



## EDITOR-IN-CHIEF'S WORD

Dear Readers,

We are very pleased to present you the new issue of our Academy's Bulletin in English „*Engineering Power*“ Vol. 12(3) 2017, which has been guest-edited by Zdravko Virag, Member of the Academy in the Department of Mechanical Engineering and Naval Architecture.

One of the principal goals of our Academy, apart from the promotion and popularization of technological and biotechnological sciences, is to promote interdisciplinary approaches to solving engineering problems, which result in cutting-edge technologies that will shape future scientific improvements. „*Engineering Power*“ is one of our selected media through which we hope to draw your attention to the efforts and achievements of our Academy and its members.

Editor-in-Chief

Vladimir Androćec, President of the Croatian Academy of Engineering



## EDITOR'S WORD

Croatian Academy of Engineering, as the only scientific institution in the Republic of Croatia that brings together scientists and researchers of all profiles in technological and biotechnological sciences, especially encourages interdisciplinary co-operation in particular fields as one of the principal leverages of scientific and technological development. We are also witnessing the emphasizing of interdisciplinary priorities of research topics in the field of application of research projects to domestic and international scientific grant application procedures and programs, such as Croatian Science Foundation and Horizon 2020.

Although this trend is visible in a number of research fields, both in fundamental and applied ones, the interconnection of technological and biomedical disciplines is a distinct *success story* of contemporary science.

The advancement in their complementation and rapid development based on mutual stimulation and even permeation, such as in some cases where the technical and technological part of research is inseparable from its biomedical constituent and vice versa, has contributed to the development of treatment and diagnostics techniques that have significantly improved the contemporary quality of life and were almost inconceivable just a few years ago.

In that regard, the Croatian Academy of Engineering is especially pleased to present in two subsequent issues of its Bulletin „*Engineering Power*“ a part of research activities that are being conducted at the University of Zagreb, and that synergically combine technological and biotechnological sciences. The invited editors are leaders of the research teams at the University of Zagreb Faculty of Mechanical Engineering and Naval Architecture. In research activities the teams are associated with colleagues from the University of Zagreb, Faculty of Medicine as well as with distinguished international institutions.

It is my great pleasure to announce Prof. Zdravko Virag, PhD, the invited editor of the expert part of this issue, the first in the sequence. Prof. Zdravko Virag, PhD, Member of the Academy, is the Head of the Department of Fluid Mechanics at the Faculty of Mechanical Engineering and Naval Architecture, and the leader of the research group in the field of hemodynamic modeling of the cardiovascular system.

Editor

Zdravko Terze, Vice-President of the Croatian Academy of Engineering



## FOREWORD

Biomedical engineering is one of the fastest developing fields, which touches many specialties and provides a basis for the faster development of medical science. Close and fruitful cooperation of medical doctors and engineers results in team synergy, thus enabling faster progress than in the case when everyone works separately in their own “silos”. At the University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture we recognized the necessity of such cooperation more than ten years ago. Today, our several engineer teams are teamed up with medical doctors in projects related to medicine. As pathological conditions in the cardiovascular system (such as atherosclerosis, formation of aneurysms, valvular heart diseases, etc.) are strongly interlinked with the hemodynamics of the cardiovascular system and tissue remodeling, they attract interest of our departments. The Department

of Fluid Mechanics is now in charge of hemodynamics and the Department of Mechanics is in charge of tissue remodeling and formation of aneurysms.

The papers below provide the Department of Fluid Mechanics team with a short overview over research activities and results in the field of hemodynamic modeling of the cardiovascular system. We have developed models and numerical methods with different levels of complexity: from a lumped parameter model to one-dimensional and quasi two-dimensional to three-dimensional model. The simplest lumped parameter model is important for clinicians, since it describes the principal part of the cardiovascular system with a relatively small number of parameters, each having a clear physiological meaning crucial to understand the system function. Such a model is being applied in an ongoing project considering a non-invasive method for the model parameter identification of pulmonary circulation in subjects with pulmonary hypertension. The problem with one-dimensional and three-dimensional models is that they require more input data (e.g. space variation of blood vessel diameter and wall properties) that cannot be easily measured, but still such models are very important for understanding wave phenomena in the arterial tree and for estimating the local flow parameters, important for the prediction of some diseases (such as aneurysm growth). The developed models and methods are a good basis for prospective cooperation with other medical and engineering teams. Recently, we have established the Laboratory for Artificial Cardiovascular Circulation in cooperation with the University of Zagreb, School of Medicine with the purpose of collaborative research on artificial heart development and education of prospective medical engineering students.

Guest-Editor

Zdravko Virag, University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture