Preface

A mathematical model is an intellectual device that works. The models have various purposes and, according to these purposes they differ by the level of simplification. There are many possible ways to construct the mathematical model we need.

We can start from a detailed model – a hypothesis which reflects all our knowledge of the first principles and then go down the stair of simplification.

We can go the opposite way and use a metaphor or an analogy and start from a very simple model, then add more details and develop a better and more complicated intellectual tool for our needs.

We can use plenty of intermediate approaches as well. In 1980, R. Peierls in his seminal paper [1] suggested that one might distinguish seven different types of models and demonstrated various types of confusion that can result if the nature of the model is misunderstood.

He proposed the term *model making*. Such a wording should awake associations with a very applied type of work like "shoe making". The logic of the applied activity of model making seems to be close to engineering. By analogy with chemical or mechanical engineering we can use the term *model engineering* [2]. It is not by chance that many new achievements in mathematical modeling were produced by engineering experts, by interdisciplinary teams or individual researchers who combine mathematical background with an engineering view on the result: a mathematical model is an intellectual device that must work.

Model reduction is one of the main operations in model making. Following Peierls we can state that the main difference between models is "the degree of simplification or exaggeration they involve" [1]. We have to simplify detailed models. It is also necessary to simplify models even before they reach their final form: in reality the process of model simplification and identification should be performed simultaneously.

The technology of model reduction should answer the modern challenges of the struggle with complexity. Many approaches and specific tools are developed during the last decades. In this volume we collect extended versions of selected talks given at the international research workshop: Coping with Complexity: Model Reduction and Data Analysis (Ambleside, Lake District, UK, August 31 – September 4, 2009; in conjunction with the A4A6, the 6th Conference on “Algorithms for Approximation", supported by the EPSRC).

The theme of the workshop was deliberately broad in scope and aimed at promoting an informal exchange of new ideas and methodological perspectives in the increasingly important interdisciplinary areas of model reduction, data analysis and approximation in the presence of complexity. Participants had a wide variety of expertise reflecting the interdisciplinary nature of the workshop. The papers collected in this volume may help to circumvent some of the "language barriers" that unnecessarily hinder researchers from different disciplines.

The papers cover various application areas, from chemical engineering, fluid dynamics and quantum chemistry to population dynamics. Nevertheless all papers share a common property: they all present new ideas and methodological innovations and they provide new tools for model engineering.

This volume may appeal to academics and PhD students in applied mathematics and mathematical modeling in physics, chemistry, chemical en- gineering and other fields of science and engineering.

References

1. Peierls, R. Model-making in physics. Contemporary Physics, **21** (1980) 3–17
2. Model Reduction and Coarse–Graining Approaches for Multiscale Phenomena. Ed. by A.N. Gorban, N. Kazantzis, I.G. Kevrekidis, H.C. Öttinger, C. Theodoropoulos, Springer, Berlin-Heidelberg-New York (2006)

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