

SUBJECT: Ph.D. Dissertation Defense

BY: Jason Aughenbaugh

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LOCATION: MARC Building, Room 201

TITLE: Managing Uncertainty in Engineering Design using Imprecise Probabilities and Principles of Information Economics

COMMITTEE: Dr. Chistiann J. J. Paredis, Chair (ME)
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SUMMARY

The engineering design community recognizes decision making as an essential part of the design process. Because decisions are generally made under uncertainty, engineers need appropriate methods for modeling and managing uncertainty. Two important characteristics of uncertainty in the context of engineering design are imprecision and irreducible uncertainty. In order to model both of these characteristics, it is valuable to use probabilities that are most generally imprecise and subjective. These imprecise probabilities generalize traditional, precise probabilities; when the available information is extensive, imprecise probabilities reduce to precise probabilities. An approach for comparing the practical value of different uncertainty models is developed. The approach examines the value of a model using the principles of information economics: value equals benefits minus costs. The benefits of a model are measured in terms of the quality of the product that results from the design process. Costs are measured not only in terms of direct design costs, but also the costs of creating and using the model. Using this approach, the practical value of using an uncertainty model that explicitly recognizes both imprecision and irreducible uncertainty is demonstrated in the context of a high-risk engineering design example in which the decision-maker has few statistical samples to support the decision. It is also shown that a particular imprecise probability model called probability bounds analysis generalizes sensitivity analysis, a process of identifying whether a particular decision is robust given the decision maker's lack of complete information. An approach for bounding the value of future statistical data samples while collecting information to support design decisions is developed, and specific policies for making decisions in the presence of imprecise information are examined in the context of engineering.