

Applied Simulation and Optimization 2

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Editors

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New Applications in Logistics, Industrial
and Aeronautical Practice

 Springer

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To my Parents and Christina

Foreword

Simulation allows to reproduce complex behaviors of existing real-world and hypothetical future systems as well as to carry out experiments on virtual environments to improve understanding, to develop new concepts, and to test technologies in a cost-effective way and safe environment.

Experience gained in the last years indicates that the extensive use of simulation constitutes an invaluable methodology to cope with most critical scenarios and threats, and it is evident that the future will introduce further challenges.

These scenarios typically need to be studied by using the theory of complex systems, characterized by many highly correlated elements, strongly not linear components and emergent behavior. In order to succeed in these scenarios, it becomes necessary to develop new solutions (i.e., technologies, systems, new doctrines, operational plans, etc.). These innovative solutions require to be immersed within the specific operational scenario which means to be able to conduct detailed experimentation in realistic conditions. Obviously, the adoption of a comprehensive approach stresses even more these aspects and creates additional challenges for being able to acquire such experience. It results evident that this knowledge should be available in advance to support decision process; therefore, simulation is probably the only suitable approach and the critical technology for succeeding in this area.

This means that in order to anticipate innovation and transformation, it is necessary to simulate the new solution within virtual environments. Therefore, the new challenging scenarios and the innovative solutions introduce the necessity to create, maintain, and extend knowledge and experience.

Indeed, simulation is a science to study real world based on facts learned through experiments and observations carried out on a virtual environment. The concept is quite revolutionary, providing the opportunity to conduct “a priori” experimentation to know a real-system behavior even before it is realized or put in place. Obviously, models and simulators are able to reproduce real systems just based on approximations that should be regulated based on the specific nature of their specific purpose; sometimes, very simple models could be effective, while in other cases

Big Data is required. In any case, M&S (modeling and simulation) potential is very impressive even if it is still subjected to limitations in terms of fidelity, usability, and maintainability as well as of the Simuland: the representation of the real system under analysis based on our knowledge, assumptions, hypotheses, and available data, as it was defined by John McLeod, founder of the Society for Modeling and Simulation International (SCS).

After more than 50 years, these concepts are still valid and M&S represents a strategic asset further reinforced by data abundance and enabling technologies as well by advances in methodologies and techniques. Indeed, simulation science enables scientific and quantitative analysis and operational exercises within synthetic environments reproducing real scenarios, future challenges, new solutions, and systems.

So, it is evident that M&S is a cornerstone in modern optimization of complex systems, especially when facing cases with many entities and interactions, high degrees of stochasticity and complex behaviors.

The present volume addresses this topic and presents cases, where it becomes clear how M&S could serve optimization in addressing very challenging environments from public transportations to retail and from mechatronic systems to decision-making.

The introduction of new tools and techniques is very important to guarantee a strategic advantage in designing, engineering, managing, and operating modern systems, and this book presents them in application to real problems providing clear understanding of their potential, guidelines for their reuse as well as proofs their validation. This is exactly how the scientific method was defined when it was introduced over four centuries ago that requires to be able to test, experiment and to repeat experiences in order to check their validity; in this sense, this book brings a value for the reader for being able to acquire capabilities and to understand how to put them at work.

Simulation is a continuous evolving world, and new techniques and methods continuously emerge to get benefits of upcoming developments and to face emerging challenges; based on this consideration is easy to understand how developing and presenting case studies is critical community. This is very important for young researchers because it allows them to develop new skills and also to being aware of experiences and real developments to direct their future researches and projects. Therefore, the contents proposed in this book are also very useful for experienced simulationists to further extend their knowledge with reliable data, references, and case studies.

Each day real world situations are the result of more and more interconnected fields areas, and the resulting complex systems are characterized by a impressive number of variables, high uncertainty, and challenging dynamics and behaviors; as soon as we are able to develop reliable models of a system, we are used to discover that we need to develop new ones to address a more extended case where additional precision or comprehensive approach are required to address the new needs of users and decision makers. This is a loop but also a great opportunity for simulation considering its flexibility and capabilities. However, it requires to develop real

transdisciplinary capacities among researches and scientists as well as to develop the user community in being able to use and trust simulation science; this book presents, defends, and promotes advances in simulation science applied to optimization and related tools and techniques.

In my opinion, such achievement is not surprising knowing since very long time the authors and their enthusiasm and capabilities in developing scientific researches coupled to real cases; personally I consider this the most proper approach to research, keeping it strictly connected with development to create solutions to the most challenging problems, that usually are the real one: industry, social life, and transportations are environments able to propose big problems, and simulation is an elegant solution to face and solve them. I really appreciated the opportunity to provide them with few of my thoughts for this valuable contribution to simulation advances.

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