

Preface

This monograph has arisen in an attempt to address the issue of manufacturing competitiveness in a complex, global industrial environment. In order to improve competitiveness at the global market, the ultimate strategy of today's leading companies is a strong focus on the consumer-driven quality that is accomplished by translating consumers' expectations into the design of industrial processes. The main idea of the research presented in the monograph is to offer an integrative model for the knowledge-based process design in a context of intelligent, knowledge-based manufacturing paradigm.

The process parameter design has been widely and successfully used over the past decades to optimise various industrial processes. However, emerging manufacturing technologies affect modern industrial processes that have become more complex over the time, implying multiple control parameters and multiple correlated responses. This book presents an intelligent, integrated, problem-independent method for multiresponse process optimisation, based on the Taguchi's robust parameter design, advanced multivariate statistical methods and artificial intelligence techniques. In contrast to the traditional approaches, the idea of the proposed integrated method is to provide a unique model to optimise various multiresponse processes, without imposing assumptions related to the type of process, interdependences in a process, type and number of process parameters and responses or correlations among them.

This book consists of six chapters. Chapter 1 presents a discussion on the process optimisation in a modern industry, reminds on the basic principles of Taguchi method and also considers the need for new, advanced approaches for multiresponse optimisation as required by the highly competitive manufacturing sector. An extended overview of methods that are used for multiresponse process optimisation is presented in Chap. 2, including (i) conventional, statistical or mathematical search-based methods: iterative mathematical search techniques; experimental design techniques (response surface methodology, factorial design and Taguchi method); and (ii) non-conventional, artificial intelligence-based methods: methods based on fuzzy logic; methods based on artificial neural networks; methods based on metaheuristic search algorithms (genetic algorithm,

simulated annealing, particle swarm optimisation, ant colony optimisation, tabu search, artificial bee colony, biogeography-based optimisation and teaching-learning-based optimisation); and methods based on expert system. Chapter 3 depicts in detail intelligent, integrated, problem-independent method for multiresponse process optimisation that is given in a form of a hybrid intelligent system model, i.e. model of an intelligent system for multiresponse robust process design (IS-MR-RPD). IS-MR-RPD model is composed of three modules: expert system for the design of an experimental plan; the factor effects approach that performs processing of experimental data based on Taguchi's quality loss function and multivariate statistical methods; and process modelling and optimisation based on artificial neural networks and metaheuristic optimisation algorithms. The purpose of this method is to optimise parameters of highly complex manufacturing processes with respect to the specification for several correlated output quality characteristics (responses). The application of the proposed IS-MR-RPD model is presented in Chap. 4. The implementation of this model is demonstrated in detail using four case studies from high-tech industrial sectors (e.g. semiconductor industry) and the advanced, non-conventional processes (e.g. laser-based manufacturing). Chapter 5 discusses the performance of IS-MR-RPD model and results of its implementation and gives comparison to the other related methods for multiresponse process optimisation. This is followed by the recommendations for future research, in terms of the improvement of the IS-MR-RPD model and its extension to the dynamic problems. The concluding remarks, including the position of presented research in the competitive sustainable manufacturing and in the digital manufacturing context, are presented in Chap. 6.

The monograph could be used as a reference book for scientists, professionals and industrial practitioners that deal with process parameter design of highly complex, nonlinear, non-conventional, advanced industrial processes. Since certain toolboxes are required for the application of the proposed model, the guidance and program codes in MATLAB are provided in this book in order to facilitate wider adoption in the industrial practice. The monograph is also suitable as a reference book in high education postgraduate courses (master and PhD studies) in manufacturing and industrial engineering, quality management, applied artificial intelligence, applied statistics and other related scientific fields.

Belgrade
May 2015

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<http://www.springer.com/978-3-319-19254-3>

Advanced Multiresponse Process Optimisation

An Intelligent and Integrated Approach

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2016, XVII, 298 p., Hardcover

ISBN: 978-3-319-19254-3