Human Factors and Ergonomics in Consumer Product Design

Methods and Techniques

Edited by
Waldemar Karwowski
Marcelo M. Soares
Neville A. Stanton

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Methods and Techniques

Ergonomics Design and Management: Theory and Applications

Series Editor

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Preface

Every day, we interact with thousands of consumer products. As users, we expect these products, no matter how simple or complex, to perform their expected functions in a safe, reliable, and efficient manner. Unfortunately, this is not always the case, as designing consumer products that satisfy human needs and expectations is not an easy task. The design process that involves the application of human factors and ergonomics (HF/E) principles and knowledge strives to achieve the above goals and, at the same time, reduce the risk of product malfunction or failure, reduce the potential for accidents, and contribute to overall product acceptance and utility, all while reducing the total product life cycle cost.

HF/E is a unique and far-reaching discipline that focuses on the nature of human–artifact interactions, which are viewed from a unified perspective on science, engineering, design, technology, and management of human-compatibility systems (Karwowski 2005). The HF/E discipline promotes a holistic, human-centered approach that considers physical, cognitive, social, organizational, environmental, and other design-relevant factors. As such, HF/E aids designers by raising their awareness of the full scope of knowledge required when designing consumer products, and plays an important role in facilitating a better performance of consumer products in general. HF/E-based design of products encompasses a wide variety of consumer preferences, and accounts for differences in such preferences due to factors such as age, gender, or health issues.

The goal of the human-centered design paradigm as applied to consumer products is to improve levels of user satisfaction, efficiency of use, increase comfort, and assure safety under normal use as well as foreseeable misuse of the product. It is in this context that we are very pleased to present the first volume of the *Handbook of Human Factors and Ergonomics in Consumer Product Design*. The motivation to produce this *Handbook* was to facilitate wider acceptance of HF/E as an effective body of knowledge for improving quality of life and safety for millions of users of consumer products with a variety of needs and expectations. In this *Handbook*, consumer products are defined as those goods used by the general public without any special training, skills, or supervision. Consumers are individuals of any age, gender, or physical condition with varying educational, cultural, and economic backgrounds. Consumer products are usually used in or around the home, in a social setting, rather than in a workplace environment with commercial needs.

Currently, there is substantial and convincing evidence that the application of HF/E knowledge can improve critical features of consumer products. These features include: ease of use, ability to learn product functions, efficiency, comfort, safety, and adaptability, all of which meet the needs and contribute to consumer satisfaction. Therefore, this two-volume *Handbook* aims to offer a comprehensive review of the HF/E state of the art relevant to design, development, testing, evaluation, and use of consumer products. The *Handbook* also aims to provide a comprehensive source of information regarding new methods, techniques, and software applications for consumer product design.

The first volume, *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques*, contains 29 chapters divided into four sections. Section I contains information about a variety of methods and techniques that can be applied in product design. These include the user-centered design approach, starting with a definition of users, the tasks they perform, and a way to translate design research into useful and usable products. Also included are chapters about human design technology, consumer products conceptual design, and development of smarter products using a systems engineering approach.

Section II, which contains 13 chapters, discusses the user-centered design process, starting with a discussion of how mental workload affects every day interactions with consumer products, and what lessons may be applied to product design. Other chapters focus on the various aspects of

creativity, innovation, standards and guidelines, culture, environment, affect, aging, and complexity in product design process.

Section III contains six chapters that consider the ever-increasing role of information technology, including digital imaging, video and other media, and virtual reality applications in consumer product design. Finally, section IV contains five chapters focusing on a variety of user-centered aspects of consumer product development. These chapters discuss such topics as user-centered vs. task-based approach, articulation and assessment of user requirements and needs, interaction with design models, as well as eco-design.

We hope that this first volume will be useful to a large number of professionals, students, and practitioners who strive to incorporate HF/E principles and knowledge in the design of consumer products in a variety of applications. We also hope that the knowledge presented in this volume will ultimately lead to an increased appreciation of the benefits of the HF/E discipline by ordinary consumers of the myriad of products used every day, and increase the HF/E literacy (Karwowski 2007) of citizens around the world.

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Editors

Waldemar Karwowski, PE, is currently professor and chairman of the Industrial Engineering and Management Systems Department at the University of Central Florida, Orlando. Florida. He holds an MS (1978) in production engineering and management from the Technical University of Wroclaw, Poland, and a PhD (1982) in industrial engineering from Texas Tech University, USA. He was also awarded the DSc (dr hab.) postgraduate degree in management science, by the Institute for Organization and Management in Industry (ORGMASZ), Warsaw, Poland (2004). He is a recipient of honorary doctorate degrees, including those from the South Ukrainian State University of Odessa, Ukraine (2004), the Technical University of Koscie, Slovakia (2006), and the MIRA Technical University of Moscow, Russia (2007). Dr. Karwowski is a board certified professional ergonomist (BCPE). His research, teaching, and consulting activities focus on human systems integration, work systems compatibility, human–computer interaction, prevention of work-related musculoskeletal disorders, manufacturing enterprises and management ergonomics, and theoretical aspects of ergonomics science. He is past president of the International Ergonomics Association (2000–2003), and of the Human Factors and Ergonomics Society, USA (2006–2007). Dr. Karwowski currently serves as editor of *Human Factors and Ergonomics in Manufacturing* (John Wiley), and the editor-in-chief of *Theoretical Issue in Ergonomics Science* (TIES) (Taylor & Francis Group, London).

Marcelo M. Soares, PhD, is currently a professor in the Department of Design and the Department of Industrial Engineering at the Federal University of Pernambuco, Brazil. He was an invited lecturer at the Technical University of Lisbon, Portugal, and the University of Guadalaraja, Mexico. He was also a visiting scholar and lecturer at the University of Central Florida, USA. He holds an MS in production engineering from the Federal University of Rio de Janeiro, Brazil. He was also awarded his PhD at the Loughborough University in England. Dr. Soares is a professional certified ergonomist from the Brazilian Ergonomics Association (ABERGO). He was president of this organization for seven years. He has also provided leadership in Human Factors and Ergonomics Latin America and internationally as a member of the executive committee of the International Ergonomics Association. He is currently the chairman of IEA 2012 (the Triennial Congresses of the International Ergonomics Association), which will be held in Brazil. His research, teaching, and consulting activities focus on manufacturing ergonomics, usability, product design, and information ergonomics. Dr. Soares currently serves on the editorial board of *Theoretical Issues in Ergonomics Science* (TIES), *Human Factors and Ergonomics in Manufacturing*, and several other publications in Brazil. He has also done significant research and consulting for several companies in Brazil.

Neville A. Stanton, PhD, was appointed chairman in human factors in the School of Civil Engineering and the Environment at the University of Southampton in February 2009. Prior to that, he held a chair in human factors at Brunel University (since September 1999). Previously, he held a lectureship and then readership in engineering psychology at the University of Southampton (since September 1993). Professor Stanton was also a visiting fellow at Cornell University during 1998. He has published over 140 peer-reviewed journal papers (including papers in *Nature* and *New Scientist*) and 18 books on human factors and ergonomics. In 1998, he was awarded the Institution of Electrical Engineers Divisional Premium Award for a co-authored paper on engineering psychology and system safety. The Ergonomics Society awarded him the Otto Edholm medal in 2001 and the President's Medal in 2008 for his contribution to basic and applied ergonomics research. In 2007, The Royal Aeronautical Society awarded him the Hodgson Medal and Bronze Award with colleagues for their work on flight-deck safety. He also acted as an expert witness for Network

Rail in the civil litigation following the Ladbroke Grove rail accident. He has undertaken research work for the Ministry of Defence, and received grant funding from ESRC, EPSRC, EU, DTI, Ford, Jaguar, and National Grid. Professor Stanton is an editor of the journal *Ergonomics* and is on the editorial board of *Theoretical Issues in Ergonomics Science*. Professor Stanton is a fellow and chartered occupational psychologist registered with The British Psychological Society, and a fellow of The Ergonomics Society. He has a BSc (Hons) in occupational psychology from the University of Hull and a PhD in human factors from Aston University in Birmingham.

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