



President's Message

*International System Safety Society President
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Complexity

Many years ago when I was doing biomedical research I had occasion to carefully study what is now a classic medical textbook [Ref 1]. It explained that the human body is composed of thousands of control systems; some operate at the cellular level, some at the level of organs and some at the whole-body level. Examples of these systems include the regulation of oxygen and carbon dioxide in the extracellular fluid as well as the insulin control system that maintains the concentration of glucose in the blood. Life goes on when all these control systems function properly. Moderate dysfunction of some of these control systems results in illness, while extreme dysfunction results in death. This, I believe, has some parallels to complex engineered systems.

For several decades, a systems or “complexity science” world view that applies to natural and engineered systems has been developing. This view holds that the whole is more than the sum of the parts. The whole has properties that none of the parts possess [Ref 2]. The control systems of the human body do not work in isolation but interact with each other to a greater or lesser degree. The whole cannot be understood by looking only at the parts individually; an understanding of the relationships of the parts is required (understanding the individual parts, of course, is also important for understanding the whole). What we have here is a “new” world view that goes by names such as “complexity science” or “systems thinking.”

Complexity science can be defined as “the study of phenomena which emerge from a collection of interacting objects ...” [Ref 3]. Examples of these phenomena include traffic jams, economic market crashes, hurricanes, guerilla wars, and a complex engineered system not behaving as expected. The key property of complex systems that concerns us is “emergent behavior” that may be extreme and is usually surprising (i.e., hard to predict). “Black swans,” which have caught the popular imagination in recent years, are an important example of emergent behavior [Ref 4]. Emergence can be a good

thing (e.g., a hit movie) or a bad thing (e.g., a sudden conflict) but does not always happen without the correct levels of interdependence, connectedness, diversity and adaptation [Ref 5]. Some workers in this area like to differentiate complicated things from complex things. Your clock is complicated, while your dog is complex. Your clock does not exhibit emergent behavior but your dog sometimes does.

The “old” world view is sometimes referred to as “reductionism,” “mechanistic thinking” or “determinism.” This view holds that the material world — including living things — can be explained by the functioning of its individual parts. System safety engineers who follow the “old” world view tend to treat “safety” and “reliability” as pretty much the same thing. The thought is, “If the parts do not fail, we are safe.” There are many situations where this is a perfectly good approximation of reality, but it is not appropriate for complex systems. The “new” view questions the interaction of the parts and the design of the system; this is “safety through design.” Of course, the new view also wants the parts not to fail.

Some of the leaders in system safety have written extensively on the relation of systems thinking/complexity science to systems safety [Ref. 6 and 7], so these ideas are readily available to engineers. I have had the opportunity to review a fairly large number of system safety programs during the last several years. My observation, based on unscientific sampling, is that the practice of system safety is heterogeneous. Some system safety practitioners have long used systems thinking to at least some degree when doing their work. However, a significant fraction of practitioners hold the mechanistic world view and seem to have no knowledge of the concepts discussed here. The latter group treats system safety as a “warmed over” form of reliability.

The International System Safety Society is interested in advancing the practice of system safety. The International System Safety Conference (ISSC) this August will feature a keynote panel discussion on the subject of “increasingly complex systems and the implications for

the practice of system safety engineering.” The panel will include several distinguished individuals: Chris Johnson, Drew Rae and C. Michael Holloway. The ISSC will also feature a paper by Malcom Jones on the subject of “Black Swans,” as well as several papers on the application of the

Systems Theoretic Accident Model and Process (STAMP) [Ref 5]. I hope to see you there.

*Best Wishes,
Chuck*

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