
Foreword

The employees of a mathematical Fraunhofer Institute spend a great deal of their time discussing problems with industrial clients and then solving these problems with the help of mathematics and computers. The periods of reflection occasionally made possible by public projects and self-financed preliminary research are normally used to build the mathematical foundation necessary for finding our clients' solutions. Taking a step back to critically examine one's own activities and then to precisely and understandably articulate them requires great inspiration and an enormous commitment of time. Nonetheless, 18 employees and 5 other mathematicians closely connected to the Institute have ventured to report on their thoughts and actions in this book.

Our point of entry is represented by the four basic concepts that determine our work: modeling, computing, optimizing and analyzing data. What these terms mean to us is described in four relatively short concept chapters.

Next, five projects—perhaps better referred to as project groups—are presented as examples; and here, we take this business of presenting very seriously. First, we describe the non-mathematical problem and explain the deficiencies in the standard approaches for its solution. We also explain why the existing mathematics is often inadequate and describe how many preliminary works surrounding question clarification have already emerged from the Institute for Industrial Mathematics ITWM, in the form of doctoral theses, for example. The core of these five research chapters, however, is solid mathematics—the models and their numerical evaluation. Finally, we describe the “solution,” that is, what the customer gets from us, which often includes software.

In a closing chapter, we describe in detail how this problem-driven, model-based, solution-oriented mathematics can be integrated into mathematics instruction in our schools, in order to emphasize its significance and to promote students' joy in learning mathematics.

In writing this book, we have kept quite diverse groups of readers in mind: First, there are the people in industry and business, to whom we wish to make clear that mathematicians don't just discuss or analyze problems, they also solve them. Second, there are the university mathematicians, whom we want to convince that this approach can also provide

new impulses to mathematics. Third, there are university students, who want to know, and with good reason, what they will really be doing later in their professional lives—for only a small number of them will lecture at universities. And finally, there are those who want to become teachers or who already are; this group can read how mathematics instruction in the classroom can be revitalized.

Is a mathematical Fraunhofer Institute really entitled to claim that it can fulfill all these promises? There are more than 65 institutes in the Fraunhofer-Gesellschaft, and three of them are based on mathematical methods: The ITWM in Kaiserslautern, the SCAI (Institute for Algorithms and Scientific Computing) in Sankt Augustin, and MEVIS (Institute for Medical Image Computing) in Bremen. Among these, the ITWM today enjoys the highest industrial revenues and the most rapid growth. The Institute's fantastic growth over the nearly 20 years of its existence is shining evidence that mathematics really has become a key technology. For this reason, we believe that we can indeed turn all of our readers into fans of our kind of mathematics!

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