Preface

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Biographical notes: Rafi L. Muhanna is an Associate Professor and the Director of Center for Reliable Engineering Computing at Georgia Institute of Technology, USA. He received his PhD from the Higher Institute for Structure and Architecture, Sofia, Bulgaria. His research activity is in the general area of computational solid and structural mechanics that includes uncertainty modelling, structural reliability, computational reliability, shell theory and optimisation of masonry building materials in structural systems.

Robert L. Mullen received his PhD in Applied Mechanics from Northwestern University. He was a pre-doctoral fellow at NASA Langley. He joined the faculty of Case Western Reserve University in 1980 and is currently the Frank Neff Professor of Civil Engineering. He also holds a joint appointment in Mechanical and Aerospace Engineering. He was a NASA faculty fellow during 1982–1983 and was the associate director of the Center for Adhesives, Sealants and Coatings from 1986 to 1988 and a board member of the Institute for Computation Methods in Propulsion. He received the Jeffcott award for best paper on rotating machinery in 1987 and the Meritorious Service Award of the Case Alumni Association in 2005. He is currently the Co-director of the Center for Reliable Engineering Computing at Georgia Institute of Technology. He is a Fellow of the American Society of Civil Engineers, a member of the American Society of Mechanical Engineers.

This special issue focuses on Imprecise Probability in Engineering Analysis. The papers represent selected contributions to the National Science Foundation workshop held at the Center for Reliable Engineering Computing at Georgia Tech Savannah in 2008.

Design of an engineered system requires the performance of the system to be guaranteed over its lifetime. One of the major difficulties a designer must face is that neither the external demands of the system nor its manufacturing variations are known exactly. In order to overcome this uncertainty, the designer currently provides excessive capabilities and over designs the system. As analysis tools continue to be developed, the predictive skills of designers have become finer. In addition, the demands of the market place require that more efficient and reliable designs be developed. In order to satisfy these current requirements in designs subject to uncertainties, the uncertainties in the performance of the system must be included in the analysis. Quantification of uncertainties requires knowledge about the probability of various system parameters; for continuous parameters, uncertainty can be defined by a Probability Density Function (PDF).

In light of the above, the routine application of probability based design has been slower than one would expect. We hypothesise that there are two fundamental reasons for this slow adoption: the first is the difficulty of acquiring the needed information (PDFs) for risk-based design and the second is the lack of viable engineering tools allowing for imprecise or incomplete information to be employed in a less than fully probabilistic design. Over the last three decades a number of methods have been developed to handle such situations in which information is incomplete, scarce, vague or conflicting. These methods include interval probability, probability bounds analysis, Dempster-Shafer theory, fuzzy-based, information-gap theory, clouds and the most general approach that comes from the theory of imprecise probability.

We believe that these papers provide a foundation for the continued development of methods under general imprecise uncertainty representation that will change how engineering design is conducted in the future.