IntechOpen

Interdisciplinary Expansions in Engineering and Design With the Power of Biomimicry

Edited by Gulden Kokturk and Tutku Didem Akyol Altun

INTERDISCIPLINARY EXPANSIONS IN ENGINEERING AND DESIGN WITH THE POWER OF BIOMIMICRY

Edited by **Gulden Kokturk**
and **Tutku Didem Akyol Altun**

Interdisciplinary Expansions in Engineering and Design With the Power of Biomimicry
http://dx.doi.org/10.5772/65987
Edited by Gulden Kokturk and Tutku Didem Akyol Altun

Contributors

Ayça Tokuç, Feyzal Ozkaban, Özge Andiç Çakır, Julien R Serres, Thierry Darmanin, Sabri Taleb, Frédéric Guittard, Petra Gruber, Tim McGinley, Manuel Muehlbauer, Irem Deniz, Tugba Keskin, Maria Lorena Lehman, Hyunsoo Lee, Nayeon Kim

Published by InTech
Janeza Trdine 9, 51000 Rijeka, Croatia

Notice

Statements and opinions expressed in the chapters are these of the individual contributors and not necessarily those of the editors or publisher. No responsibility is accepted for the accuracy of information contained in the published chapters. The publisher assumes no responsibility for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained in the book.

Publishing Process Manager Romina Skomersic
Technical Editor SPi Global
Cover InTech Design team

First published March, 2018
Printed in Croatia
Legal deposit, Croatia: National and University Library in Zagreb

Additional hard copies can be obtained from orders@intechopen.com

Interdisciplinary Expansions in Engineering and Design With the Power of Biomimicry, Edited by Gulden Kokturk and Tutku Didem Akyol Altun
p. cm.
Print ISBN 978-953-51-3935-5
Online ISBN 978-953-51-3936-2

Meet the editors

Assist. Prof. Dr. Gülden Köktürk is an electrical and electronic engineer in Dokuz Eylül University, Department of Electrical and Electronic Engineering in Izmir (Turkey). She has been working as a lecturer in Dokuz Eylül University since finishing her PhD degree. She obtained her graduate degree and PhD degree in Electrical and Electronic Engineering in 1987 and 1999, respectively. Her research interests are signal and image processing, biomedical image processing, sustainability in energy, biodesign, and biomimicry. Dr. Köktürk has published many scientific papers, conference presentations, and exhibitions. She is one of the founding members of the Turkish Biodesign Team (TBT), which is the first biodesign team of Turkey and has an interdisciplinary structure study between biomimetic, engineering, science, and design intersection. She continues to work on biodesign in science and engineering with her teammates.

Other InTech publications

Book chapter Wavelet Based Speech Strategy in Cochlear Implant by Gulden Köktürk in the book *Cochlear Implant Research Updates* edited by Cila Umat and Rinze Anthony Tange, ISBN 978-953-51-0582-4, InTech, April 4, 2012.

Assoc. Prof. Dr. Didem Akyol Altun is an architect in Dokuz Eylül University, Department of Architecture. She lives in Izmir (Turkey), a city located in the west of the country. She has been working at the Dokuz Eylül University as an instructor for 17 years now. She obtained her graduate degree in 2000 and PhD degree in Architecture in 2010. She deals with all areas of design and continues to work in the biomimetics, nature-inspired architecture, and design-engineering interface. She has many published scientific papers, conference presentations, exhibitions, awards from architectural competitions, and one TUBITAK (Scientific and Technological Research Council of Turkey) project coordinatorship. She is one of the founding members of the Turkish Biodesign Team (TBT), which is the first biodesign team of Turkey and has an interdisciplinary structure study between biomimetic, science, and design intersection. She continues to work on biodesign with her teammates.

Contents

Preface

Biomimicry or the similar word biomimetic comes from the unification of the Greek words "bios" (life) and "mimesis" (mimic). It was first used by the American engineer Otto Schmidt in the 1950s. Biomimicry could simply be defined as being inspired from biological forms, functions, systems, components, or processes in nature. It is also a design principle that searches for results for solving problems of humankind through analyzing nature. In contemporary approaches, biomimicry searches for a balance between nature and people. Accordingly, it suggests thinking and acting like nature instead of having a metaphorical attitude.

Biomimicry is an interdisciplinary topic related to electronics, communication, medicine, biology, chemistry, physics, math, art, and many other areas. Janine Benyus, in her book *Biomimicry: Innovation Inspired by Nature*, published in 1997, remarked on the necessity of interdisciplinary cooperation between biological research and industrial and/or construction technologies.

Biomimicry is commonly used in the design of artificial devices, prostheses, medical equipment, and robots. It is a method that has been significant in the fields of medicine, architecture, and civil engineering for many years.

The relationship between biology and design is based first on biomimicry. The process can be summarized as inspiring/adapting/learning from nature. This interaction seems to have had different forms over the years and is called biomorphic, metaphoric, or analogic approaches in the design literature. However, implied samples are completely formal inspirations, revealed from natural organisms. This attitude of mimesis was transformed at the end of the twentieth century with the notion of biomimesis and biodesign. The design practice of this period contains a conscious learning and inference goal from nature in terms of materials, structural generation, and systematic process rather than formal analogies. The target is to design products that really work as part of nature. We can call this new approach biodesign.

The investigation of living organisms at the molecular scale opens up probable ways to inspire from the genetics of organisms. Even using living organisms in design can be used as an example. Designers use different data from many science areas such as architecture, design, biotechnology, nanotechnology, biology, math, geometry, physics, chemistry, etc. Accordingly, interdisciplinary relationships between different fields are inevitable in the twenty-first century.

Biomimicry has now brought together engineers and designers, and this collaboration creates innovative and creative outcomes. Nevertheless, more research is needed in this area because many studies on biomimicry are generally about the health sector. It can be said that engineering studies come in second place. However, there are a few studies on design and biomimicry from an interdisciplinary point of view. Similarly, interdisciplinary foundations between sci-

ence, engineering, and design are very few globally. Undoubtedly, there are a number of strong foundations or teams in Europe, America, and East Asia. But their concern is biodesign in medical science. So new studies, both foundational and theoretical in between design, science, and engineering, are clearly a necessity. Accordingly, this book aims to fill this gap in the literature.

The book contains eight chapters from expert and well-known authors in their fields. Petra Gruber, Tim McGinley, and Manuel Muehlbauer in their chapter "Towards an Agile Biodigital Architecture: Supporting a Dynamic Evolutionary and Developmental View of Architecture" are focused on a strategic methodology for architectural design processes using evolutionary and genetic principles. They used the potential of computer science that links biological concept to architectural application by making a bridge between biology and design. The authors actualized five parallel workshops to explore their biological concept in design and tried to generate an active design tool based on agile principles integrating biological models in a new multistage design process. The inputs of their work are a dynamic representation of the explored typology of the South Australian House.

Maria Lorena Lehman deals with designing an optimization method for communication between buildings by using a biomimetic approach to derive lessons from the human eye and its focusing abilities. She suggests this method to uplift the urban quality of life by transforming the buildings—which are often static without adapting to the ever-changing context that surrounds them—into "communication bridges" in her chapter "Human Eye Behaviors Inform Systems Design for Inter-Building Communication."

Inspired robot design by nature is widely used. By considering this point, Julien Serres tries to bring a different perspective to drone miniaturization and navigation inside buildings. In his chapter "Taking Inspiration from Flying Insects to Navigate Inside Buildings," bio-inspired sensors and optic flow-based direct feedback loops were applied to a micro air vehicle and this design has been demonstrated for a drone flying inside buildings.

Regarding the relationship between biology and design, we could mention "bio-cooperation" as a new approach in the twenty-first century. It is noticed that using living organisms and nature in design is beyond inspiring . In this context, the next two chapters are concerned with hybrid design synthesis between biology and design collaboration.

İrem Deniz and Tuğba Keskin Gündoğdu introduce the use of living organisms in the design area from a bioengineer's point of view. The possible uses of bacteria, microalgae, and fungi in biomimetic design are briefly discussed in their chapter "Biomimetic Design for a Bioengineered World." They also mention biomaterials for biodesign. Using the potential of bacteria, fungi, and microalgal strains in the building creates an exciting balance between cost-effective, non-toxic, and natural characteristics. The authors also noticed that interdisciplinary cooperation could be utilized to develop bio-based products in the future.

In the chapter "Biomimetic Façade Applications for a More Sustainable Future," Ayça Tokuç, F. Feyzal Özkaban, and Özge Andiç Çakır look at the possibilities of biomimetics and biodesign methods in sustainable façade designs. They introduce the design principles of sustainable façades first, and then related construction materials and some contemporary examples are explained. The authors mention the harmony between the concept of biomimicry and sustainability but point out that every biomimetic application is not always sustainable. They suggest bio-cooperation with natural elements in façade design as another way to learn from nature.

These two chapters also mention a biodesign team in Turkey, Turkey Biodesign Team, that is promising for Eastern European countries.

Hyunsoo Lee and Nayeon Kim in a chapter called "Bio-inspired Adaptable Façade Control Reflecting User's Behavior" present the process of methodology for designing an adaptable façade to change environments and requirements for humans. The design of the adaptable façade inspired from nature is also one of the main reasons for the work to be included in this book. Moreover, biomimetic façade control is implemented in the content.

In nature, many plants and animals have superhydrophobic properties. These superhydrophic properties provide us with new technological products by focusing on these living beings. In the chapter "Switchable and Reversible Superhydrophobic Surfaces," parts one and two, written by Sabri Taleb, Thierry Darmanin, and Frédéric Guittard, a superhydrophobic surface is described. Surfaces with robust superhydrophobic properties are needed for practical applications. This work presents how a superhydrophobic surface is able to be stabilized in the Cassie-Baxter state.

Reading and interpreting the chapters of this book as editors, we have learned many things during the process. We are very appreciative to all contributing authors for their efforts and to dear Romina Skomersic, our publishing process manager, and Anja Filipovic, our commissioning editor, for their patience and endeavor.

It would appear that the twenty-first century is producing many new and amazing designs. Before these educative and exciting processes can be combined, this book will be an important guide to take a quick look at all the possibilities.

Gulden Kokturk
Dokuz Eylu◎l University, Turkey

Tutku Didem Akyol Altun
Dokuz Eylu◎l University, Turkey

Edited by Gulden Kokturk and Tutku Didem Akyol Altun

People have been finding inspiration in nature in solving their problems, from the very beginning of their existence. In the most general sense, biomimicry, defined as "inspire from the nature," has brought together the engineers and designers nowadays. This collaboration creates innovative and creative outcomes that encourage people with their interdisciplinary relationships. Accordingly, the aim of this book is to bring together different works or developments on biomimetics in interdisciplinary relationship between different areas, especially biomimicry, engineering, and design. The twenty-first century has conceived many new and amazing designs. The book in your hands will surely be an important guide to take a quick look at the future possibilities.

ISBN 978-953-51-3935-5

Photo by rawpixel.com / Unsplash

IntechOpen