The RAC Matrix: A Universal Tool or a Toolkit?

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The risk assessment matrix, a long-used tool of system safety practice, affords the advantage of disciplining recognition of risk as a severity-probability doublet[1] and serves to both support the subjective assessment of risk and determine either the acceptability of that risk or the appropriate management level to make the risk decision. Applying quantified scales to the matrix axes has come to be an accepted practice and is supported by respected standards. As next steps in matrix evolution, several refinements are foreseen: The assignment of numerical scales to matrix axes will converge on practical and universally accepted logarithmic displays; a zero value will be included for the probability axis; and matrix zones historically indicating areas of *de minimis* risk acceptance and strict risk avoidance will come to be separated by a third, intermediate zone in which non-mandatory efforts should be devoted to further reducing risk according to an "As Low As Reasonably Practicable" (ALARP) rule. Additionally, the lower bound of the topmost, "dread risk" boundary will be set according to the prudent coalescence of accepted standards now in use.

A panel discussion of the Risk Assessment Code (RAC) Matrix was held at the 2004 International System Safety Conference (ISSC). The purpose of the panel was to review the history, uses, strengths and weaknesses of the current RAC Matrix, to investigate and discuss ideas for RACs of the future, and to develop recommendations for the RAC Matrix to be published in the upcoming version of MIL-STD-882. This article presents a summary of the panel discussion.

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Background, Advantages and Shortcomings

Risk assessment matrices, used in many variations by system safety practitioners today, have proliferated widely, both in the literature of the field and in practical use following the 1984 promulgation of MIL-STD-882B, which included a matrix as an appendix [Ref. 1]. Although qualitative scales of hazard severity and probability had appeared in earlier versions of the military standard, they had not been displayed in matrix format. Earlier researchers [Ref. 2] have reported that the matrix in MIL-STD-882B had its origins in the hazard abatement process set forth in the 1978 version of the Department of Defense Instruction 6055.1, "Department of Defense Occupational Safety and Health Program" [Ref. 3]. In earlier configurations, matrix axis scales were given stepwise subjective descriptors but were not quantified, and the probability axis was equipped with a "zero/impossible" level, which was later abandoned. Adoption of the matrix spread rapidly throughout both government and the private sector. The matrix has been adapted for a variety of non-military settings, including the medical device industry and health care delivery. Variations in the matrix configuration proliferated and continue to do so. A summary of the development of risk levels and matrices for use in the U.S. Department of Defense is as follows:

- MIL-S-38130A — No levels or matrix.
- MIL-STD-882 — No matrix. Defined hazard levels.
- MIL-STD-882A — No matrix. Reversed hazard levels. New qualitative probability levels.
- MIL-STD-882B — Qualitative risk matrices in appendix.
- MIL-STD-882C — Qualitative and quantitative matrices in appendix. Established risk acceptance levels.
- MIL-STD-882D — Qualitative matrix, but quantitative probability levels.

Risk has been described in terms of probability and severity since Blaise Pascal, in 1662, wrote the following [translated from the Latin – Refs. 4 and 5]:

> *"These rules [referring to earlier chapters], which are helpful for judging about past events, can be easily applied to future events…So, then, our fear of some harm ought to be proportional not only to the magnitude of the harm, but also to the probability of the event."*

A conventional risk assessment matrix, typical of those in use today, applies this Pascalian concept

[1] This article uses the term "doublet" as a broad definition of the two components of risk. Some practitioners prefer the more mathematically concise "product" (two terms multiplied), as used by Pascal.

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