A. Wayne Wymore: His Legacy to Simulation

Submitted by Bernard P. Zeigler and Tuncer I. Ören

This is a brief tribute to A. Wayne Wymore, who died early this year. Wymore’s system engineering accomplishments are well-known and include establishment of the world’s first Systems Engineering Department at the University of Arizona. So we write from our perspectives as advocates for the emerging discipline of modeling and simulation.

Wayne’s book, *A Mathematical Theory of Systems Engineering: The Elements*, John Wiley, New York [1967] appeared in an era that spawned the concept of a mathematical system as a generalization of the control systems of engineers and the automata theories of computer scientists. Wymore employed the unusual term “Tricotyledon Theory of System Design” to portray the tri-partite nature of his theory. Tricotyledon, or three leaved seed, pictures a leaf for the class of models of the behavior of the system being designed, a second leaf for the technologies that are available to implement the system, and a leaf for the intersection of the two previous classes, namely, the technologies that can implement the models according to specified evaluation criteria. In subsequent work over three decades, he deepened the theory and applied it to numerous system engineering problems. The theory became the basis for his book, “Model-based System Engineering”, CRC Press, Inc. Boca Raton, FL, USA © 1993 and helped to spawn the trend toward use of systems modeling tools for systems design. However, Wayne himself did not emphasize the use of modeling and simulation as essential tools in systems engineering practice.

Nevertheless, Wayne was among the first to formalize the idea, expressed in one of the cotyledons, that modeling of desired system behavior was an essential element in disciplined system engineering methodology. It was this insight that inspired the authors of this note to seek ways to integrate Wymore’s methodology with the practice of modeling and simulation.

One of us, Tuncer Ören, received his Doctorate under Wayne’s supervision at the University of Arizona, as one of his first students. The other, Bernard Zeigler, ran across Wayne’s first book in the library while preparing to teach his first course in simulation. Ören developed, for his dissertation, the GEneral System Theory implementor (GEST), the first model-based simulation specification language–for continuous and piece-wise continuous systems–based on the same book. Zeigler based his Discrete Event System Specification formalism and software on Wayne’s formal theory. From these initial events, our paths converged as we both agreed that Wayne’s system theory would provide the right way forward to build the future of modeling and simulation.

What we have accomplished, as members of the Modeling and Simulation Hall of Fame, can be seen as a logical extension of Wayne’s initial insights into how modeling and simulation was an essential tool of to the progress of systems engineering.

As a foundation for his methodology, Wayne recognized that unification of the quite distinct realms of continuous and discrete simulation would be necessary in order to handle the “convergent” or “cyber-physical” systems that are emerging powered by today’s information and engineering technologies. The second edition of the book, “Theory of Modeling and Simulation”, co-authored by Zeigler, T.G. Kim and H. Praehofer Academic Press, Boston, 2000 bears the subtitle: “Integrating Discrete Event and
Continuous Complex Dynamic Systems” which seeks to operationalize Wymore’s concepts.