Volume 4

Xavier Fischer
Alain Daidie
Benoit Eynard
Manuel Paredes
Editors

Research in Interactive Design

Mechanics, Design Engineering and Advanced Manufacturing

Springer

Research in Interactive Design (Vol. 4)

Xavier Fischer · Alain Daidie
Benoit Eynard · Manuel Paredes
Editors

Research in Interactive Design (Vol. 4)

Mechanics, Design Engineering and Advanced Manufacturing

Springer

Editors
Xavier Fischer
Bidart
France

Alain Daidie
Mechanical Engineering Department
INSA
Toulouse Cedex 4
France

Benoit Eynard
Département GSM
UTC
Compiegne
France

Manuel Paredes
INSA Toulouse
Toulouse
France

ISBN 978-3-319-26119-5 ISBN 978-3-319-26121-8 (eBook)
DOI 10.1007/978-3-319-26121-8

Library of Congress Control Number: 2015959574

Printed on acid-free paper

This Springer imprint is published by SpringerNature
The registered company is Springer International Publishing AG Switzerland

Instructions

Research in interactive Design – Vol. 4 presents the last successful developments in Interactive and Integrated Product Design and Manufacturing. *Research in interactive Design – Vol. 4* is a publication addressed to all researchers, industrial experts and teachers interested in the implementation of efficient solutions to support decision making in product engineering and to improve industrial innovation.

The book includes 10 main chapters. They are referencing exhaustive works being displayed in the second part of the book. 81 full papers foster the main argumentation. These articles written by high experts of product design and manufacturing were presented during the 2014 Joint Conference on Mechanical Design Engineering and Advanced Manufacturing.

All full papers are referenced and identified in the main argumentation according to the following presentation:

Title: Article Title

Authors: list of authors.

Key Words: key words.

Details on the results, process and solutions related to a specific topic of Interactive Design and Manufacturing.

Paper Number: ID, Page: pp.

Acknowledgement

We wish to start this section by sincerely thanking all the authors for their high-quality contributions integrated within the present manuscript *Research in Interactive Design – Vol 4*.

The high quality of different technical and scientific argumentations is ensured thanks to the realization of manuscript reviews realized by an international committee of experts. These prestigious researchers are sincerly gratefully for their involvement.

This book was not able to exist without the implication of the Chapter Editors. They were also the Track Chairs of the 2014 Joint Conference on Mechanical Design Engineering and Advanced Manufacturing.

Each of these persons are named at the beginning of each book chapter.

We benefit this short section to highlight the great involvement of representative of three organizations: Pierre Castagna, University of Nantes from AIP-PRIMECA (Ateliers Inter-établissements de Productique - Pôles de Ressources Informatiques pour la MECAnique) network from France, Gianmaria Concheri, University of Padua, Antonio Lanzotti, University of Naples, Vincenzo Nigrelli, University of Palermo, Stefano Tornincasa, Polytechnic University of Turin from the italian association ADM (Associazione Nazionale Disegno di Macchine) and Guillermo Peris-Fajarnés, Polytechnic University of Valencia, David Corbella, Polytechnic University of Madrid, Felix Sanz, University of Rioja from INGEGRAF (Asociación Española de Ingeniería Gráfica) from Spain.

Preamble

From the year 2006, the book series *Research in Interactive Design* highlights original studies leading to solutions being able to foster industrial innovation.

These solutions are providing answers to all researchers, engineers or students looking for basic information on:

- original engineering processes and industrial organizations,
- new tools and softwares allowing experts to implement product engineering process in a virtual way,
- numerical methods leading to the interactive exploration of engineering spaces,
- new methodologies to model of knowledge and behaviours,
- new approaches for collaborative design and the systemic engineering.

The fourth volume of the book series *Research in Interactive Design* is addressing solutions either for product manufacturing or product designing. A new dimension related to the teaching of product design is also introduced.

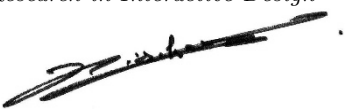
The authors of *Research in Interactive Design Vol. 4* have gathered together the most significant articles on the original topic of interactive and integrated product engineering.

The reader will find enclosed the authors coming from the whole

world who have left their mark with their new proposals, often by demonstrating the impact of their own solutions by solving real industrial problems.

Research in Interactive Design Vol. 4 is presenting the latest efficient approaches allowing innovation to be reinforced.

Pr. Xavier Fischer
Editor-in-Chief of the book series
Research in Interactive Design



Contents

Part I

Recent Studies on Interactive Design and Manufacturing

1

Integrated and Interactive Practices in Product Engineering

Authors:
Alain Daidié
INSA, Toulouse - France

Manuel Paredes
INSA, Toulouse - France

Benoit Eynard
UT Compiègne - France

Research in interactive Design – Vol. 4 presents the most recent successful developments in mechanics, design engineering and advanced manufacturing for innovation in product, process and production engineering. The readers are invited to discover new techniques, methods, models and tools based on integrated and interactive design approaches. In a context of worldwide competition, there is an unquestionable need for such approaches to improve the reactivity, flexibility and capacity for innovation of engineers faced with particular challenges in enhancing the development of transport systems, the production of energy, the manufacture of consumer goods, the building engineering or the product design. But these approaches are also of great interest to academics, to improve the content of their curriculum and education programmes and to define novel research roadmaps in the

X. Fischer et al. (eds.), *Research in Interactive Design (Vol. 4)*
DOI 10.1007/978-3-319-26121-8_1

field of mechanics, design engineering and advanced manufacturing.

Interactive and integrated design can be of great help to designers by supplying efficient solutions from an analysis of cognitive or physical interactions. *Research in interactive Design – Vol. 4* addresses a wide range of issues related to design. Design methods such as evolutionary approaches, design of experiments, robustness and optimization are improved to help designers. Virtual prototyping and virtual reality simulations are also of key interest. In addition, the latest developments in product design and simulation, computer-aided design, computer-aided engineering and reverse engineering are presented.

The need for industrial agility also implies a need for innovations in manufacturing. *Research in interactive Design – Vol. 4* presents papers related to information technology for manufacturing, production engineering, process planning, automated processes, inspection engineering (metrology, 3D scanning, tolerancing), robotics and the continuing improvements of recent manufacturing processes and technology, such as water jet milling, additive manufacturing or orbital drilling.

Simultaneously, the worldwide increase in industrial production has to be controlled by managing the associated environmental impacts. Thus sustainability has become a major area of interest for mechanical, design, manufacture and construction engineers. Consequently, *Research in interactive Design – Vol. 4* includes papers dealing with eco-design, lifecycle assessment, recycling management, end-of-life of products and sustainability of manufacturing processes.

All the innovations and research issues presented are aimed at helping designers and engineers face the new challenges of society. We also know that the forthcoming challenges are not yet identified; there is thus a real need for innovative young engineers. It is clear that the characteristics of students are evolving greatly: today's students are known as digital natives (the millennials) and our education strategies have to be remodelled to be efficient. For that reason *Research in interactive Design – Vol. 4* includes not only "learning by doing" issues but also pilot projects, collaborative work and knowledge management experience. Of course, the management of innovation itself can be improved. Knowledge transfer, collaborative design, patent modelling, and product lifecycle management appear to be key issues for disruptive

innovation.

Research in interactive Design – Vol. 4 contains the right arguments for all researchers, industrial experts and teachers aiming to implement efficient solutions to support decision making for improving creativity and innovation. Through the various chapters, readers are invited to take a look at some papers written by top experts in mechanical engineering, product design and manufacturing process.

The papers are organized in nine chapters, successively focusing on:

- latest advances in design methods,
- innovations in behavioural modelling and simulation for design,
- new trends in decision support systems for product engineering,
- current approaches in geometric modelling and CAD,
- innovation and collaboration in product engineering,
- new methods for sustainability engineering,
- latest trends in manufacturing processes,
- current advances in robotics,
- mechatronics and product engineering, novel practices in education for product engineering.

The editors of *Research in interactive Design – Vol. 4* are convinced of the interest that discovering the deep content of the proposed research works hold for readers.

Chapter 2 presents the latest advances in design methods. The section on design from objectives includes the merging of technical drawings and graphic engineering technology for industrial design and creativity. It proposes modular structuring of products for the redesign process with an application in eco-design. A design improvement strategy for increasing the comfort of products is also developed with a case study on seats. With the section on the design process, we focus on traceability and modelling of the design process so as to capture the design rationale. A design synthesis method is proposed to enable dimensional management of the assembly process. A spline coupling test rig capable of performing wear tests on components working in