Linc 05

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Like many of the researchers who were ready and eager to try out their new LINCS, Joseph Hind, a University of Wisconsin neurophysiologist, immediately put LINC to work. In his laboratory, LINC was devoted to physiology of the auditory system, particularly the response of single neurons. Since Hind's background had been in both engineering and neuroscience, he was in a particularly good position to appreciate LINC's advantage over the then-current lab equipment. According to Hind, "LINC revolutionized the practice of neurophysiology. The LINC instruction set was amazingly visionary and far-reaching in its power." Speaking recently, he said, "Even today, machines lack the characteristics of LINC, especially its potential for hands-on control of experiments."

Hind was so taken with LINC that he eventually convinced his department to buy six LINC machines. He reported that "no experiment was ever interrupted or data lost by a LINC failure." Not only was LINC an extraordinarily effective laboratory instrument, but its reliability became legendary. Although LINCs at Wisconsin were eventually replaced by faster, more powerful computers Hind concluded that some important features were lost in the exchange.

Hind's success with LINC prompted his colleague at Wisconsin, Phil Hicks, to acquire a LINC for analyzing clinical laboratory data. Hicks later formed a company serving hospitals and clinical centers with LINC-based analyses of blood samples and tissue cultures. At Johns Hopkins, Bernard Weiss had been using two commercial computers in his study of operant behavior in rats. Weiss was interested in how food reinforcement affects the timing and frequency of lever pressing in learning experiments. He was frustrated by his inability to perform microanalyses of the rats' behavior with the then state-of-the-art lab equipment. Though Weiss was initially skeptical of LINC's utility, when it arrived, he abandoned the traditional approach to the study of operant behavior and began for the first time to formulate hypotheses "on the fly" as data were accumulated. The resulting richness of his results led to a significantly enhanced understanding of learning and reinforcement. As Ron Wood, a researcher in Weiss's current lab at the University of Rochester, put it, "the machine (LINC) influenced our science."

LINC's success in most of the 12 original labs can be attributed partly to what the board's evaluation called "an aura of adventure that one finds rarely in academic and scientific pursuits."

While the researchers were busy on their LINC, the LINC development team had their difficulties with the MIT administration. They felt that a change of institution would allow them a greater degree of autonomy. Jerome Cox, of Washington University's Biomedical Computer Laboratory, and on the LINC Evaluation Board, had become intrigued with LINC's potential and urged the university to provide a permanent home for LINC and its future development. Accordingly, in early 1964, the core of the peripatetic LINC team decided to join Cox and moved to St. Louis.

At Washington University, Molnar continued his dual interest in laboratory technology and neuroscience. In his role as neuroscientist, Molnar was interested in the same general problem Starr investigated a decade earlier: how the auditory system transduces a sound entering the ear into brain impulses. For some time, scientists had known that an acoustic signal enters the inner ear where it energizes a drum-like sheet called the "basilar membrane." The membrane produces a new signal to the cochlea, a spiral organ which in turn stimulates neural receptors to send signals to the brain's higher centers. In 1969, after research carried out on Molnar's LINC, two researchers, Tom Goblick and Russell Pfeiffer, found the last missing piece of the puzzle of how the cochlea responds to sound. In Molnar's words, "a revolutionary change in our understanding of cochlear mechanics depended on a set of properties discovered with LINC." Hallowell Davis the grandfather of peripheral auditory physiology, called the result "startling and compelling."

In other work, LINC allowed researchers to visualize the molecular properties of drugs and to design new drugs. As other researchers around the country came to recognize the extraordinary utility of LINC as laboratory equipment, the ideas diffused quickly though the scientific community, largely by word-of-mouth. About 50 "classical" LINC machines were ultimately shipped to research labs. These machines were, to a large extent, identical or highly similar to the LINC developed in Cambridge in 1963 under the LINC evaluation program. In the only unmet design objective, post-1964 LINC cost about $35,000, still cheap enough for laboratory equipment.

As computer components became faster and cheaper over time, the LINCs ultimately were replaced by newer machines. However, the LINC ideas stuck; much laboratory research was transformed. The evaluation program had demonstrated conclusively that, with a LINC, experiments could be designed and executed more quickly and efficiently. But, more importantly, LINC had stimulated new insights into biomedical processes, knowledge that could only be gained with on-line, hands-on experiment control. Today, LINC's descendants have become the sine qua non of the biomedical laboratory.

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