Preface

INTRODUCTION

Product design and development (PDD) is an area of increasing importance to industrial competitiveness. In a global market, the competitive advantage of companies will lie not only on mastering existing processes and methodologies, but most of all on their ability to pursue different directions, with increased value to their customers. This can only be achieved with an up-to-date knowledge of the field, but also with the inherent risk associated with innovative PDD processes and methodologies.

Each of the main topics covered by this handbook is perceived as contributing to an improved knowledge of PDD. Although each chapter will present possible approaches and solutions, there are no recipes for success. Each reader will find his/her balance in applying the different topics to his/her own specific situation. Case studies presented throughout will help in deciding what fits best to each situation, but most of all any ultimate success will come out of the interplay between the available solutions and the specific problem or opportunity the reader is faced with.

The main mission of the proposed book is to provide a snapshot of the current issues, trends, challenges, and future perspectives on product design and development, an area of growing interest and increasingly recognized importance for industrial competitiveness and economic growth. Product design and development is affecting not only industry, but society in general, as new and innovative products shape our way of life. The book intends to disseminate the latest approaches, practices, solutions, and pitfalls recognized by experts in this field.

A very important aspect of the book is to approach product design and development not only from the technology side, but to consider the business and social aspects of this area. For the past few years, the need to have a systems view on product design and development has caused many changes in the previously established methods and practices. It is now necessary to provide a fresh perspective on current trends in this field.

The overall objectives of the present Handbook are:

- To discuss the importance of product design and development and the most recent trends and approaches.
- To introduce state-of-the-art tools and technology to support PDD.
- To introduce the non-technological aspects, namely the most recent organizational and business aspects of PDD, but also the social perspective.
- To discuss the challenges associated to systems integration along the entire product development chain, and present success approaches.

- To tackle the important educational issues associated with the teaching of new product design and development.
- To address environmental issues associated with new product design and development.
- To present practical case studies that demonstrate pivotal solutions and pitfalls of relevance to the topic of this book.

To achieve the objectives stated above, contributions were accepted from 58 authors in 15 countries from all the continents: Australia, Belorussia, Brazil, Denmark, Finland, Hong Kong, India, Italy, The Netherlands, New Zealand, Portugal, Singapore, South Africa, UK, and USA.

ORGANIZATION OF THE BOOK

The book is divided in seven sections, each section encompassing several chapters:

- Section 1: Design Methodologies
- Section 2: Supporting Technologies
- Section 3: Organization and Process Management
- Section 4: Enhancing Creativity and Innovation
- Section 5: Social Sciences and Environment
- Section 6: Systems Integration
- Section 7: Case Studies

Section 1 is devoted to design methodologies. Within this section, six chapters explain different methods used in PDD. Chapter 1, "*Trends in Public Design for the Disabled: A Case Study on Public Design for Visually Impaired People*", looks at the ways in which product developers can design for an inclusive environment in which people with disabilities can live feel less dependent from others. To that aim, the authors present a methodology for PDD and a case study of aircraft lavatories design. Chapter 2, "*New Design Paradigm: Shaping and Employment*", presents a new proposal for a universal design theory, based on modularity principles and a scientific grounding, encompassing the design problem, design process and design representation. Chapter 3, "*Interdisciplinary Interaction for the Early Stages of Product and Service Development*", presents a different experience for structuring the multidisciplinary front end innovation with the INNOstudio® concept that facilitates innovation sessions. Chapter 4, "*Empathic Design Research Strategies: Designing for, with and by People with Disabilities*", presents its authors' view of a world designed by people with disabilities for users with and without disabilities. The authors call this design approach as empathic design, and state that it is a strategy that relies on the end user being an active partner in the design process, a co-creator of knowledge. Using this approach, students with (visible) physical disabilities and product design students worked together designing everyday products. Chapter 5, "*Tool and Information Centric Design Process Modeling: Three Case Studies*", proposes a new modeling approach for the process of product development, since the ability of engineers to understand the dynamic nature of information throughout the design processes is critical to their ability to complete these tasks. Chapter 6, "*Embedded RFID Solutions: Challenges for Product Design and Development*", presents an exploratory study on the implications of embedding electronic

traceability devices in the product development process and the manufacturing process, especially if these devices are hidden within the product's body.

Section 2 is dedicated to the supporting technologies for PDD, containing three contributions. Chapter 7, "*Implementation of Rapid Manufacturing Systems in the Jewellery Industry in Brazil: Some Experiences in Small and Medium-Sized Companies*", describes how rapid prototyping can be used in small and medium-sized companies to assist in developing new products, focusing on the jewelry industry. Chapter 8, "*Creative and Visualization Tools in Context of Design*", looks at several aspects of a creative product, discusses the thought process of designers with a special focus on creative and visualization tools: sketches, storyboards, rough models, developing scenarios for the usage of proposed concepts, etc. These tools are discussed in parallel with creative tools serving as aids to externalize thought processes. Chapter 9, "*Virtual Reality Systems for Industrial Design Application*", investigates different CAD-3D software interaction techniques and outline their benefits and drawbacks compared to the interaction tasks required in the specific field of product design.

Organization and process management are the subjects for Section 3.This section contains two contributions from an educational perspective. Chapter 10, "*Integrating 'Designerly' Ways with Engineering Science: A Catalyst for Change within Product Design and Development*", suggests a new approach to engineering – product design engineering. The authors combine knowledge from design education and engineering education to build a degree program on product design engineering to educate engineering professionals with increased skills on creative design, social and environmental awareness, and a human-centered approach. Chapter 11, "*Rediscovering Design Education as a Social Constructivist Foundation for Innovative Design Thinking*", discusses design education, concluding that design education must change to adapt to the increasing pace at which different social groups are evolving new ways of communicating and living.

Section 4 has four chapters with a common background in the general topic of enhancing creativity and innovation. Chapter 12, "*Concept Naming: Exploratory Methods in the Development of Product Design and Brand DNA*", offers a unique alternative for integrating product personality in brand development. A new method, a specific derivation of product personality assignment referred to as 'Concept Naming,' is offered in combination with other more standard research methods. Chapter 13, "*PDD Trends: Research Driven by Laws of Product Evolution*", presents a framework that uses an evolutionary process to study the emergent behaviour, architectural innovation and organization redesign that can result from the development of radically new products and services. In a context of increasing awareness by companies to user needs and preferences, chapter 14 "*Customer Involved Open Innovation: Innovation of New Products with End Users and Customers*" provides guidelines for the involvement of end customers in the product development process, namely when, in which phases, which customers to involve, and which tools to use to support this involvement. Chapter 15, "*Stimulating Creativity and Innovation in and around Organizations: Co-Creation Experiments from Ongoing Research in a Bank*", outlines different approaches and developments related to co-creation, emphasizing its capacity also as a design approach. The chapter further defines the challenges of co-creation and reports experiences from an ongoing research in a service environment.

Four chapters compose Section 5 on social sciences and environment. The section is mainly devoted to the implications of considering non-technical issues when developing new products. Chapter 16, "*Research Project 'Future of the Present': The Process and the Importance Signs Observation into Fashion*", brings up a study of observation, analysis, and interpretation of signs and how new trends are possible to comprehend when developing new products. Understood as a language, the exploration of the signals

issued by the society is a cross-behavioral study guide which enables tangible recommendations for all levels of products development. Chapter 17, "*Design for Desirability: A Collaborative Innovation-Initiative between New Zealand Design Academia and Industry*", outlines an innovative and collaborative design research project that connects New Zealand SME manufacturers with advanced design thinking about affective design. University and academia have collaborated to foster 'design-for-desirability' thinking and develop capabilities by means of knowledge sharing, enterprise training and individualized projects. The chapter provides a novel model for collaboration between industry and academia that focuses on implementing 'design-for-desirability' thinking in SME companies with the aim of improving their international competitiveness. Chapter 18, "*The Influence of Ageing on User Experience*", brings to analysis the topic of ageing. At both the individual and collective levels, ageing causes several changes in people's lives that influence their needs and the way in which they interact with products. The chapter describes how the possible physical and cognitive decline of older users increases the need to focus on all aspects of their experience when developing products directed at this target market. Chapter 19, "*The Contribution of Ergonomic Analysis in the Product Design for Recycling*", takes on the topics of Design for Environment (DFE), specifically Design for Recycling (DFR) and Design For Disassembly (DFD), in a particular social and economic situation, and the ways in which product designers need to take this into account when designing products that have to be disassembled or recycled.

Section 6 on systems integration has two chapters that aim to understand the ways in which a systems approach can be used to develop products. Chapter 20, "*Understand Complex Design Problems Using Systems Thinking*", provides a brief overview of systems theory and suggests that product designers could use systems theory and systems dynamics models to improve the understanding of complex Product Design research problems, anticipating how and where changes in these dynamically evolving systems might occur and interact with the current system in which the product is bound to be used. Chapter 21, "*Integrated Approach to Product and Process Design Based on Life Cycle Engineering*", introduces an integrated approach to product and process design and development based on Life Cycle Engineering principles. The aim is to propose a structured framework to drive the design team in their discussions and analysis towards the creation of design concepts and process alternatives and in their global evaluations towards informed decisions on a life cycle perspective. A simple case study is presented using the proposed integrated methodology.

Section 7 will present case studies of product design and development that are perceived as good examples in their fields. Six chapters compose this section. Chapter 22, "*The "Madame Butterfly" Robot: A Case Study in Product Design and Development*", is a case study of an industrial robot produced by Euroimpianti Spa. It is the result of the unusual cooperation between a cutting-edge robot factory and Fontanatelier, an unconventional architecture studio. The contrasting opinions between engineers and architects on this project forced a radical change in points of view, in such a complicated and challenging field as robot production. Chapter 23, "*Transformal Role of Product Design in Singapore's Transition to a Service Economy*", brings the reader into an environment where Chinese, Malays, Indians, Arabs, Europeans and others on crosses their paths in Singapore on their journey through the southern seas. The chapter recounts the policies and subsequent actions put in place in Singapore from the 1960s until the present day to promote the creative industry, including product design, in order to transform a market dependent economy into a service centred economy.

Chapter 24, "*The Value of Storytelling in Product Design*", outlines the end-user's relationship with products and the designer's role in this emotional and conceptual exchange of storytelling in product design through a framework defined by the authors as Narrative, Manufacture, History, and Interaction.

A case study will support this approach. Chapter 25, "*Deploying and Adapting an Indoor Positioning System in the Clinical Setting*", presents an innovative project at Massachusetts General Hospital where industrial design, operations research and outcomes research are weaved together with emerging technologies to provide a means for objectively and reliably measuring service time in the primary care setting. The RFID in Clinical Workflow Project aims to provide a tool with which to understand resource allocation and to shape appropriate and effective policy where the multidisciplinary team used a hybrid of design techniques sourced from the different disciplines represented. Chapter 26, "*Designing Toys, Gifts and Games: Learning through Knowledge Transfer Partnerships*", presents the Knowledge Transfer Partnerships (KTPs), a programme in the United Kingdom, administrated on behalf of the Technology Strategy Board (a Government Agency), where academics give their expertise to provide a solution for a particular problem, helping organizations improve their competitiveness and productivity. This case study investigation exemplifies some of the strengths and pitfalls of this type of knowledge transfer in the context of the global toy, games and gift markets. Chapter 27, "*Product Form Evolution*", brings about the notion that function and form are complimentary factors in improving the user's experience of a product and competing in saturated consumer goods markets. Through different methodologies with a case study on mobile phones, the authors have developed theories about the continuities that occur in product forms over time, and the forces that can disrupt this behaviour, and suggest how this view of form can benefit the design of future products.