area of growing interests from the research community. Potential applications include virtual training for surgeons, remotely touching materials via internet, automotive industry, active interfaces for blind persons, and sensory substitution devices. The sense of touch is quite rich and includes beside the cutaneous sensitivity, the sensitivity to an applied pressure, vibration and a variation in the temperature. Different research groups have developed laboratory prototypes to study and understand the sense of touch. However, the designs and the actuator technologies used cannot satisfy mass production, as the assembling of different parts becomes time-consuming and practically impossible at the scale of these micro actuators which have a size in the millimeter range. Tactile stimulation can be accomplished in different ways. The technologies for virtual environment systems were inspired from dot matrix printers technologies and Braille systems for blind peo-

ple. Solutions based on mechanical needles actuated by electromagnetic technologies (solenoids, voice coils), piezo-electric crystals, Shape Memory Alloys (SMA), pneumatic systems, and heat pump systems based on Peltier modules have been proposed. Other technologies such as electrorheological fluids, which cause an apparent change in the viscosity under the application of an electric field, are under investigations. Technologies dedicated to medical applications such as electro-tactile and neuromuscular stimulators have not yet been used because of their invasive nature. This paper gives an overview of different tactile interfaces that have been developed at CEA LIST in order to communicate different types of information through the sense of touch. Vibrotactile stimulators have been developed based on micro litors and piezoelectric ceramics. These interfaces have a limited number of actuators (typically a matrix shape with 8x8 or 10 x 10 actuators). They are also called dynamic interfaces. A finger (or few fingers) rests on the display whose content is continuously refreshed. However, the information transmitted to the skin is limited compared to a static display that is explored by the hand (applications for blind persons). In fact, dynamic interfaces do not reproduce the friction forces generated when a finger explores a relief, which is an important source of information for the visually impaired. In order to satisfy these requirements for blind applications, quasi static interfaces have been developed and will be covered in a dedicated section of this paper. Finally, a thermal interface is presented. The heat transfer occurring between the fingertip and different explored surface materials is simulated and reproduced on the thermal interface. A comparison between a thermal model and some experimental results are also presented in this paper.

Full Article: VC2005IS8001

Contribution 2

Title: Touch Analysis and Tactile Device design: an Overview of STIMTAC Project

Authors: B. Semail, F. Martinot, F. Giraud, P. Plénacoste, K. Talbi, N. Tiercelin, Ch. Chaillou, Ph. Pernod

Key Words: tactile, gesture, analysis, piezo-electric, magnetic.

The aim of this paper is to present the « Stimtac » project which deals with the design of tactile devices. Firstly, the scientific approach

is explained. It is made up of several stages as the tactile gesture analysis, the corresponding vibration determination, the tactile device design and, at last, its evaluation. This approach is undertaken thanks to different experimental works. They are described in the paper and the first conclusions about tactile gesture analysis are given. As for tactile device design, two studies are presented, either with a discrete structure of magnetic actuation or a continuous vibrating piezo-electric sheet.

Full Article: VC2005IS8002

Contribution 3

Title: Towards A New Tactile Language to Communicate Emotions

Authors: M. Benali Khoudja, A. Sautour, M. Hafez

Key Words: tactile interface, vibrotactile, haptic, communication language, emotional information, equivalent building blocks for tactile language.

Tactile displays are deformable surfaces that communicate information through the sense of touch. For virtual reality or telepresence applications we seek to restore the "basic" tactile percepts (roughness, smoothness, etc.), whereas for the handicapped people or in usual telecommunication field we seek to restore a "tactile language". In this paper, the fundamentals of a new tactile "language" are presented. The basics of this language are inspired from hand-written and voice recognition. All the steps to design such a language are presented. These steps are characterized by various phases of development and validated systematically by user tests. The obtained results show that the first elementary "tactile words" displayed by VITAL interface are well adapted to communicate "emotional" and "feelings" information.

Full Article: VC2005IS8003

3.9 Reality and Virtuality in Manufacturing

3.9.1 Summary

Session Chair: J.R. Villalobos

Affiliation: Arizona State University - USA

Key Words: electronic manufacturing, image analysis, inspection.

The application of computer vision to industrial production also known as automated visual inspection (AVI) has been around for at least twenty years. However, the full potential of the AVI systems has not yet been exploited. For instance, to date the main use of these systems has been to perform screening inspection rather than to improve the underlying manufacturing system to avoid producing defective parts in the first place. This may seem paradoxical: on one hand the AVI systems have the capability to generate tremendous amount of multivariate, real-time data seemingly ideal for the implementation of SPC techniques for the improvement of assembly systems, on the other hand there is almost a total absence of AVI systems with meaningful SPC capabilities on the market. One of the reasons for this absence of AVI systems with SPC capabilities is the lack of flexibility in the existing AVI systems ability to adapt to new products. This lack of flexibility, combined with the rapid introduction and retirement of electronic products, has deterred equipment manufacturers and the electronic assembly industry from investing in the development of AVI systems more convenient for process improvement.

In this session we propose the development of an Integrated Quality Environment (IQE) that, when fully developed, will provide the flexibility needed by the AVI systems to bridge the gap between defect removal and process improvement. In the first part of the session we identify the issues that need to be addressed to make the envisioned environment possible.

In the second part of the presentation we propose some techniques to address these issues. Specific examples and results will be given based on the electronics assembly industry.

3.9.2 Abstracts

Contribution 1

Title: Integrated Quality Environments for Automated Visual Inspection Systems

Authors: J.R. Villalobos, H.C. Garcia

Key Words: automated visual inspection, surface mounted technology, electronics assembly, distributed and quality System.

This paper discusses an integrated quality system that integrates the information provided by Automated Visual Inspection (AVI) systems into an information environment whose aim is the continuous improvement of the underlying manufacturing system. The environment to be described termed Integrated Quality Environment (IQE) is general enough to be applicable to those segments of industry that have on-line automated testing systems, however in this paper we focus on the application of this environment to the Surface Mounted Devices (SMD) assembly process. The objective of this paper is to describe the envisioned IQE as well as to give some of the characteristics of the components conforming it. In particular, the intent of this paper is to illustrate some of the techniques used to give IQE its functionality.

Full Article: VC2005IS9001

Industrial Sessions

4.1 Discret Event Simulation in Design

Title: Use of Discrete Event Simulation in Process Design Optimization

Authors: D. Cipres, R. Calahorra

Key Words: event simulation, assembly factory, logistics, cross-docking , what if analysis, optimisation.

The continuous improvements in productive systems make necessary the realization of improvements and create the necessity of taking decisions. The objective of this paper is to explain the experience of the Instituto Tecnológico de Aragón (ITA) using simulation software for analysing and optimisation of processes. Two cases are explained, according to the main lines of ITA in this field, automotive industry and logistics. In the manufacturing of a new vehicle model there is an effect on all the lines of an assembly plant. This effect is more critical if it is carried out in a Just in Time (JIT) sequenced production system. Simulation programs are a good support tool for this type of decisions based on what if analysis. In the logistics field, the Information Technologies (IT) is generating a huge quantity of data from the processes. This information is essential when new processes are considered. Simulation models of the new processes could import this information in order to evaluate the behaviour of new facilities.

4.2 Collaborative Design and Virtual Reality

Title: Collaborative Design and Project Management

Author: F. Applagnat Tartet

Key Words: immersive design, collaborative design, product structure, project management, haptic.

The aim of the presentation is to show the concepts of immersive design and project collaboration through different industrial examples realized by our team between 2004 and 2005. These kinds of concepts are using technological tools which require high level of skills. Our challenge is to provide tools and competences adapted to the needs of SMEs.

Full Text: VC2005I2

4.3 3D Digital Factory

Title: 3D Digital Factory and Design Methods: a Case in the Automotive Industry

Author: P. Rigot Muller

Key Words: computer-aided Production engineering, automotive industry, Japanese methods.

This article is based on a thesis work, realized at the Ecole des Mines de Paris and with Renault S.A. It analyzes the multiplication of Computer-Aided Production Engineering (CAPE) tools in the industrial engineering sector, and adopted by the French car manufacturer Renault during the 90's. We study here the interest of such implementations:

- Are these tools really useful? What is the appropriate detail level?
- What could be, in this context, the gains of a 3D Digital Factory simulation?

The study shows that of "light" tools, without 3D visualisation, are more appropriate for flexible sectors, like the general assembly, that are frequently redesigned during production.

The analysis of the Nissan Production Way supports this idea. We

have proposed a workflow, based on a bidirectional (drag and drop) 2D map, interfacing layout, logistics and line balancing expertises. These prototypes have inspired Renault's developments.

Full Text: VC200513

4.4 Emotional Agent

Title: Model for Emotional Agent based on Fuzzy Cognitive Maps

Authors: A. Nedelec, D. Follut, C. Septseault, G. Rozec

Key Words: virtual reality, multi-agent systems, fuzzy cognitive maps, emotion, social interaction.

Emotions have actually a great influence on human behaviour and finally in design and decision process. In order to develop tools for simulation integrating human behaviour, this article describes a proposal relating to emotional state influencing actions of agents in a multiagent oriented simulation. Our approach is based on a model of behavioural competences, defined by PerformanSe company, and a virtual reality platform developed at the CERV, called ARéVi 1 , for multiagent applications in a virtual environment. This platform allows integration of fuzzy cognitives maps (FCM) at the decision level of each agent to refine its behaviour according to sensorimotor concepts values of the agent's cognitive map. We define emotions as concepts of the agents's map and links between concepts of FCM as agent's personality profile. Finally emotional maps are plugged to our agents, so they can have actions in the environment based on their emotional states. This work is integrated in GRACE 2 project of RIAM network. The aim of this project is to develop simulations adapted to the dynamics of groups integrating emotions associated with a whole of personality features.

Full Text: VC200514

Plenary Sessions

5.1 Virtual Reality in Mechatronics

Invited Speaker: Pr. Okyay Kaynak

Bogazici University - Turkey
UNESCO Chair on Mechatronics,
Director of Mechatronics Research and
Application Centre,
Fellow member of IEEE

Title: The Role of Virtual Reality in Mecha-
tronics for Supporting Product Design and
Manufacturing

Pr. Okyay Kaynak received the B.Sc. degree with first class honors and Ph.D. degrees in electronic and electrical engineering from the University of Birmingham, UK, in 1969 and 1972 respectively. From 1972 to 1979, he held various positions within the industry. In 1979, he joined the Department of Electrical and Electronics Engineering, Bogazici University, Istanbul, Turkey, where he is presently a Full Professor. He has served as the Chairman of the Computer Engineering and the Electrical and Electronic Engineering Departments and as the Director of Biomedical Engineering Institute at this university. Currently, he is the UNESCO Chair on Mechatronics and the Director of Mechatronics Research and Application Centre. He has hold long-term (near to or more than a year) Visiting Professor/Scholar positions at various institutions in Japan, Germany, U.S. and Singapore. His current research interests

are in the fields of intelligent control and mechatronics. He has authored three books and edited five and authored or coauthored more than 200 papers that have appeared in various journals and conference proceedings. Dr. Kaynak is a fellow of IEEE. He served as the President of the IEEE Industrial Electronics Society during 2002-2003 and now is one of the Vice Presidents of the IEEE Computational Intelligence Society. He has served as an Associate Editor of both the IEEE Transactions on Industrial Electronics and the IEEE Transactions on Neural Networks. He is now the Editor-in-Chief of IEEE Transactions on Industrial Informatics. Additionally he is on the Editorial or Advisory Boards of a number of scholarly journals.

5.2 Virtual Environments: A New Approach in Design

Invited Speaker: Pr. John S. Gero

University of Sydney - Australia ,
Co-Director of Key Centre of Design Computing and Cognition

Title: How Virtual Environments Using Situated Computing Can Change How We Design?

Pr. John Gero is Professor of Design Science and Director of the Key Centre of Design Computing and Cognition at the University of Sydney. He is the editor/author of 39 books and has published over 500 research papers. He has been a Visiting Professor of Architecture, Computer Science, Cognitive Psychology, Civil Engineering, Mechanical Engineering and Cognitive Science in USA, UK, France and Switzerland including at MIT, UC-Berkeley, Columbia, UCLA, CMU, Strathclyde, INSA-Lyon, Provence and EPFL-Lausanne. His former doctoral students are professors in the USA, UK, Australia, India, Japan, Korea, Singapore and Taiwan. He has been the recipient of many excellence awards including the Harkness Fellowship, two Fulbright Fellowships, and various named University Chairs. He is on the editorial boards of numerous journals and is the chair of the new conference series Design Computing and Cognition. His research spans computer-aided design, design optimization,

design theory, artificial intelligence in design, design cognition and computational design creativity.

5.3 Success in Research and Business

Invited Speaker: Pr. Grier Lin

Deputy Vice President (International) at
University of South Australia,
School of Advanced Manufacturing and
Mechanical Engineering,
Director of the Centre for Advanced Man-
ufacturing Research

Title: Invisible Leadership for future Success in
Research and Business

Pr. Grier Lin is Director of the Centre for Advanced Manufacturing Research, Deputy Vice President (International), and the Professor of Manufacturing Technology and Management of the University of South Australia. He completed a five-year program in manufacturing engineering from the National Taipei University of Science and Technology and PhD in Production Engineering from the University of New South Wales. He has had many years of industrial, teaching and research experience in Taiwan, Japan, China, Malaysia, Singapore, USA and Australia.

Thematic Sessions

6.1 From CAD/CAM/CAE to Virtual Reality

Contribution 1

Title: Integrating Discrete Event Simulation into Virtual Reality for Manufacturing Process Visualization

Author: Yong Min Zhong

Key Words: virtual reality, discrete event simulation, visualization, 3D animation, software components.

The article presents a methodology to create 3D visualization of discrete event simulation. The methodology connects discrete event simulation directly to 3D animation with its novel methods of converting discrete simulation results into animation events to trigger 3D animation. In addition, it constructs a 3D animation framework for the visualization of discrete simulation results. This framework supports the reuse of both the existing 3D animation objects and behaviour components, and allows the rapid development of new 3D animation objects by users with no special knowledge in computer graphics. This methodology has been implemented with the software component technology. Results in an electronics assembly factory are also provided to demonstrate the efficiency of the methodology.

Contribution 2

Title: Realisation of a Low Cost VR-CAD-System Using Open Source Software

Authors: Holger Diehl, Felix Abicht, Udo Lindemann

Key Words: CAD, Virtual Reality, OpenSource, low cost tracking, Early phases of Design, 3D-Sketching, Freeform surface.

CAD-Systems have been established as a basic tool in product design and development. They have become very powerful but also very complex in matters of handling. Virtual Reality (VR) technology has the potential to improve the intuitiveness of product modelling. At the institute for Product Development at the TU-Munich a 3D-Sketching-System using Virtual Reality technology has been developed. For proprietary CAD-Systems it is nearly impossible to get access to the source code, making the integration of VR-modelling very difficult. Another disadvantage of proprietary systems is their high price. In contrast open source software gives users the opportunity to freely adapt functions to fit their individual needs. A renowned open source CAD-System is Open CASCADE. In the following paper we will describe our experiences with the integration of our 3D-Sketcher into Open CASCADE. Further we will discuss how we are going to realize a low-cost VR-CAD-System using open source software and self-made low-cost-VR-devices.

Full Article: VC2005115

Contribution 3

Title: Development of Virtual Product Development Platform towards Mass Customization

Authors: M. Chiu, Grier Lin

Key Words: virtual testing, multidisciplinary simulation, product optimisation, virtual product development.

Virtual product development requires the integration of modelling, simulation and visualisation tools that permits a product to be designed

and tested in digital format as a complete system or a composition of its different components. Equipped with the advanced computational capabilities of a virtual product development system, engineers can analyse the product characteristics without the existence of any product in reality. This approach enables the optimisation of a product design without repeating the traditional lengthy routes of design-prototype-test. Therefore, expenses on physical prototyping and testing can be minimised. In addition, more product features can be tweaked to satisfy customised product specifications. To this end, an effective virtual product development system will be one of the critical enablers to help manufacturers transform ideas into profitable products and deliver fast and reliable solutions. The present paper reviews some of the recent developments in CAD/CAE, and discusses the architecture of an integrated virtual product testing system, with particular emphasis on its role in optimising the product development process towards the manufacturing strategy of mass customisation.

Full Article: VC200596

Contribution 4

Title: A Tool for the Interactive Mesh Refinement in Virtual Environments

Authors: R. De Amicis, T.Ingrassia, A.Mancuso

Key Words: virtual reality, finite element analysis, mesh refinement.

Nowadays, the use of innovative visualization technologies provides several starting points for the development of new applications, for all the problems of the product design process: from the concept design to the virtual prototypes getting ready and testing. This research project, using the virtual reality (VR) technique, seeks to give the engineer a tool that allows him to analyse, in the best way, finite element analysis (FEA) results during the post processing stage. Even though almost all the commercial finite element method (FEM) packages have some modules for the results analysis, in each of them there is no truly user-friendly interface that allows the designer to make the most of his potentiality. For this reason a platform, allowing to carry out interactive mesh refinements in a virtual environment, has been developed. With this tool

the user can analyse the FEM model in VR environment, selects some model parts where to refine the mesh, and, finally, see the new results. Using VR environment stimulates the human ability in detecting and estimating the (real) surrounding world, so it's possible to achieve better results in shorter time, because the designer understands, in a better and faster way, where to operate.

Full Article: VC200534

6.2 Collaboration in Interactive Design

Contribution 1

Title: Collaborative Tools integration Into Design Process

Authors: C. Merlo, J. Legardeur, X. Fischer

Key Words: collaboration, digital mock up, interactive design, design co-ordination, product data management.

Design is a complex process that relies on several collaborative sub-processes. Collaboration is also a complex mechanism combining co-ordination actions and co-operation situations. Collaborative tools actually used in design process such as DMU tools, project review tools or PDM systems facilitate the collaboration between actors. Nevertheless an efficient collaboration depends on human, social and cultural aspects more than on technical aspects. It must be prepared through an adequate co-ordination of design activities and actors design context.

Full Article: VC2005002

Contribution 2

Title: Secure Cooperative Visualization and Verification over Internet for Decision Support in Product Design

Authors: F.J. Ridruejo, D. Borro, I. Griego, I. Aguinaga, L. Matey

Key Words: virtual reality, collaborative design, cooperative visualization.

The use of cooperative tools in order to communicate different people involved in design processes is growing nowadays. We present a generic software tool to support the cooperative visualization and verification of virtual Mock-Ups of mechanical systems. The application is able to visualize very complex and large models which other CAD applications have problems even on loading. It provides analysis and visualization techniques that favour the discussion of the users of the models. One of the most valuable resources of many engineering companies are their CAD models. Thus communication security of the data transmitted is of vital importance in any industrial use. Real-Time communications are required even for low bandwidth connections over the Internet. The communication architecture of the application also enables the transparent connection, disconnection of new users to a collaborative session, and role interchange between different users.

Full Article: VC200553

Contribution 3

Title: From a Collaborative Virtual Environment concept toward an industrial prototype for CAD project reviewing

Authors: P. Le Mer, F. Laborie, D. Jacquemond, M. Echalié, D. Pavy, S. Louis Dit Picard

Key Words: collaborative virtual environment, distributed architecture, project reviewing, experimental approach, conception use-cases.

Collaborative tools are more and more required in design processes which imply several industrial teams. Existing tools have technical, ergonomic and economical limitations mainly due to: size of data files, use of various design software, network bite rate, data confidentiality, etc. In order to overcome these issues, France Telecom R&D and INRIA Futurs/LIFL have performed a collaborative platform called Spin3D. It is based on Virtual Reality and on a distributed networked architecture. Thanks to a programming interface mechanism, it allows to develop new synchronous CSCW applications. According to our first results, Spin 3D could be considered as a very promising alternative to current tools

based on application sharing techniques. One application that we are currently developing is dedicated to CAD project reviewing. In this paper we describe the technical architecture and present the first experimental results. A comparison with application sharing technique was carried out in collaboration with EADS on their use-cases. Two key points were particularly discussed: The first one concerns the influence of network Quality of Service (traffic delay, congestion, priority queuing, etc.) and the studies on algorithms for solving them. The second one is related to the new interaction concepts necessary for designing the virtual environment interface for industrial requirements: private view, user representation, feedbacks, etc.

Full Article: VC200568

Contribution 4

Title: Methodology Integration Along The Product Development Process: A Case Study

Authors: D. Regazzoni, C. Rizzi

Key Words: innovation, PLM, Triz, modularity.

Systematic innovation is becoming more and more a must for those enterprises that consider the product development process a core competency. The capability of managing the evolution of a product during its life cycle has already showed its dramatic potential in great companies and SMEs are now starting to gain benefits from the introduction of PLM solutions. The aim of this paper is to illustrate new methodologies and tools involving several aspects of products and processes in a product life-cycle management context. In particular among the methodologies that can be adopted to support conceptual design and management of product variants, Triz methodology has been fruitfully employed, together with other tools (such as Design for Modularity or Lean Manufacturing) to create a new paradigm of product development. A step by step roadmap has been created to guide technicians along some of the phases of product life cycle in order to decrease time to market of customized products paying attention to cost and increasing quality standards. A case study in the field of electrical household appliances shows the huge potential benefits of the integrated usage of Triz methodology along with Design for Modularity.

Full Article: VC2005155

6.3 Virtual Techniques for Process Management and Organization

Contribution 1

Title: PLM Supporting Collaborative Functional Design

Author: M. Tollenaere

Key Words: product model, design process model, functional design, knowledge management, customer requirements, project memory, collaborative design.

The paper presents a framework that aims to enhance collaboration and knowledge reuse in early phases of design. It is made of a generic product model that captures product knowledge for a class of design problems, and a generic project model that allows a representation of actors, tasks and design processes. The framework has been used in two different applications in the automotive industry: the routine design of assisted steering systems and the design of ergonomic requirements. Some open research issues follow the presentation of those applications.

Full Article: VC2005003

Contribution 2

Title: Collaborative Decision in Shared Environments: Airport Management Application

Authors: D. Lourdeaux, B. Stanciulescu, Ph. Fuchs

Key Words: 3D visualisation, airport traffic, real-time, GPS, tablet-PC.

The main challenge for the air companies and airport authorities are facing today resides in a good flight schedule management and timing. To improve this management and the efficiency in airport, we help airport people to understand the activity management, by providing a real time three-dimensional view in of the airport. The present contribution presents the VisuAirport project. VisuAirport proposes to several air-

port professional branches the 3D vision of their working environment, adapted to their needs: the sight of the airport, the landing strips, the areas of circulation and parking, the airport infrastructure, planes evolving on the airport and other vehicles evolving on the airport. The main interested professionals are the ground agents, especially those in charge with the plane operations and the persons in charge with the airports. The tool proposes a 3D vision, which makes possible to any agent an instantaneous synthetic view of the zone of its choice. The airport environment not being fixed, all the vehicles and planes must be localised in real-time, thanks to localization sensors (GPS or others). It is possible to provide synthesized images, rebuilt in real-time, very similar to the real sight. The visual support is an adaptable and multi-functional visual interface, using desktop computers as fixed stations or tablet-PC as mobile working stations.

Full Article: VC200588

Contribution 3

Title: Virtual Fire Safety Environment

Authors: M. Aróstegui, J.M. Fernandez, T. Gutierrez, J.I. Barbero

Key Words: visualization, evacuation, safety, CFD, Fire.

During the last years there is taking place a revolution in the field of Fire Safety. This revolution is inspired in the increasing social sensibility towards the safety of people involved in fires, addressed by the response of the Administration modifying the regulations and codes, encouraged by the new architectural trends, and supported by the advance of the knowledge and the related technologies. This fact involves the necessity of more detailed and complex studies of the evacuation of fire scenarios in safety conditions. It requires an advance in the investigation of the evacuation related fields: the fire spreading analysis and the study of the human behavior. This article shows a realistic and interactive simulation tool which supports the decision making on safety matters, assisting the design and validation of the safety measures and emergency plans in case of fire. The knowledge base of this application is in the design of the numerical models which describe the behavior of the fire, allowing to obtain the evolution of the characteristic variables (temperature, velocity, mass fractions of the combustion effluents,), and in the probabilistic

models which allow showing the behavior of the people present in the building during its evacuation.

Full Article: VC200544

Contribution 4

Title: Animated Cartography, a visual interface to simulate car traffic

Authors: D. Sol, J. Marín, M. Schmid

Key Words: animated cartography, SVG, Popocatépetl Volcano, evacuation, GML, simulation.

Our work describes a model and an application to present the car traffic simulation on the Popocatépetl Volcano zone. Since 1994, Risk Management Office in Mexico has declared around 30 km from the Popocatépetl Volcano crater a danger zone. This office defined several roads to evacuate the people when a Volcano event can be presented. Our application takes data from GML format (Geography Markup Language) describing the simulation car traffic. The system who constructs the simulation was developed for the Fraunhofer FIRSST team in Berlin, Germany. The data are translated to SVG (Scalable Vector Graphics) format to be visualized in a browser and to produce in an animated cartography environment the car traffic simulation on the Popocatépetl Volcano area.

Full Article: VC2005137

6.4 Geometric Modelling Techniques

Contribution 1

Title: Geometric Modelling Techniques: Going natural

Author: P. Reuter

Key Words: geometric modelling, surface representations, parametric surfaces, sketching, virtual environments.

Geometric modelling is concerned with the efficient acquisition, rep-

resentation, manipulation, reconstruction and analysis of 3-dimensional geometry. The wide range of applications of geometric modelling covers areas ranging from classical computer aided design, reverse engineering and simulation, to computer graphics, scientific visualization, medical imaging, multimedia and entertainment. We particularly focus on the modelling of surfaces, i.e. 2-manifolds embedded in 3D space. There is a variety of different representations for surfaces such as parametric or subdivision surfaces, polygonal meshes or point clouds. Nevertheless, in this session we are particularly interested in the modelling of parametric surfaces defined by control points, either from scratch or by modification, as well as its conversion into polygonal meshes.

Full Article: VC2005004

Contribution 2

Title: 3D Modeling System Based on Line Sketch

Authors: Takashi Hirayama, Hideki Aoyama

Key Words: CAD, line sketch, 3D model, silhouette line, desired line.

As the design of products is getting paid attention, many kinds of product should be turned out within a short term. In such a situation, many computer-aided design (CAD) systems are being developed one after another for modeling the desired product forms and they are proving useful for increasing design efficiency. However, it is often difficult to use computers to aid aesthetic design because form designs are the creation of designers and strongly depend on their sense of beauty. In the initial designing process of external forms of products, the designer embodies the form from his or her image and concept of the targeted product by drawing line sketches. In this study, an algorithm was proposed to realize easy construction of 3D digital models using the silhouette and boundary lines hand-sketched by designers. The system developed in this study consists of a 3D modeling system, technical evaluation system of a curve, a morphing system which can propose various form solutions for products, and a system which selects a desired line from a group of lines automatically by evaluating pressure and acceleration of the pen, curvature, and frequency characteristic.

Full Article: VC200580

Contribution 3

Title: Finite Elements Re-Analysis in Virtual Reality Environments

Authors: R. De Amicis, F.Cappello, T.Ingrassia, A.Mancuso, V.Nigrelli

Key Words: virtual reality, finite element analysis, interactive stress re-analysis, NURBS manipulation.

Applying virtual reality (VR) to numerical analysis (finite element FE or fluid dynamics - CFD) produces considerable advantages, both for costs and for quality, in the mechanical engineering design process. Generally, during the stage of structural tests, after carrying out the CAD model, the designer runs FE and/or CFD analysis. Clearly, hardly ever, the obtained results are satisfactory during the first iteration, so the designer, after having analysed the first data, needs to modify some of the model parts and to carry out a new analysis. Such re-analysis process is very improved and faster if it is carried out in a virtual reality environment, that because using the virtual reality technique the designers can use, in a natural way, head and hand motions to view the results and modify the design. In this paper a tool, that allows engineers to carry out interactive stress re-analysis in a virtual reality environment, was developed. Thanks to this system, the designer can, operating directly on the tridimensional model in VR, modify the parts on which some changes are necessary, and see, after having made the above-mentioned modifications, the new finite element analysis results.

Full Article: VC200535

Contribution 4

Title: FEA-Driven Geometric Modeling for Meshless Methods

Authors: O. Ruiz, M. Garcia, M. Granados, C. Cadavid

Key Words: meshless methods, geometric modeling, orthogonal boolean operations, fix grid.

Meshless methods for Finite Element Analysis include the immersion or representation of a Boundary Representation of the object to analyze using a fixed grid or orthogonal array of regular equally sized cells. The array cells are labeled as being inside, outside or neither inside or outside (I, O, NIO respectively). More importantly, for NIO cells a complete Boundary Representation is required to set up the structural, thermal or other equations. Traditional methods of solid modeling boolean operations are inconvenient in this domain, since the number of solid solid intersections is $O(N^3)$ (N: number of cells per X, Y, or Z axis of the fixed grid). Therefore, 2-manifold construction techniques, suited for orthogonally placed solids (the cells) against flat faced polyhedra (the solid to analyze) are presented in this paper, which speed up the representation of an arbitrary solid by using I, O and NIO cells. The algorithms and results of such a representation are presented, along with applications of the representation in FEA scenarios. The implementation of the algorithms uses a paradigm with exact arithmetic through the CGAL (Computational Geometry Algorithm Library).

Full Article: VC200597

6.5 Virtual Techniques for Architecture

Contribution 1

Title: Multiple Realities of Virtual Architecture

Authors: P. Leclercq, G. Martin

Key Words: architectural design, virtual reality, new technologies for design, modelling and computer aided design.

The paper provides a short review of the virtual reality uses currently available in architecture. From a selection of examples in the forefront of technology, it illustrates the contribution of digital technologies in the work of architects.

Full Article: VC2005005

Contribution 2

Title: Feature-Based Decomposition of Facades

Authors: D. Finkenzerler, J. Bender, A. Schmitt

Key Words: virtual architecture, procedural modelling, geometrical algorithms and data structures, computer-aided design, virtual reality.

With advances in computer hardware, virtual environments become significant larger and more complex. Therefore the modelling of virtual worlds, e.g. for computer animation and games becomes increasingly time and resource consuming. In architectural settings facade features are influenced by the underlying geometrical structure or even by other facade structures, e.g. facade edges made of large stones influence the adjacent walls. To achieve an aesthetic look of the facade adjacent structures must be seamlessly aligned. The modelling of such structures is tedious work. With our approach only a few basic parameters are needed to create highly detailed facades. This relieves the designer from difficult modelling tasks and gives him more high level control. In this paper we describe a hierarchical decomposition of architectural facade features. With an order relation on it we represent the interdependencies between the facade features and introduce a geometry generator for them. We then present a strategy for a floor plan representation that permits arbitrary floor plan outlines. This simplifies the roof generation for different roof types in an easy way to achieve an aesthetic goal. With our approach every building in a large VR city looks different but shows a high grade on architectural details.

Full Article: VC200577

Contribution 3

Title: A Virtual Desktops First Evaluations for An Augmented Design Process

Authors: S. Safin, C. Boulanger, P. Leclercq

Key Words: augmented design process, Human Computer Interaction in Design, sketch based modelling, self-generated model, building engineering.

Many CAD tools already allow to create and manipulate directly ideas in a digital way. However designers still use the pen and paper technique during the early design phase of their projects. Indeed, existing CAD tools constraint the creative work : with their interaction mode, based on intention declaration (the fastidious menus), they strongly limit the freedom of action. They also impose on a high precision level and do not consider ambiguity and abstraction. There is a need for a spontaneous human computer interaction in design computing. In order to answer to this need, we develop an integrated aided design tool based on an Virtual Desktop. Our environment is composed of a mixed software and hardware solution which offers:

- the natural aspect of digital freehand sketching,
- the ability of drawing interpretation and spontaneously generating a semantic 3D model,
- the direct model manipulation and evaluation of performances (presently in building engineering).

Following the disappearing computer wave, the Virtual Desktop consists of a augmented virtual reality offering a reactive work space. The designer sits in front of a classical desktop where s/he can create and manipulate drawings and generated models (the paper will give the technical description of the device and its way of use). The paper then relates in details the observations made from an experiment about the use of the Virtual Desktop by a professional designer. That experiment demonstrates that the immersive aspect of our system interface modifies the relation existing between the designer and his/her model and, this way, its generates a new type of augmented interaction. The conclusions first underline the advantages and the limitations brought by our environment. Then we indicate the current developments (about the gesture modality) and the new opportunities for a collaborative design process, based on shared digital sketches.

6.6 Interactive Methods for Risk Prevention and Training

Contribution 1

Title: Virtual Reality, Human Factors and Safety-Related Issues: the VIRTUALIS Project

Authors: J.M. Burkhardt, P. Cabon, C. Gounelle

Key Words: safety analysis, Ergonomics, human-factors, training, virtual environment, user-centred design.

Over the past years, Hazards reduction and Safety has not received as much interest by the VR community than training and virtual prototyping did. It is recently that the idea of VR technology to address safety-related issues has gained in force. At the European level, the VIRTUALIS project aims to reduce hazards in production and storage sites by addressing end-users practical safety issues by means of VR. Today, experts and researchers usually agree to promote a systemic analysis of socio-technical systems with an equivalent emphasis on human-factors, technological function and organisational condition First inventories provide end-users and designers with a sample of situations to think about potential applications of VR for safety, either for the safety objectives, either for the VR functions. User-centred methods should improve utility, usability and acceptability of VEs. Moreover, they provide a source for innovation and research. Finally, two more practical reasons are evoked.

Full Article: VC2005006

Contribution 2

Title: Dynamic Risk Index in a Virtual Work Environment

Authors: J. Marsot, J. Ciccotelli

Key Words: virtual , risk, prevention, design, work equipment.

With application of the principles of safety integration in mind, designers of work equipment must, in order to improve the safety level of the products they design, imagine the future situations of use and es-

timate a priori the associated levels of risk. Virtual reality techniques contribute to achieving this objective. This article, presenting a feasibility study, describes the contribution of a dynamic risk indexing tool associated with these techniques. After a brief reminder of the problem, the article examines the concepts of a generic model that, depending on the socio-technical components, allows the estimation of a work situation risk index. It then goes on to describe how this model is coupled to a virtual work environment, the role of which is to better understand future work situations by physically immersing the user in the design cycle. Finally, through examples of industrial machinery, we show how this risk index enables the designer to assess the relevance of his or her choices and thus to react retrospectively on the design even before production of an initial physical prototype.

Full Article: VC2005163

Contribution 3

Title: Fork-Lift Truck Simulator For Training In Industrial Environments

Authors: M. Bergamasco, C.A. Avizzano , S. Perotti , A. Frisoli, M. Angerilli, M. Carrozzino

Key Words: fork-lift, simulator, platform, wash-out, architecture.

Since their first usage simulators have been employed in training staff in civil aeronautics and in military fields to improve driving skills without compromising safety of people and machines. The system proposed in this paper is suited to transfer this activity into the industrial field, in particular an innovative fork-lift simulator is presented. Actually most frequent causes of accident with fork-lifts are wrong manoeuvres accomplished by drivers. This simulator aims to improve skills in driving and handling materials using a fork-lift. The system can replicate inertial feedback on the operator and allows the user to control all the tasks of a fork-lift as driving and handling materials. The paper presents an overall view of the system including Stewart platform, supporting structure, physical based model, wash-out filter, system architecture and a video system mounted on board of the moving platform.

Full Article: VC2005138

Contribution 4

Title: A Numerical Control Lathe Made on a Virtual Reality Environment

Authors: P.J. Murcia Pacheco, A. Sanz Lobera, I. Sanz Lopez, E.M. Rubio Alvir

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

The conception of the Virtual Reality as a sensorial interface between the user and the simulation model can be more interesting when learning objectives are persecuted or when the use of equipment implies risk, either for the user, or for the own equipment. The use of Numerical Control Machine Tools involves both circumstances previously indicated. Besides, a high investment is needed for the equipment. Therefore, the creation of simulation models applied to this kind of machines are specially interesting since it allows, in addition to a safe learning of its operation and its behaviour in good condition, the possibility of establishing the repercussion that its implantation can suppose in more complex systems. The present paper shows the creation of a Numerical Control Lathe, based on a real lathe. Geometric modelling of lathe elements, drives and actuators behaviour or numerical control implementation are some of the features implemented in the object oriented model built on Virtools Dev[®] and Visual C++[®].

Full Article: VC2005110

6.7 Interactive Manipulation in Virtual Environments

Contribution 1

Title: Interactive Manipulation in Virtual Environments

Author: V. Larios Rosillo

Key Words: interactive manipulation, interactive virtual reality environments, haptic interfaces, planning.

Virtual Reality Environments need to integrate effective techniques to manipulate objects. The interaction covers the haptic and visual aids in the virtual environments. Haptic interfaces use can improve the interaction helping to identify the intention of the user to adapt the visual interface to help in the manipulation operation. Also, when haptic interfaces integrate physical behaviour simulation, the users have more feedback to interact with other users. The aim is to briefly describe these techniques as well as some algorithms to predict and automate some of the interaction processes when an object is manipulated. A combination of haptic devices and algorithms, depending on the application desired can give an important support for better interaction. This paper presents an overview of such techniques.

Full Article: VC2005007

Contribution 2

Title: SAMIRA : A Platform for Virtual Maintenance Simulation with Haptic Feedback incorporating a model preparation process

Authors: G. Drieux, F. Guillaume, J-C. Léon, N. Chevassus

Key Words: maintenance simulation, haptic feedback, design integration, data preparation.

We present here the SAMIRA platform which was developed by EADS Corporate Research Center for the virtual simulation of maintenance tasks. It is composed of a 3D virtual environment for interactive manipulation with physics and collision detection, and a 6-degrees-of-freedom (DoF) force feedback arm for haptic manipulation. This platform is intended to be used within a design environment to support engineers in their activity.

As a result, a big part of the job has been done on the integration of such a platform with the constraints of a real industrial design process, particularly for the adaptation and optimization of 3D models of the virtual prototypes to be tested.

Methods and criteria have been setup to allow a fast and robust preparation of 3D models, issued from CAD data, to the needs and the constraints of the SAMIRA application.

In our paper we first briefly describe the SAMIRA platform and explain its architecture. In a second part we focus on the matter of 3D

models adaptation for maintenance simulation and haptic feedback, and we present a framework for the systematic preparation of 3D models according to the application specificities.

Full Article: VC2005150

Contribution 3

Title: Human-Computer Interactions with Motion Capture for Virtual Reality Applications

Authors: M. Pouliquen, Y. Pinczon du Sel, A. Bernard, J. Marsot, L. Chodorge

Key Words: human-computer interactions, human model, virtual reality, physically-based animation, motion capture.

Motion capture has become a widespread technique to animate characters in virtual environments. To get a good feeling of immersion and a good interaction, it is essential to control human motion. We address the problem of motion driving for interactive human-like characters for virtual reality applications such as design for a better integration safety and health requirements, or training for increasing the safety awareness of the operators. As the hand is the main interface to the environment in daily life, we focus on the problem of hand tracking. After summarizing the different techniques used to animate characters, we present our virtual environment : a virtual press-brake. This dynamic simulation is coupled with virtual polyarticulated hands using a system of motion capture and data gloves. We use a biomechanically-based model of the hand. It is highly constrained with 28 degrees of freedom. We propose a very stable and robust algorithm to allow the operator interacting in real-time with the virtual press-brake or the metal sheet. Thus, we detail how our controller matches the 3D Cartesian positions into articular torques for each hand joint. Even if our algorithm is developed for industrial applications, it can be used in whatever environment.

Full Article: VC200551

Contribution 4

Title: Dynamic Virtual Environment of an Excavator Training System for Digging Tasks

Authors: H. I. Torres-Rodriguez, V. Parra-Vega, F.J. Ruiz-Sanchez

Key Words: haptic interface, anthropomorphic, Virtual environment.

In this paper we present a description of the development platform to simulate the dynamical behaviour of an excavator in a virtual environment operated with an anthropomorphic haptic interface. The full system consists of the dynamical models of the excavator and the interaction with rigid and deformable environments in a Java 3D environment with a tridimensional model of the excavator, and an anthropomorphic six degree of freedom haptic interface with active sliding masses to compensation of gravitational effects. The excavator model, obtained under Euler-Lagrange formulation, introduces mechanical effects of the hydraulic actuators in the form of new dynamics terms. The interaction between excavator and a rigid soil is modelled as an extended Euler-Lagrange equation with holonomic constraint that results in a system of algebraic differential equations. On the other hand, the interaction with deformable surfaces is modelled as a dynamic mesh that changes its form (nodes and branches) according to a rule based on the direct kinematics of the excavator. We include some results employing a robust non linear PID force-position tracking control.

Full Article: VC2005140

6.8 Interactive Approach in Manufacturing

Contribution 1

Title: Interactive Approach in Manufacturing

Author: A. Bernard

Key Words: virtual manufacturing, process simulation, technological modelling, virtual reality.

The industrial context is in favour of a highest frequency for new product design. It is now well known that the design offices spend a long time creating new products with a very low percentage of them being commercialised. This is the same for subcontractors that reply to many

proposals but obtain only 5 to 10% of contracts. What are the consequences of such kind of evolution? The most important one is related to the necessity of validating the life-cycle issues of the product. This means that design offices have to be able to create products with respect to manufacturability, maintainability, disassemblability, etc in a cost objective approach. The main consequence of such requirements concerns the tools that are needed for such design and validation process. The tools have to integrate many new functionalities that allow the designer manipulating integrated models in a coherent environment. In addition, a PDM system enables to manage the information management within the project team working on a given product, sometimes on product families having the same platforms or being manufacture on the same production systems. But these elements are still limited and are not enough in a way of global validation of the product life cycle.

Full Article: VC2005008

Contribution 2

Title: Realistic Machine Behaviour in Virtual Reality

Authors: M.F. Zäh, M. Spitzweg, U. Munzert, W. Vogl

Key Words: virtual reality, hardware-in-the-loop, physics simulation, robot cell, control device hardware.

The article shows an integrated development platform in form of a virtual reality environment combined with Hardware-in-the-loop-technologies. The connection between the virtual reality environment and the real control device hardware is the basis of a virtual environment, where collaboration among mechanical, electrical and control engineers is supported without requiring the real machines. The feasibility of this approach is demonstrated with a software prototype of a virtual assembly robot cell as example.

Full Article: VC200575

Contribution 3

Title: A Proposal For a Virtual Reality Environment For Plastic Injection Engineering

Authors: I. García, T. Porcel, J.L. Ajuria, J.D. Gómez de Segura, J. Guasch

Key Words: virtual environments, simulation, plastic injection, mould design and manufacturing.

EUVE and ASCAMM have been working together in order to explore the real possibilities of developing a virtual reality based interface for plastic injection industry. The project has been carried out in two phases. First phase of the project defined a virtual environment for mould injection process simulation visualization. In this virtual environment it can be seen the simulation of the plastic injection process, integrating the output of a commercial simulation application. The purpose was to develop a virtual environment for training people, reducing the use of real machines during training. The second phase developed the prototype previously defined, and analysed the possibility of a virtual environment for mould design, simulation and manufacturing, in order to integrate all engineering activities related with mould design and manufacturing, and simulation of the injection process. In this second phase it has been carried out an analysis of current state of the technologies and it is proposed and architecture for this virtual environment. The purpose of this phase is more ambitious. The intention of the paper is to show the prototype for the simulation of the process and to shown the architecture defined and that will be implemented in a prototype during 2005.

Full Article: VC200594

6.9 Virtual Prototyping

Contribution 1

Title: A Practitioners view Of Virtual Prototyping

Author: P. Huang

Key Words: virtual prototype, virtual prototyping, physics attributes, virtual environment, human system integration.

The term virtual prototyping has been widely used by various indus-

tries. This paper states the view from an industry practitioner who has used virtual prototyping because of necessity then became a firm believer of it. When it was applied correctly, virtual prototyping can save substantial time and resources and in many situations, virtual prototyping may also be the only option to complete a projects/program. This author has seen the evolution of virtual prototyping from its humble start, very crude constructed virtual prototypes were used in the early days, to the modern prototype, possessing all relevant physics attributes, and presenting it in a well orchestrated setting. New viewing capabilities provide such a realistic feeling that it blurs the line between reality and virtual environment. In this paper, the author reports the results from several programs/activities that virtual prototyping were used successfully.

Full Article: VC2005009

Contribution 2

Title: Virtual Prototyping in the Design of Brazed Aluminium Plate-Fin Heat Exchangers

Authors: F. Bilteryst, M. Lazard, P. Corvisier, I. Lewon

Key Words: heat exchanger, Finite element-volume simulation.

The design and manufacturing of multi-stream brazed aluminium plate-fin heat exchangers is a very competitive domain. The continuous challenge for a manufacturer such as Nordon Cryogenie (France) is to continuously adapt the equipments to meet the new requirements of the market by developing new types of heat transfer exchangers and by constantly updating the design and manufacturing related technologies. So, a large variety of cryogenic processes have been made possible due to the brazed heat exchangers. The present paper deals with some VR applications deployed into a recent research and development program in partnership with Nordon Cryogenie. More specifically, we focus on the integrating role played by virtual reality in the post processing of simulations based on Finite Element Methods or Finite Volume Methods. The combined visualization of these results gives a better understanding of the complex coupled structural/fluid behavior during the heat exchange of the turbulent circulating fluids.

Full Article: VC200532

Contribution 3

Title: To Interactively Assemble Virtual Mechatronic Prototypes in VR Environment

Authors: Qing Shen, M. Grafe, J. Bauch, R. Radkowski

Key Words: virtual reality, mechatronic system, solution elements, virtual prototyping, interactive assembly.

The challenges of future mechatronic systems call for a more reliable and efficient design method. In order to resolve the problem, Solution Elements (SE) are used in the design. These elements encapsulate engineering expertise which reuse proved solutions for new design tasks. Solution elements can be mechanical components as well as electronic assemblies and mechatronic function modules. This concept applies to the customization and variant construction as well as to new designs. Additionally, how to comprise the mechatronic parts in virtual prototyping system still attract the researchers' sight. Since SE already contains engineering expertise, a certain Typed Ports are also predefined for assembling them. These ports are defined by extending and combining the basic concepts of electrical ports and physical covariants. They are typed interfaces of solution elements to connect to other solution elements and used for mechanical connection, electronic connection and information flow in VR environment. In this paper we present our idea of how to interactively assemble SE in the virtual reality environment, the design method of SE based mechatronic prototypes and how the system support collaborative work. To evaluate the theory, a prototype of our virtual prototyping system is also introduced in the end of the paper.

Full Article: VC200543

Contribution 4

Title: Integration of a Balanced Virtual Manikin in a Virtual Reality Platform Aimed at Virtual Prototyping

Authors: A. Micaelli, X. Merlhiot, C. Andriot, F. Guillaume, N. Chevassus, D. Chablat, P. Chedmail

Key Words: manikin, virtual human, virtual prototyping, environment, interaction.

We have made a virtual human animation package aimed at virtual prototyping. We implemented an interactive control through a motion capture system. This article is dedicated to the explanation of the technical choices we made so as to develop the package. It allows to animate in an interactive way a virtual human interacting with its environment in such a way that the manikin is prevented from penetrating its environment, moreover it allows to manipulate tools, push buttons, turn levers. There are two main problems to deal with: contact, and redundancy management. No existing solution completely addresses the problem. The most natural way to interact with the environment is to compute contact forces. The simplest way to deal with forces is to use a first order dynamic model, also called pseudo-static. We used the results of Munthe-Kass, which allow to integrate in a stable way, on Lie groups. Our contact is managed thanks to an LCP as stated by Ruspini. We introduce a new way to manage redundancy on first order dynamics models, through a multi-tasks prioritised scheme. Finally we will conclude this article with the application of the system we have developed on an interactive virtual cockpit example.

Full Article: VC200573

6.10 Simulation in Interactive Design

Contribution 1

Title: Simulation in Interactive Design

Author: P. Sébastien

Key Words: model reduction, model qualification, interactive modelling.

Decision support systems and real time simulation for interactive design in virtual environments are facing with major difficulties related to knowledge modelling and simulation of complex physical environments. Interactive design is currently limited by the knowledge modeling process of complex systems. A general approach of the model adaptation problem to interactive design applications still lacks. Most of the model

adaptation methods are dedicated to specific domains of physics analysis as they are based on mathematical transformations linked to physics phenomena. However, model adaptation methods may be classified in four main categories: - Parsimonious approximation methods are based on analytical or numerical integration approaches. These mathematical methods tend to increase the parsimony of models by increasing the model specialization. The precision and exactness of models are lowly altered throughout the adaptation process, - Mixed methods increase the parsimony of models by adapting both model specialization and precision. These methods may be based on mathematical, physics and technological considerations to manage the precision of some of the model parameters, - Analogical methods are based on the analogy between different physics models. Model exactness is altered by the physics analogy but may be improved by limiting the application range of the model or by introducing imprecise parameters within the model, - Standardization methods are based on the restriction of the model range of application to punctual domains. These punctual domains correspond to standard configurations of the system being investigated. The standardization process highly limits the application range of the model to application cases and therefore highly increases the model parsimony and specialization. The aims to investigate recent developments in knowledge modeling and system simulation for interactive concerned with: - Physics-based cloth modelling system for the virtual prototyping of garments, - Inverse modeling and VR animation for the Virtual prototyping (VP) tools of wheel loaders - The development of an integrated CAD, CAE and Virtual environment for 3D visualization of cracks in aircrafts structures.

Full Article: VC20050010

Contribution 2

Title: Computer-aided Apparel Tailoring with Virtual Simulation

Authors: M. Fontana, C. Rizzi, U. Cugini

Key Words: apparel design, tailoring features, physics-based modelling, virtual simulation.

Cloth modelling is a challenging issue, of increasing interest for computer animation and computer-aided design purposes. Although several

methods and tools already exist for cloth modelling and visualization, industrial manufacturers still claim a general lack of CAD-oriented systems, to assist the cloth design and manufacturing process and make it faster. To this aim, we have developed a cloth modelling system with physics-based simulation, targeted at the virtual prototyping of garments of real interest and production. The system should allow designers to validate their styling/design choices on a digital apparel model before (or in place of) any physical prototyping. Taking into account the design complexity of real tailored apparel, 2D CAD apparel models can be defined that incorporate information about tailoring/assembly features. A graphical interface allows a user to create his/her tailored garment by interactively specifying design elements such as layers, seams, pockets, constraints, aesthetic and functional lines. A discrete Newtonian particle-based model is considered for physics-based cloth simulation, originally defined for single textile layers and then extended to real-shaped apparel, by taking into account structural properties of materials and the previously defined design/assembly rules. Several garment models are proposed as test cases, designed for real apparel manufacturing, and simulated on virtual mannequins.

Full Article: VC200582

Contribution 3

Title: Visualization of Cracks in a hybrid CAD, CAE, and Virtual Environment

Authors: A. Roncalli Oliveira Guerra, J. Beverage, F. L. Van Scoy, B. Kang

Key Words: visualization of cracks, virtual reality, CAD/CAE interface.

Varying loads and stress cycles may cause the structural cracking or fatigue cracking. Some environments factors like saltwater, humid air, and sump water can also produce cracks due to corrosion. Among the NDT approaches for detecting defects, the most commonly used today are: ultrasonic method, visual methods, radiography, liquid penetrant method, and Eddy current method. Despite the NDT chosen, if microcracks or even small cracks (1.1 to 5.7mm in size) are being investigated it becomes harder to both detect and visualize them. This work intends to help overcome this difficulty by designing and developing an integrated

CAD, CAE and Virtual environment for 3D visualization of cracks in aircrafts structures. The CrackView environment is a hybrid system that provides an online integration with a commercial FEM package. The system improves the cracks 3D visualization by automatically generating a virtual model to be proper zoomed and displayed through virtual reality facilities.

Full Article: VC2005165

Contribution 4

Title: Reality-Driven Virtual Wheel Loader Operation

Authors: Kjell Andersson, Ulf Sellgren

Key Words: virtual prototyping, inverse modeling, FE, MBS, visualization.

Virtual prototyping (VP) tools enable us to investigate, explore, and communicate the performance and behavior of an evolving product and thus reduce the number of physical prototypes needed. FE- and MBS tools are frequently used for Virtual Prototyping in mechanical engineering today. It is well known that that these kinds of tools can be an effective means to support the process of problem identification, concept verification, and detailed optimization. In order to increase the benefit of VP tools in industry there is a need to develop supporting methods for situated modeling, efficient simulation, and visualization based on Virtual Reality (VR) technology. In this paper we have concentrated on development of methods for inverse modeling and VR animation. The presented method is illustrated with simulation and visualization of internal dynamic forces in a wheel loader when excavating granulated material, e.g. gravel or seed.

Full Article: VC200545

6.11 Assembly and Collision Simulation

Contribution 1

Title: Assembly and Collision Simulation

Author: F. Bennis

Key Words: assembly, simulation, collision, virtual reality.

Design for assembly is the evaluation of different aspects of product assembly considerations during the design stage. These evaluations include assemblability, disassemblability, part accessibility, and part layout. The simulation tools provide powerful solutions for planning and designing of complex assembly facilities, lines and workplaces. It should assist designers with assembly considerations throughout the phases of a products design -from conception to the final process plan development. Two main approaches are commonly used: the automatic path planning and the simulations through robotic or virtual reality tools. These approaches deal with the definition of collision free trajectories for solid objects.

Full Article: VC20050011

Contribution 2

Title: Constraint Based Virtual Conceptual Design

Authors: G. Brunetti, P. Schneider, A. Stork

Key Words: conceptual design, embodiment design, constraint-based assembly modelling, kinematics simulation of mechanisms, virtual reality.

The paper will introduce an approach towards modelling and validation of mechanisms in the conceptual design phase applying virtual reality techniques and kinematics simulation. The presented system allows to interactively assemble mechanisms and to experience its behaviour within the same process. The described approach incrementally builds kinematic chains reducing stepwise degrees of freedom. Kinematics is expressed in terms of geometric constraints, which are solved in real-time during interaction with the virtual prototype. The result is exported to CAD and represents the embodiment of the mechanism to be further detailed in subsequent downstream applications.

Full Article: VC2005145

Contribution 3

Title: An Impulse-Based Dynamic Simulation System for VR Applications

Authors: J. Bender, D. Finkenzeller, A. Schmitt

Key Words: VR-system, dynamic simulation, impulse-based method, multi body systems .

A VR application with realistic mechanical behaviour has to simulate dynamic effects, to detect collisions and to resolve them in real-time. A description of a VR scene must include the properties of all rigid bodies and the joints between them (e.g. ball joints, hinge joints, servo motors etc.). This paper describes a system for dynamic simulation of linked rigid bodies in real-time. The system was developed to simulate mechanical behaviour in VR applications. An extension for a 3D modelling tool was developed which provides the possibility to model a VR scene including the geometries and mechanical parameters of all rigid bodies and the properties of the joints between them easily. For the dynamic simulation an impulse-based method is used. The distinguishing feature of this method is that all kind of constraints are satisfied with the iterative computation of impulses. The advantage of this iterative technique is that it is fast and accurate results can be achieved. The dynamic simulation system uses efficient collision detection methods. For every collision that is detected a contact region between the objects is determined to provide an accurate collision response.

Full Article: VC2005101

Contribution 4

Title: Proposal of a Methodology for Assembly/Disassembly Simulation of Deformable Parts in a Virtual Reality Environment

Authors: A. Mikchevitch, J.-C. Léon, A. Gousskov

Key Words: assembly, evaluation, flexible parts, mechanical modelling, methodology, virtual reality.

It is important to consider different requirements related to mechani-

cal design, assembly/ disassembly (A/D), maintenance, ergonomics, etc. during the product design process. The use of technologies like Virtual Reality (VR) systems gives a new dimension in terms of efficient development of products. This paper proposes to apply VR technologies to study/optimize complex mechanical systems and, in particular, to simulate the A/D of flexible parts. Virtual A/D manipulations of such parts have to take into account different constraints: real-time simulation requirements, adequate modelling of complex behaviour of flexible parts, particularities of the VR interfaces required, etc. In order to satisfy various constraints of flexible part manipulation, a general methodology for virtual A/D simulation of deformable components is proposed in this paper. The main particularity of the methodology is the use of fast mechanical models of flexible parts adapted to VR devices. Moreover, the proposed methodology takes into account different constraints due to the real-time simulation, the material properties characterisation, the VR interfaces, the CAD model adequacy, the use of specific metaphors, etc. Hence, general consideration of various problems of deformable part simulation in the context of virtual A/D allows to produce realistic data: forces, deformed shape, A/D path, etc.

This information is very useful for efficient and fast study/evaluation process of A/D operation based on different criteria proposed. An example presented in this paper demonstrates the efficiency of the proposed approach with regard to industrial needs.

Full Article: VC200554

6.12 Human Integration in Design

Contribution 1

Title: Integrating the User into the Design Process: Approaches and Challenges

Authors: F. Gamboa Rodriguez, J.L. Pérez Silva

Key Words: user centred design, usability, Human-Machine Interaction.

In this work we review the different approaches that have been proposed to integrate the user into the design process: theories, approaches,

models, methodologies, etc. The aim is to establish a framework that permits the reader to better understand the different works that are reported in the literature, and to point out the challenges of the field.

Full Article: VC20050012

Contribution 2

Title: A New Approach to Participatory Design: Usability Tests in Virtual Environment

Authors: F. Bruno, R.M. Mattanò, M. Muzzupappa, M. Pina

Key Words: virtual reality, usability, user-centred design, interface design

The quality of a user-centred product is strongly influenced by comfort and usability. The usability analyses are usually performed on the physical mock-ups through some tests with the users. But this approach needs the product functionalities have already been defined. Our task is to evaluate the possibility of measuring the usability in virtual environment. So the usability can be evaluated also in the preliminary phases of the product development process, when not all the characteristics of the product have been defined. The usability tests in virtual environment allow the designers to involve the users in the design process, getting important feedback from them and employing these useful information in many decision making tasks. This paper analyzes benefits and problems related to the virtual usability tests. We report the results of a study addressed to determine how the virtual environment influences the results of the tests. We have reproduced in virtual reality the interface of an existing industrial product and we have performed the same test both on the physical product and the virtual one, comparing the results, to determine how the presence of the virtual reality interface modifies the results of the tests with respect to the real ones.

Full Article: VC200560

Contribution 3

Title: An Approach to Evaluate the Ergonomics of Boards of Control

Authors: G. Colombo, F. De Angelis, L. Formentini

Key Words: virtual reality, haptic, ergonomics, controls.

In this work we propose an approach to evaluate the ergonomics of boards of control (with buttons, slide-bars, knobs) for different applications (such as automotive, household appliances and so on), based on integration of virtual prototyping, virtual reality and haptic devices. A first prototype of ergonomic workstation was implemented and it is described in the paper, it consists of a HMD visualizing the product and a haptic device simulating the behavior of different knobs (with continuous adjustment or steps, less or more torque,). The tester, wearing the HMD device, is immersed in a virtual world where the virtual product is visualized, and interacts with its dashboard. The haptic device reproduces the effects of the regulation and the mechanical reaction of the real knob, these effects are exerted by a mechatronic, reprogrammable, specific purpose and specifically designed device. The tester can quickly and easily evaluate different design solutions, modifying geometric model of the knob, and/or programming different reaction laws for the haptic device. In this way, s/he can identify the best one. In the paper we describe the workstation architecture, the haptic device and we discuss also problems related to human body tracking and representation in virtual environment to increase realism of the tests.

Full Article: VC2005148

Contribution 4

Title: Realistic Interaction for Maintainability Tests in Virtual Reality

Authors: G. Di Gironimo, P. Leoncini

Key Words: maintainability, virtual reality, realistic interaction, simulation of physical behaviours.

In a virtual reality environment to be employed for subjective evaluations, the realism of two components, namely visualization and interaction, greatly improves the acceptance of the experience by the user, and rises the reliability of these evaluations.

Looking at the improvement of the visual realism, shadows play the most important role whenever spatial relationship among scene objects

have to be perceived, such as the position of the virtual model of a hand, which user controls through a sensor-equipped glove, with respect to those objects in the environment which he wants to interact with. On the other hand, with the aim to make interactions more realistic, the key is to correctly model the physical behavior of bodies in the virtual environment, which leads to objects that react as most similarly as possible to the real life, both to direct interaction and when forces are conveyed through collisions and kinematics chains. In this work an industrial application experience of a virtual reality system designed with the illustrated key features is given. Such system results from the integration of open-source software, namely a scene graph library, and a real-time simulation engine of rigid body dynamics, which also controls the interaction of user hand with the virtual environment.

Furthermore the implementation of a hardware shadow mapping algorithm, which mostly relies on modern OpenGL graphics card acceleration, makes the use of real-time shadows feasible even with 3D models made of one million of triangles or more, a typical size of complex CAD assemblies.

Carrying out maintainability tests in virtual reality allows bringing in a design, or in some mid-life revamp of a project, the ability for a man to take care of its maintenance lately. In the presented application the described system hasyed, along with sive virtual reality devices (glove, tracker, stereoscopic head-mounted display), to verify the ability to install (mount and connect) a certain subsystem in the executive aircraft Piaggio Aero Industries P180 Avanti, a particularly critical operation since of the limited space in which the work takes place, of the structural constrains, and of shape and dimension of the main component.

Full Article: VC2005166

6.13 Human Being in Virtual Environments

Contribution 1

Title: Human Being in Virtual Environments

Author: J.F. Petiot

Key Words: design, perception, sensation, simulation, interaction.

The last decade has been marked by the introduction of computers in almost every domain of the human activity. The development of human-friendly interfaces allows the creation of virtual environments, with which the human being is able to interact with a high level of complexity. So, Virtual reality thus differs from visual simulation for :

- the ability to deeply interact with the virtual world,
- the idea to put a human within the virtual world (immersion - inclusion) rather than to look at it in the typical out-of-the-window approach that is common in visual simulation applications.

By offering presence simulation to users as an interface metaphor, it allows operators to perform tasks on remote real worlds, computer generated worlds or any combination of both. Moreover, the simulated world does not necessarily have to obey to natural laws of behaviour. Such a statement is the key point of VR and it makes nearly every domain of human activity a candidate for a VR application.

Full Article: VC20050013

Contribution 2

Title: Virtual Reality: a Human Centred Tool for Improving Design and Manufacturing

Authors: F. Bennis, D. Chablat, P. Depince

Key Words: virtual reality, design, optimization, virtual manufacturing, multi-agents system, manikin.

Design and Manufacturing are both using Virtual Reality tools to enhance the product life cycle. Their definitions are still in flux and it is necessary to define their connections. Thus, firstly, we will introduce more closely some definitions where we will find that, if the Virtual Manufacturing concepts originate from machining operations and evolve in this manufacturing area, there exist a lot of applications in different fields such as casting, forging, sheet metalworking and robotics (mechanisms). From the recent projects in Europe or in USA, we notice that the human perception or the simulation of mannequin is more and more needed in both fields. In this context, we have isolated some applications as ergonomic studies, assembly and maintenance simulation, design or training where the virtual reality tools can be applied. Thus, we find

out a family of applications where the virtual reality tools give the engineers the main role in the optimization process. We will illustrate our paper by several examples where virtual reality interfaces are used and combined with optimization tools as multi-agent systems. This work has been done thanks to the EC under framework 5 Thematic network on Manufacturing Technologies (MANTYS).

Full Article: VC200599

Contribution 3

Title: Interactive Visualization of Express Cargo Handling with the ImseCAVE

Authors: H. Lau, L. Chan

Key Words: interactive simulation, imseCAVE, automated material handling, immersive VR.

With the increased in the deployment of automated material handling systems in the ever growing logistics industry in Hong Kong, the design and analysis of these complex systems such as air cargo terminals and distribution centers require effective means for their evaluation. A low cost, versatile immersive virtual reality system known as the imseCAVE has been developed at the University of Hong Kong for the interactive simulation of these complex automated material handling systems. The imseCAVE provides 3-D stereographic imaging on the walls of the system, which is driven by a distributed object-oriented virtual reality engine running on a cluster of PCs connected with a high bandwidth LAN. User interfaces including wireless joysticks, tracking devices, etc. are integrated to provide ergonomic means to interact with the virtual reality models in real-time. With this system, simulation models of a number of cases that involve the evaluation of express cargo handling logistics were undertaken with collaboration with the logistics industry. By mapping the material handling processes in association with the vivid computer graphic entities, system designers, managers and operators can rapidly evaluate their concepts prior to full implementation. In this paper, we describe the architecture of the imseCAVE and present the case studies that were undertaken.

Full Article: VC2005108

Contribution 4

Title: Auditory and Tactile Modalities for a Non Visual Representation: a Blind Sailing Application

Authors: M. Simonnet, J.Y. Guinard, J. Tisseau

Key Words: blind sailors, spatial representation, haptic modality, auditory localisation, cognitive map

We have elaborated a spatial strategy for blind sailors. With auditory information, they can locate the sound buoys along the track. Vocal watches allow time measurement during the course. After some experiments that have isolated these different tools, we can conclude that tactile maps allow stocking accurate tactile pictured representation of the course. However, these do not allow any adjustment as to the boat position during action. Even with a limited precision, the auditory feed back makes turning around the buoys along the track possible for blind people. Because of a space time relation, they can transform a time value into a distance value on the map. This strategy implicates a very important cognitive load. That is why we would like to use virtual reality techniques to up-to-date haptic pieces of information about the position of the boat on a virtual map during sailing.

Full Article: VC200595

6.14 Haptic Systems in Interactive Design

Contribution 1

Title: Haptic Systems for Simulation of Primary Commands of Cars

Authors: A. Frisoli, M. Carrozzino, S. Marcheschi, F. Salsedo, M. Bergamasco

Key Words: interactive digital mock-ups, haptic interfaces, driving simulation, by-wire command systems.

The paper presents the application of haptic systems in automotive

digital mock-ups. In particular it discusses the application of haptic interfaces for the simulation of primary commands, during the ergonomic assessment of internal parts of cars.

Full Article: VC20050014

Contribution 2

Title: New Six Degree-of-Freedom Haptic Device based on the Orthoglide and the Agile Eye

Authors: D. Chablat, P. Wenger

Key Words: haptic device, interface, parallel mechanism, orthoglide, agile eye.

The aim of this paper is to present a new 6DOF haptic device using two parallel mechanisms. The first one, called Orthoglide, provides the translation motions and the second one produces the rotational motions. Thus, these two motions are decoupled to simplify the direct and inverse kinematics, as it is needed for real-times control. To reduce the inertial load, a transmission using two universal joints brings the rotational motions from the base to the end-effector. To justify our design, we will start the paper by a review of the 6DOF haptic devices. We will justify our new device and we will present its kinematic behavior as well as CAD prototype. The main property of the Orthoglide and Agile Eye mechanism is their isotropic configurations. Thus, for the Orthoglide, the length legs and the range limits are optimized to have homogeneous performance throughout the Cartesian workspace. The former has a regular shape that is closed to a cubic workspace. These properties permit to have high stiffness throughout the workspace and workspace limits easily understandable by the user.

Full Article: VC200587

Contribution 3

Title: A Multimodal Human-Scale Virtual Environment

Authors: F.X. Inglese, S. Jeong, P. Richard, M. Sato

Key Words: virtual reality, virtual environment, bimanual interaction, multimodal feedback, product design, maintenance.

This paper presents a multimodal virtual environment for industrial applications. Users interact with virtual products using a human-scale interface called SPIDAR. This interface provides haptic sensation to both hands and is used to display various aspects of force feedback associated mainly with contact, weight, and inertia. Olfactory and auditory displays are used to improve user immersion in the VR simulation or to provide users with sensory feedback. Stereoscopic images are displayed on a retro-projected large screen (2m x 2.5m) and viewed using polarized glasses. Two applications were developed using our system : (1) a maintenance application for automotive industry and (2) a product design application.

Full Article: VC200536

Contribution 4

Title: A Haptic Aesthesis API and Its Application To The Pre-Operative Planning For Total Hip Arthroplasty

Authors: N.G.Tsagarakis, M. Petrone, R. Mayoral, D.G. Caldwell

Key Words: haptic, API, rendering, hip, arthroplasty.

The importance of haptic information, transmitted to the hands and fingers through haptic devices particularly in applications requiring dexterous manipulation is increasingly recognised. Specific applications include virtual prototyping, surgical simulators, medical education and training, surgical planning, scientific analysis and the study and evaluation of new surgical procedures. This paper outlines the design, development, application and testing of a flexible Haptic application programming interface (API). The API uses a multithread architecture and a flexible interface to ease the control of haptic devices and the rendering of haptic related effects. A detailed description of the API architecture is provided presenting the flexibility of the API. A communication API build on top of the TCP/IP interface enables the graphics station application to communicate with the Haptic API through a high level communication protocol and send high-level commands to the haptic server e.g. to load a particular haptic renderer, configure the haptic renderer according to the graphics data or synchronize the properties of the haptic entities with those of the corresponding graphical entities involved in

the renderer. The haptic server receives these high level interaction data from the graphics client, calculates the haptic cues, updates the haptic probe position and sends control commands to the haptic device. The flexibility of the haptic API is presented with the application of the interface in the medical planning procedure of total hip arthroplasty. The haptic renderers specific to this application are presented to demonstrate the ease of integration of the haptic application programming interface.

Full Article: VC200533

6.15 Emotion, Perception and Virtual Reality in Design

Contribution 1

Title: Mutual Awareness in Virtual Environments for Design

Author: I. Thouvenin

Key Words: mutual awareness, collaborative virtual environment, believability of virtual worlds.

Mutual transmission of users faces images fails when it is needed to coordinate a shared task action. None of current systems give the sensation to share a common collaborative environment. We propose a solution based on the principle that the real problem is to access to the interlocutors point of view (and vice versa). This can be realized giving directly the vision of what the others have in front of them.

Full Article: VC20050015

Contribution 2

Title: A Sensorimotor Approach

Author: D. Mestre

Key Words: virtual environments, immersion, presence, ecological validity, transfer.

In a Virtual Environment (VE), Immersion, defined in technical terms,

is capable of producing a sensation of Presence, the sensation of being there (part of the VE), as regards the user (Ijsselsteijn & Riva, 2003). Presence is indeed, historically, at the core of Virtual Reality (VR). Presence has often been conceived as a sign of "ecological validity" of VR devices, also as a sign of potential positive transfer of skills or knowledge learned in a VE to the real world. In this paper, we first present current conceptions of Presence. Secondly, we review current methods for measuring presence, and we emphasize the potential interests of a sensori-motor approach to presence measurement. Finally, we discuss the operational aspects of presence in a design process using VR as a tool.

Contribution 3

Full Article: VC200537

Title: Potential Applications of the AdapTIVE Model: Distance Learning, E-Commerce and Games

Authors: C. Trojahn dos Santos (1), F. Santos Osório

Key Words: intelligent virtual environments, intelligent virtual agents, user modeling, distance learning, games, e-commerce.

Virtual Reality (VR) became an attractive alternative for the development of more realistic and interesting visual interfaces for the user. Nowadays, the attention of research community has been focused to the integration of Artificial Intelligence (AI) and VR. The main objective is to obtain larger usability and realism from the interfaces, exploring the combination of three-dimensional objects and intelligent entities. This paper presents the model and applications of the AdapTIVE (Adaptive Three-dimensional Intelligent and Virtual Environment) in several domains, such as learning and entertainment. The AdapTIVE is a virtual environment which has its structure and presentation (spatial organization) customized according to users' interests and preferences. This reorganization is based on the user and contents models, that can be automatically adjusted/updated by the system. An intelligent agent assists users during the navigation in the environment and retrieval of relevant information. We will present the potential application of the AdapTIVE to create highly interactive environments to Distance Learning, E-Commerce and Games.

Full Article: VC200579

Contribution 4

Title: An Architecture for Emotional Agent with Memory Mechanism

Author: Cheng-Yu Lu

Key Words: emotional agent, memory mechanism, adaptive behavior, interaction, real-time.

This paper describes the implementation and evaluation of a architecture for modeling emotions in complex, with memory mechanism agent. The objective of this research is trying to make emotional agent more realistic and more real, by integrating memory function that affect humans. In our framework, we regard emotions essentially as another kind of restrictions or connective opportunities in cognition model, and memory mechanism would be the temporary compiled storage for cognition models to generate next physical behavior or higher cognitive processes. Thus, our point explicitly concentrates the interaction between emotional models and memory system. This is our opinion that although emotional states are main factors of interaction between decision process and expression result, memory categories would be the key part. For this purpose, we have adopted several different approaches in memory-oriented to promote the influence between emotions and decision making, represented in the symbolic model.

Full Article: VC200546

6.16 Devices in Interactive Design

Contribution 1

Title: Peripheral Vision and LOD Management

Authors: D. Paillot, C. Ballaz, F. Mérienne, M. Neveu

Key Words: visual acuity, LOD management, psycho physics tests, real time.

The design review in immersive virtual environment becomes a tool integrated in the process of design in manufacturing industry and in

particular in the car industry. The constraints imposed by designers are strong in terms of render quality and interactivity. Thus adequacy between high perception and real-time rendering must be required. The work presented in this paper relates to the management in real time of the level of details (LOD) for an application in a CAVE like system. User in such a display is surrounded by virtual models. Its field of view is completely requested. Tests have been developed to study and measure the variation of the visual acuity and its influence on visual perception. Results define a method that takes into account the characteristics of the human visual system in the management of LOD. More precisely, the frame rate could be increased with no change on the visual perception of the scene, by using LOD management according to the eccentricity in the user field of view.

Full Article: VC2005111

Contribution 2

Title: A New Virtual Design Mockup for Digital Devices with Operable GUI using RFID chip and Mixed Reality

Authors: Soh Horiuchi, Satoshi Kanai, Takeshi Kishinami, Shoichi Hosoda, Yasuaki Ohshima, Yoshiyuki Shiroma

Key Words: mixed Reality, RFID, CAD, graphical user interface, mock-up, usability test.

The awareness of design for usability requires usability testing in early design stage. Various mock-ups are used for the testing. But, existing mock-ups do not enable us to assess the usability from cognitive and physical aspects simultaneously at low cost. To solve it, we propose a new mixed reality system of virtual and physical mock-ups using RFID embedded user interface, and apply it to usability testing for digital devices such as PDAs, mobile phones and small electric appliances. This proposed new mock-up can fulfill following conditions:

1. usability of the housing shape and UI software of a digital device can be tested both from physical aspect and from cognitive aspect simultaneously on a single mock-up,
2. the mock-up can be built at low cost in the early design phase,

3. the operations on the mock-up executed by the user can be accurately recorded as a digital data. For realizing the mock-up which fulfills above conditions, we newly propose a UI-embedded mock-up using RFID.

This mock-up has a physical housing, virtual UI software and RFID tags which enables interactions between them. The paper describes functions and features of our proposed UI-embedded mock-up and shows it applied to two case studies of usability testing and re-designing of a wireless video communication device and a remote commander of video recorder. As a result of the case studies, we confirmed that the operation log given from the proposed mock-ups could be effectively used to identify problems on UI design, and that the loop of usability test and redesign for small IT devices could be effectively done by using the proposed mock-up.

Full Article: VC2005154

Contribution 3

Title: Virtual Prototyping using Hand-Held Devices

Authors: O. Khan, A. Sleder, P. Huang

Key Words: hand-held virtual prototyping device (HVPD), virtual prototyping, virtual reality, augmented reality, training of U.S. armed forces, built-in wireless communications, field service applications, RGP.s.

Virtual Prototyping conventionally uses high end graphics and computing resources for its implementation. This paper discusses the use of a physically small, Hand-held Virtual Prototyping Device (HVPD) for a variety of VP applications. An HVPD comprises of a computing unit with a smaller footprint operating system and wireless communication capabilities. Handheld devices provide the advantage of mobility, rapid accessibility and faster initialization time. On the other hand, the use of handheld devices for Virtual Prototyping and Virtual Reality applications provide challenges in terms of graphics-processing bottlenecks. Virtual Prototyping is a main ingredient in the training of the U.S. armed forces, and with the rapid deployment of handheld devices

within the forces for communications, situational awareness and pre-mission analysis, the demand for handheld based training is increasing rapidly. An HVPD provides a solution not only for the training of technical personnel but also offers solutions for engineers and technicians that are involved in routine service and maintenance applications by providing Virtual and Augmented Reality Prototypes for field service applications. The HVPD proves to be a powerful tool for the users of Virtual Prototype-based maintenance by providing support from remote Graphics Processing Units (GPU) with the aid of its built-in communications channels.

Full Article: VC200591

6.17 Shape Digitalization and Movement Tracking in Design

Contribution 1

Title: Virtual Concept Session on Shape Digitalization and Tracking In Design

Author: J.R. Villalobos

Key Words: human shape, motion tracking, human motion, shape digitalization, movement tracking.

We give a brief introduction to the areas of Shape Digitalization and Movement Tracking. In particular, we focus on human motion. We provide a historical perspective of this field and briefly discuss some of the sub-fields of research.

Full Article: VC20050017

Contribution 2

Title: Efficient Human Body 3D Capture System for Clothing Industry

Authors: P. Guerlain, F. Noel, P. Keiter, B. Durand

Key Words: 3D acquisition system, virtual mannequin, body measurement, garments sizes selection, made to measure clothes.

This article presents the methods developed, evaluated and finally used in the LPMT laboratory and by Telmat Industrie in its human body 3D capture and measure system called Symcad. The aim of that system is to quickly and efficiently capture the shape of a human body and to create a virtual body. This virtual body helps taking measurements that can be used to select the correct sizes in a set of garments or to make special made-to-measures clothes. The biggest problem in that process is to mesh, close and smooth the initial acquired 3D points cloud to obtain the virtual mannequin that is fundamental for the measuring operations.

Full Article: VC200570

Contribution 3

Title: Silhouette-Extraction for Interactive VR-Systems Involving Dynamically Changing Rear-Projection Screens

Authors: J. Herwig, S. Thüring, A. Schmitt

Key Words: virtual reality, background subtraction, dynamic background, silhouette extraction, markerless optical tracking.

Markerless optical motion tracking is the method of choice if you dont want to use expensive tracking hardware or invasive equipment in a VR-System. Combined with silhouette-extraction based on background subtraction real-time interaction is reachable. But most methods using this scheme are most likely unable to adapt their background model to the fast changing unpredictable images shown on a projection screen. This restriction makes them unusable for applications involving spatially immersive displays (SID) where users are interacting in front of projection screens. This paper describes an approach to solve this challenging problem. Based on a client-server architecture it makes use of frame buffer and screen timing information delivered by the presentation computer and standard digital cameras attached to the tracking computer. The system requires no special hardware, therefore it is comparatively cheap and furthermore fast and reliable. Sufficiently accurate algorithms are used, allowing usage in a real-time system.

Full Article: VC2005130

6.18 Rendering and Visualization in Interactive Design

Contribution 1

Title: Physically-Based Rendering Contributions to Multisensorial VR Applications

Author: J.M. Cieutat

Key Words: physically base rendering, global illumination, light and material interactions, vision, touch.

Recently, there has been a significant amount of research focusing on the improvement of VR systems. A first high interest has been to reproduce a virtual realistic world with a lot of effort devoted to geometric modelling and light modelling. A second high interest has been to model dynamic systems, using either an animation approach or a physically-based modelling approach. The animation approach has been before all focussed on recovering the kinematics of observed motions, while the physically-based modelling approach has been an efficient way to compute forces and the movements as the consequence of the forces. More recently, the introduction of force feedback systems has been emphasized the physically-based modelling approach interest. For the users, VR systems have become multisensorial. In addition to vision and sound, there is also the action-vision cooperation and the connection between hand and eyes. These evolutions raise several problems. Since research focused more on improving VR systems than on human perception, it is natural to ask how a VR user integrates the information provided from several sensors, and what the underlying cognitive aspects are.

Full Article: VC20050018

Contribution 2

Title: Tools for Simulation and Visualization of Complex Illumination Environments

Authors: E.J. Sobreviela, F.J. Seron, S. Baldassarri, J.A. Magallon, D. Gutierrez

Key Words: CAVE, stereoscopy, lighting design, ray-tracing, radiosity, perception, virtual humans, human locomotion.

The aim of this paper is to present the developed tools and methods for the visualization and simulation of industrial complex illumination projects, such as the ergonomics and usability of space inside buildings or the analysis of vial security scenarios. In such cases, not only realistic illumination but also moving objects or persons are key for human perception. The developed tools consist of two software packages for calculating lighting simulation, a package for the simulation of the human visual system and another package for the animation of human locomotion. All these software are integrated in our new Cave-Like System (CLS), an evolution of the previously one, exposed in Virtual Concept 2002. The simulations done with our hardware and software include the physical phenomena that happen when light and matter interact in complex environments where there are moving elements, amongst which virtual humans stand out. Virtual humans are necessary in order to achieve a natural feel in the scene, more credible environment and a greater sensation of reality, or are even essential elements when studying certain problems in areas such as road lighting. In this way, the results presented in the immersive environment are as close to reality as possible, as perceived by a human observer.

Full Article: VC200562

Contribution 3

Title: Assessing the Use of Virtual Reality in Daylighting Ambiences Design: A Case Study

Authors: S. Tahrani, G. Moreau, P. Woloszyn

Key Words: solar effects, urban planning, navigation, methodology, visual perception.

The aim of this study is to assess the use of Virtual Reality technologies in cognitive evaluation of daylighting ambiences. We will introduce VR as a new methodology for urban planning development. We attempt to compare solar effects visual perception in a real and virtual urban path. Preliminary results showed that visual perception largely depends on the users movement in space. Therefore our next objective was to improve our methodology by using free movement in the virtual world

to evaluate urban daylight. However, because of the limited size of the immersive room, we have to limit the users motion. We are, instead, implementing the concept of a less free movement by using the guided visits navigation strategy. We evaluate pedestrians visual perception by studying peoples personal classification of outdoor urban daylighting during their walk in real and virtual urban paths.

Full Article: VC200558

Contribution 4

Title: 3D Shape Measurement and Reconstruction for Virtual Environments Based on the Phase Method

Authors: Lushen Wu, Qingjin Peng

Key Words: virtual environment, phase method, 3D measurement, surface reconstruction.

Three-dimensional (3D) modeling is the basis of virtual environments (VEs). The 3D shape measurement and rebuilding are required to construct VEs based on an existing world. Non-contact techniques have been widely applied in the 3D shape measurement. The image-based technique is a cost-effective solution among Non-contact techniques. However, some technical problems in current image-based techniques include the low accuracy and slow processing speed, which are barriers of effective applications of the image-based modeling methods in VEs. This paper proposes a phase technique to gain 3D information and build the 3D surface in VE applications. The phase technique uses a virtual grating projected by a non-intervened lam-house to the surface of an object. A CCD camera is used to capture the scene to gain 3D data of the object. The data are then processed and transformed into Pro/Engineer system to reconstruct shape of the object with the extension of ibl data format. The method can provide a fast, simple processing and a real-time measurement. It can also integrate the data measurement and shape processing to offer a new method in the reconstruction of VEs. An example is presented to verify the feasibility of the proposed method.

Full Article: VC2005118

6.19 Virtual Environment Building Techniques

Contribution 1

Title: Building Virtual Reality Applications

Author: L. Matey Muñoz

Key Words: virtual reality, object-oriented systems, hardware devices, haptics, software systems.

Virtual Reality applications design and implementation is a complex process due to some particularities of this kind of applications. Virtual Reality design starts normally defining a hardware scenario of immersion that uses some complex devices for input and output. This scenario aims to represent the important aspects of a real scenario where people develop activities that should be simulated. Input devices are chosen trying to reproduce friendly and with naturalness real operations that will be simulated. Output devices, especially visual devices are chosen taken into account some real aspects like field of view, ergonomics, movement, etc. These aspects are important too if we are trying to simulate more senses using sound, movement, forcefeedback, etc. Force-feedback devices should be considered like input-output devices when people become a part of the control loop. At this point, we have a collection of hardware that we have to ensemble in our application to reproduce in an immersive way some user activities that have to be realistic. This realism is achieved through simulation components that have to accomplish in a real or near real behaviour of the tasks that the user will perform to learn a process, plan an activity, etc. The main problem starts now, when we have to put together in one application all this software and hardware components to work in real time. We have to remember that real-time requirement is very important in these scenarios, when the user is part of the system. In fact if we choose some specific hardware like haptics, the response of the system is very restrictive, because we have to control devices at frequencies of 1 KHz. For other components like visual systems frequencies of 25-30 Hz are enough for having immersion. A well defined architecture will help us with the implementation of the tool. At this level, some engineering soools will help the programmer to produce the application. There are models based on components, others are based on scripts. At CEIT we use object-oriented components and

well structured APIs to reuse and to perform the fusion of the components in an application to solve a problem. Normally we develop using PC clusters and APIs are encapsulated through network protocols in order to assure the independence of the components. We have developed a lot of components for generic visualization of systems (immersive, with one or more visual channels, etc), for realistic simulation of systems (like multi-body systems), for evaluation in the case of learning tools, and for input devices like gloves, haptics, motioncapture systems, etc. In some cases authoring tools have been developed for the definition and evaluation of new tasks in a well defined environment. These kinds of applications provide a powerful added value to the tools, and establish the way in which a user can evolve the application for new uses. Some companies are trying to provide generic frameworks for developing the core of a Virtual Reality application. In these cases some components are provided with the tools, like input and output components, synchronism between them, but there is no guarantee to fulfil all the possibilities that a Virtual Reality application could need.

Full Article: VC20050019

Contribution 2

Title: Conceptual Modeling of Object Behavior in a Virtual Environment

Authors: B. Pellens, O. De Troyer, W. Bille, F. Kleinermann

Key Words: conceptual modeling, virtual reality, high-level specifications, behavior.

Today, the design of a Virtual Reality (VR) application is still a difficult and time consuming task. Many techniques and software tools have been created to facilitate the development process. However, they all require considerable knowledge of VR technology. Furthermore, modeling the behaviors of the objects in a Virtual Environment require programming skills or knowledge about script languages. For this reason, we have been developing an approach called VR-WISE that allows specifying a VR Environment at a conceptual level, free from any implementation details, and from the viewpoint of a domain expert, allowing non-VR-experts to participate in the design of a Virtual Environment. This approach uses ontologies, incorporating domain knowledge, and high level modelling concepts for describing the Virtual Environment. In this pa-

per, we explain how the behaviours of objects in a Virtual Environment can be described at a conceptual level. We show how simple behaviors can be combined for composing more complex behaviors. We illustrate the different modeling concepts for behavior by means of examples.

Full Article: VC200569

Contribution 3

Title: Using Virtual Reality for Scenario Based Product Design

Authors: M. Tideman, M.C. van der Voort, F.J.A.M. van Houten

Key Words: virtual reality, scenario based design, intelligent agents.

Application of virtual reality technology within product design processes can offer more than only a tool for analysis, it also offers opportunities for intended users to synthesise design information themselves. Within the virtual environments constraints - set and managed by the designer - users can experience usage scenarios, define designs, and assess those designs by directly experiencing them within the scenarios. By observing and measuring the choices that users make within the scenarios - and combining these observations with oral or written feedback - the designer develops a profound insight into the context of use of the proposed product. Moreover, the designer is directly presented candidate designs. This paper describes how virtual reality can be used to support scenario based product design. Products resulting from this approach are expected to better fulfil users demands and desires. Moreover, it is expected that less unanticipated effects emerge when these products are used in a real-world context.

Full Article: VC200565

Contribution 4

Title: Generic Visualization System: The Link Between Digital Simulations and a Virtual Environment

Authors: C. Holmes, J. Wolff, D. Challou, P. Huang

Key Words: real time, simulation, virtual, environment, visualization, 3d, algorithms, distributed, onesaf, jsaf.

The combination of complex physical simulations and realistic real-time interactive virtual environments provides engineers with a means to test the design in various environments before finishing the final products, and program management with a means for better communication and measurement of progress. Customers objectively know what they will receive by test driving the product before the designers complete the design. However, achieving this capability is non-trivial. Constructing an extensive dictionary of software objects, special effects, terrain and meteorological data and synchronizing their real-time display is one of the most difficult problems. The visualization component has to be flexible enough to combine real-time and non real-time simulation data and display it in real-time. Real time unification of the aforementioned data requires intelligent algorithms to produce smooth frame by frame motion, so discontinuities are not human-perceptible. The need to operate in secure distributed computing environments further complicates this effort. This paper reports the development of a system that combines complicated physical simulations with a real-time visualization software tool, and displays the results in realistic 3D environments. The Generic Visualization System (GVS) displays the combined results of many different simulation programs, including several Semi-Automated Forces (SAF) variations (e.g., OneSAF, JSAF, and others), simultaneously.

Full Article: VC200590

6.20 Location, Identification and Annotations in Interactive Design

Contribution 1

Title: Annotations in Product Design to Foster Collaborative Processes

Authors: J. Legardeur, C. Merlo

Key Words: annotation, collaborative processes, product data management, innovation.

Annotation processes during design projects are quite unstructured.

The confrontation of the different actors points of view leads to informal information exchanges. In this paper we analyse how collaborative processes can be supported by the way of annotations in tools.

Full Article: VC20050020

Contribution 2

Title: Acquiring, Structuring Shapes and Annotating them with Semantics to Improve Design Activities

Authors: J.C. Léon, F. Giannini, B. Falcidieno, G. Brunetti, H. Graf, A. Stork, F. Vexo, D. Thalmann

Key Words: shapes, semantics, design process, annotations, aesthetics, simulation, virtual humans.

Shapes incorporate geometry as well as semantics and can be defined in 2D, 3D or higher dimensions. Geometric models can be structured in such a way that they can provide a relevant framework to insert semantic information or view dependent information about a product to form features. Combining such features with an immersive environment allows the user to interact more efficiently with an object. This framework will be illustrated in the context of free-form surface modelling for aesthetic design purposes, one among the research themes of the network of excellence AIM@SHAPE. Virtual environments can also contribute to the efficiency of the design process through appropriate models of interaction between the objects contributing to a given simulation environment (a maintenance task, a surface deformation process for aesthetic design for example). To this end, virtual humans bring new capabilities to enhance simulations though they require new models of interaction to incorporate the appropriate semantics during an object manipulation. This second aspect is also part of the ongoing research actions of AIM@SHAPE and will be addressed to show how it is complementary to the previous one. As a result, this set of contributions demonstrates how various categories of semantic can enhance the design process.

Full Article: VC200555

Contribution 3

Title: Knowledge Enhanced VR Annotating Environment for Collaborative Design

Authors: S. Aubry, I. Thouvenin, D. Lenne, S. Okawa

Key Words: 3D Annotations, product design, ontology, knowledge management, CVE.

In distant collaborative product design, the use of appropriate tools to communicate between the project members is fundamental. While we can find collaborative environments designed for this kind of task, they lack integration between the subject of the collaboration (the product) and the information that is exchanged (messages between the members of the project). This led us to study the use of annotations in collaborative virtual environments. We first present our annotation model, which gives the user the possibility to simultaneously use multiple media on the annotation, including VR-specific media (3D objects, haptic information) and to integrate relations to a structured knowledge model. We then provide a detailed description of the knowledge model we use, as well as four test-situations of exploitation of this knowledge model: helping the annotation author to annotate the model, helping the reading of the annotated model, re-use of previous projects and navigation through the knowledge model. For each of these situations, we propose tools to exploit the possibilities of the integration of knowledge in the annotated product. Finally, we present the architecture of our system, which is based on the use of multiple clients per user, letting the user work in custom immersive configurations.

Full Article: VC2005104

Contribution 4

Title: Semi-Automated Ultrasound Interpretation System Using Anatomical Knowledge Representation

Authors: M.S. Downes, B.A. Barsky

Key Words: augmented reality, ultrasound, image processing, computer vision.

Interpreting ultrasound data presents a significant challenge to medical personnel, and this difficulty limits the clinical applications of the technology. We have addressed this issue by developing a novel, flexible, and efficient view-based high-level representation for anatomical knowledge and using this model to create a semi-automated ultrasound in-

terpretation system that labels structures in ultrasound images, thereby assisting non-expert users. Essentially, we treat the collection of images generated during an ultrasound examination as an ordered sequence of views of the anatomical environment and pick out key views in which the contents of the scan image changes. The system stores descriptions of expected key views and robustly matches incoming images to this key view sequence during an orientation phase of an examination. It uses information in the stored view descriptions to label the anatomical structures present in an input image and generates simple 3D anatomical models registered to the patient in order to create structure labels that align with incoming images during a subsequent free scanning phase. Overall, the design represents a novel approach to processing and augmenting ultrasound data and to representing spatial knowledge, and it lays the groundwork for future efforts to develop fully automated medical imaging systems.

Full Article: VC200526

6.21 Assembly Support System in interactive Approach

Contribution 1

Title: The Future of Assembly Support Systems in Design

Author: M. Carsten

Key Words: augmented reality, assembly support, design, mobile computing, user interface.

Instructions on how to assemble a product, known as assembly plans, are traditionally presented to operators in the form of a paper document. In this form they are expensive to maintain and any changes to the plans in subsequent issues are not highlighted to the operator. Software development is nowadays oriented in building tools with the aim to integrate various enterprise areas from powerful database systems and enriched CAD systems. This integration step will allow designers and manufacturers to collaborate, in a distributed way, from different locations inside and outside the enterprise building. This paper describes the chances

and potentials of future assembly support systems in design using mobile devices and new user interfaces like augmented reality.

Full Article: VC20050021

Contribution 2

Title: Analyzing Architectures For A Distributed Environment in Assembly Simulation

Authors: R. Iglesias, S. Casado, T. Gutiérrez, A.R. Carrillo, J.I. Barbero, A. García-Alonso

Key Words: distributed virtual environment, CORBA, consistency, collision detection, assembly simulation.

Recently, Virtual Environments (VEs) are increasingly used as environments for design, where a group of designers distributed geographically around the world can interact with this VE. Several collaborative multiuser environments over the network have been developed in different applications, but most of them are applied for collaborative visualization frameworks. In these cases, only the interaction of one user is possible with the VE, while others watch the scene. It is not common to find systems where several users interact simultaneously with the same VE in a dynamic, efficient and realistic way, even more if we consider the possibility of multimodal interaction. We found several challenges in these VEs, such as network resources (latency, jitter, reliability, bandwidth,), multiuser interactions (coordination mechanism, consistency among users,). These coupled with the integration of haptic interaction are critical factors, which can seriously degrade the performance of haptic-based applications. In this paper three different architectures of an interactive distributed environment (client-server) are described and the results obtained with them are reported. An assembly simulation application was chosen for the analysis of these architectures.

Full Article: VC2005123

Contribution 3

Title: A Video Tracking Solution for any Props in TUI Design

Authors: N. Couture, F. Depaulis, L. Garreau, J. Legardeur

Key Words: 3D visualization, tangible user interface, CAD/CAM, interaction.

Many technical domains, as mechanical part assembling, or architectural design, require 3D object handling and visualization that take into account real world parameters, hidden in the numerical world. For example, while designing a mechanical part with CAD software, an engineer would like to test an assembling task so as to avoid problems as relative positioning. New devices (spatial mice, data-gloves, etc.) are too generic and don't provide the required feedback, Tangible User Interfaces (TUIs) are often based on complex techniques and require expensive and bulky hardware. Moreover, most of time they don't permit to use other objects than those initially foreseen. In this paper, we present a TUI based platform that allows to use any everyday life real world object to handle and visualize any 3D numerical model. This platform is based on a video capture system: once a real world object, called interactor, has been acquired, it is possible to associate it with a 3D numerical model. Then, any operation (planar translation and rotation) performed with an interactor is reflected into the application. This solution is non intrusive and is based on interaction objects that are all the more in balance with the user task as they have been chosen by the application designer.

Full Article: VC2005120

Contribution 4

Title: Hardware Accelerated Validation of Extraction Directions in an Automatic Selective Disassembly Planner

Authors: I. Aguinaga, A. Amundarain, I. Mansa, D. Borro, L. Matey

Key Words: disassembly planning, product lifecycle, hardware acceleration.

This paper presents a method for the validation of unidirectional extraction paths for a selective disassembly planner, using the graphics hardware of a Graphics Processing Unit (GPU). The knowledge of correct sequences for the selective disassembly of certain parts is required for many industrial tasks such as preventive maintenance or disposal for recycling. Thus, such a system could be useful during product design and early stages of development. Nevertheless, the generation and validation

of these sequences is a time and resource consuming process, worsen with increasing numbers of parts and geometrical complexity. Current state of the art GPUs are able of computing fast and efficiently images of highly complex geometries, allowing certain tasks and analysis to be offloaded from the CPU. One of the tasks that can be offloaded from the CPU to the GPU is the validation of extraction paths. This validation process is required during the disassembly planning in order to determine whether a certain part can be extracted along the selected directions avoiding collisions.

Full Article: VC2005112

6.22 Modelling in Interactive Design

Contribution 1

Title: Characteristics, Development and Use of Models in Interactive Design

Author: X. Fischer

Key Words: design problem modelling, capitalization, value, domain, model reduction, model qualification, model up-dating.

Simulation of physical behavior involves the use of mathematical models that intend to accurately represent the natural phenomenon we can analyse in real environments. The last decads have seen the development of simulation techniques based on the well-known Finite element or difference methods. These methods that really constitute a success have some major disadvantages: they do not allow engineers to see in real time the simulation, the handled models are heavy and huge, the models are high-specialized and none-generic. Recently, some new techniques, often linked to the classical previous methods, are developed in order to obtain some reduced and generic representation of the behaviors. These techniques, named model reducing techniques, are often based on a combination of classical numerical methods and Artificial Intelligence Techniques. We propose in our article an overview of the families of reduction techniques. We demonstrate how such models may be used in order to explore design solution space or to implement interactive sim-

ulation environment dedicated to support product design. Our article highlight a new way of modelling and to use these new kinds of models in order to support decision in product design and manufacturing.

Full Article: VC20050022

Contribution 2

Title: Poisson Based Soft Object Deformation with Haptic Feedback

Authors: Yongmin Zhong, B. Shirinzadeh, G. Alici, J. Smith

Key Words: deformation, soft objects, surgery simulation, Poisson equation, analogous systems.

Most of the existing methods for soft object deformation are fully built on an elastic model that is an ideal tool to describe the deformation. However, the behaviours of soft objects such as human tissues are extremely nonlinear. The common deformation methods, such as mass-spring, Finite Element Method and Boundary Element Method, 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, which only allow the displacements to be less than 10% of the deformable object size. Although the few methods based on the nonlinear elastic model 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 Poisson equation and elastic deformation. The deformation is formulated as a Poisson equation. The potential energy stored due to a deformation caused by an external force is calculated and treated as the source injected into the Poisson system, as described by the energy conservation law. An improved Potential 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 both isotropic and anisotropic materials easily through simply changing the Poisson coefficients. Examples are presented to demonstrate the effi-

ciency of the proposed methodology. Despite the frequent appearance of the Poisson equation in various computational frameworks, the use of this equation in mesh modeling and editing is still very limited, especially in deformable modelling. To the best of our knowledge, this study is the first to directly use Poisson equation to mimic the deformation of soft objects under externally applied loads. The contribution of this paper is that the Poisson equation is solved on the object surface to propagate the energy generated by the external force for extrapolating internal forces.

Full Article: VC2005100

Contribution 3

Title: Simulation Agent Model in Designing Solidification Casting Process

Authors: S. Bieniasz, K. Cetnarowicz, S. Kluska-Nawarecka, E. Nawarecki, H. Pocik

Key Words: simulation, agents, casting, solidification.

In many industrial products the base elements are castings. The quality final products depends also on casting quality. In designing castings the important role places solidification and cooling process. Generally we are interested in receiving the same microstructure in the whole casting as well as similar temperature distribution during solidification process. On the course of this process depends main parameter values of casting. To receive the proper temperature during solidification we have to apply suitable cooling system, which can be obtained by numerical simulation of the whole solidification process. We have to take into account heat exchange, crystallization and the proper cooling medium. It is difficult to realize a such simulation using existing software. In paper authors presents agent simulation model and system MAFES (Multi Agent Finite Environment System) which can be used to solve the above mentioned problems. The different agents are described in paper. Some tasks of the complex simulation are realized by chosen agents of MAFES system. The structure of the multi-agent system as well as some simulation results we also present in paper. Comparison simulation results and physical experiments are also included in article.

Full Article: VC2005149

6.23 Virtual Laboratories

Contribution 1

Title: Construction of a Virtual and Distributed Laboratory as an Operative Tool for the Mx-US Manufacturing Network, MANET

Authors: F.J. Ruiz-Sánchez, V.M. Larios-Rosillo, J.R. Villalobos-Cano, J. Leon

Key Words: virtual laboratories, manufacturing research and education, distributed systems, research networks.

In this paper we present a brief description of the technological evolution of the Virtual Manufacturing Lab that was designed to be an operational tool for the Mx-US Manufacturing Network, MaNet. First, we introduce the project of MaNet, a logistic network of US and Mexican universities working on research and educational projects in the area of manufacturing and then we review the three technological stages in the construction of a distributed virtual laboratory starting with the Teleoperated Manufacturing Lab on Java, passing to the Jini Virtual Manufacturing Lab, to the Virtual Manufacturing Lab with JADE.

Full Article: VC20050023

Contribution 2

Title: Optimization of 3D object Management in Virtual Reality Environments to Support Distributed Laboratories for Manufacturing Design and Support over the Internet

Authors: V.M. Larios Rosillo, M.E. Zavala Villa

Key Words: distributed 3D objects loading optimization, distributed virtual laboratories, distributed collaborative environments.

Distributed Virtual Reality Laboratories is an emergent concept to support communities of experts interacting to improve product and manufacturing design processes. For such communities, is critical to allow high interaction with complex networked 3D models where optimization

works in the networked visual interface is needed. Complex 3D objects are usually composed of many elements organized inside of a hierarchical graph and a key issue the creation of partitions depending on the viewers scope and interaction for the their management in the distributed system keeping the adequate coherence for users. Hence, this paper proposes a dynamic 3D object loader system and algorithms for a distributed architecture to support Virtual Reality Laboratories and multiple participants with rich interaction. Finally, to support a large community, the proposed system is aimed to support Virtual Reality in heterogeneous platforms and network access over the Internet.

Full Article: VC2005135

Contribution 3

Title: Communication model based in workflow for Virtual Reality Distributed Laboratories to support the collaborative manufacturing design processes

Authors: M.E. Meda-Campaña, S. Amador-Larios, S. Hidalgo-Pérez

Key Words: communication model, distributed virtual reality laboratories, manufacturing process, workflow.

Given the advances in information and communication technologies, nowadays communities of researchers in distributed laboratories are tending to work in Virtual Reality Collaborative Environments (VRCE). For designing and manufacturing a product, a set of specifications must be accomplished and an effective communication among participants is necessary. This paper proposes a workflow methodology integrated into a VRCE to coordinate the users interactions during the product design and manufacturing processes with the aim to provide an effective and successful collaboration. The communication workflow models are designed to be integrated into a multi agent platform to keep track of the distributed participants sharing the VRCE. Finally, the model keeps the state of the system and manages the connections in the network in an efficient manner.

Full Article: VC2005136

6.24 Virtual Techniques for Hand-Design

Contribution 1

Title: Human-Computer Interactions for Digital Styling Design - A difficult road toward bridging the gap between concepts and 3D models

Author: Satoshi Kanai

Key Words: digital styling design, human-computer interaction, sketch-based modelling, reverse engineering, haptic-based modelling, content-based model retrieval, digital ergonomic assessment.

This paper reviews novel research and practical technologies concerning with the human-computer interactions for helping styling designer originate 3D geometric models in the styling design process. First, the problem of the human interface of the current commercial 3D CAD systems is pointed out from the industrial designers viewpoint. Then several novel human-computer interaction technique in order to realize the effective creation and intuitive manipulation of the 3D geometric models both in the commercial CAD systems and in basic research, are introduced. Four major approaches of human-computer interactions are especially focused on: reverse engineering, sketch-based modelling, haptic-based modelling and content-based 3D model retrieval. Current technical abilities, future possibilities and limitations of them are discussed.

Full Article: VC20050024

Contribution 2

Title: Design Products with your Hands

Authors: M. Bordegoni, U. Cugini

Key Words: product design, virtual prototyping, haptics, shape modeling, hand-made prototyping.

Current practices in the product design sector include the production of hand-made prototypes created by skilled modelers in order to show and validate the concepts related to a new product. This prac-

tice is expensive, requires long time and several loops for execution and modifications, is carried out by skilled craftsmen, and needs downstream activities, like digital model reconstruction, that are not consolidated practices and require time and are error prone. On the other side, designers using digital tools for representing their ideas are still very few, and anyway, they necessitate physical prototypes for evaluating their ideas. Companies require to improving the design process performances, for allowing designers to be put into the overall design process loop and to validate their ideas through physical prototypes they can make themselves, and for allowing modelers to produce digital models out of the physical ones, while preserving their manual skills. The research work is carried out in the context of a European funded project TnD Touch and Design (www.kaemart.it/touch-and-design) coordinated by Politecnico di Milano, and including think3 and FCS as technology providers, Université Aix-Marseille I and Universitat de Girona as academic partners, and Alessi, Pininfarina and Eiger as end-users operating in the product design sector. The project aims at providing a system that can be used by both modelers and designers. It aims at providing some operating modalities that are familiar to modelers, since resembling the actions they do in the workshop for building physical prototypes. Easy-to-use and natural interaction techniques will be provided that convince designers to make use of digital tools, and that can be used in an efficient and effective way. The working modality offered by the TnD system will allow users to perform operations like scraping matecking surface quality, by using an enhanced CAD tool integrated with an ad hoc developed haptic tool. The system captures and supports the creation and modification of smooth high quality surfaces that can be seen on a screen and also touched. Users will have continuous contact with the object shape during its creation and evaluation. The TnD system is conceived in such a way so as to be an everyday working environment that designers and modelers find easy and intuitive to use, useful and productive, and without having to bother about technological aspects, but instead being concentrated on creative activities. The TnD system will also improve the product design process making tighter the integration of creation and validation activities, allowing for the creation and validation of more ideas and therefore improving product design quality, and finally reducing time and efforts devoted to making physical prototypes, and for surface reconstruction since the digital model is ready to use for subsequent detailing design activities. The system will also

facilitate communication between different departments (mainly design, engineering, and marketing) since a unique digital object is provided, instead of supplying physical and digital prototypes made with numerous and different types of techniques. The research results will be a major improvement for industrial design companies that will be able to shorten product design lifecycle, improving design quality, while preserving valuable skills of operators. The paper presents the system requirements and its functionality, the architecture of the systems and the first experimental results.

Full Article: VC200567

Contribution 3

Title: Handling Shape Semantics in Virtual Styling

Authors: G. Brunetti, G. Ucelli, P. Santos, R. De Amicis, A. Stork

Key Words: conceptual design, virtual styling, semantic web, ontologies, PLM.

The motivation for developing virtual styling systems is to provide stylists and industrial engineers with a computer-aided environment that is intuitive to use, does not hinder their creativity, and still allows to produce CAD models instead of sketches on paper or sculptured models, e.g., made of clay or wood. But the creativity is not just promoted by an appealing system environment, rather are a diversity of multimedial information like sketches, excerpts from newspapers and magazines, pictures, 3D models and videos the main sources of inspiration and means of communication of design ideas.

To allow industrial designers to access these resources also during a virtual design session, we integrated our virtual styling system via Web services with a semantically reach ontology-based content management system managing this multimedial content relevant to conceptual form design.

Furthermore, we implemented the (semi-)automatic extraction of semantics from the currently designed model to upload the model along with its semantic metadata to the content management system for future re-use.

The paper will discuss the implementation issues targeting the communication between virtual environment and content management sys-

tem, the multimodal (e.g., speech- and writing-recognition) front-end on VR side for user-interaction, and finally also the ontology modelling the metadata interrelating the different concepts and contents relevant to industrial design.

Full Article: VC2005146

6.25 Interfaces for Virtual Reality Application Development in Design

Contribution 1

Title: Interfaces for VR Applications Development in Design

Authors: A. Garcia-Alonso, J.J. Gil, D. Borro

Key Words: virtual reality, user interface, virtual prototype, immersive design.

VR requires the integration of different elements that deal with: data description and management, display or rendering techniques and user integration in the simulation loop. Data comprehends not only objects description and behaviour, but also display control, user interface and networking. So VR systems can grow to become very large and complex integration problems. This session shows this fact addressing three VR environments: machine design and simulation, virtual vehicles operating in virtual worlds, and the engineering design process coupling design and analysis. On the other hand, we present the interface problems that appear when dealing with a haptic interface in an immersive application for maintenance analysis of aircraft engines.

Full Article: VC20050025

Contribution 2

Title: Using High Level Models for Modelling Industrial Machines in a Virtual Environment

Authors: A. Sghaier, T. Soriano

Key Words: virtual prototyping, industrial machine, high level modelling, hybrid automata, SFC.

The work presented in this paper deals with a platform independent model formalism for designing virtual reality applications. In our approach, we focused on industrial machine simulators design. The structure of an industrial machine model is composed by Virtual Components which corresponds to the physical industrial components of the machine and a control part which corresponds to the functional specification of the machine. Each virtual component is modelled by VRML model for geometry and by hybrid automata (HA) for behaviour. The control part is modelled by Sequential Function Charts (SFC), as it is the case in the majority of industrial machines. Those SFC are translated to HA and composed with the virtual components HA. The whole HA model of the machine is then implemented in the generic virtual environment OpenMASK by specific software translation tools which was developed previously. This method makes virtual prototyping accessible by the specialists in the domain of industrial machine design domain. In this paper, we describe the high level modelling method putting the accent on the coupling between the control part and the process and then we apply it in the case of an assembly machine.

Full Article: VC2005131

Contribution 3

Title: SUMIT: A Virtual Reality Embedded User Interface Prototyping Toolkit

Authors: M. Quinn, J. Molin, A. Ziegler, P. Pukite, D. Chalou

Key Words: virtual prototype, user interface, immersive design environment, UML, immersive design toolkit.

United Defense Armament Systems Division has created the Simulation User Machine Interface Toolkit (SUMIT). SUMIT is a web-enabled rapid development environment for the fast synthesis of operational user requirements. SUMIT enabled us to generate an operational conceptual user interface and integrate the user interface with virtual vehicles (i.e., user interface, simulation software middleware, virtual hardware,

and synthetic environment) in under one month. We then used the resulting virtual vehicle prototypes to support immersive design reviews. SUMIT provides a three dimensional interactive context in which the proposed UI design can be exercised. SUMIT-generated user interfaces are embedded in a virtual vehicle that is High Level Architecture (HLA) compliant, so they can be interfaced to, and run real-time in distributed collaborative exercises. SUMITs built-in trace functionality produces Extensible Markup Language (XML) data in real-time. The XML data is used to automatically generate Unified Modeling Language (UML) sequence diagrams and automated system test cases for verifying key performance-based requirements. SUMIT is completely constructed out of open-systems software components including OpenGL, Python, and XML.

Full Article: VC2005122

Contribution 4

Title: Closing the Gap Between Engineering Design and Virtual Reality

Authors: M. Augello, J. Schaefer, S. Rudolph

Key Words: design compilation, design compiler, virtual reality.

Interactive and realistic visualisation of objects is the driving paradigm in virtual reality. After a decade of both substantial and innovative software and hardware advances (e.g.: modelling languages, viewer software, immersive hardware ...) a phase of relative saturation has now been reached. Even the most advanced real-time synthesis of complete virtual worlds concentrates mostly on the geometrical/aesthetical aspects or temporal behaviour of its objects. In this respect, especially the complex and interdisciplinary physical coupling which is typically found in engineering design situations are still ignored. Thus, a remarkable gap between engineering design modelling and virtual reality simulation exists and needs to be overcome. The gap may be closed by a tighter integration of the virtual result visualisation in the preceding engineering design process. As a result of that, the various simulation techniques used in engineering design can be directly used for the virtual behaviour models. This is achieved by the concept of a design compiler, which com-

bins a set of lower-level product component descriptions to a coherent system model during a design process. The associated numerical or analytical simulations are generated automatically and in parallel. Linking these models to a virtual environment closes the existing gap and helps to further speed up the feedback of virtual reality impressions into the process of engineering design.

Full Article: VC2005125

Posters

Contribution 1

Title: Improvements in Design Process of Organization and Building with Virtual Reality

Author: M.P. Mobach

Key Words: architectural design, immersive virtual reality, interdisciplinary research, organizational design, pharmacy shop.

The professional practices of manager and architect are entwined in the design process of a building. However, managers experience serious problems to understand two-dimensional representations of architectural design and to confront these with their own ideas. In this paper it is argued that immersed virtual reality can improve decision-making in these interdisciplinary design practices. It allows static visualizations of the interior, e.g. floor layout, volume, colour, and form and dynamic visualizations, e.g. moving agents, real-time changes in the physical layout, and discussion of its possible organisational impact based on organisational facts and figures. As a consequence, a new corporate debate emerges. For example, in an advanced detailed virtual representation of a new pharmacy shop the logistic streams of patients and staff are visualized, interior details at the waiting room can be changed real-time and these visualized changes and its supposed organisational impact can be discussed.

Contribution 2

Title: Automated Test Environment with the Simulation-Emulation-Stimulation (SESTM) Process

Authors: Hiroko Kato Hart, Kasra Naghshineh, B. Hamamoto

Key Words: virtual environment, simulation, emulation and stimulation (SES), test and integration environment, software test environment, near realistic tests, software qualification tests (SQT) environment.

This paper describes the Automated Test Environment (ATE) as used at UDLP for software test. ATE utilization has resulted in reduced costs and an improved schedule for the Bradley Fighting Vehicle (BFV) M2A3 program. The Simulation, Emulation, and Stimulation (SESTM) process used at UDLP is the backbone of both the integration process and the software test environment. The SESTM process has gone through several evolution cycles as the Program called for a more powerful test and integration environment. Using the SESTM, a "virtual environment" was created. The ATE combined with the SESTM generated VE, all BFV M2A3 tactical software can be tested automatically in this VE. In this manner, near realistic tests can be conducted in the convenient and comfort lab environment. Substantial cost reduction has also been achieved using this technique. Since October 1997, Combat Simulation and Integration Laboratory (CSIL) at UDLP has offered extensive software qualification tests (SQT) environment for formal software releases. This test environment was built on a Modeling and Simulation based system Integration platform and was implemented from the start as a system-engineering tool to validate the system specifications. All BFV M2A3 software releases for seven years have been successfully tested on CSIL test beds.

Contribution 3

Title: Support of reengineering using wearable computers and the knowledge server concept

Author: J. Nacsa

Key Words: wearable computer, knowledge server, reengineering.

Recent years the mobile computing got more and more importance in almost every field of life. Typical mobile computing devices are the so called wearable computers, that provides PC like resources in a miniature format including keyboard and screen I/O-s and wireless network connections. The first part of the paper introduces wearable computers especially a simple prototype built in our laboratory. Even if these computers are available the intelligent applications are very limited by now. In the second part of the paper the so-called KSC (knowledge server for controllers) concept will be extended to allow knowledge processing for the wearable computers. The third part of the paper shows how these tools are able to support the reengineering process of different expensive workpieces. The idea will be illustrated in a prototype application where the designers can remotely examine the different high value waste pieces and decide about the further usage and processing of them.

Full Article: VC2005106

Contribution 4

Title: A String-Based Haptic Interface for Cave-Liked Immersive Virtual Space

Authors: R. Fesharakifard, P. Fuchs, J.L. Dautin

Key Words: haptic interface, cave-like space, virtual space, string-based interface, force feedback, spatial parallel manipulator.

In this paper a haptic interface is developed for SASCube. SASCube is a CAVETM-like immersive virtual space with 4 screens. A string-based interface is proposed to trace and limit the hand's movement of the person who is situated in this space. This interface is a spatial paral-

lel manipulator, which uses four strings to transfer the couple of motors to the hand. It has four motors to supply three translational degrees of freedom. In relation to other types of interfaces, it seems to be the most appropriate because of its scalability and transparency. This interface can be fitted to a human-scale virtual space like the SASCube. Additionally it is transparent in the immersive room and does not obscure the visual display. The interface concept is presented, along with the required mechanical modeling and mathematical transformations. To verify the system feasibility, it is simulated under some collisions during different examples.

Full Article: VC200578

Contribution 5

Title: Virtual reality distributed laboratories to support micro and nano manufacturing design and research

Authors: V. Larios-Rosillo, F. Ruiz-Sanchez, R. Villalobos, J. Leon

Key Words: distributed virtual reality laboratories, collaborative environments, micro manufacturing technologies, logistic networks.

International communities of multidisciplinary working groups are key factors for the improvement and development of newer manufacturing techniques and more specific for newer in the area of micro and nano manufacturing technologies. To support these communities is critical a sophisticated communication infrastructure and interfaces to enable high interaction between researches and students with remote access to distributed laboratories. Virtual Reality is a key technology to go beyond standard communication levels and this paper presents a 3rd version of the MaNet (Manufacturing Network) distributed laboratories that is under development integrating full teleoperation of physical devices and instrumentation to support a logistic network of shared resources. Also, this version integrates a multiagent architecture covering different issues for the Virtual Reality environment to support and manage efficiently the distributed resources.

Full Article: VC2005132

Contribution 6

Title: Methodology for modular Industrial Plant Development using ALM tools: An Action Research Approach

Authors: N. Peñaranda, J. Aca, A. Molina

Key Words: Asset Life-Cycle Management, Design for Function, Action Research Methodology.

The development of industrial facilities is a complex process that requires the integration of different disciplines (mechanical, electrical, civil, Control and Ambient) and companies during engineering, construction and maintenance stages. It has been recognized that is not possible to verify full consistency using conventional techniques for communication and coordination among stakeholders of the project. This paper proposed a based in concepts of Design for Function to support the Industrial Plant Development Process. The implementation of this methodology is based on: (a) Use of Asset Life-Cycle Management (ALM) tools, (b) Development of a 3D CAD model to support the knowledge sharing methodology among stakeholders, (c) Web-based services to share knowledge and foster collaboration among stakeholders, and (d) Workflows to keep track all the process design (e) Product Data management functions. Finally a case study is presented to demonstrate how these concepts can improve the Industrial Plant Development Process. This paper demonstrates how ALM tools can improve the industrial plant development supported on Action Research Methodology.

Full Article: VC2005103

Contribution 7

Title: Digital Architecture, Wearable Computers and the Necessity of Providing Affinity

Authors: M. Guglielmi, H.L. Johannesen

Key Words: wearable, affinity, performative space, performing body, ambient media.

This paper aims at the tendency to create space that fosters and

supports communication, emotion and experience. Traditionally, architecture has been a static, physical solution of course with vivid concepts, but with new technology you could propose supple solutions that recognize architecture as the setting for the events of experience. Contemporary architecture is a meta-space residing almost any thinkable field, striving to blur boundaries between art, architecture, design and urbanity and to break down the distinction between the material and the user or inhabitant. The presentation for this paper will, through research, a workshop and participation in an international competition, focus on the exploration of boundaries between digital architecture, performative space and wearable computers. Our design method in general focuses on the interplay between the performing body and the environment between ambient potential media and active media. Our approach is playful and we use flow experience to express and explore the symbiotic or seamless relation between consciousness and behaviour. To develop a genuine relation between consciousness and behaviour our main concern is to provide affinity between architecture and inhabitant, and in that way aim deeper than just playfulness.

Full Article: VC200538

Contribution 8

Title: Real Time Simulation of Non Linear Mechanical Model

Authors: J.L. Dulong , F. Druesne , P. Villon

Key Words: real time, non linear model, model reduction, Karhunen-Loève expansion.

In mechanical engineering, virtual prototyping is a promising way to reduce the design phase. Possibilities for operator to assembly parts on production line, or to access easily to part during maintenance operation could be verified in a virtual environment. In many cases, these operations lead to a part deformation, which should be simulated in real time. But complex mechanical problem can not be solved by classical numerical method, like Finite Element Method (FEM) in real time. So, some load cases, characteristic of possible manipulations, were calculated by FEM in a pre-calculation step. The space disk necessary to save these pre-computed results could be very large. A model reduction approach, the Karhunen-Loève expansion, was used to determine the most sig-

nificant structure deformations. A linear combination of these modes allowed to approximate the deformation induced by the manipulation. This methodology was applied to an automotive hose, for a quasi-static mechanical model, and a hyper-elastic material with large deformations. We succeeded to deform in real time this hose in a Virtual Reality environment. Accuracy for the displacements was very satisfying, even with large deformations. This method should allow us to simulate a complex mechanical behaviour for industrial applications.

Full Article: VC200550

Contribution 9

Title: Object Manipulation in a Dynamically Simulated Virtual Environment

Authors: M. Baas, A. Schmitt

Key Words: virtual environments, interactive systems, physically based animation, inverse dynamics, motion control.

In a Virtual Environment that is closely modeled after the real world, the movement of objects has to be governed by Newtonian mechanics, including collision detection and response. Consequently, during the manipulation of an object by the user this object should still be dynamically simulated as its manipulation might have consequences for other objects in the scene or vice versa. As a result, the manipulation of the object has to be done by applying forces and torques to the object. This can either be done directly by the user or indirectly by a controlling algorithm which in turn is controlled by the user. Such an indirect method is given by using a ghost object which is a copy of the object to be manipulated and which acts as an attractor for the original object. The ghost object can be controlled kinematically using well known standard interaction techniques. This also allows reducing the degrees of freedom to be manipulated at a time, so that low dimensional input devices such as a conventional mouse can also be used for interaction.

Full Article: VC2005128

Contribution 10

Title: Safety Management Activity with Virtual Reality in Industrial Context

Author: E. Plot

Key Words: safety management, data conceptual model, support decision making, human factor.

For virtual concept 2005, INERIS can present his data conceptual model called SIRI (Software for Integration of Risk Indicators), created on the basis of ATHOS, ARAMIS and LOPA methods (an approach called "by safety barriers"). SIRI will allow to develop virtual tools for safety management activity, support decision making, in chemistry industry, pyrotechnic installations, gas industry, etc. The breakthrough offered by SIRI is a full monitoring system of Q-HSE risks related to the use of hazardous substances integrating three key aspects :- probability, kinetics and seriousness of accident scenarios, - the technical, organisational and human factors / indicators of safety - the cost of alternative solutions (linked to their lifecycle). SIRI is a conceptual framework dedicated to : - the selection of safety solutions, in design phase or change management phases, - the follow up of the risk control level, in its exploitation phase. SIRI will be use in the European project called VITHUALIS : Virtual Reality and Human factors Applications for improving Safety (50 partners, 19 million euro).

Full Article: VC200552

Contribution 11

Title: Simulator for Prototype Combat Manned Ground Vehicle

Authors: L. Lee, C. Johnson, C. Loza

Key Words: automated test, tactical software virtual environment.

United Defense L.P (UDLP), Combat Simulation Integration Laboratory has created a virtual environment (VE) that replicates the operating environment in which the Bradley Fighting Vehicle tactical computer operates. The VE allows integration and testing to be done within

a controlled laboratory environment. The VE consists of high fidelity, physics based, software models that take the place of actual system components and a PC based program called Automated Computer Assisted Test (ACAT). Use of software models saves the expense of actual hardware, provides debugging data, and allows the insertion of faults and malfunctions. These models have been verified and validated as realistic substitutions for the actual system. ACAT controls, monitors, and reports the results of automated tests within the VE. ACAT captures the in-depth knowledge of the test engineers and allows the test be repeated in a consistent manner using less senior level engineers and/or technicians. ACAT is also be used by UDLP technicians in the field with the results being sent via the Internet to be analyzed by engineers in the lab. This VE reduces program costs by allowing a high degree of testing to be completed prior to testing within the actual vehicle with actual system hardware.