

Biosystems & Biorobotics

Maria Chiara Carrozza

# The Robot and Us

An 'Antidisciplinary' Perspective  
on the Scientific and  
Social Impacts of Robotics

 Springer

# Biosystems & Biorobotics

Volume 20

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## *Aims & Scope*

Biosystems & Biorobotics publishes the latest research developments in three main areas: 1) understanding biological systems from a bioengineering point of view, i.e. the study of biosystems by exploiting engineering methods and tools to unveil their functioning principles and unrivalled performance; 2) design and development of biologically inspired machines and systems to be used for different purposes and in a variety of application contexts. The series welcomes contributions on novel design approaches, methods and tools as well as case studies on specific bioinspired systems; 3) design and developments of nano-, micro-, macrodevices and systems for biomedical applications, i.e. technologies that can improve modern healthcare and welfare by enabling novel solutions for prevention, diagnosis, surgery, prosthetics, rehabilitation and independent living.

On one side, the series focuses on recent methods and technologies which allow multiscale, multi-physics, high-resolution analysis and modeling of biological systems. A special emphasis on this side is given to the use of mechatronic and robotic systems as a tool for basic research in biology. On the other side, the series authoritatively reports on current theoretical and experimental challenges and developments related to the “biomechatronic” design of novel biorobotic machines. A special emphasis on this side is given to human-machine interaction and interfacing, and also to the ethical and social implications of this emerging research area, as key challenges for the acceptability and sustainability of biorobotics technology.

The main target of the series are engineers interested in biology and medicine, and specifically bioengineers and bioroboticists. Volume published in the series comprise monographs, edited volumes, lecture notes, as well as selected conference proceedings and PhD theses. The series also publishes books purposely devoted to support education in bioengineering, biomedical engineering, biomechatronics and biorobotics at graduate and post-graduate levels.

## *About the Cover*

The cover of the book series Biosystems & Biorobotics features a robotic hand prosthesis. This looks like a natural hand and is ready to be implanted on a human amputee to help them recover their physical capabilities. This picture was chosen to represent a variety of concepts and disciplines: from the understanding of biological systems to biomechatronics, bioinspiration and biomimetics; and from the concept of human-robot and human-machine interaction to the use of robots and, more generally, of engineering techniques for biological research and in healthcare. The picture also points to the social impact of bioengineering research and to its potential for improving human health and the quality of life of all individuals, including those with special needs. The picture was taken during the LIFEHAND experimental trials run at Università Campus Bio-Medico of Rome (Italy) in 2008. The LIFEHAND project tested the ability of an amputee patient to control the Cyberhand, a robotic prosthesis developed at Scuola Superiore Sant’ Anna in Pisa (Italy), using the tf-LIFE electrodes developed at the Fraunhofer Institute for Biomedical Engineering (IBMT, Germany), which were implanted in the patient’s arm. The implanted tf-LIFE electrodes were shown to enable bidirectional communication (from brain to hand and vice versa) between the brain and the Cyberhand. As a result, the patient was able to control complex movements of the prosthesis, while receiving sensory feedback in the form of direct neurostimulation. For more information please visit <http://www.biorobotics.it> or contact the Series Editor.

More information about this series at <http://www.springer.com/series/10421>

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*To my father,  
absorbed on the typewriter,  
steadfast gaze and smiling,  
traveler in the name of  
Agricultural Law*

# Preface

“The mark of science is in its teaching”. I learned this very early, from my father, a rigorous and watchful scholar of Agricultural Law, who wanted to certify the autonomy of his discipline as progress and distinction with respect to the others that existed at the time. It was from his interpretation of Aristotle that he drew the motivation that summarized his effort to write a book for students. Without a manual, a text with a methodological systematization of knowledge, it is not possible to train students and build a discipline within which a scientific community can be developed, and which can then be reflected in the programs of university courses and research areas.

Destiny has decreed, after almost 20 years since my father’s death, that I have found myself, by experience and by pure chance in life, working in a relatively new and original sector. This is biomedical engineering, in particular biorobotics, which requires the same systematic activity in order to become well established.

But today, we are in the years when the scientific disciplines, and consequently their teaching, are undergoing an impetuous evolution, and the age-old and slow effort to divide them into separate sectors is being constantly tested by the emergence of new methods and forms of knowledge. These are transforming the very method of teaching through manuals and textbooks, and they endorse a drive toward interdisciplinarity, or rather, *antidisciplinarity*.

The tendency to cross and break down barriers stems from the request to address the contingent problems of humanity manifested by public opinion and politics in relation to the scientific community. This is because an increasing number of skills are required that cross the various scientific areas in order to resolve the problems of a general nature, and the solutions are never confined to a single discipline. In order to face the problems of society,

it is necessary to federate between scientists of various sectors and to collaborate in programs aimed at involving more areas. On the contrary, if we consider the needs of teaching, the stimulus is in the opposite direction. To train, we need to compare and deepen, systematize, and build a discipline with its methodologies, so as to be able to prepare the scholars and professionals of tomorrow. Who teaches knows well that the training must be thorough and rigorous, and be based on the “fatigue of the concept” in order to allow a true transmission of knowledge to those who one day will not only make it theirs, but who will also modify it with their own original contribution.

Within this context, this book is the first step toward an attempt to present an area, that of robotics, which is studied in the most advanced engineering courses, and attracts a great deal of attention as a scientific and technological field. Not only is this due to its various applications and current implications, but also for its potential to revolutionize our life.

It is therefore a journey through robotics on its way toward its evolution from industrial to social applications. This book originated from a series of lessons that I held at the School of Politics in Rome, during 2016. The lessons represented a landing point, at the end of a transitional period that I experienced with my dual spirit of scientist and politician, following my return to Parliament after the experience of government in 2014. In fact, in a very difficult phase of life, I reinvented my research activity and the parallel political initiative, attempting to integrate them in an original proposal, starting again with study, and wishing to constructively close my chapter of Ministerial experience.

There is nothing better than a break from work, a period of sabbatical like the extraordinary one that I experienced in the government, to return to study and reflection with a new stimulus and with the spirit of observation that only a detached perspective can bring. Studying and preparing to reenter the world of robotics with greater awareness and maturity, I came across a veritable explosion of literature on the subject. This was not only purely scientific but of various kinds, including science fiction, journalism, education, and economics, which all showed a new vitality of the industry, a new life for robotics, with a huge impact on society. I immediately realized that in the course of just two years the world had changed profoundly, especially from a scientific and technological point of view. We were entering a phase of profound transformation in the production of goods and services, with a capacity to change society, work, and our way of life. From 2014 to 2016, I then tried to observe this transformation, to understand the real effects, more than the theoretical or potential ones, of what is commonly called the “fourth industrial revolution”. In this period of research and reflection, I evidently