

# Chapter XXIII

## Neo-Symbiosis: The Next Stage in the Evolution of Human Information Interaction

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### ABSTRACT

The purpose of this article is to re-address the vision of human-computer symbiosis as originally expressed by J.C.R. Licklider nearly a half-century ago and to argue for the relevance of this vision to the field of cognitive informatics. We describe this vision, place it in some historical context relating to the evolution of human factors research, and observe that the field is now in the process of re-invigorating Licklider's vision. A central concept of this vision is that humans need to be incorporated into computer architectures. We briefly assess the state of the technology within the context of contemporary theory and practice, and we describe what we regard as this emerging field of neo-symbiosis. Examples of neo-symbiosis are provided, but these are nascent examples and the potential of neo-symbiosis is yet to be realized. We offer some initial thoughts on requirements

to define functionality of neo-symbiotic systems and discuss research challenges associated with their development and evaluation. Methodologies and metrics for assessing neo-symbiosis are discussed.

### BACKGROUND

In 1960, J.C.R. Licklider wrote in his paper "Man-Machine Symbiosis,"

*The hope is that in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today (p. 5).*

This statement is breathtaking for its vision — especially considering the state of computer technology at that time, that is, large mainframes, punch cards, and batch processing. The purpose of this article is to re-address Licklider's vision and build upon his ideas to inform contemporary theory and practice within the broader field of human factors as well as to offer a historical perspective for the emerging field of cognitive informatics.

It is curious to note that Licklider did not use the term symbiosis again, but he did introduce more visionary ideas in a symbiotic vein. A paper he co-authored with Robert Taylor, titled "The Computer As a Communication Device," made the bold assertion, "In a few years, men will be able to communicate more effectively through a machine than face to face" (p. 21). Clearly the time estimate was optimistic, but the vision was noteworthy. Licklider and Taylor described the role of the computer in effective communication by introducing the concept of "On-Line Interactive Vicarious Expediter and Responder" (OLIVER), an acronym that by no coincidence was chosen to honor artificial intelligence researcher and the father of machine perception, Oliver Selfridge. OLIVER would be able to take notes when so directed, and would know what you do, what you read, what you buy and where you buy it. It would know your friends and acquaintances and would know who and what is important to you. This paper made heavy use of the concept of "mental models," relatively new to the psychology of that day. The computer was conceived of as an active participant rather than as a passive communication device. Remember that when this paper was written, computers were large devices used by specialists. The age of personal computing was off in the future.

Born during World War II, the field of human factors engineering (HFE) gained prominence for its research on the placement of controls — commonly referred to as knobology within the field of HFE, which was an unjust characterization. Many

important contributions were made to the design of aircraft, including controls and displays. With strong roots in research on human performance and human errors, the field gained prominence through the work of many leaders in the field who came out of the military: Alphonse Chapanis, a psychologist and a Lieutenant in the U.S. Air Force; Alexander Williams, a psychologist and naval aviator; Air Force Colonel Paul Fitts; and J.C.R. Licklider. Beginning with Chapanis, who realized that "pilot errors" were most often cockpit design errors that could be corrected by the application of human factors to display and controls, these early educators were instrumental in launching the discipline of aviation psychology and HFE that led to worldwide standards in the aviation industry. These men were influential in demonstrating that the military and aviation industry could benefit from research and expertise of the human factors academic community; their works (Fitts, 1951a) were inspirational in guiding research and design in engineering psychology for decades. Among the most influential early articles in the field that came out of this academic discipline was George Miller's (1956) "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity to Process Information," which heralded the field of cognitive science and application of quantitative approaches to the study of cognitive activity and performance.

An early focus of HFE was to design systems informed by known human information processing limitations and capabilities — systems that exploit our cognitive strengths and accommodate our weaknesses (inspired by the early ideas represented in the Fitts' List that compared human and machine capabilities; Fitts, 1951b). While the early HFE practice emphasized improvements in the design of equipment to make up for human limitations (reflecting a tradition of *machine centered computing*), a new way of thinking about human factors was characterized by the design of the human-machine system, or more generally, *human- or user-centered computing* (Norman &

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