

**Final Report of Technical Committee on
Quantitative Risk Assessment**
Sponsored by ASCE-CDRM

Prepared by Prof. A. H-S. Ang for ASCE

Report of Activities and Results:

The TC organized and presented a Workshop/Tutorial on QRA at the CECAR4 in Taipei, Taiwan that was held on June 26-28, 2007. The Workshop was sponsored in part by the Council on Disaster Risk Management (CDRM) of the ASCE. The Workshop was preceded with a tutorial to introduce the basic tools of QRA.

The Tutorial was presented in the form of a 3-hour lecture session in the morning followed by the Workshop in the afternoon of the same day. The Workshop consisted of six full papers on risk analysis of several natural hazards plus six short prepared discussions presented by colleagues representing other ACECC member societies; all by experts in the field of quantitative risk assessment (QRA). The lectures and the full papers were printed in a set of notes that was made available as handouts during the CECAR4.

The complete programs of the Tutorial and Workshop are as follows:

**Tutorial Lectures on
*Introduction to Fundamentals for QRA***

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Presiding Chair: Dr. William Marcusson, *President ASCE*

Lecturer: Prof. A. H-S. Ang, *University of California, Irvine*

Lecture #1: Fundamental Tools of QRA -- Basics of Probability

- Events – Combination of events: union and intersection
- Mathematics of probability
 - Addition & multiplication rules
 - Total probability
 - Bayes' rule

- Basics of statistic

- Estimation of mean and variance from sampled data

Lecture #2: Analytical Models

- Random variables and distributions
 - Gaussian, lognormal distributions
 - Binomial and Poisson distributions
- Mean and variance, correlation between two variables

- Functions of random variables

Sum or normals; product of lognormals
Mean and variance of functions of random variables

Monte Carlo Simulation – probabilistic numerical method

Fundamentals of Reliability Engineering
First-Order Reliability Method (FORM)

Lecture #3: Illustrative Application of QRA
Hypothetical example of hurricane risk
Information for practical risk-informed decisions; risk-averse
decisions for design

The Workshop consisted of presentations on a number of major applications in civil infrastructure engineering for mitigating the forces of natural hazards by prominent international researchers and practitioners as follows:

Workshop on
Engineering Applications of Quantitative Risk Assessment

Session Chair – Professor A. H-S. Ang,
University of California, Irvine

Presentations of Full Papers:

1. “Quantitative Risk Analysis Applied to Dams”
Professor Eric Van Marcke, *Princeton University*
2. “Risk Assessment for Wind Hazards”
Professor Nasim Uddin, *University of Alabama*
3. “Quantitative Earthquake Risk Assessment”
Professor Anne Kiremidjian, Evangelos Stergiou, and Renee Lee
Stanford University
4. “Risk Assessment for Bridge Decision Making”
Professor Dan Frangopol, *Lehigh University*
5. “An All Hazards Methodology for Critical Asset and Portfolio Risk Analysis”
Professor Bilal Ayyub and Mr. William McGill, *University of Maryland*
6. “Risk Analysis of a Protected Hurricane Prone Region”
Professor Bilal Ayyub, *University of Maryland*

Prepared discussions were presented by:

1. Professor Hitoshi Furuta, *Kansai University, Japan*
2. Professor Hyo-Nam Cho, *Hanyang University, Korea*
3. Professor Chin-Hsiung Loh, *National Taiwan University, Taiwan*
4. Professor Wilson Tang, *Hong Kong University of Science & Technology*
5. Dr. Tony Webb, *University of New South Wales, Australia*

After a lively general discussion, the Workshop concluded with a resolution on the role of QRA in civil engineering as follows:

Resolution on Role of QRA in Civil Engineering

Whereas, safety and performance reliability of civil engineering systems are recognized to be matters of acceptable risk, and for engineering purposes such risks ought to be assessed in quantitative terms in order to be consistent with other engineering analysis;

And whereas, current engineering analyses seldom explicitly include the significance of uncertainty and its effects on risk in evaluating the safety and design of engineering systems;

And whereas, quantitative information on risk is important also in many decisions under uncertainty and needs to be made available to decision makers;

We resolve that quantitative methods for assessing risk and reliability should be more widely made available, and implementation of this methodology needs to be encouraged in engineering decision-making.