

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: 5th Annual Symposium of the International Council on Systems Engineering
20-5702-221
20-5702-152

DATE/PLACE: July 23-26, 1995, St. Louis, MO

AUTHORS: P. Mackin
A. DeWispelare

Persons Present: Authors and approximately 500 other participants

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BACKGROUND AND PURPOSE OF TRIP:

P. Mackin attended this symposium to present a featured paper titled, "The Application of Systems Engineering Techniques in a Regulatory Environment: NRC High-Level Waste Regulatory Program." Other authors include: Robert L. Johnson of the NRC, and A. DeWispelare and R. Brient of CNWRA. A. DeWispelare attended the symposium as a professional development opportunity. The symposium was the fifth annual meeting of the National Council on Systems Engineering, and at this symposium, the name of the organization was changed to the International Council on Systems Engineering (INCOSE).

SUMMARY OF PERTINENT POINTS:

On Sunday, July 23, the authors attended a tutorial titled, "Touchy-Feely Numbers in Systems Engineering" presented by Dennis Buede, Ph.d. of George Mason University. This tutorial addressed risk/decision analysis as a framework for trade studies, and for the elicitation of quantitative judgments. Both the risk analysis and the elicitation of judgments were relevant to work being conducted by the NRC in the high-level waste program, and the authors attended this tutorial to gain additional insight in these areas. The risk/decision analysis considered such aspects as the use of probability theory for measuring uncertainty, the determination of preferences among alternatives, certainty equivalents, substitution of equivalents, and maximization of expected utility. The tutorial demonstrated the use of simple probabilistic models, influence diagrams, and decision trees as tools to assist in decision making. Value curves were also illustrated as a tool for making decisions once utilities from various alternatives are evaluated. The tutorial stressed that rational decision making requires the adoption of a set of guiding principles and then making decisions that are consistent with these principles, focusing more on good decisions than on good outcomes. The utility and capabilities of human beings as experts were evaluated. Some literature indicates that humans are not very capable when used as experts. However, the instructor

noted that properly qualified and trained human experts are valuable for their ability to seek dynamic feedback from the environment, emphasize accuracy over consistency, seek the opinions of others, try to understand why things happen, and not to be concerned with defending their past positions. The instructor noted that evidence indicates that, to be a true expert, an individual should have 20 or more years experience in a given field. The tutorial also covered a basic general elicitation process, including the development of probability distributions and methods for aggregating the results of expert elicitations. The instructor proposed that such aggregation of results was always desirable and that mechanical methods were available for this aggregation.

Highlights of various presentations will be provided in the text that follows.

Dr. J. Allan of the University of Birmingham presented a paper titled, "Systems Engineering of Renewals and Extensions in Mass Transit Railways." This presentation discussed the update of a portion of London's subway system. The work required incorporation of new technologies, increases in size of vehicles, and an increasingly complex commercial and legislative environment. The city of London chose to apply systems engineering techniques to help solve these problems. The work required extensive integration of technical and regulatory issues. The author stated that the techniques applied were broadly applicable to other complex renewal and extension projects.

Ms. R.C. Carter of NASA Goddard Space Flight Center presented a paper titled, "Spacecraft Performance Requirements, Tracking, and Verification for the Tropical Rainfall Measuring Mission." Ms. Carter's paper addressed the application of an automated, computer-based requirements tracking and verification system to a space mission midway through the mission development process. This application of systems engineering used an off-the-shelf relational database tool for managing project requirements. One product of the application is a set of verification matrices which will be used to ensure compliance with requirements as well as to analyze potential implications of noncompliance or failure.

Mr. P.E. Thompson of Transport Canada discussed "Development of Operating Concepts." His presentation addressed an equipment update for the Canadian airspace control system and included the methods used by Transport Canada to elicit, review, discuss, and document the operating concepts for the evolution of this air traffic control system. The presentation was specifically focused on constraints of budget and changing technology.

Mr. V.L. Saladin of the U.S. Department of Energy discussed the application of systems engineering at the Hanford Nuclear Site. Mr. Saladin's surprisingly pessimistic presentation lead the audience to believe that DOE's applications of systems engineering at Hanford will not be successful. Included in Mr. Saladin's contentions were that DOE does not have in place a standard for defining systems engineering, and that the number of people with knowledge of systems engineering is so limited that success will be unlikely.

Mr. D.A. Jones of Texas Instruments, Inc. discussed, "Some Lessons Learned in Requirements Management." This presentation was consistent with a general theme of the symposium that systems engineering must examine ways in which management of systems requirements can be streamlined and simplified. Mr. Jones presented some challenges to currently held principles about the development and tracking of requirements and stressed that systems engineers must be extremely careful to ensure that things that are not requirements are not artificially made into requirements. In his simplified statement, "if you gotta do it, that's a requirement."

Dr. W.F. Mackey of Computer Science Corporation presented a paper titled, "A Systems Engineering Approach to Technology Management." This paper dealt with a strategy for the management of new technology and incorporation of new technologies into developing systems. It addressed techniques that can be used to measure risks associated with new technologies and to ensure the successful integration of those technologies into systems and operations. It addressed a process of technology management that includes assessments of technology maturity. The process defines six stages of technology commitment, based on experience with and confidence in an emerging technology.

Mr. B. Holub of Westinghouse Electric Corporation presented a paper titled, "Tailoring a Military Systems Engineering Methodology for the Commercial Market: A Case Study of the Westinghouse Street Link System." This excellent presentation described the successful effort by Westinghouse to conduct commercial systems engineering. The application was to provide a link to criminal justice-related database information in police cars. The Westinghouse team described the process they followed to install such a system at minimal cost and in minimum time, and they compared this process to what was done in their formal military systems engineering process. Their conclusions were that although many of the formal steps of the military systems engineering process were not formally documented and may have been done extremely rapidly, in essence, they were all performed. The lesson learned was that in the commercial environment the emphasis is on doing things right the first time, at minimal cost, and that systems engineers must seek ways to streamline their techniques.

Dr. W.F. Mackey of Computer Sciences Corporation presented "A Case-Based Reasoning Approach for the Access and Reuse of Lessons Learned." This presentation was extremely interesting from the standpoint that the application used off-the-shelf software to build an automated system for recording and using lessons learned. In these respects it is quite similar to the Open Item Tracking System (OITS) which the CNWRA has developed with the NRC. Comparing this system with OITS, it appears that while there are pros and cons to both systems, there is excessive documentation and data input required to enter an item in the lessons learned system in comparison with the NRC OITS.

The authors became involved in the Emerging Applications Working Group of INCOSE. P. Mackin was selected as secretary of this group. The purpose of this group is to encourage and to monitor nontraditional and emerging uses of systems engineering. It should be noted that the author's featured paper presented at this symposium was a portion of an Emerging Applications session. P. Mackin agreed to contribute a section on waste management and disposal to an Emerging Applications Working Group white paper, which is a statement of their charter.

IMPRESSIONS/CONCLUSIONS:

INCOSE remains an excellent forum for examining the ways in which systems engineering techniques can be applied in support of the NRC. There is an increasing emphasis on commercial applications, and these applications are felt to be useful for work with the NRC in that, in general, they utilize modifications and methods for streamlining more traditional systems engineering techniques. Future attendance at this symposium is recommended.

A copy of papers presented at the symposium is available in hard copy and CD ROM format from the authors.

