SOCIETY OF ACTUARIES

Article from:

# Health Watch

January 2011 – Issue 65

# Complexity Science – A New Frontier for Actuarial Exploration

by Steven Siegel

*"I think the next century will be the century of complexity."*

***—Stephen Hawking, 2000***

*"Wanna get it right this time.*
*Complicated is all right.*
*Complicated it's all right"*

***—lyrics from Poi Dog Pondering's "Complicated"***

Steven Siegel, ASA, MAAA, is a research actuary for the Society of Actuaries in Schaumburg, Ill. He can be reached at *ssiegel@soa.org*.

What comes to mind when you see the acronym: **KISS**? Perhaps, a rock band of a certain vintage that was fond of face paint and flamboyant outfits. Me, too, but that's a topic for another article. No, I'm referring to an acronym first coined by Kelly Johnson, lead engineer at the Lockheed Skunk Works (creators of well-known spy planes) for the design principle: **K**eep **I**t **S**imple **S**tupid. The message of this well-known phrase is that simplicity should be a key goal in design and that unnecessary complexity should be avoided. This certainly seems like a worthy goal. But, how many of you would say that the current health care system has adhered to this principle? I'm confident there are none or very few who would. Furthermore, even if you know nothing about Complexity Science, I'm also willing to wager that you would describe the health care system in the United States as a complex one, as opposed to simple. If you don't agree with this observation, I'd be interested in hearing why not.

At the SOA's 2009 Health Spring meeting, Alan Mills gave a thought-provoking presentation on Complexity Science and its relationship to the health care system. One of the attendees at that session, Judy Strachan, who is also current chair of the Health Section, saw the potential importance of Complexity Science for the work of health actuaries. As a result, she proposed that the Health Section sponsor Mills to write an introduction to the field. With that was launched for me a fascinating journey into Complexity Science with the end result being Mills' brilliantly written primer on the topic and cool (no other word for it) software that accompanies it.

The report and software, which are available at: *http://www.soa.org/research/research-projects/health/research-complexity-science.aspx*, include an overview of the field's key results, detailed instructions for building complexity science models, examples of working models, a review of practical models applicable to the work of actuaries, an extensive literature review, and a discussion of how actuaries can apply complexity science in their work. All of this is presented in an engaging style that presumes no previous background in the subject on the part of the reader. Particularly enjoyable to read are the sidebars that help to set the context for the narrative with quotations from seminal works in the field and other relevant descriptions.

As quoted below, Mills presents five themes throughout the primer:

**"1. Social systems are complex systems**. The social systems in which actuaries work are complex systems, with mechanisms dramatically different from those of simple systems such as planets and dice. To understand and manage the behaviors of such systems—this is society's greatest challenge.

**2. We must study complex system behavior from the bottom up**. The behavior of a complex system arises from the bottom-up, from its components, the relationships among its components, and the behavior rules that the components follow. To understand and manage such systems, we must model them from the bottom up, using special methods of Complexity Science, rather than top-down traditional actuarial methods.

CONTINUED ON **PAGE 30**

I would strongly encourage readers to learn more about Complexity Science.

3. **Long-term prediction of complex systems is impossible.** The long-term behavior of complex systems —such as the fluctuations of financial market prices and health care trend rates—cannot be accurately predicted for more than short periods. Actuaries pursuing long-term prediction of complex systems are wasting time.

4. **Understanding and effectively managing complex systems is possible.** Though the long-term of complex systems cannot be predicted, their behavior can be understood and managed, like a farmer manages the cultivation of crops.

5. **Actuaries can help solve society's great problems.** Using our unique skills and knowledge—along with the tools and insights of Complexity Science—actuaries can effectively address the great problems of complex social systems, and lead the development of new social policy, rather than merely administer existing problematic systems."

For much of the primer, Mills leads readers through the four archetypal models that are used in Complexity Science: (1) Networks, (2) Cellular Automata, (3) Artificial Societies and (4) Serious Games. These agent-based models are the heart of Complexity Science. The primer devotes a chapter to each of these model types and shows how the models become progressively more sophisticated. And to really solidify your understanding of the models, there is no better way than to play around with the software that illustrates each of them. For example, the beautifully elaborate cover art depicting a gene ontology network can be readily reproduced using the software that accompanies the chapter on networks.

Besides the primer itself, Mills provides summaries of a list of the top 10 books on Complexity Science as well as other essential resources. These resources are a great way to expand your knowledge in the area and a next step towards familiarizing yourself with the concepts. In addition, actuaries who are unfamiliar with conducting a literature search will find it valuable to follow the process that was used to seek out and assess the relevant sources.

The Health Section is continuing to explore Complexity Science through sponsorship of a call for models that applies Complexity Science to a component of a health care system. Cash awards will be presented for the top three models submitted. You can find out more about the call for models at: *http://www.soa.org/research/research-opps/data-request/2010-10-health-complexity-models.aspx*

I would strongly encourage readers to learn more about Complexity Science. There are a number of ways to do this including reading the material on the SOA website, the other resources noted in the report and perhaps, even developing a model that you apply to your own work. I think you'll find the concepts not only stimulating, but surprisingly intuitive, for while a **KISS** may still be a **KISS**, the world is undoubtedly growing ever more complex. ■