Chapter 1
J.C.R. Licklider and the Rise of Interactive and Networked Computing

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ABSTRACT

This chapter examines J.C.R. Licklider's legacy as a contributor to the development of modern networked computing. In 1960 Licklider published his seminal "Man-Computer Symbiosis," the first of three articles that attempted to redefine the human-computer interaction. Licklider outlined a vision for interactive, networked computing and, ultimately, the Internet that we experience today. Providing an overview of Licklider's role as a visionary of the computerized communication networks of today, this chapter pays particular attention to the main ideas conveyed in "Man-Computer Symbiosis" and the influence of these ideas on academic and professional researchers during the following decades.

INTRODUCTION

The history of humankind's attempts to create communication networks is complex and longstanding (Mattelart, 2000), ranging from early forms of optical telegraphy to contemporary electronic networks. The long history makes pinpointing the exact origin of the Internet difficult. However, many technology historians and researchers agree that Joseph Carl Robnett (J.C.R.) Licklider was instrumental in envisaging, writing about, and assembling the team of engineers that helped to foster the rise of networked computing and computer-mediated communication (Brate, 2002; Hafner & Lyon, 1998; Packer & Jordan, 2001; Randall, 1997; Segaller, 1999; Waldrop, 2001). A key event in Licklider's contribution to the development of computer networks occurred in 1960 with the publication of "Man-Computer Symbiosis" in the inaugural issue of *Transactions on Human Factors in Electronics* published by the Institute of Radio Engineers (IRE). The first of three articles by Licklider that explored and redefined the human-computer relationship, this prescient piece outlined a vision for interactive, networked computing and, ultimately, the Internet that we experience today. Licklider's vision and

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his penning of "Man-Computer Symbiosis" are considered to be watershed events that ushered in the Digital Age. As reporter Charles Cooper (2007) observed of Licklider, "He may be the most important computer theorist you've never heard about."

This chapter provides an overview of Licklider's role as a visionary in the development of computerized communication networks during the 1950s and 60s, paying particular attention to his academic writings on the subject. In particular, focusing on the main ideas that Licklider conveyed in "Man-Computer Symbiosis," this chapter presents findings from a study that examined the spread and influence of the article among academic and professional researchers over a 40-year period from 1960-2001. The chapter concludes with recommendations concerning directions for future research that investigate the roles and contributions of technology visionaries; it also discusses future trends in the development of social interaction and collaboration technologies in light of current technological developments and in the context of technology challenges in computing that Licklider identified in the 1960s, challenges that persist in varying degrees today.

BACKGROUND

Contrary to what one might expect of a computer visionary, Licklider's career did not originate in computing; in fact, computer science as a formally recognized field would not develop until many years after Licklider had articulated his vision of networked computing (Hafner & Lyon, 1998). Instead, his studies began in "physiological psychology," the field known today as neuroscience. In particular, Licklider investigated the brain's ability to understand speech in the presence of signal distortion (Waldrop, 2001). These early studies helped Licklider to understand the workings of the human brain and prepared him to foresee the potential for improved human-computer interactions, which, in turn, enabled him to hold prestigious academic and governmental positions later in life.

Born March 11, 1915 in St. Louis, Missouri, Licklider was the only child of Margaret and Joseph Licklider. In his youth and throughout life, Licklider possessed "a lively sense of fun, an insatiable curiosity, and an abiding love of all things technological" (Waldrop, 2001, p.8). Highly intelligent and inquisitive, Licklider was also known for his sense of humor and self-effacing nature. In 1937, Licklider earned a triple degree in physics, mathematics, and psychology from Washington University. A year later, he earned a master's in psychology from the same university and then began doctoral studies at the University of Rochester in 1938, where his dissertation "made what may well have been the first maps of neural activity on the auditory cortex" (p. 13), which helped to identify those areas of the brain that are responsible for interpreting sound frequencies.

Notably, Licklider came of age alongside the emergence of electronic computing. Built in the 1940s, the Electronic Numerical Integrator Analyzer and Computer (ENIAC) was among the first operational electrical computers, a primary function of which was to calculate missile trajectories (Hafner & Lyon, 1998). Prior to this technological advancement, computers were mechanically-based, consisting of gears and levers rather than electrical switches and vacuum tubes. Among the more famous mechanical computers were: (1) Charles Babbages' Analytic Engine, which was only partially built in 1830 and performed basic mathematical operations; (2) Herman Hollerith's 1888 tabulating machine, which used an early version of punch cards and tallied the U. S. census in 1924; and (3) Vannevar Bush's 1933 Differential Analyzer, which solved partial differential equations (Waldrop, 2001). In each case, the mechanical computers took considerable time—days or weeks—to program and were greatly limited in their calculating abilities. Electronic computing, using electrical switches

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