香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

土木及環境工程學系
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

SEMINAR

MODELING AND ANALYSIS WITH EPISTEMIC UNCERTAINTIES IN ENGINEERING

Speaker
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Abstract

Epistemic uncertainties appear across all engineering fields to quite some significant extent. Although they can often be described phenomenologically and qualitatively, they counteract a rigorous quantitative description, which is needed as a basis for a realistic risk assessment. In the presence of epistemic uncertainties the specification of a probabilistic model and the associated risk analysis lead to hypothetical results presuming some intuitive guess to capture the influence of the epistemic uncertainty. That is, we quantify risk based on conditions that represent assumptions rather than facts. Such results can be significantly misleading. It is thus of paramount importance to quantify epistemic uncertainties most realistically. This quantification should neither introduce unwarranted information nor should it neglect information. On this basis there is a clear consensus that epistemic uncertainties need to be taken into account for a realistic assessment of risk and reliability. However, there is no clearly defined procedure to master this challenge. There are rather a variety of concepts and approaches available to deal with epistemic uncertainties, from which the engineer can chose. This choice is made difficult by the perception that the available concepts are competing and opposed to one another rather than being complementary and compatible. Clearly, the first consideration should be devoted to a probabilistic modelling, naturally through subjective probabilities, which express a belief of the expert and can be integrated into a fully probabilistic framework in a coherent manner via a Bayesian approach. While this pathway is widely accepted and recognized as being very powerful, the potential of set-theoretical approaches and imprecise probabilities has only been utilized to some minor extent. Those approaches, however, attract increasing attention in cases when available information is not rich enough to meaningfully specify subjective probability distributions. The presentation will feature models for epistemic uncertainties, and it will highlight their capabilities and added value when used for engineering analysis and design. Illustrative examples are used to explain the respective features. The discussion on the models is complemented by presenting a powerful numerical technology for processing epistemic uncertainties even in very complex and nonlinear engineering analyses. This technology can be used not only for reliability analysis, but also for sensitivity analysis, design, model updating and more.

Biography

Michael Beer is Professor and Head of the Institute for Risk and Reliability, Leibniz Universität Hannover, Germany. He is also part time Professor at the University of Liverpool and guest Professor at Tongji University and Tsinghua University, China. He obtained a doctoral degree from Technical University Dresden, Germany, and worked for Rice University, National University of Singapore, and the University of Liverpool, UK. Dr. Beer's research is focused on uncertainty quantification in engineering with emphasis on imprecise probabilities. Dr. Beer is Editor in Chief of the ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A Civil Engineering and Part B Mechanical Engineering. He is also Editor in Chief (joint) of the Encyclopedia of Earthquake Engineering, and Associate Editor of Information Sciences. He has won several awards including the Alfredo Ang Award on Risk Analysis and Management of Civil Infrastructure of ASCE. Dr. Beer is the Chairman of the European Safety and Reliability Association (ESRA) and a Co-Chair of Risk and Resilience Measurements Committee (RRMC), Infrastructure Resilience Division (IRD), ASCE. He is serving on the Executive Board of the International Safety and Reliability Association (IASSAR), on the Executive Board of the European Association of Structural Dynamics (EASD), and on the Board of Directors of the International Association for Probabilistic Safety Assessment and Management (IAPSAM). He is a Fellow of the Alexander von Humboldt-Foundation and a Member of ASCE (EMI), ASME, CERRA, IACM and GACM.

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