Curriculum Vitae of Riccardo Sacco
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Academic Position
• 11/2001-present: Associate Professor of Numerical Analysis, PoliMi
• 03/2017: Italian National Habilitation (ASN) at the rank of Full Professor in Numerical Analysis

Professional Preparation
• 02/1989: B.S./M.Sc. Electronic Engineering, PoliMi
• 11/1989-06/1993: PhD in Applied Mathematics, Universita` degli Studi di Milano, Italy (UniMi)
• 06/1993-06/1994: Post-Doc Fellowship in Applied Mathematics, CNR, Italy
• 06/1994-12/1995: Post-Doc Fellowship in Applied Mathematics, UniMi

Appointments
• 02/1989-11/1989: Lecturer in Calculus and Researcher, PoliMi
• 02/1989-11/1989: Scientific Consultant, ST Microelectronics, Agr. Br. Italy
• 11/1990: Visiting scientist at AT&T Bell Labs. Murray Hill NJ, USA
• 12/1995-11/2001: Assistant Professor in Numerical Analysis, PoliMi
• 08/2003: Visiting scientist at the Department of Aerospace Engineering, Georgia Tech, Atlanta GE, USA
• 01/2015-05/2015: Visiting scientist at the Department of Mathematics and IRMA, Universite` de Strasbourg, Strasbourg FR
• between 09/2018 and 05/2019: Visiting scientist at the Department of Mathematics of North Carolina State University, Raleigh NC, USA and Department of Mathematics of University of Missouri, Columbia MO, USA
• 01/2014-present: Scientific Consultant, Micron Semiconductor Italia S.r.l., Vimercate (MB), Italy

Honors and Awards
• 2001: included in the "Who's Who in the World 2001", 18th Edition, p. 1877, New Providence NJ
• 2013: co-author of the "Most Downloaded Article" in the Journal Computer Methods in Applied Mechanics and Engineering (CMAME): de Falco C, Sacco R, Verri M. Analytical and numerical study of photocurrent transients in organic polymer solar cells. CMAME. Vol. 199 (2010) 1722-1732

An Overview of My Research

My research addresses the solution of open problems and urging questions in engineering and life sciences by means of an interdisciplinary approach that utilizes physically-based mathematical modeling to help identify, characterize and disentagle the multitude of mechanisms giving rise to the complex phenomena and behavior observed in the design and function of novel devices and in clinical and experimental studies. In doing this, I focused my effort on overcoming the limitations of off-the-shelf mathematical techniques that are commonly adopted and that, very often, do not suffice to reach the scope at hand, thereby requiring the development of new theoretical approaches and computational methods.

As a consequence, my research brings novel contributions to various disciplines in mathematics, numerical analysis, scientific computing, engineering and life sciences, while, at the same time, advancing science and technology in a broader sense. My scholarly production includes 9 books, 5 book chapters, 76 peer-reviewed articles, 25 peer-reviewed conference papers, 13 reviewed abstracts for proceedings and 63 oral presentations at international and national conferences. My research has been published in top journals in mathematics (e.g., Archives of Rational Mechanics and Analysis, Nonlinear Analysis: Theory, Methods and Applications), numerical analysis (e.g., SIAM Journal on Numerical Analysis, Numerische Mathematik), scientific computing (e.g., Computer Methods in Applied Mechanics and Engineering, Journal of Computational Physics), engineering (e.g., IEEE Transactions on Biomedical Engineering, IEEE Transactions on Power Electronics), biosciences (e.g., Mathematical Biosciences) and ophthalmology (e.g., Expert Review of Ophthalmology).

I have coauthored my work with undergraduate students, MS graduate students, PhD graduate students, private company employees, physicists, biologists, neuroscientists, clinical researchers, medical students and medical trainee/fellow.

Currently, Google Scholar indicates that my **h-index is 27, my_i10-index is 58, and that my publications received a total of 4837 citations to date.**

Synopsis of My Research Interests

• Multiscale and Multiphysics Models and Methods in Medicine, Biology and Bioengineering

This research activity is primarily devoted to address the main open questions in the comprehension of the physiology of the eye and its connection with the onset of neurodegenerative pathologies of the optic nerve head such as glaucoma, which is nowadays the main cause of blindness worldwide. Despite being significant *per se*, this study has a much broader impact in medical clinic and therapy since the eye is the only organ in the human body that can be accessed noninvasively. This makes the eye *a window on the patient's whole system* through which the clinical investigator is potentially able to measure or predict disfunctions occurring in every other compartment of the body. Significant instances of this paradigm are represented by the possibility of detecting the presence of cardiovascular disorders and diabetes through the routine measurement of the intraocular pressure and visualization of the retinal vasculature through a fundus camera analysis, or diagnosing neurological disorders such as Alzheimer's disease through the measure of the concentration of amyloid-beta in the eye fluid.
The continuously increasing availability of measured data in human patients urgently demands for the development of advanced mathematical techniques for their interpretation and cross-correlation. This is the main scope of the research topics listed below.

1. Multiscale 0D, 1D, 2D and 3D coupled models of fluid flow, mass transport and mechanical deformation of ocular vasculature for the numerical simulation of microcirculation in the eye. Application to the study of glaucoma and neurodegenerative disorders
2. Electrochemical and fluid-dynamical mathematical approaches for the study of ion transport across biological membranes. Application to the characterization of ion transporters involved in the process of aqueous humor production by the ciliary epithelium of the human eye
3. Mechanobiological description of growing tissues using the theory of mixtures applied to the modeling and simulation of problems in Regenerative Medicine. Application to the *in silico* recostruction of the articular cartilage of the human knee
4. Fluid-mechanical and chemical coupled mathematical models for the biophysical description of the interaction between the cardiovscular system, the lymphatic system and the interstitial space, Application to the study of rare diseases of the lymphatic system such as Systemic Capillary Leak Syndrome
5. Physical-based theoretical modeling of the cardiovascular function and development of quantitative methods for the clinical interpretation of electrical measurements on individuals. Application to the ballistiocardiogram

6. Mathematical characterization of bulk and interface phenomena affecting ion transport and heat transfer in retinal prostheses. Application to the characterization of the thermo-electrochemical properties of the system composed by an organic polymer substrate in contact with a neuronal cell and immersed within a physiological solution

• Computational Models in Semiconductor Device Simulation:

This research area is strongly connected with my background education as an electronic engineer. Semiconductor devices are everywhere, and oftentimes we do not even realize how much they impact on our everyday's life. Thinking about how many times we pick up a cellular phone or google throughout Internet would give only a gross underestimate of the role of electronics in our existence. As a matter of fact, elementary devices are becoming increasingly small (according to Moore's Law) and, as consequence, the performance of the machines resulting from the assembly of zillions of them are increasingly faster and the amount of data that can be managed is virtually becoming unlimited. This allows us to reach targets that were completely unaffordable until a little time ago, but opens also the designer to face technological challenges that were totally unpredictable only a few years ago, such as the development of genuinely three-dimensional architectures to replace the conventional planar approach in the construction of nanoscale memories for data storage and elaboration. These challenges make the need of physically-based models and efficient and accurate simulation algorithms imperative for the design of the devices of the next 10-year generation. This is the main scope of the research topics listed below.

1. Multiphysics computational models for the numerical simulation of inorganic semiconductors. Application to the design of novel MOS technologies for nanoelectronics industry
2. Thermo-mechanical coupling with electron transport in new generation memory devices. Application to the design of phase change and resistive memories for nanoelectronics industry
3. Homogenized models of photoconversion phenomena in organic solar cells. Application to the design of novel systems for sustainable energy conversion and production
4. Functional iterations for the theoretical study and numerical approximation of drift-diffusion systems. Application to the development of effective algorithms for the simulation of semiconductor mixtures for nanoelectronics

• **Numerical Approximation of Partial Differential Equations Using Mixed and Discontinuous Finite Elements:**

This research area represents, within the spectrum of my personal interests in mathematics, the “theoretical” part. Nonetheless, its importance is central for the development of sound numerical schemes to be used in the approximation of realistic challenging problems. At the center of my focus, I see the urgent need of developing numerical formulations hat are able to reproduce at the discrete level the same properties that are satisfied by the dependent variables in the continuous case. Particularly important in this perspective are the notions of *local balance and interelement conservation.* Both properties express physical laws that are respected by the solutions of the mathematical model and should be preserved when passing to the discretization. Specifically, the method should preserve the energy balance, the mass balance and the continuity of flux exchanged between two neighbouring elements in the partitioned computational domain. Devising locally conserving methods is the main target of the topics listed below.

1. Computational models in visco-poro-elasticity based on the use of Hybridized Discontinuous Galerkin (HDG) Finite Element Methods. Application to the study of the impact of age on the viscoelastic properties of the human retinal tissue
2. HDG approximation of scalar convection-diffusion-reaction equations with application to Darcy's flows in presence of thin interfaces and advective-dominated phenomena. Application to the characterization of blood flow with an homogenized model of the lamina cribrosa in the retina
3. Development and analysis of mixed-hybrid finite element schemes for the stable approximation of compressible/incompressible models in continuum mechanics. Application to the simulation of oxide growth in semiconductor process technology

Research collaborations of Riccardo Sacco

I provide below a detailed list of my present collaborations and ongoing projects, which are diverse but connected by a common thread constituted by the adoption and development of advanced mutidisciplinary, multiscale and multiphysics computational models for Applied and Life Sciences.

Multiscale and Multiphysics Models and Methods in Medicine, Biology and Bioengineering

PROJECT SUBJECT 1: Eye2Brain, Multiscale modeling of fluid-dynamical and metabolic links between eye and brain: towards ocular biomarkers for neurodegenerative disorders

TEAM PARTNERS:

• Prof. Alon Harris and Dr. Alice C. Verticchio Vercellin: Department of Ophthalmology, Icahn School of Medicine at Mount Sinai Hospital, New York, NY

• Drs. Brent Siesky and Matthew S. Lang: Eugene and Marilyn Glick Eye Institute, Indiana University School of Medicine (IUSM), USA

• Prof. Giovanna Guidoboni and Nicholas M. marazzi (PhD student): Department of Electrical Engineering and Computer Science, College of Engineering, University of Missouri, Columbia, MO (USA)

• PhD Daniele Prada, IMATI-CNR, Pavia, Italy

• PhD Lucia Carichino and PhD Simone Cassani, Worchester Polytechnic, MA, USA

• Aurelio Giancarlo Mauri (MSc): Micron Semiconductor Italia S.r.l. Via Trento 20871 Vimercate (MB) -Italy and Dipartimento di Matematica PoliMi

• Prof. Lorena Bociu: Department of Mathematics, North Carolina State University, Raleigh NC, USA

• Prof. Christophe Prud'homme, Prof. Marcela Szopos and Dr. Lorenzo Sala: Institut de Recherche Mathématique Avancée (IRMA), Université de Strasbourg, France

• Dr. Dario Messenio, Eye Clinic, Department of Clinical Science, Luigi Sacco Hospital, University of Milan, Milan, Italy

• Prof. Yoichiro Mori: Calabi-Simons Chair in Mathematics and Biology, Department of Mathematics, School of Arts and Sciences University of Pennsylvania, Philadelphia, PA USA

• Prof. Joseph W. Jerome: Department of Mathematics, George Washington University, Washington, DC USA

• Prof. Maurizio Verri: Dipartimento di Matematica, PoliMi

RESEARCH THEMES:

• Multiscale 0D, 1D, 2D and 3D coupled models of fluid flow, mass transport and mechanical deformation of ocular vasculature for the numerical simulation of microcirculation in the eye with application to the study_of glaucoma and neurodegenerative disorders
• Electrochemical and fluid-dynamical mathematical approaches for the study of ion transport across biological membranes with application to aqueous humor dynamics in the eye and neurovascular couplng mechanisms in the retinal vasculature

PROJECT SUBJECT 2: Theoretical description of the interaction among lymphatic system, cardiovascular system and interstitial space: how fluid flow and protein exchange establish a subatmospheric interstitial pressure

TEAM PARTNERS:
• Prof. Giovanna Guidoboni and Nicholas M. marazzi (PhD student): Department of Electrical Engineering and Computer Science, College of Engineering, University of Missouri, Columbia, MO (USA)
• Prof. Marjorie Skubic and Prof. James Keller: Department of Electrical Engineering and Computer Science, College of Engineering, University of Missouri, Columbia, MO (USA)
• Prof. Virginia Huxley: Department of Physiology and Pharmacology, University of Missouri, Columbia, MO, USA
• Dr. Gian Marco Podda: Dipartimento di Scienze della Salute, UniMi, Milano Italy
• Dr. Maddalena Wu: Dipartimento di Scienze Biomediche e Cliniche, Ospedale Fatebenefratelli-Sacco, Milano, Italy

RESEARCH THEMES:

• Fluid-mechanical and chemical coupled mathematical models for the biophysical description of the interaction between the cardiovscular system, the lymphatic system and the interstitial space, Application to the study of rare diseases of the lymphatic system such as Systemic Capillary Leak Syndrome
• Physical-based theoretical modeling of the cardiovascular function and development of quantitative methods for the clinical interpretation of electrical measurements on individuals. Application to the ballistiocardiogram

PROJECT SUBJECT 3: Coupled description of mass transfer and biomass growth in Tissue Engineering: application to articular cartilage regeneration

TEAM PARTNERS:

• Prof. Manuela T. Raimondi: Dipartimento di Chimica, Materiali e Ingegneria Chimica “Giulio Natta” PoliMi
• Prof. Paola Causin: Dipartimento di Matematica “F. Enriques”, UniMi

RESEARCH THEMES:

• Mechanobiological description of growing tissues using the theory of mixtures applied to the modeling and simulation of problems in Regenerative Medicine

PROJECT SUBJECT 4: Ion electrodiffusion and charge photogeneration phenomena in Bio-Hybrid Systems

TEAM PARTNERS:

• Prof. Guglielmo Lanzani and Dr. Maria Rosa Antognazza: CNST, IIT@PoliMi
• Prof. Giovanna Guidoboni, Department of Electrical Engineering and Computer Science, College of Engineering, University of Missouri, Columbia, MO (USA)
• Greta Chiaravalli (MSc in Physics Engineering) Politecnico di Milano and CNST, IIT@PoliMi
• Prof. Maurizio Verri: Politecnico di Milano, Dipartimento di Matematica

RESEARCH THEMES:

• Mathematical characterization of ion transport and heat transfer in neural interfaces based on inorganic and organic substrates
• Electrolyte-Oxide-Semiconductor interfaces in Neuroelectronics
• Homogenized modeling, theoretical analysis and numerical simulation of photoconversion phenomena in organic solar cells

Computational Models in Semiconductor Device Simulation

PROJECT SUBJECT 1:
Electro-Thermo-Chemo-Mechanical Computational Models for 3D Memories

TEAM PARTNERS:
• Aurelio Giancarlo Mauri (MSc): Dipartimento di Matematica Politecnico di Milano, Micron Semiconductor Italia S.r.l. Via Trento 20871 Vimercate (MB) - Italy
• Prof. Joseph W. Jerome: Department of Mathematics Northwestern University, Evanston IL, USA
• Prof. Maurizio Verri: Dipartimento di Matematica Politecnico di Milano

RESEARCH THEMES:
1. Multiphysics computational models for the numerical simulation of inorganic semiconductors with application to nanoelectronics industry
2. Thermo-mechanical coupling with electron and ion mass transport in new generation memory devices
3. Mathematical models of the coupled interaction between ferroelectric and piezoelectric behaviors in semiconductors

Numerical Approximation of Partial Differential Equations Using Mixed and Discontinuous Finite Elements

PROJECT SUBJECT 1: Development and implementation of 3D finite element Hybridizable Discontinuous Galerkin (HDG) methods

TEAM PARTNERS:
• Prof. Giovanna Guidoboni: Department of Electrical Engineering and Computer Science, College of Engineering, University of Missouri, Columbia, MO (USA),
• Prof. Bernardo Cockburn: School of Mathematics, University of Minnesota, Minneapolis MN, USA
• Prof. Christophe Prud'homme, Prof. Marcela Szopos, Dr. Lorenzo Sala: Institut de Recherche Mathématique Avancée (IRMA), Université de Strasbourg, France
• Dr. Daniele Prada, IMATI-CNR, Pavia, Italy

RESEARCH THEMES:
1. HDG computational models in poro-visco-elasticity
2. HDG computational models of 3D parabolic problems in heterogeneous domains with active interfaces and with boundary conditions of integral type

Research Grants financed by Italian National Agencies

The list reported below contains the records of the supporting grants I received from various Italian agencies and foundations. The amount of the received funding is also reported.

• 1999-2000: Innovative methods in computational fluid-dynamics. Funding agency: Ministery of University, Research, Science and Technology (MURST). Principal Investigator (PI): Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 67139 Euros. FINANCED AMOUNT BY MURST: 46998 Euros.
• 2001-2002: Advanced numerical for partial differential equations and their applications. Funding agency: MURST. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 68689 Euros. FINANCED AMOUNT BY MURST: 48030 Euros.
• 2004-2005: Numerical and modeling adaptivity for partial differential problems. Funding agency: MURST. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 142800 Euros. FINANCED AMOUNT BY MURST: 100000 Euros.
• 2007-2008: Electrochemical models and fluid-dynamics. Funding agency: PoliMi. PI: Massimo Longaretti. Research advisor: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 20000 Euros.
• 2008-2009: Adaptive and non-conforming techniques for the numerical approximation of multi-physics problems. Funding agency: MURST. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 110000 Euros. FINANCED AMOUNT BY MURST: 77000 Euros.
• 2009-2013: Computational models in nano-bio-electronics. Funding agency: PoliMi. PI: Carlo de Falco. Research Advisor: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 250000 Euros
• 2010: Computational models for multiphysics/multiscale problems with biological interfaces. Funding agency: GNCS. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 5000 Euros.

Project Grants Financed by Industrial Partners

The list reported below contains the records of the supporting grants I received from various private companies. The amount of the received funding is also reported. **NOTE:** The financial support from Micron Technology is part of an ongoing consulting activity.

• 1998: Numerical Simulation of Semiconductor Devices in Optoelectronics. Industrial partner: CoReCoM Milano, Italy. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 10000 Euros
• 2002-2003: Modeling and Numerical Simulation of the Short-Circuit Process in Spark Plugs. Industrial partner: Federal Mogul Ignition s.r.l.. Carpi (Mo), Italy. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 8000 Euros
• 2003-2004: Numerical Simulation of Tethered Buoy Dynamics. Industrial partner: Resinex s.p.a., Brescia, Italy. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 16000 Euros
• 2009-2010: Thermo-fluid computational models for a two-phase cooling system. Industrial partner: ABB Research Laboratory, Baden-Dattwil, Switzerland. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 10000 Euros
• 2014-2015: Mathematical models for the simulation of ferroelectric behavior in semiconductor devices. Industrial partner: Micron Technology Italia, Vimercate (MB), Italy. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 30000 Euros.
• 2015-2016: Financial support for “The International Congress of Advanced Technologies and Treatments for Glaucoma (ICATTG)”, October 29-31, 2015, PoliMi. Industrial sponsor: Micron Foundation. PI: Riccardo Sacco. TOTAL AMOUNT OF THE SPONSORSHIP: 5250 Euros.
• 2016-2017: Modeling of tunneling and charging dynamics. Industrial partner: Micron Technology Italia, Vimercate (MB), Italy. PI: Riccardo Sacco. TOTAL AMOUNT OF THE PROJECT: 30000 Euros.

Editorial and Reviewing Activities

The list reported below contains a detailed summary of the various activities that I have the honor to conduct in connection with my position as scientist in Applied Mathematics.

- Associate Editor of the Journal of Coupled Systems and Multiscale Dynamics, American Scientific Publishers
- Associate Editor of the Journal for Modeling in Ophthalmology, Kugler Publications
- Reviewer for the American Mathematical Society since 2006
- Member of REPRISE: Register of Expert Peer Reviewers for Italian Scientific Evaluation, Ministero dell'Istruzione, dell'Università e della Ricerca (MIUR)
- Reviewer for international funding agencies including National Science Foundation (USA), Austrian Science Fund, Deutsche Forschungsgemeinschaft (DFG), Fund for Scientific Research-FNRS (Belgium), National Sciences and Engineering Research Council of Canada, Research Promotion Foundation Nycosia, Cyprus
- Reviewer for more than 20 international scientific journals, including: Computer Methods in Applied Mechanics and Engineering, Biotechnology and Bioengineering, Mathematical Biosciences, Journal of Theoretical Biology, Molecules, International Journal for Numerical Methods in Engineering, Applied Physics Letters, Applied Mathematics Letters, Applied Mathematical Modelling, Computers & Mathematics with Applications, Applied Mathematics, Numerische Mathematik, SIAM Journal of Numerical Analysis, Mathematics of Computation, SIAM Journal on Scientific Computing, Journal of Computational Physics, Nonlinear Analysis Series A: Theory, Methods & Application, Numerical Methods for Partial Differential Equations, Numerical Algorithms., COMPEL, Applied Mathematics and Computation, Mediterranean Journal of Mathematics, Acta Mathematica Scientia, Physica B, Computing in Science and Engineering, Processes, Materials, Polymers, Communications in Applied and Industrial Mathematics.

MSc Teaching Activities

I started my lecturing activity many years ago, actually, already during my Master Thesis under the guidance of Prof. Emilio Gatti, in 1987. I never stopped from then. I love teaching, mentoring and advising, because they are all expressions of the same human attitude: teaching is learning. You cannot be a good teacher if you are not good at listening the others' opinion and observations. This is easy to say in words, not so easy to implement in real life. I don't know if I succeded, for sure, I strived a lot and I am still doing.

The list below is a synopsis of the courses I have been teaching at Politecnico di Milano over these years for undergraduate and graduate students in the Schools of Engineering and Architecture. One remark is in order related to the educational activity which is presently ongoing during the Fall Semester of the Academic Year 2019-2020. Specifically, within the course "Numerical Analysis" that I held for graduate students in the MSc of Civil Engineering (an audience of more than 250 enrolled individuals), we are experimenting for the very first time at Politecnico di Milano the interactive participation to the computer laboratory classes of Prof. Giovanna Guidoboni, Department of Electrical Engineering and Computer Science; Department of Mathematics, University of Missouri, Columbia MO, USA, through the use of an Internet connection mediated by the software zoom. During the lecture, Giovanna exploits her worldwide recognized expertise in computational models and methods for fluid-structure interactions in biological tissues, with particular emphasis on Ophthalmology and Cardiovascular/Lymphatic Systems, to illustrate the students examples and projects suggested by realistic applications, and guides the audience to a critical use of theoretical methods learned during face-to-face classes and self-evaluation of obtained results on the basis of physical intuition and mathematical rigor. This interactive dialogue between students and mentor (on the other side of the Atlantic Ocean) is receiving a great interest and attention by the audience and preliminary results of my evaluation of the individual student assignement is, until now, very positive and represents an encouraging indication of the success of this initiative. Based on these outcomes, we are planning to replicate this educational approach also to the other course I will teach to graduate students in Mathematical Engineering, Physical Engineering and Biomedical Engineering in the nextcoming Spring Semester.

• 1989-1995: lecturer/teaching assistance for courses in Calculus and Numerical Analysis: undergraduate and graduate students in Electronic, Nuclear and Civil Engineering, PoliMi, undergraduate students in Architecture, Politecnico di Milano
• 1995-2001: courses/teaching assistance in Numerical Analysis and Numerical Methods for Engineering: undergraduate and graduate students in Mechanical, Aerospace and Electronic Engineering, PoliMi
• 2001-present: courses in Numerical Analysis, Functional and Numerical Methods for Engineering, Numerical Methods for Civil Engineering, Physics Engineering, Computational Electronics, Computational Modeling in Electronics and Biomathematics: undergraduate and graduate students in Mechanical, Civil, Electronic and Mathematical Engineering, PoliMi

The teaching and assistance activities related to all of the above listed courses was conducted by implementing theoretical methods on the computer platform using the MatLab scientific environment. For this part of the educational process, I have personally coded algorithms, exercises and student assignments, providing also the audience all the teaching material for personally verifying the outcome of each computation. The material wa made available to the students on the web resources officially provided by PolMi, specifically, the Beep portal, which is accessible by every student by login with personal credentials.

PhD Appointments

• Member of the Board of the PhD School Mathematical Models and Methods in Engineering, Dipartimento di Matematica PoliMi from 2010.

Advanced Education

During my lecturing career I had the honor to teach several courses on special topics of wide interest by Applied Mathematicians and, more generally, by users in Engineering and Biomedical applications. Below, there is a list of the courses and initiatives I have contributed to organize and/or been involved.

• 2003: **Numerical Modeling of the Vascular Flow. International School on Biomathematics, Bioengineering and Clinical Aspects of Blood Flow**. Mathematical Sciences Research Institute, University of California, Berkeley, CA USA, July 2003. Lecturer: Riccardo Sacco
• 2003, 2004: **The Finite Element Method: Foundations and Advanced Applications**. Corsi di Formazione Permanente, PoliMi. Organizers: Prof. Alfio Quarteroni, Prof. Riccardo Sacco. **NOTE:** these courses were provided to PhD students of PoliMi and other Italian Institutions, and to personnel of private companies such as ENI and MathWorks. A registration fee was required for attendance.
• 2007, 2009: **An Introduction to Mixed and Hybrid Finite Element Methods in Computational Fluid-Mechanics**. PhD course in Mathematical Engineering, PoliMi. Lecturer: Riccardo Sacco
• 2010: **Hybridizable Discontinuous Galerkin Methods**. PhD course in Mathematical Engineering, PoliMi. Lecturer: Riccardo Sacco
• 2014: **Multiscale Modeling of Interface Phenomena in Biology**. PhD course in Mathematical Engineering/Mobility Project “Athens”, PoliMi. Lecturer: Riccardo Sacco. **NOTE:** this course was an initiative under the auspices of the Athens network (Advanced Technology Higher Education Network/SOCRATES), made up of 14 prestigious technical European universities. Initially funded in 1996 thanks to the European Community Socrates Programme, the mission of the Athens Programme is to facilitate the exchange of students, of professors, of researchers within the network and to encourage integration, cooperation and the creation of innovative projects for the technological development of Europe. In the specific case of the course I hold in 2014, I registered the participation of 10 foreign students from all Europe.

Synergistic Activities (period 2008 - present)

I spend a significant part of my daily time in Politecnico to develop initiatives aimed at building solid bridges between people of different Institutions and Countries. We live in a global world, so that we need a global networking approach rather than a self-referential scheme. This is true in human relationships, and, even more, when it comes to teaching and making science. Below, there is a list of the international events I have contributed to organize in collaboration with friends and colleagues from everywhere in the world, particularly from USA.

- **Co-organizer** (jointly with Prof. Roderick Melnik and Prof. Giovanna Guidoboni) of the minisymposium “Multidisciplinary alliance in Biosciences: Modeling, Computing, Technology and Clinical Applications”, 13th. World Congress on Computational Mechanics (WCCM XIII), New York, 22-27 July 2018
- **Local organizer** of the Course "Thermodynamics II", PoliMi, May 28 - June 22 2018. Lecturer: Prof. Patrick J. Pinhero, Interim Department Chair of the Chemical Engineering Department, College of Engineering,University of Missouri, E2501 Lafferre Ha ll, Columbia, MO 65211
- **Director** of the PhD course “Life2Math: A Mathematical Shuttle from Molecules to Neurons to Functions and Back”. Doctorate School of PoliMi, Italy, November 14-18, 2016. Main instructors: R.S. Eisenberg, G. Guidoboni, A. Harris, A.G.Mauri. https://www.eko.polimi.it/index.php/LIFE2MATH/
- **Local Organizer** of The International Congress of Advanced Technologies and Treatments for Glaucoma, October 29th-31st, 2015, PoliMi. Congress Chairs: Prof. A. Harris, Prof. G. Guidoboni. Committee Members: Prof. I. Januleviciene, Prof. R. Sacco https://www.icatto.org/archive/icattg2015/
- **Director** of the PhD course Multidisciplinary approaches in the study of biological fluids and tissues: mathematical modeling and clinical experience, Doctorate School of PoliMi, April 20-24, 2015. Main instructors: G. Guidoboni, A. Harris, J. Arciero https://www.eko.polimi.it/index.php/EyePhD2015/EyePhD2015
- **Guest Co-editor** (jointly with G. Guidoboni) of the special issue on Multiphysics/Multiscale Modeling and Applications of Coupled Processes in Biological and Nanotechnological Systems within the Journal of Coupled Systems and Multiscale Dynamics, American Scientific Publishers, 2015
- **Co-organizer** (jointly with Prof. Roderick Melnik and Prof. Giovanna Guidoboni) of the minisymposium “Computational Modeling of Multiphysics/Multiscale Coupled Processes in Biological and Nanotechnological Systems”, WCCMXI Conference, July 20-25, 2014, Barcelona Spain
- **Proposer** (jointly with G. Guidoboni) and representative of PoliMi for the Agreement of academic collaboration between the Trustees of Indiana

University on behalf of the School of Science at IUPUI and PoliMi, signed on 07/2014

• **Co-organizer** (jointly with P. Causin, A. Harris and G. Guidoboni) of the International workshop Integrated Multidisciplinary Approaches in the Study and Care of the Human Eye, PoliMi and UniMi, June 26-27 2013

• **Co-organizer** (jointly with Prof. Roderick Melnik) of the minisymposium “Mathematical Modeling and Numerical Simulation of Coupled Multiphysics Systems in Nano and Biotechnologies”. WCCM8 Conference, 06/30/2008-07/04/2008, Venice Italy

Student Mentoring Activity (period 2000 - present)

Student mentoring is by far the most exciting and rewarding activity in the life of a teacher. It does not really matter whether it is graduate or high school or elementary school students. It is always a mission taking a lot of effort, patience and humbleness. But when it comes to seeing progresses, results and new ideas, well, inner satisfaction is much worth the price of the ticket. Below, there is a list of students that I had the fortune, pleasure and honor to advise and supervise, many times in tandem with other colleagues, during their career as undergraduate, graduate and PhD. I am very proud to say that most of these young people have found a very satisfactory position in real life, while some of them (a significant portion) has continued their pursuance of an academic career. Also in this latter case, I am very happy and proud to confirm that the seed originally sown gave very good fruits. The reason for this is their own talent, I was only there to grasp it. They developed it.

• 3 PhD students in Applied Mathematics at UniMi: Luca Ballestra (2001, co-advised with Prof. F. Saleri), Paola Causin (2002) and Carlo de Falco (2005)

• 3 PhD students in Models and Mathematical Methods in Engineering at PoliMi: Marco Restelli (2007), Matteo Porro (2014) and Francesca Malgaroli (2016, co-advised with Prof. P. Causin)

• 1 PhD student in Physics Engineering at PoliMi: Greta Chiaravalli (2019, presently co-advised with Prof. G. Lanzani and G. Guidoboni)

• 50 MSc students, divided in: 8 students in Electronic Engineering (PoliMi), 2 students in Aerospace Engineering (PoliMi), 1 student in Mechanical Engineering (PoliMi), 1 student in Civil Engineering (PoliMi), 1 student in Physics Engineering (PoliMi), 1 student in Biomedical Enginering (PoliMi), 2 students in Mathematics (UniMi), 1 student in Mathematical Engineering (Politecnico di Torino) and 33 students in Mathematical Engineering (PoliMi)

• 6 BSc students in Mathematical Engineering (PoliMi)

Promoting International Education

Strongly connected with the previously described mentoring activity, I have devoted a significant portion of my professional and human lifetime to promote and strengthen the collaboration between the University of Missouri (MU) and PoliMi. The basis of this collaboration was settled during my visit to MU in November 2017, which was organized by Prof. Giovanna Guidoboni. In only two years (November 2017-November 2019), this collaboration has resulted into the series of accomplishments listed below:

1. **Co-Mentoring of 6 master students pursuing their degree at PoliMi and developing their Master thesis within a research internship in the lab of Prof. Guidoboni at MU.** The research internships have been financially supported by prof. Guidoboni and they occured during Spring 2018 and Spring 2019. Prof. Guidoboni was the primary advisor of each student during their research internship and, in addition, she continued to co-advise them, jointly with me, until their graduation. Two students graduated in Mathematical Engineering (Giulio Bonifazi, session of December 2018; Francesca Bellucci, session of April 2019), one student (Nicholas Mattia Marazzi) graduated in Civil Engineering (session of December 2018) and one student graduated in Physics Engineering (Greta Chiaravalli, session of December 2018). Thanks to this inspiring experience, Nicholas Mattia Marazzi has continued with his graduate studies at the University of Missouri, where he is currently pursuing a PhD degree in Electrical and Computer Engineering under the supervision of Prof. Guidoboni. Greta Chiaravalli has obtained a PhD Fellowship at the Center for Nanoscience and Technology of IIT @ PoliMi, for which Prof. Guidoboni is serving as official co-advisor jointly with Prof. Guglielmo Lanzani (Director of CNST of IIT @PoliMi) and myself. Giulio Bonifazi has obtained a PhD Fellowship at the Basque Center for Applied Mathematics, Bilbao Spain, and, Francesca Bellucci has obtained a PhD Fellowship in Compuer Science at the University of Antwerp (Belgium). The two students who visited MU in Spring 2019 for their master research internship, Raul Invernizzi and Marta Seminara, are planning to graduate in April 2020. Marta Seminara will be graduating in Physics Engineering and Raul Invernizzi will be the first PoliMi student to obtain a dual master degree in Civil Engineering and Mathematical Engineering.

2. **Organization of the Course "Thermodynamics II"**, held at PoliMi by Prof. Patrick J. Pinhero (Interim Department Chair of the Chemical Engineering Department, College of Engineering, University of Missouri) during the period May 28 - June 22 2018. The course was attended by 25 MU students and by several PoliMi students, including 3 MS students in Chemical Engineering and 2 PhD students in Chemical Engineering and Materials Science. I was the local organizer of the course at PoliMi and

Prof. Guidoboni was the essential catalyzer of the project. As a matter of fact, this initiative was made possible by the meeting with Prof. Pinhero that Prof. Guidoboni organized during my visit at MU in November 2017, during which the basic structure of the initiative and its logistics were discussed.

3. **Innovative lectures within the Course "Numerical Analysis"** for graduate students in Civil Engineering at PoliMi, offered in Fall 2019. The course consists of face-to-face lectures (of the duration of 3 hours each) and computer laboratory lectures (of the duration of 2 hours each), for a total number of 66 hours (corresponding to a 6-credit course). The number of attending students largely exceeds two hundreds (currently, 283 students are officially enrolled and the number is still increasing). Prof. Guidoboni is giving a fundamental contribution to the computer lab lectures, during which she connects remotely via zoom in real time and is able to dynamically interact with the students attending the lecture in the PoliMI auditorium. Students are equipped with laptops running the MatLab computing environment and are supervised by Prof. Guidoboni in the critical analysis of mathematical models and numerical methods for realistic problems arising in Mechanical and Biomedical applications. Ms. Greta Chiaravalli serves as teaching assistant; she is present in the room and mediates the virtual interaction between Giovanna and the students, while guiding them in the implementation of the numerical algorithms on the computer machine. Each laboratory session is recorded and the material is being saved for future access by students of both PoliMi and MU.

The initiatives mentioned above have a significant impact on the quality of the educational mission of PoliMi because they contribute to broaden the exposure of our students to new ideas, visions and problems thanks to the internationally recognized experience of Prof. Guidoboni in applying theoretical methods to solve problems in engineering and life sciences. In my viewpoint, these initiatives are not only beneficial to PoliMI, but also for MU. Inspired by the truly interdisciplinary nature of the lectures and the positive experiences of PoliMi students who have already visited the MU campus, several of the 283 students currently enrolled in the course of Numerical Analysis at PoliMi are expressing their interest in MU graduate programs. In addition, lectures and projects that Prof. Guidoboni is developing and delivering remotely at PoliMi constitute an innovative set of teaching material that Prof. Guidoboni will have available to integrate in the courses at MU for the direct benefit of MU students. Given the novelty of such material, we are already planning the development of a new book, which will serve as the natural applied counterpart to the monograph "**A Comprehensive Physically Based Approach to Modeling in Bioengineering and Life Sciences**" that we recently published with Elsevier.

In Spring 2020, we are going to repeat the teaching experience illustrated in item nr. 3 of the previous list of initiatives by applying the same lecturing approach to the course "**Computational Modeling for Electronics and Biomathematics (CMEBM**)", which is a 8-credit course delivered to graduate students in Mathematical, Electronic and Biomedical Engineering at PoliMi. This course is characterized by a strongly innovative and interdisciplinary flavor. In particular, the course has benefitted over the years from the continuous interaction with the Italian site of an American private company, Micron Technology, Inc (MT), which is a worldwide leader in the area of semiconductor memory devices. Over the period 2013-2019, this interaction has led to remarkable deliverables:

- 10 graduates in Mathematical and Electronic Engineering at PoliMi, two of whom were co-advised jointly with Prof. Guidoboni;
- 7 articles published in high-impact peer-reviewed Journals on Applied Mathematics and Ophthalmology, 3 of which were co-authored with Prof. Guidoboni;
- one monograph (of almost 900 pages) on computational modeling in life sciences and bioengineering, published in 2019 by Elsevier Inc., Cambridge MA, co-authored with Prof. Guidoboni, and one chapter of a book on ocular fluid dynamics which will be published by Springer-Birkhauser New York by the end of 2019.

In addition, MT provided concrete financial support to PoliMi, demonstrated by two consulting contracts that have been signed in the last three years, for a total duration of 24 months and a total amount of 60,000 Euros (about 67,000$), and Micron Foundation provided the funding of 5,250 Euros (about 5,860$) in support of international congresses co-organized by Prof. Guidoboni, myself and international colleagues in ophthalmology.

All of the initiatives, achievements and funding opportunities described in these pages summarize a plethora of activities that, in only two years, have already led to remarkable tangible outcomes, while planting the seeds for an even stronger and broader collaborative framework benefitting both MU and PoliMi for many years to come. I feel privileged and honored to have found in Prof. Guidoboni and the University of Missouri such supportive and energetic partners who believe, as much as I do, in promoting education, training and research across disciplines and across continents, and I am looking forward to seeing this partnership grow even more in the future.

List of publications of Riccardo Sacco

Below, a complete list of my publications, divided into: books, book chapters, lecture notes, papers in international peer-reviewed journals, papers under peer-review, papers in peer-reviewed conference proceedings, reviewed abstracts of presentations (in oral form and/or poster form) at the ARVO Annual Meeting (Association for Research and Vision in Ophthalmology) and technical reports published by PoliMi.

1. Books

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3. P. Causin, G. Guidoboni, F. Malgaroli, R. Sacco, A. Harris, "Mathematical Modeling of Retinal Microcirculation and Oxygen Delivery", pp. 161-175 of the volume "Integrated Multidisciplinary Approaches in the Study and Care of the Human Eye", Kugler Publications, Amsterdam (2014).

4. G. Guidoboni, A. Harris, R. Sacco. "Mathematics and ophthalmology: from theory to clinical applications". Introductory chapter of the volume "Ocular fluid dynamics. Anatomy, physiology, imaging techniques, and mathematical modeling". Editors: G. Guidoboni, A. Harris, R. Sacco. Springer-Birkhäuser (New York), (2019, in press).

5. R. Sacco, G. Guidoboni and A. G. Mauri, "Mathematical and physical modeling principles of complex biological systems", Chapter 1 of the volume "Ocular Fluid Dynamics Anatomy, Physiology, Imaging Techniques, and Mathematical Modeling" (18 pages). Editors: G. Guidoboni, A. Harris, R. Sacco. Springer-Birkhäuser (New York), (2019, in press).

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3. R. Sacco, G. Guidoboni, J. W. Jerome, G. Bonifazi, N. M. Marazzi, A. C. Verticchio Vercellin, M. S. Lang, A. Harris. "Electrochemical characterization of ciliary epithelium physiology: a theoretical approach". Submitted to Life (2019).

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1. S. Micheletti, A. Quarteroni, R. Sacco, "Nonlinear Block Iterative Solution of Semiconductor Device equations by a Domain Decomposition Method", in 'Domain Decomposition Methods in Scientific and Engineering Computing', D. Keyes et al. (eds.), Contemporary Mathematics, American Mathematical Society, Vol. 180, 525-531 (1994).
2. R. Sacco, E. Gatti, L. Gotusso, "A discussion on two-dimensional finite element solutions of the drift-diffusion semiconductor device equations. Theory and numerical examples", in 'International Workshop on Advanced Mathematical Methods in Electrical and Electronic Measurements', IEEE - North Italy Section, 177-201 (1994).
3. R. Sacco, F. Saleri, "Exponentially fitted mixed finite volume methods for convection-diffusion problems", in 'Proceedings of the Ninth International Conference on Finite Elements in Fluids, New Trends and Applications' (Eds.: M. Morandi Cecchi, K. Morgan, J. Periaux, B. A. Schrefler, O. C. Zienkiewicz), 1587-1596 (1995).
4. R. Sacco, F. Saleri, "A new mixed finite volume method for drift-diffusion models in semiconductors", in 'Finite Volumes for Complex Applications. Problems and Perspectives' (Eds.: F. Benkhaldoun, R. Vismeier), Hermes-Paris, 365--372 (1996).
5. F. Bosisio, E. Gatti, R. Sacco, F. Saleri, "Exponentially Fitted Mixed Finite Volumes for Energy Balance Models in Semiconductor Device Simulation", ENUMATH97, Proceedings of the Second European Conference on Numerical Mathematics and Advanced Applications, 188-197 (1998).
6. S. Micheletti, R. Sacco, "New Developments in the Numerical Approximation of the Drift-Diffusion Semiconductor Device Equations", ENUMATH97, Proceedings of the Second European Conference on Numerical Mathematics and Advanced Applications, 469-478 (1998).
7. P.Causin, R. Sacco, "Mixed-Hybrid Galerkin and Petrov-Galerkin Finite Element Formulations in Continuum Mechanics", Proceedings of the Fifth World Congress on Computational Mechanics (WCCM V), Editors: H.A. Mang, F.G. Rammestorfer, J. Eberhardsteiner, Publisher: Vienna University of Technology, ISBN 3-9501554-0-6, http://wccm.tuwien.at, Vienna, Austria (2002).
8. S. Micheletti, R. Sacco, P. Simioni, "Numerical Simulation of Resonant

Tunnelling Diodes with a Quantum-Drift-Diffusion Model", Scientific Computing in Electrical Engineering (SCEE-2002, June 23-28, 2002, Eindhoven, The Netherlands),Eds. W.H.A. Schilders, E.J.W. ter Maten, S.H.M.J. Houben, Lecture Notes in Computer Science, Springer-Verlag, 313-321 (2004).

9. P. Causin, R. Sacco, "Mixed-Hybrid Finite Element Methods for Coupled Problems in Silicon Dioxide Technology", Lecture Notes in Computer Science, SCEE2002, Eds. W.H.A. Schilders, E.J.W. ter Maten, S.H.M.J. Houben, Eindhoven, The Netherlands, pp. 154--162, Springer-Verlag (2004).
10. C.L. Bottasso, P. Causin, R. Sacco, "An Upwind-Mixed Method for Advection-Diffusion Problems with Static Condensation", Applied and Industrial Mathematics in Italy, Series on Advances in Mathematics for Applied Sciences, M. Primicerio, R. Spigler, V. Valente (Eds.), Vol. 69, World Scientific, Singapore, 167-178 (2005).
11. B. Chini, J.W. Jerome, R. Sacco, ``Multi-Physics Modeling and Finite Element Approximation of Charge Flow in Ionic Channels", Proceedings of EuroSimE 2006, ``Thermal, Mechanical and Multi-Physics Simulation and Experiments in Micro-Electronics and Micro-Systems", L.J. Ernst, G.Q. Zhang, P. Rodgers, M. Meuwissen, S. Marco, O. de Saint Leger (Eds.), IEEE Shaker Publishing, Maastricht (The Netherlands), 153-160 (2006).
12. G. Cassano, C. Giulianetti, C. de Falco, R. Sacco, ``Quantum Corrected Drift-Diffusion Modeling and Simulation of Tunneling Effects in Nanoscale Semiconductor Devices", Scientific Computing in Electrical Engineering, Proceedings of the SCEE-2004 Conference held in Capo d'Orlando (ME), Series: Mathematics in Industry, The European Consortium for Mathematics in Industry, Vol. 9, A.M. Anile, G. Ali`, G. Mascali (Eds.), Springer-Verlag Berlin Heidelberg, 300-307 (2006).
13. P. Causin, R. Sacco, ``Hybridization of Galerkin and Petrov-Galerkin Mixed Finite Element Methods for 2nd Order Elliptic Problems", Communications to SIMAI Congress, ISSN 1827-9015, DOI: 10.1685/CSC06168, Vol. 2 (2007).
14. M. Longaretti, J. W. Jerome, R. Sacco, B. Chini, ``Computational Models for The Numerical Simulation of Voltage Operated Channels in Nano-Bio-Electronics", PAMM, Proc. Appl. Math. Mech., 7, 1030803-1030804 (2007).

15. C. de Falco, J. W. Jerome, R. Sacco, ``A Functional Iteration for the Quantum Drift-Diffusion Model: Existence Analysis and Numerical Approximation'', PAMM, Proc. Appl. Math. Mech., 7, 1130603-1130604 (2007).
16. R. Sacco, "Multi-Physics Models for Bio-Hybrid Device Simulation", MathKnow, Mathematics, Applied Sciences and Real Life, M. Emmer, A. Quarteroni Eds., Modeling, Simulation and Applications, Vol. 3, Springer-Verlag Italia, 229-240 (2009).
17. C. de Falco, R. Sacco, "Error Estimates for a Mixed Hybridized Finite Volume Method for 2nd Order Elliptic Problems" (October 2010). BAIL 2010 - Boundary and Interior Layers, Computational and Asymptotic Methods. Lecture Notes in Computational Science and Engineering, 2011, Volume 81, 109-117, DOI: 10.1007/978-3-642-19665-2_12.
18. C. de Falco, A. Iacchetti, M. Binda, D. Natali, R. Sacco, M. Verri, "Modeling and Simulation of Organic Solar Cells". Proceedings of the Conference "Scientific Computing in Electrical Engineering SCEE 2010", Series: Mathematics in Industry, Vol. 16, Subseries: The European Consortium for Mathematics in Industry, Michielsen, B., Poirier, J.-R. (Eds.), 1st Edition., ISBN 978-3-642-22452-2 (2011).
19. P. Causin, R. Sacco, "A Computational Model for Biomass Growth Simulation in Tissue Engineering". Communications in Applied and Industrial Mathematics DOI: 10.1685/journal.caim.370 (2011).
20. G. Novielli, A. Ghetti, E. Varesi, A. Mauri, R. Sacco. "Atomic Migration in Phase Change Materials". Proceedings of IEDM 2013 (IEEE International Electron Devices Meeting), Washington, DC, December 9-11, 2013, 978-1-4799-2306-9/13/, pp. IEDM13-589-IEDM13-592, 2013.
21. M. Porro, C. de Falco, R. Sacco and M. Verri. "Multiscale Modeling of Heterojunction Organic Photovoltaic Devices", pp. 17-22 Progress in Industrial Mathematics at ECMI 2012, Magnus Fontes, Michael Guenther, Nicole Marheineke Eds., Springer International Publishing Switzerland 2014. http://dx.doi.org/10.1007/978-3-319-05365-3_3
22. P. Causin, G. Guidoboni, F. Malgaroli, R. Sacco, A. Harris. "Impact of blood flow on ocular pathologies: can mathematical and numerical modeling help preventing blindness?", pp.: not available The European Consortium for Mathematics in Industry, Editor-in-chief: Capasso, V.

Series Editors: Bonilla, L.L., Guenther, M., Scherzer, O., Schilders, W. Series: Mathematics in Industry, Springer, 2015.

23. R. Sacco, S. Cassani, G. Guidoboni, M. Szopos, C. Prudhomme, A. Harris. "Modeling the coupled dynamics of ocular blood flow and production and drainage of aqueous humor", pp. 608-611 Proceedings of the 4th International Conference on Computational and Mathematical Biomedical Engineering - CMBE2015 29 June-1 July 2015, France. P. Nithiarasu and E. Budyn (Eds.)
24. F. Stefanoni, A. Harris, M. Szopos, C. Prud'homme, R. Sacco, D. Messenio, M.L. Costantino, G. Guidobon. Clinical assessment of intraocular pressure: a whole-eye dynamic model. Journal for Modeling in Ophthalmology 2(2) (2018) 18-23. VII Annual Meeting of the Italian Chapter of the European Society of Biomechanics (ESB-ITA), September 28-29, 2017, Rome (Italy).
25. R. Sacco, A. G. Mauri, A. Cardani, B. A. Siesky, G. Guidoboni, A. Harris. "Multiscale modeling and simulation of neurovascular coupling in the retina". Journal for Modeling in Ophthalmology, Vol.2 (2), 30-35 (2018). VII Annual Meeting of the Italian Chapter of the European Society of Biomechanics (ESB-ITA), September 28-29, 2017, Rome (Italy)

Peer-Reviewed Abstracts for the ARVO Annual Meeting (Association for Research and Vision in Ophthalmology)

1. Theoretical investigation of factors influencing oxygen levels in retinal vessels and tissue, Giovanna Guidoboni; Francesca Malgaroli; Paola Causin; Riccardo Sacco; Brent A Siesky; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2014; 55(13):4323. doi:
2. Effect of scleral anchorage on the perfusion of the lamina cribrosa. Daniele Prada; Giovanna Guidoboni; Samuele Terragni; Riccardo Sacco; Paola Causin; Brent A Siesky; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2014; 55(13):4255. doi:
3. Influence of blood pressure and vascular resistance on the response to medications lowering intraocular pressure: a mathematical model. Giovanna Guidoboni; Alon Harris; Brent Siesky; Christophe Prud'homme; Riccardo Sacco; Marcela Szopos. Invest. Ophthalmol. Vis. Sci.. 2015; 56(7):5820. doi:
4. The role of HCO - 3 and Na/K ATPase in the regulation of aqueous humor production: a mathematical model. Riccardo Sacco; Aurelio Giancarlo Mauri; Lorenzo Sala; Simone Cassani; Brent A Siesky; Giovanna Guidoboni; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2016; 57(12) doi:
5. Influence of tissue viscoelasticity on the optic nerve head perfusion: a mathematical model. Daniele Prada; Riccardo Sacco; Bernardo Cockburn; Lorena Bociu; Justin Webster; Brent A Siesky; Alon Harris; Giovanna Guidoboni. Invest. Ophthalmol. Vis. Sci.. 2016; 57(12):3558. doi:
6. Mathematical modeling and statistical analysis of aqueous humor flow towards individualized glaucoma treatment. Simone Cassani; Giovanna Guidoboni; Marcela Szopos; Christophe Prud'homme; Riccardo Sacco; Brent A Siesky; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2016; 57(12):6404. doi:
7. PATIENT-SPECIFIC VIRTUAL SIMULATOR OF TISSUE PERFUSION IN THE LAMINA CRIBROSA. Lorenzo Sala; Christophe Prud'homme; Daniele Prada; Fabrizia Salerni; Christophe Trophime; Vincent Chabannes; Marcela Szopos; Rodolfo Repetto; Silvia Bertoluzza; Riccardo Sacco; Alon Harris; Giovanna Guidoboni. Invest. Ophthalmol.

Vis. Sci.. 2017; 58(8):727. doi:

8. Increased levels of nitric oxide may pathologically affect functional hyperemia in the retina: model and simulation. Riccardo Sacco; Aurelio Giancarlo Mauri; Alessandra Cardani; Brent A Siesky; Giovanna Guidoboni; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2017; 58(8):214. doi:

9. A theoretical study of the role of conformational properties of transepithelial ion pumps on aqueous humor production. Riccardo Sacco; Lorenzo Sala; Aurelio Giancarlo Mauri; Dario Messenio; Giovanna Guidoboni; Brent Siesky; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2018; 59(9):1656. doi:

10. Quantifying retinal and choroidal contributions to macular oxygenation: a theoretical approach. Alice Chandra Verticchio Vercellin; Alon Harris; Thomas A Ciulla; Greta Chiaravalli; Riccardo Sacco; Brent A Siesky; Ingrida Januleviciene; Giovanna Guidoboni. Invest. Ophthalmol. Vis. Sci.. 2019; 60(9):28. doi:

11. Electrochemical characterization of ciliary epithelium physiology: a theoretical approach. Giovanna Guidoboni; Giulio Bonifazi; Riccardo Sacco; Anita Layton; Sarah D Olson; Maila C Brucal Hallare; Brent A Siesky; Carlo Bruttini; Alice Chandra Verticchio Vercellin; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2019; 60(9):3202. doi:

12. A theoretical investigation of the role of arachidonic acid in astrocyte vasoactive agent production. Riccardo Sacco; Giovanna Guidoboni; Aurelio Giancarlo Mauri; Brent A Siesky; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2019; 60(9):4393. doi:

13. A theoretical study of vascular configurations of retinal capillary plexi based on OCTA data. Greta Chiaravalli; Giovanna Guidoboni; Riccardo Sacco; Thomas A Ciulla; Alon Harris. Invest. Ophthalmol. Vis. Sci.. 2019; 60(9):149. doi:

Technical Reports

1. R. Sacco, "Introduzione al metodo degli elementi finiti: teoria e applicazioni" (in italian), Technical Report n. 13/R, Dipartimento di Matematica "F. Brioschi", Politecnico di Milano (1995).
2. P. Causin, S. Micheletti, R. Sacco, "Introduzione all'uso di MATLAB per il Calcolo Scientifico" (in italian), Technical Report n. 29/R, Dipartimento di Matematica "F. Brioschi", Politecnico di Milano (2000).

Invited talks and conferences held by Riccardo Sacco

1. February 1991: "Metodi numerici per la simulazione dei dispositivi elettronici", Dipartimento di Matematica "F.Brioschi", Politecnico di Milano.
2. October 1991: "Metodi numerici per la soluzione delle equazioni dei semiconduttori", Dipartimento di Matematica "F.Brioschi", Politecnico di Milano. Lecture in the Course "Modelli Differenziali alle Derivate Parziali : Simulazione Numerica e applicazioni a problemi dell'Ingegneria" (Organizer: Prof. A. Quarteroni).
3. Maggio 1994: "On the numerical solution of convection-dominated flow problems: applications to drift-diffusion models in semiconductors", Department of Mathematics, University College Cork, Irlanda (invited by Prof. Martin Stynes).
4. January 1995: "Divergence-free exponentially fitted finite elements for convection-diffusion problems". Lecture in "Numerical Methods for Singular Perturbations", Mathematisches Forschungsinstitut Oberwolfach (Germany), Organizers: Proff. Pieter Hemker, Hans G. Roos and Martin Stynes.
5. November 1997: "Stabilization of mixed finite elements for convection-diffusion problems". Lecture in "International Workshop on the Numerical Solution of Thin Layer Phenomena", 20-21/11/97, Amsterdam.
6. April 1999: "Metodi ad Elementi Finiti Misti Duali a Tre Campi per Fluidi Incomprimibili". Lecture at Dipartimento di Matematica "F. Enriques", Università degli Studi di Milano, for the Seminario di Matematica Applicata (Organizers: Proff. L. Pavarino and B. Ruf).
7. October 2002: "Mixed-hybrid Galerkin finite element formulations in fluid mechanics". Lecture at Institut fuer Angewandte und Numerische Mathemaik, Technische Universitaet, Vienna (invited by Prof. Carsten Carstensen).
8. December 2002: "Coupling of quantum and classical models for the numerical simulation of nanoscale semiconductor devices". Lecture at MOX, Dipartimento di Matematica "F. Brioschi", Politecnico di Milano, in the "Second International Workshop on Model Reduction " (WG12) (organizer: Prof. A. Quarteroni).
9. May 2003: "Modelli Matematici in Elettronica". Lecture for the Seminari Culturali at the Collegio di Milano, Milano Italy.

10. May 2003: "Discontinuous mixed-hybrid finite elements in fluid mechanics". Lecture at INRIA-Rocquencourt, Paris (invited by Prof. J.F. Gerbeau).
11. June 2003: "Modelli e metodi numerici nella simulazione di dispositivi a semiconduttore: applicazione al processo di ossidazione termica e al trasporto in dispositivi di dimensione nanometrica". Lecture at STMicroeElectronics, Agrate Brianza, Milano (invited by Dr.Ing. A. Benvenuti).
12. July 2003: "Numerical simulation of semiconductor devices using quantum models". Lecture at Johann Gutenberg Universitaet, Mainz (Germany). Invited by Prof. A. Juengel.
13. June 2004: "Hierarchical Models and Numerical Methods in Semiconductor Device Transport Simulation: From Drift-Diffusion to Quantum Equations". Lecture in ECMI2004, Eindhoven, The Netherlands (Organizer: Prof. A. Bartel).
14. February 2005: "Discontinuous Finite Element Methods with Mixed and Hybrid Variables for Ellptic and Advective-Diffusive Problems". Lecture at Meeting Gemitsche und nicht-standard Finite-Elemente-Methoden mit Antwendugen, Oberwolfach (Germany). Organizers: Proff. Dietrich Braess, Carsten Carstensen, Klaus Hackl.
15. April 2005: "Mathematical Modeling and Finite Element Methods for the Numerical Simulation of Nanoscale Semiconductor Devices". Lecture at the Thirteen Conference Finite Elements for Flow Problems, 4-6/04/05, Swansea, Wales UK (Organizer: Prof. M. Cecchi Morandi).
16. April 2005: "Numerical Simulation of Nanoscale Semiconductor Devices". Lecture at Dipartimento di Matematica ed Applicazioni dell'Università degli Studi Milano Bicocca. Invited by Prof. Alessandro Russo.
17. September 2005: "Multi-Physics Simulation of Nanoscale Semiconductor Devices". Lecture at WIAS (Weierstrass Institute for Applied Analysis and Stochastics) Berlin, for the Workshop "Analysis, Modeling and Simulation of Multiscale Problems" (Organizers: Proff. A. Arnold, A. Juengel, H.-C. Kaiser).
18. December 2005: "Modelli Multi-Fisica e Metodi Numerici per la Simulazione di Semiconduttori Nanometrici", Lecture at Dipartimento di Matematica ``Ulisse Dini", Firenze Italy, for the Workshop in the INdAM 2006-2007 Project ``Mathematical Modeling and Numerical Analysis of

Quantum Systems with Applications to Nanosciences" (Organizer: Prof. Andrea Sacchetti).

19. February 2006: "Hybridization of Galerkin and Petrov-Galerkin Mixed Finite Element Methods for Second Order Elliptic Problems", Lecture at Dipartimento di Ingegneria Industriale, Universita` degli Studi di Bergamo, for the Workshop ``Discontinuous Galerkin Methods: From Theoretical Development to Industrial Applications" (Organizers: Proff. Francesco Bassi and Stefano Rebay).
20. April 2006: "Multi-Physics Modeling and Finite Element Approximation of Charge Flow in Ionic Channels", Lecture at EuroSimE 2006, Como, 24/04/2006, ``Thermal, Mechanical and Multi-Physics Simulation and Experiments in Micro-Electronics and Micro-Systems" (Organizers: Proff. G.Q. Zhang and A. Corigliano).
21. May 2006: "Electro-Thermal Modeling of Semiconductor Devices: Coupling The MOS To The IC", Lecture at SIMAI 2006, Baia Samuele (Rg), 25/05/06, Mini-Symposium M3-Coupling of Circuits, devices and thermal effects (Organizers: Proff. V. Romano and G. Ali`).
22. June 2006: "Hybridized Upwind--Mixed Finite Elements for Diffusion-Advection-Reaction Problems", Lecture at MAFELAP 2006, 16/06/06, Brunel University (UK), Mini-Symposium ``New Hybrid and Hybridized Methods" (Organizers: Proff. B. Cockburn and J. Gopalakrishnan).
23. July 2006: Conservation and Discrete Maximum Principle Properties of Finite Element Methods for the Discretization of Diffusion-Advection-Reaction Problems. Lecture at WCCM7 (Los Angeles, USA, 20/07/06), Mini-Symposium ``Multilevel Stabilized Methods or Other Method for Convection Dominated Problems by Finite Elements and/or Wavelets" (Organizers: Proff. M. Morandi Cecchi and L. Xanthis).
24. July 2006: Mathematical Modeling and Numerical Simulation of Charge Transport in Ionic Channels. Lecture at WCCM7 (Los Angeles, USA, 21/07/06), Mini-Symposium ``Transport and Coupled Processes in Micro-and Nanotechnology" (Organizer: Prof. R. Melnik).
25. July 2006: Upwind Mixed Finite Element Methods with Hybridization for Diffusion-Advection-Reaction Problems. Lecture at WCCM7 (Los Angeles, USA, 21/07/06), Mini-Symposium ``New Hybridization Techniques" (Organizers: Proff. B. Cockburn and J. Gopalakrishnan).

26. February 2007: Multi-Physics Modeling and Numerical Simulation of Electrothermal Effects in Semiconductor Devices. Lecture at the workshop SEMIC 2007 - COMSON Research Training Network (Wuppertal, GE, 5-7/02/07, Organizer: Prof. Micheal Guenther).
27. July 2007: Quantum Corrected Drift-Diffusion Models: Solution Fixed Point Map and Finite Element Approximation. Lecture at ICIAM07, (ETH Zurich (CH), 17/07/07), Mini-Symposium ``Mathematical and numerical modeling of quantum transport in nano-structures'' (Organizers: Proff. Florian Mehats and Pierre Degond).
28. July 2007: Computational Models for The Numerical Simulation of Voltage Operated Channels in Nano-Bio-Electronics. Lecture at ICIAM07, (ETH Zurich (CH), 20/07/07), Mini-Symposium ``Mathematical models and computational methods for nano-and bio-technologies'' (Organizers: Prof. Roderick Melnik and Dr. Jack Tuszynsnki).
29. December 2007: Multiscale/Multiphysics Models in Computational Electronics and Bio-Electronics. Lecture at the workshop Nano-Brixen '07 (Bressanone, 19-22/12/07, Organizer: Prof. Giovanni Naldi).
30. September 2008: Fixed-Point Iteration and Finite Element Approximation of Quantum-Corrected Drift--Diffusion Models. Lecture at SIMAI 2008, Roma, 15/09/08, Mini-Symposium M15 - Mathematical Problems from Semiconductor Industry (Organizers: Proff. Vittorio Romano, Giuseppe Ali`, Orazio Muscato and Giovanni Mascali).
31. June 2009: Multi-Physics/Multi-Scale Computational Modeling of Ion Transport in Neurobiology. Lecture at Istituto Mario Negri, Milano, 3/06/09, on invitation of Dr. Tiziana Mennini, Head of Laboratory of Receptor Pharmacology, Dept. of Molecular Biochemistry and Pharmacology.
32. May 2010: Hybridizable Discontinuous Galerkin Methods for Advective-Diffusive Models. Lecture held by Marco Restelli at SIAM conference on "Emerging Topics in Dynamical Systems and Partial Differential Equations", DSPDEs'10, 31/05/2010, Barcelona, Spain, Minisimposium: "Discontinuous Galerkin Methods for Partial Differential Equations", organized by: B. Ayuso de Dios, L.D. Marini and C.W. Shu.
33. June 2010: Multi-Physics Computational Models in Neuroelectronics. Lecture held by Carlo de Falco at SIMAI 2010, 21/06/2010, Minisymposium MSP23 - Mathematical Models and Numerical Methods for Charge Transport in Semiconductors

(Organizers: Proff. V. Romano, Giuseppe Ali`, Orazio Muscato and Giovanni Mascali).

34. June 2010: Multi-Physics Computational Models in Tissue Engineering. Lecture held by Giovanni Naldi at SIMAI 2010, 23/06/2010, Minisymposium MSP48 - New Trends in Scientific Computing: Computational Biology (Organizer: Prof. Giovanni Naldi).
35. September 2010: A Decade of Computational Models in Engineering. Seminar held on 13/09/2010 at ABB Switzerland Ltd, Baden (Invited by PhD. Francesco Agostini, Principal Scientist).
36. December 2010: Computational Models for Bio-Hybrid Systems. Seminar held on 01/12/2010 at Dipartimento di Matematica, Politecnico di Milano, Giornata in Ricordo di Fausto Saleri (Organizer: Prof. A. Quarteroni).
37. January 2011: Ingegneria e Biologia: anche il corpo umano ha bisogno della Matematica. Seminar held on 20/01/2011 at Politecnico di Milano (Invited by Proff. L. Rossi and T. Norando).
38. June 2012: Multiscale Modeling and Simulation of Organic Solar Cells. Lecture at SIMAI 2012, Torino, 26/06/12, Mini-Symposium MSP-030 - Mathematical Problems in Semiconductors and Related Topics (Organizers: Proff. Orazio Muscato, Majorana, Vittorio Romano).
39. July 2013: Multiscale Models of Retinal Microcirculation: Mass Transport Phenomena. Lecture at Euromech Colloquium 2013, Biomechanics of the Eye, Genova, 22/07/13 (Organizer: Prof. Rodolfo Repetto).
40. October 2013: A 3D Electro-Thermal Mathematical Framework for Memory Devices. Lecture at the 4th International Workshop on Simulation and Modeling of Memory Devices, Micron Semiconductor Italia (Agrate Brianza (Mi)), 30/10/2013 (Organizers: Dr. Andrea Marmiroli, Prof. Luca Larcher, Dr. Paolo Fantini).
41. January 2014: A Challenge in Neuroscience: Neuro-Electronic Interfacing for Biosensoring and Neuroprosthetics. Lecture held on 30/01/2014 at Liceo "Marie Curie" Meda (Mi) (Invited by Dr. Aurelio Mauri).
42. February 2014: Modelli, Simulazione e Tecnologia: Una Triplice Alleanza per le Scienze della Vita. Lecture held on 03/02/2014 at Liceo "Berchet" Milano (Invited by Prof. Tiziana Marsico).
43. July 2014: Multiscale Modeling and Simulation of Neuro-

Electronic Interfaces. Short communication held on 04/07/2014 at FENS2014 - Biologically-based models of neurons and microcircuits, University of Pavia, Pavia Italy (Organizers: Proff. Egidio D'Angelo and Jeanette Kotaleski).

44. September 2014: A Mathematical Microscope for Tissue Engineering Simulation: From Fluid Mechanics to Mechanobiological Processes. Lecture held on 09/09/2014 at the Workshop MECHANOBIOLOGY OF THE CELL AND TISSUES MORPHOGENESIS, Politecnico di Milano, Milano Italy (Organizers: Proff. Davide Ambrosi and Pasquale Ciarletta).
45. March 2015: Bio-Polymer Interfaces for Optical Cellular Stimulation: A Computational Modeling Approach. Lecture held on 11/03/2015 at the Workshop AMASIS2015 (Applied Mathematics and Simulation of Semiconductors), Weierstrass Institute Berlin, Germany (Organizer: Proff. Annegret Glitzky).
46. March 2015: Computational Biology: a Natural (and unexpected) Synthesis between Fluid-Mechanics and Electronics. Lecture held on 17/03/2015 at the Department of Mathematics of University of Strasbourg and IRMA, Strasbourg, France. (Invited by Prof. Christophe Prud'homme and Prof. Marcela Szopos).
47. March 2015: Modeling and Simulation of Ion Flow in Biological Channels Lecture held on 24/03/2015 at the Workshop "FUD4 Meeting", Department of Mathematics of University of Strasbourg and IRMA, Strasbourg, France (Organizer: Prof. Christophe Prud'homme).
48. July 2015: Modeling the coupled dynamics of ocular blood flow and production and drainage of aqueous humor Lecture held on 01/07/2015 at the 4th International Conference on Computational & Mathematical Biomedical Engineering 29 June - 1 July 2015, Cachan (France), Session E: Modelling of Retinal Hemodynamics (Organizer: Proff. Jean-Frederic Gerbeau and Giovanna Guidoboni).
49. November 2015: Modeling and Simulation of Ion Flow in Biological Channels Including Electrochemical, Fluid, Thermal and Mechanical Forces Lecture held on 20/11/2015 at the Workshop Modeling and Computation of Transmembrane Transport 16 November - 20 November 2015, Columbus Ohio (USA), Mathematical Biosciences Institute (Organizers: Proff. Benoit Roux, Guowei Wei and Marie-Therese Wolfram).

50. May 2016: The role of HCO3- and Na/K ATPase in the regulation of aqueous humor production: a mathematical model Lecture held on 01/05/2016 at the ARVO2016 Conference, 1-5 May 2016, Seattle WA (USA).
51. May 2016: A 3D Finite Element Framework for Comprehensive Multi-Physics Simulation of Semiconductor Devices Lecture held on 17/05/2016 at FEM2016 - Finite Element for Microwave Engineering, 16-18 May 2016, Firenze (Organizers: Prof. Roberto D. Graglia and Giuseppe Pelosi).
52. May 2016: A Theoretical Model of Neurovascular Coupling in Retinal Blood Flow Regulation Lecture held on 23/05/2016 at the First Readings Group Seminar Workshop: May 23rd, 2016 - Dipartimento di Matematica Universita` degli Studi di Milano, Milano, Italy (Organizer: Dr. Thierry Nieus, IIT Genova).
53. March 2017: Multiscale Integration of Blood Flow Mechanics and Neural Signaling to Model Retinal Microcirculation Lecture held on 02/03/2017 at the SIAM Conference on Computational Science and Engineering CSE2017, Atlanta GA USA (Minisymposium MS241 New Approaches to Complex Coupled Multiscale Systems, organized by Prof. Malgorzata Peszynska Oregon State University, USA).
54. May 2017: Increased levels of nitric oxide may pathologically affect functional hyperemia in the retina: model and simulation. Poster presented on 06/05/2017 at the ARVO2017 Conference, 6-11 May 2017, Baltimore MD (USA).
55. June 2017: A Dual Mixed Hybridized Finite Element Method for Three-Dimensional Transmission Problems. Poster presented on 29/06/2017 at the Workshop "Recent Advances and Challenges in Discontinuous Galerkin Methods and Related Approaches", June 29 - July 01, 2017, IMA Minneapolis MN (USA).
56. July 2017: A Multiscale Model of Retinal Microcirculation Integrating Blood Flow and Tissue Mechanics with Neural Signaling. Lecture held on 19/07/2017 at the SMB2017 Annual Meeting, July 17-20, 2017, Salt Lake City, USA. Workshop organizers: Proff. Tracy Stiepen and Timothy Secomb.
57. September 2017: Multiscale Modeling and Simulation of Neurovascular Coupling in the Retina. Lecture held on 28/09/2017 at ESBITA 2017, September 28-29 2017, Roma, Italy. Thematic session

organizer: Prof. Anna Pandolfi.

58. October 2017: Modeling of Tunneling and Charge Dynamics. Lecture held on 03/10/2017 at Micron Technology, Vimercate (MB), Italy. Chairman: Dr. Claudio Lombardi.

59. November 2017: Electro-Thermo-Chemical Simulation of Three-Dimensional Nanoscale Semiconductor Memories. Lecture held on 08/11/2017 at the Department of Electrical Engineering and Computer Science, University of Missouri, Columbia MO. (Invited by Prof. Giovanna Guidoboni).

60. November 2017: A Stabilized Dual Mixed Hybrid Finite Element Method with Lagrange Multipliers for Three-Dimensional Problems with Internal Interfaces. Lecture held on 09/11/2017 at the Department of Mathematics, University of Missouri, Columbia MO. (Invited by Prof. Giovanna Guidoboni).

61. May 2018: A theoretical study of the role of conformational properties of transepithelial ion pumps on aqueous humor production. Poster presented on 04/30/2018 at the ARVO2018 Conference, April 29 - May 3, 2018, Honolulu HI (USA).

62. May 2019: A theoretical investigation of the role of arachidonic acid in astrocyte vasoactive agent production. Poster presented on 05/01/2019 at the ARVO2019 Conference, April 28- May 2, 2019, Vancouver BC (Canada).

63. September 2019: A Continuum-Based Model for the Theoretical Study of Aqueous Humor Secretion Coupling Electrochemical and Fluid-Dynamical Mechanisms. Lecture held on 30/09/2019 at the ENUMATH2019 Conference, Egmond aan Zee (The Netherlands) (Minisymposium "Mathematical Modeling of Biological Fluids: Theoretical and Numerical Aspects", organized by Proff. Giovanna Guidoboni, Christophe Prud'homme and Marcela Szopos).