Frontiers of Engineering for Development: Sustainable Global Wellbeing

Session 1: The Future of Global Health

Session chairs:

Louise Thwaites

Louise is a Clinical Research Fellow based at the Oxford University Clinical Research Unit Ho Chi Minh City where her research interests include improving management of critically ill patients in resource-restricted settings.

Maoyi Tian

Maoyi's main research areas focus on mHealth and healthcare technology for chronic disease prevention and management. He received his BEng from University of York and his MSc from University of Oxford. He graduated with his PhD of Biomedical Engineering from University of New South Wales in Australia.

Speakers and talks:

Million Mufata, University of Malawi
Million is an electrical engineer specializing in instrumentation and control systems and works at the University of Malawi. He has research experience in deployment of sustainable off-grid community-based PV systems. His interest is in the application of WSNs in healthcare delivery. Million designs and builds healthcare devices for low-resource settings.

Low-Cost Biomedical Devices – Challenges and Opportunities in Low-Resource Settings: Case Study of Malawi

Malawi, being one of the poorest countries in the world, relies on donations for her medical equipment base. However, most of the donated equipment is either too complex to operate or difficult and expensive to maintain. Spare parts are usually not available locally. As such, most of the donated high-tech equipment is rendered unusable. Many high-tech equipment fail prematurely due to the harsh environment of sub-Saharan Africa where Malawi is located. It is therefore important to develop and build technologies that are robust, low-cost and effective to suit the environment. One such technology is a phototherapy unit. This unit is used to treat jaundice in neonates. Jaundice, which is the build-up bilirubin in organs, can cause permanent brain damage and/or death. Commercial phototherapy devices are available but are either very expensive (>$500) or not suitable for the harsh environment of sub-Saharan Africa. A low-cost unit has been designed and built using, primarily, locally available materials. Since 2015, over 60 units (each costing $218) have been built, tested, and deployed in the neonatal units of central and district hospitals in Malawi. The device is robust, effective, and easy to maintain. It must be noted that there is a growing hunger of such devices in both public and private hospitals in Malawi. This is an opportunity for inventers and innovators of biomedical technologies.

Walter Karlen, ETH Zurich

Walter is an Assistant Professor in the Department of Health Sciences and Technology heading the Mobile Health Systems Laboratory since 2014. He has a Master degree in micro-engineering and a PhD in Computer, Communication and Information Sciences, both from the Ecole Polytechnique Fédérale de Lausanne (EPFL). For the duration of his PhD, he was a research assistant at the Laboratory of Intelligent Systems under the supervision of Prof. Dario Floreano and a scientific consultant for physiological monitoring in extreme environments for Solar Impulse S.A., Switzerland.

In the period between April 2009 and October 2014, Walter Karlen was a post-doctoral researcher at the Biomedical Engineering Research Group of the Department of Mechanical and Mechatronics Engineering at the University of Stellenbosch, South Africa, the research group of the Department of Anesthesia of BC Children's Hospital and Child and Family Research Institute, and the Electrical and Computer Engineering in Medicine Research Group of the University of British Columbia in Vancouver, Canada where he worked on mobile phone implementations of biomedical sensors for global health applications and novel algorithms for automated analysis of biomedical signals during anesthesia. During this time, he was supported by the Swiss National Science Foundation, the Canadian Institutes of Health Research, and Grand Challenges Canada.

Mobile health tools for diagnosing and monitoring childhood illness

Home-based health care combined with mobile communication technologies (mHealth) is a solution to bring health care closer to the patient. Across the globe, people are rapidly acquiring low-cost mobile phones as daily tools for communication. Thus, bio-medical diagnostic sensors and applications embedded on mobile devices could be easily adopted by lay health workers in areas where access to hospitals and advanced diagnostic systems is limited. In this talk I will present two application scenarios where digital health tools can reduce the burden of childhood illness at the point-of-care. I will present our approach for developing sensor based systems as tools for diagnosing pneumonia and managing dehydration in infants. The systems combine physiological with data driven modeling to enhance the performance in local settings. We will discuss how the introduction of these advanced technologies can be evaluated in the target setting.

Ajay Vamadevan, Centre for Chronic Disease Control, New Delhi

Ajay Vamadevan, is the Head of Health System Unit at the Centre for Chronic Disease Control (CCDC), New Delhi, India. He holds a doctoral degree in non-communicable disease epidemiology from the London School of Hygiene and Tropical Medicine, University of London.

His research work focuses on strengthening Health Systems with the use of mHealth /eHealth technologies and electronic clinical decision support systems for improving access and quality of chronic disease care in primary care. He is part of the leadership team who led/leading six large mHealth/eHealth research projects in India. His work led to the development of the mPower Heart mHealth system which took evidence-based clinical management guidelines for hypertension and diabetes, implemented successfully at primary care in the Indian states of Tripura and Mizoram.

He has deep domain knowledge, combined with a strong technical background clinical research, operational, and strategic planning. He was an Emerging Leader Fellow of the World Heart Federation and was a Public Health Leader Fellow of the PHFI-Emory University Consortium. Has authored more than 30 scholarly papers in scientific journals, and over 15 chapters/books/reports/abstracts.

Li-Qun Xu, Research Institute of China Mobile

Li-Qun Xu became Chief Scientist of China Mobile Research Institute in 2010. He leads primarily R&D activities in broad areas of mHealth and Smart healthcare concerning setting business strategy, building partnership and core research competence, as well as technology, applications and service innovation towards delivering end-to-end optimized healthcare services

An integrated Eye Care System powered by AI-based Analytic Engine and Big Ophthalmic Data

The prevention of blindness-prone eye diseases in large rural populations is a challenge for communities around the world. In this presentation, Dr. Xu will focus on the particular challenges faced by China, as an example. In order to address these challenges Dr. Xu is developing an integrated three-tier eye care system that currently being trialed in a northeastern province of China, in close collaboration with eye care institutions and professionals. The key to enable this eye care system is the software and technologies solutions that have been built based on a big ophthalmic data platform and machine learning/deep learning techniques. This currently includes three parts: 1) An automated eye diseases screening system from analyzing anterior segments and fundus images, respectively; 2) A big ophthalmic data analytic platform built on the data from HIS systems in a large network of eye hospitals and clinics; and 3) A diabetes (diabetic retinopathy patients) self-care management system, with support from experts. This service system has deployment challenges and opportunities, which Dr. Xu will discuss.

Session 2: Sustainable Cities and Infrastructure

Session chairs:

Ana Mijic

Ana is a Senior Lecturer in Urban Water Management at Imperial College London. She has a first class degree in Civil Engineering from the University of Belgrade, Serbia. Before commencing her MSc, Ana worked at the same University as a teaching assistant in Fluid Mechanics and Hydrometry. She obtained a master's degree with distinction in Hydrology for Environmental Management from Imperial College London in 2009 and a PhD in Earth Science and Engineering in 2013. Ana's research interests are focused on systems modelling and full-scale experiments to develop water management strategies for sustainable development. She leads the IAHS Panta Rhei programme Working Group on Energy and Food Impacts on Water. She is also leading the Imperial College London initiative, with partners, to address the issue of groundwater infiltration into urban infrastructure.

Rodrigo Velasco

Rodrigo is an Architect and M.Eng in Computational Design. He has over 15 years of experience in the use of new technologies in sustainable construction. His professional career includes teaching and research work at various universities, and several international publications. Currently, in addition to his work a researcher at Universidad Piloto de Colombia he is director at Frontis3d.

Speakers and talks:

Brittany Harris, Buro Happold

Brittany works for Buro Happold in their water team and has worked with Engineers Without Borders and World Merit in partnership with the UN. She is focused on the role of engineers in achieving global sustainable development and is using her role as ICE presidents apprentice and NCE Graduate of the Year to drive change in the civil engineering industry.

Total Engineering

As engineers, we are trained to create systems to solve problems; however this is only half the story.

Total functionality comes when a system not only exists, but is used to it's full potential. Post occupancy evaluation regularly shows us that we fail in this context time and time again; in BREEAM excellent buildings that consume far more energy and water than they are designed to, and new university campuses that make its students feel lost and disconnected.

Charles Leadbeater, of Centre for London, calls this element 'Empathy'. We as engineers need to start influencing empathy as much as designing systems.

This presentation explores a soft innovation in engineering - how design with empathy in mind can revolutionise the sustainability of our engineering project and how the role of

engineers is changing to meet modern demands. We are no longer simply systems designers, we must positively influence the behaviours of those who use and occupy those systems. Exploring this nexus of systems and empathy relates to a city, a building and individual products. Challenging our clients to consider the wider societal impact of their investments and leading the way to a more sustainable future

Neil Carhart, University of Bristol

Neil is a Teaching Fellow and Senior Research Associate within the University of Bristol's Department of Civil Engineering. Following a period within the civil nuclear industry his research focuses on the development of Systems Engineering practice and the application of the Systems Approach to infrastructure resilience, sustainability and interdependency challenges.

Infrastructure for Sustainable Global Wellbeing

Infrastructure systems facilitate the services that underpin our economies and quality of life. They are fundamentally entwined with sustainability and wellbeing. Inadequate infrastructure limits access to health services, education, information, trade, employment and other opportunities that positively affect wellbeing.

Many nations are facing challenges in renewing their ageing infrastructure while others are seeking to implement, expand and develop their own. The UK Department for International Trade projects global spend on infrastructure renewal and construction to be $15.5 trillion by 2030.

The ability of this current focus on infrastructure to actually enhance sustainable wellbeing is threatened by traditional paradigms of infrastructure planning and delivery. The outcomes people need and value are often an emergent product of the complex interactions of multiple infrastructure systems, yet there is a tendency to view infrastructure projects as discrete technical challenges. They are all too frequently considered in relative isolation from other infrastructure systems and the people they are intended to serve.

This talk looks at the role infrastructure systems play in supporting wellbeing and the ways in which Systems Engineering can provide a means to embrace the complexity and in doing so reconnect infrastructure projects with the needs and values of societies.

Priyanka Jamwal, Ashoka Trust for Research in Ecology and The Environment

Priyanka is a Fellow in the Centre for Environment and Development at ATREE. Her work focuses on identification of contaminant sources in surface water bodies, modelling the fate and transport of contaminants in urban hydrological systems and assessing the risk to human health due to exposure to contaminants.

Strategic In-stream Systems (STRAin-s): A Decentralized, Anticipatory Approach to Urban Wastewater De-contamination Within India's Emerging Cities.

India's established cities are in the midst of a serious water crisis—rivers choked with solid waste, disappearing wetlands, lakes which catch fire on a regular basis and contaminate local food chains. Emerging cities and

towns across the country are now poised to follow the same unsustainable path if serious efforts aren't made to anticipate the ongoing risks of watershed contamination.

Strategic In-Stream Systems (STRAin-s) is an innovative new way of tackling these issues from the bottom up, by means of low-tech, affordable and flexible interventions which fit within urban stormwater channels. STRAin-s will target domestic effluents such as grey and blackwater, as well as partially treated industrial effluents which comprise the most widespread and common form of wastewater contamination within the urban and peri-urban context in India.

Working in collaboration with local organizations and stakeholders, a catchment-based strategy promises sustainability. Pre-implementation and post-implementation water quality monitoring will demonstrate the impact of individual interventions as well as their aggregated impacts on the larger urban watershed. Environmental, economic, and social factors will also be closely tracked to inform the development and iteration of the design and implementation of STRAINS.

Although these bottom-up decontamination strategies will not provide a total solution, they hold the potential to work in concert with existing efforts from the top-down, and thus provide a more comprehensive, preventative approach to urban watershed health which can evolve and scale as emerging cities grow.

Tse-Hui Teh, University College London

Tse-Hui is a lecturer in the Bartlett School of Planning, University College London. She uses coevolutionary actor-network theory to understand the persistence and reconfiguration of the materiality of space; and create new methods of public participation for changing urban infrastructure. Her research focuses on water, sanitation and well-being.

A Coevolutionary Actor-Network Theory Approach to Changing the World

Sustainable global wellbeing requires changing the world we live in, whether it is the way we behave, the values we hold, the infrastructure and technology we use, or the ecosystems we create. But more often than not these efforts to change the world are met with obstacles and the transformations we believe are necessary do not eventuate. How can we understand the complex reasons for this? And are there ways we can increase the effectiveness of our efforts towards change?

Coevolutionary actor-network theory offers one way to comprehend reasons for obduracy and mutability in the world, and identify probable trajectories for change. Coevolutionary actor-network theory uses actor-network theory to understand the network relations that create phenomena in the world; and insights from socio-technical coevolution to find and test how these network relations are changing.

This framework is applied to understand London's urban water-cycle and how it is likely it is to become more sustainable in the future. The analysis shows that if there were a change to the availability of water network relations would change. If water availability remained limited for the foreseeable future, coevolution would occur to create networks of water reuse and dry sanitation systems. Furthermore the water-cycles created by water conserving individuals give an indication of how existing network relations are likely to change. This example shows how we can understand the reasons for the limited move towards sustainable water-cycles in London and the types of change necessary for this future to occur.

Session 3: Innovation for Sustainable Development

Session chairs:

Jim Watson, UK Energy Research Centre

Jim is Director of the UK Energy Research Centre and a Professor of Energy Policy at the University of Sussex. He has 20 years' research experience on climate change, energy and innovation policy. He is a member of the Global Challenges Research Fund strategic advisory group and the UK government's fossil fuel price projections panel.

Marialena Nikolopoulou, University of Kent

Marialena is an architectural engineer specialised in environmental design. She is Director of the Research Centre for Architecture and Sustainable Environment at the University of Kent. She has extensive experience in managing large collaborative research projects funded by different national and international funding bodies on sustainability, comfort in complex environments, energy in the urban environment and environmental quality. She is author of over 100 publications including co-author of the revised 2015 CIBSE Guide A, Chapter A1 "Environmental Criteria for Design" and Chair of Chapter A8 "Health Issues". Her work has received awards from diverse bodies (International Society of Biometeorology, Royal Institute of British Architects).

Speakers and talks:

Paolo Bombelli, University of Cambridge

Paolo has a multidisciplinary background with specific interests in energy conversion and photosynthesis. His work is instrumental in studying the integration of biological and photobiological elements with physical components for the direct generation of electrical current, drive electrosynthesis, wastewater treatment, food production and as bio-environmental sensors

Vanesa Castan Broto, University College London

Vanesa is a Professorial Fellow at the Faculty of Social Sciences at the University of Sheffield. Her research focuses on urban infrastructure and sustainability transitions, climate change governance, and energy access in rapidly urbanizing areas. She has recently published *A Companion to Energy Geographies* and *Urban Sustainability Transitions*

Sukumar Natarjan, University of Bath

Sukumar is Associate Professor in the environmental design of buildings at Bath; Director of the EPSRC Centre for Decarbonisation of the Built Environment (dCarb). The overall aim of his research is to deliver healthy and comfortable low-carbon buildings that perform well into the future. His total research income exceeds £7M.

Martin Pauli, Arup Germany

Martin is Senior Foresight + Research + Innovation manager at Arup Germany. He graduated with a Master of Science in Architecture at the Technical University in Berlin. He has significant expertise in the management of Innovation and Strategic Industry Foresight projects, particularly in the field of product and business model innovation in the Circular Economy. With his background in Architecture he is very passionate about how new technologies enable our current building and construction ecosystem to develop towards more resource effectiveness. Martin published widely about the positive ecosystem contributions, buildings could have in order to mitigate the effects of increasing urbanization such as Urban Heat, Air Pollution and Acoustic Noise. He has a track record of successful technical and business consulting projects with large international corporate clients and is a frequent speaker on national and international conferences.