Control of Physiological Systems in Medicine: Models, Identification and Clinical Application

Organisers: There are several organisers for the track to ensure a broad range of expertise to help organise what we expect to be a large track of 40-60 papers. In an effort to bring new ideas and energy to the TC there is a mixture of organisers who have or have not led the organisation of sessions for the TC at past world congresses.

Dr Thomas Desaive University of Liege GIGA In Silico Medicine Allee de 14 Aout, 17 (Bat 5) Liege B4000 Belgium Em: tdesaive@ulg.ac.be	**Prof. Steffen Leonhardt** Helmholtz Inst, RWTH Aachen Pauwelsstr. 20 D-52074 Aachen Germany Em: leonhardt@hia.rwth-aachen.de	**Assoc Prof Neil Evans** University of Warwick Systems, Measurement & Modelling University of Warwick Coventry CV4 7AL United Kingdom Em: Neil.Evans@warwick.ac.uk
Dr Christopher Pretty University of Canterbury Dept of Mechanical Engineering Private Bag 4800 Christchurch New Zealand Em: chris.pretty@canterbury.ac.nz	**Dr Michael Chappell** University of Warwick Systems, Measurement & Modelling Coventry CV4 7AL United Kingdom Em: M.J.Chappell@warwick.ac.uk	**Dr Paul Docherty** University of Canterbury Dept of Mechanical Engineering Private Bag 4800 Christchurch New Zealand Em: paul.docherty@canterbury.ac.nz
Dr Teresa Mendonca Faculdade de Ciencias Universidade de Porto Rua Campo Alegre PT-4169-007 Porto PORTUGAL Em: tmendo@fc.up.pt	**Prof. J. Geoffrey Chase** University of Canterbury Centre for Bio-Engineering Private Bag 4800 Christchurch New Zealand Em: geoff.chase@canterbury.ac.nz	

Special Note: This proposal is to organise an ***open invited track*** (OIT) due to the very strong response received to our CFP among colleagues, and prior World Congresses, where we had 40-50 papers in this area in invited sessions and open sessions. <u>We already have expressions of interest for 35 papers from colleagues</u>.

Main goals: of the OIT and its organisation include:

1. **Balance and Emerging Research Areas**: Create a spread of papers in the OIT to ensure balance across modeling, system ID, and clinical applications of physiological systems based on feedback from the IFAC TC 8.2 BMS 2015 symposium where sessions with specific topics and focuses resulted in a more unbalanced programme and lack of spread across geographic areas and universities.

   This approach should spread the works better and enable new, emerging research areas and topics to appear in these sessions and help reinvigorate the TC and broaden its appeal.

2. **New Researchers**: Attract a range of new topics and efforts from Asia, N. America and S. America where the TC has been weak in recent years, without targeting very specific focus areas of work. Thus, we are hoping a mixture of "shoulder tapping" invitations and the advertisement of an OIT will serve to attract "new blood" and new ideas to our TC

IFAC Technical Area:

This OIT is one of two sponsored by IFAC TC 8.2 "Biological and Medical Systems" and captures a major central focus within the TC's far broader, overall research focus to meet the main goals stated above. This one focuses on the physiological and biological aspects, where the second focuses on hardware/software medical devices and the use of modeling and control in their application. Both are clinical application focused.

Session Description:

As computational, control and sensor technologies advance the potential in application to medical and biological systems has increased exponentially. As a result, there has been an increasingly tight inter-relation between engineering and clinical medicine. This session thus focuses on modeling, system identification and control of physiological systems in medicine, including clinical applications.

A secondary goal of the session is to provide a broad cross section of the area, rather than focusing on specific organs or systems. These specific sessions tend to narrow the focus to specific research groups and thus a limited number of people, where a broader session will draw better numbers and be less exclusive.

As such, this session has another main goal of providing a broader overview of this application area to any "outsiders" who may attend, as well as to attracting new areas of TC relevant research that are only now emerging.

The overall goal is to provide a range of sessions in this OIT, focused with respect to being clinically applicable, but broad with respect to area of clinical application and to engineering sciences (modeling, system ID, control, theory, computation, application and so on).

Paper topics are not necessarily limited and could thus include:

- Multi-scale modeling of physiological systems from detailed or high order models to lower order, very simplified physiological models
- Metabolism
- Cardiovascular modelling for diagnosis and therapy selection
- Lung mechanics in mechanical patient ventilation
- Cellular and macro level pharmacokinetics and dynamics
- The dynamics of decision support systems for antibiotic therapy
- System Identification methods and applications related to the above
- Biomechanics modeling and analysis, including elements of tissue engineering which is emerging as a potentially new area for aspects of this TC.

Overall, this session focuses, broadly, on model-based applications of dynamic systems modeling, control and system identification to clinical medicine. The application areas are broad, but include current and emerging applications, as well as a broad array of potential application spaces.

Note that at WC 2011 in Milan, there were 4 invited sessions comprising 24 papers in this area, which was 7 sessions and 42 papers in WC 2014 in S. Africa. From a broader, OIT (versus invited session) approach the TC hopes to benefit from:

- Greater strength and broader research areas at the next IFAC BMS Symposium in 2018
- Greater geographic breadth including particularly Asia and S. America
- Greater inclusion of younger and women researchers

Session Theme and Rationale:

This session focuses on the convergence of technological advance and aging population demographics as they impact clinical medical practice. Aging populations have put increased stress on medical resources with a greater demand for critical care and other acute care treatment starting to exceed availability in many first world nations. At the same time, the past 20 years have seen a tremendous growth in the application of technology to clinical practice, as well as in the computing power available in every-day and medical devices.

However, despite these changes, the practice of medicine, particularly in the diagnostic and therapy selection parts of practice have seen little change in the past 30 years. At the same time clinical practice is under increasing strain due to limited resources. Hence there is significant opportunity to augment and (partially) automate diagnosis and therapy selection using patient specific modeling. This opportunity is particularly relevant in high cost acute care wards, such as the intensive care unit

(ICU), where significant clinical decisions must be made rapidly by staff under increasing demand for their time. However applications can spread across a variety of clinical wards and outpatient settings, as well as across a variety of biological systems not restricted just to humans.

Hence, there has been some recent growth in the use of models to help test and evaluate new hypotheses in the physiological development of diseases. This trend has been most notable in the analysis of drug therapy pharmacokinetics and in the study of metabolic disorders. <u>This session therefore examines the application of models to medical practice, in both research and clinical practice, through all critical modeling steps from model derivation to patient specific parameter identification to the clinical validation</u>.

The goal of research in this area is to unleash the potential of patient specific physiological or systems biology models to improve patient care and clinical practice requires advances in a broad array of biological systems modeling, identification and simulation areas. Given the growing potential for the clinical use of such model-based methods, it is a good time to examine them in greater detail. This session thus takes a very clinical applications oriented approach, including examining problems that arise from different types of clinical data, as well as the impact on outcomes.

The overall goal is to provide a range of sessions in this OIT, focused with respect to being clinically applicable, but broad with respect to area of clinical application and to engineering sciences (modeling, system ID, control, theory, computation, application and so on).