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Driving data-informed decision-making

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Preface

The 2nd International Conference on Smart Infrastructure and Construction (ICSIC) was held in Cambridge, UK, on 1-3 July, 2019. The theme, "Driving data-informed decision-making", expresses the core intent of the conference: to bring together researchers and practitioners from across the globe to present new research and case studies that further the use of data to improve the way infrastructure is planned, designed, built, assessed, and maintained.

The papers compiled in these proceedings provide a broad reaching subset of active research by the global community, as well as examples of the implementation of this research in practice. The papers were arranged in eight themes. Each theme contributes to "driving data-informed decision making" in different ways. The **1) sensing** theme provides examples of new or improved sensing techniques that contribute to the fundamental aspect of *data collection*. The **2) structures** and **3) geotechnics** themes also provide core contributions in data collection, and then discuss methods of *optimizing* data collection, *interpreting* data, and *leveraging* data through mechanics-based computational modelling. The **4) data analytics** and **5) asset management** themes address the *distillation* of large amounts of data using frameworks and metrics to inform *decision-making*. Meanwhile, the **6) construction**, and **7) cities** themes span across data collection, interpretation and management aspects, with a particular focus on large amounts of data. Finally, the **8) policy** theme considers how we procure and legislate for data-collection, and make it secure, critical barriers that are preventing data-informed decision making. Of course, many papers provide contributions across multiple themes.

Notably, in comparison to the first ICSIC in 2016, the contributions herein demonstrate significant advances, as well as the emergence of new or rapidly expanding fields.

- The development of new ***sensing techniques*** has continued, while existing techniques have become increasingly utilized. In particular, the increase and improvement of remote sensing is evident in numerous papers utilizing photogrammetry, videogrammetry, and UAVs, and the increase in accuracy of satellite (InSAR) monitoring.
- The ease of collecting ***large amounts of data*** at the asset- or city-scale, and the use of High Performance Computing (HPC) to enable ***city-scale simulation***, is also evident in these contributions.
- The use of image-based tools, including use of artificial intelligence (AI), machine learning, virtual reality (VR) and augmented reality (AR) are ***transforming construction*** at a rapid rate through tracking progress, quality control, and site management.

These developments emphasize the urgent need for new policy and asset management tools, some examples of which are contained herein, that enable better use of the "big data" being generated.

KEYNOTE ABSTRACT: SMART INFRASTRUCTURE AND CONSTRUCTION: SERVING SOCIETY'S NEEDS

Dr K. Bowers

Abstract

We create and operate infrastructure to meet our society's needs. But how well does the infrastructure construction sector really understand what those needs are and how best to address them? This lecture will ask a number of questions about smart infrastructure and construction and the part it could and should play in supporting our society.

The first set of questions are around whether we, as representatives of an industry sector, really understand what society's needs are? For that matter does our society know how to express its infrastructure needs? How can the needs be described, quantified and prioritised? And is this a debate into which engineers can contribute? Is addressing some of these questions a starting point for developing the right smart infrastructure and construction for the future? The lecture will explore the use of structured value models as a tool to guide our thinking on how to turn society's strategic goals, such as better health and welfare or the reduction of carbon footprint, into specific and tangible objectives for infrastructure programmes.

Further questions then relate to what smart technologies can offer. As engineers and scientists, we instinctively want to see our technologies as building blocks for future society. But can we describe effectively to society what we could do now that we could not previously? What is enabled by new sensors? What can we achieve with better data analysis? Also, is it the technology itself that has the greatest impact or is it really disruptive thinking that is the most important part of promoting positive change?

The last part of the lecture will then look how we can better link our emerging technical capability to society's needs. Do we have a clear enough route map to link sensors and data to sensemaking and practice? By thinking about these things in a structured way can we improve the uptake of technology in the sector and thus better meet society's needs?

The lecture will take illustrations from tunnelling and underground construction – reflecting the speaker's own experiences. The tunnelling industry provides some great examples of technical innovations and "Modern Methods of Construction" being applied. Yet other tunnelling work, even on the same projects, is still done by methods the Victorian pioneers of the London Underground might have considered "old". We are using off-site manufactured products and robotic plant alongside men digging the ground by hand. Why is this the case and how might smart infrastructure thinking help? Sensors are widely suggested as being a key tool for future health monitoring of structures and an opportunity to learn about potential efficiencies. An application involving sensors being applied to the people themselves, together with new data analysis, will provide an illustration into how we are already using smart thinking to improve construction industry performance.

KEYNOTE ABSTRACT: R&D GOVERNMENTAL PROGRAM IN JAPAN FOR EFFICIENT MAINTENANCE, RENOVATION AND MANAGEMENT OF INFRASTRUCTURE

Professor Y. Fujino
Institute of Advanced Sciences, Yokohama National University, Japan

Abstract
A R&D program named "Infrastructure maintenance, renovation and management" started in 2014 under the Council of Science, Technology and Innovation (CSTI)s Strategic Innovation Program (SIP), Cabinet Office of Japan. This 5-year program covers various subjects of infrastructure maintenance with key technologies in condition assessment using non-destructive testing, monitoring and robotics; long-term performance prediction of infrastructure, development of durable high-quality of material for repair and replacement, and management of large amount of bridges and other infrastructure data using advanced information and communication technologies (ICT). The program consists of about 60 research projects involving universities, government research institutes and industries. This initiative is expected to prevent accidents and setting an example for efficient bridge and infrastructure maintenance by reducing the burden of maintenance works and cost. In the lecture, outline and major output of this SIP program are explained.

KEYNOTE ABSTRACT: ENHANCING URBAN RESILIENCY THROUGH SMART CITY TECHNOLOGIES: EXPERIENCES IN PROTOTYPING SOLUTIONS WITH CITIES

Dr. J.P. Lynch
Donald Malloure Department Chair of Civil and Environmental Engineering,
University of Michigan, Ann Arbor, Michigan, USA

Abstract
The increasing number of sensing and information technologies being integrated with our built environment is a core attribute of smart cities. Fundamentally, smart city solutions are cyber-physical systems (CPS) with monitoring and control features that aim to enhance the performance and resiliency of our urban systems. These technologies provide an ever-expanding set of solutions that can be used to address many of the grand challenges we now face globally including climate change and rapid urbanization. At the same time, smart city solutions have a number of challenges including unproven cost-benefit ratios, unequal access to benefits, and privacy concerns. To advance smart city solutions, the University of Michigan Urban Collaboratory works closely with partner cities to define stakeholder challenges and to form multidisciplinary research teams that explore and prototype novel smart city solutions. This presentation will highlight the presenter's experiences in advancing smart city solutions in a number of partner cities. First, a CPS framework for the asset management of bridges managed by the Michigan Department of Transportation will be introduced. Computer vision for traffic tracking is combined with bridge monitoring systems to quantitatively assess structural health. Second, self-sufficient sensor nodes that communicate data to the cloud using cellular and LoRa networks are introduced. The presentation highlights how communities can collect their own urban sensing data using these powerful platforms. Finally, the presentation concludes with recent work exploring the use of camera technologies to measure the use and benefits of public spaces within cities. This effort works closely with park managers to assess the usage patterns of park patrons to informed decision making centered on how to optimally allocate resources in the upkeep of parks.