

Preface

Bionics has become more and more popular during the last few decades. Many engineering problems are now solved by copying solutions found in nature. Especially the broad field of optimization has been inspired by the variety of methods to accomplish tasks that can be observed in nature. Popularly known examples include the strategies that ant colonies use to reduce their transport distances to feed their always hungry population, the dynamics of swarms of birds or fishes, and even replication of the brain's learning and adapting to different challenges.

Over more than a decade, we have been studying Bionic Optimization at the Reutlingen Research Institute (RRI). After early attempts to design optimization solutions using parameterized CAD-systems and evolutionary strategies, our field of interest became broader. Our work taught us how the different bionic optimization strategies might be applied, which strong points and which weaknesses they exhibited, and where they might be powerful and where inappropriate.

During a series of joint research projects with different partners and supported by the German government and other sponsors, we studied many aspects of these techniques. Additionally, the interest of the scientific community in Bionic Optimization is increasing along with the fuller understanding of how engineering can be influenced by non-deterministic phenomena. In this book we intend to give an introduction to the use of Bionic Optimization in structural design. Readers should be enabled to begin applying these nature inspired procedures. Furthermore, hints about the implementation, useful parameter combinations, and criteria to accelerate the processes are included.

To formulate most bionic optimization processes, scientists have attempted to base the strategies on a strong and reproducible theoretical foundation. On the other hand, most of these methods are so easy to understand that we realize they are working even if we decline to base them on a strict mathematical background. In this book we decided to explain the basic principles, show examples that are easy to understand, and list easily reproducible pseudocode to help new users to start working immediately. Comments on meaningful parameter combinations and warnings on problems and critical configurations may motivate readers to verify whether our proposals are justified, or if they can be expanded to broader regimes.

The work presented in this book mostly is a re-composition of different papers, theses, work reports, and presentations written throughout the last decade. The authors are former or current students at Reutlingen University, colleagues at the RRI, people who like working in Bionics, and young engineers who had, and have, plenty of ideas and are not too easily frustrated by flops. We have been following many tangents, have done thousands of studies, and have found solutions to many questions, but sometimes have failed to find the answers to others.

We begin with basic definitions and motivations, giving simple examples, and explaining how to set up an optimization environment. Some more elaborate applications then exhibit the power of these methods. Finally, a discussion about the future developments indicates how we expect optimization to be used in the future.

All this work would not have been possible without the support of many different sponsors. Besides the financial support of the German government in some research projects, many software companies and manufacturing enterprises gave us the opportunity to scan the wide range of bionic optimization in industry. We recognize their help, the fruitful discussions, and the generous handling of the licensing of the software packages. Additionally, we would like to express our gratitude to the heads of Reutlingen University, the RRI, and the faculty of engineering all of whom gave us access to space, time, and nearly endless computing power. We want to express our gratitude to Springer, especially Mrs. Eva Hestermann-Beyerle and her staff, who have helped so much to transform the collection of many different papers in different formats into one readable book.

Reutlingen, Germany
April 2015

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Bionic Optimization in Structural Design
Stochastically Based Methods to Improve the
Performance of Parts and Assemblies

Steinbuch, R.; Gekeler, S. (Eds.)

2016, XII, 160 p. 103 illus., 6 illus. in color., Hardcover

ISBN: 978-3-662-46595-0