The Career of a Computer

Project Whirlwind. The History of a Pioneer Computer. KENT C. REDMOND and THOMAS M. SMITH. Digital Press, Bedford, Mass., 1980. xvi, 280 pp., illus. $21. Digital Press History of Computing Series.

The definitive history of the digital computer has yet to be written. This book, appropriately set in type by computer, traces an important link among the many paths followed to the modern computer in the period after the second World War. Initially funded as an airplane simulator for pilot training, Project Whirlwind grew into the fastest real-time digital computer in the world in 1951.

Its builders—Jay Forrester, Robert Everett, and the staff of the Servomechanisms Laboratory at MIT—planned to use servo-control and analog computation to allow real-time feedback so that the pilot would feel the effects of his actions in the controls. But postwar word of wartime advances in digital computation at the Moore School in Philadelphia, the Institute for Advanced Study in Princeton, and the Bell Telephone Laboratories tempted Forrester to build digital control instead. It would operate in parallel transmission mode, simultaneously transporting all binary digits of a result, in order to speed its operation.

The airplane simulator was funded by the wartime Special Projects branch of the Navy. As it transformed into a computer project in the postwar period, its funding unit was subsumed under the Office of Naval Research; and the parent organization had increasing difficulty justifying to its mathematician referees the extraordinarily large costs incurred by Forrester. Other contemporary computers—MARK-I, ENIAC, the IAS machine, EDVAC, UNIVAC—cost under three-quarters of a million dollars apiece. Whirlwind consumed about a million dollars a year during the five-year period of design and construction.

Part of the expense was due to an unyielding commitment to engineering design procedures, part to very high quality control on parts and subassemblies. Forrester defended the expense claiming that whereas von Neumann, for example, was constructing a breadboard computer for specific mathematical problems, Whirlwind was a prototype machine for general systems analysis. It had to work accurately over long periods of time. Forrester took as a model the development of comparatively "simple and straightforward" radar during the war, a program that he knew had cost hundreds of millions of dollars.

In its final form Whirlwind would use 5,000 pentodes and 11,000 diodes, consume 150,000 watts of electrical power, and perform 20,000 arithmetic operations a second. One of the chief problems was to monitor the tubes, to find those on the verge of failure whose erratic behavior would affect computed results. Forrester adopted a method called "marginal checking," wherein selected segments of the circuitry were subjected to abnormally high currents or voltages while errors in calculated test problems isolated the components at fault. Eventually the machine was able to type out instructions for its own diagnoses.

The machine took shape in the Barta Building in Cambridge, Massachusetts, starting in 1948. By then the tail was vigorously wagging the dog: the flight simulator, now viewed by project staff as only one (time-consuming) example of a multitude of foreseen applications, was dropped entirely. The Whirlwind now faced a storm of its own making. ONR advisers failed to see beyond the limited mathematical qualifications of the machine. Forrester's plans to apply Whirlwind to real-time systems analysis for new sorts of problems—convoy protection against submarines, automatic radar tracking and air control—did not prevent the ONR from reducing funding.

The reduction occurred at the start of the Cold War in 1949. Soviet success with a fission bomb suddenly made the Air Force aware of how vulnerable the United States was to air attack. Air Force adviser George Valley at MIT realized that Whirlwind might hold the key to analysis of data from a nationwide system of radar units watching air approaches over the North Pole. This provided Whirlwind the kind of large-scale systems analysis application for which Forrester had early on designed the machine. Its storage-tube memory was not yet operational when support from the Air Force made it possible to complete the original design. Whirlwind was demonstrated in 1951, consuming data from 14 overlapping radar units about mock attacking airplanes, converting the information in real time into accurate intercepting trajectories for fighter pilots. The machine lived on as the model for more advanced computers, built by former Whirlwind staff at MIT's Lincoln Laboratory, for the SAGE early warning system.

A crucial innovation was developed as a result of Air Force funding. Forrester was dissatisfied with the progress of the electrostatic storage system that Whirlwind used (a cathode beam tube painting a 16×16 bit matrix on a plate). In the fall of 1949, Forrester and his assistant William Papian developed a prototype magnetic core memory, which would become the standard for internal computer memory until the use of transistor units in the 1960's.

Redmond and Smith's narrative touches only lightly on the technical aspects of innovative Whirlwind design and concentrates on questions of funding. There is surprisingly little on human interaction with the machine, either input-output devices or programming. But understanding of evolving digital computers will benefit from the path that Redmond and Smith have cut through the underbrush of correspondence in government bureaus and unpublished internal reports. As for many government-supported research ventures in the postwar period, the semi-public form in which the documentation exists has obscured the significance of Whirlwind to those not immediately involved in its design.

BRUCE R. WHEATON
Office for History of Science and Technology, University of California, Berkeley 94720

Social Psychology

Social Cognition. Papers from a symposium, London, Ontario, Canada, Aug. 1978. E. TORY HIGGINS, C. PETER HERMAN, and MARK P. ZANNA, Eds. Erlbaum, Hillsdale, N.J., 1981. x, 438 pp., $30. The Ontario Symposium, vol. 1.

There used to be a crisis in social psychology. Lately it seems to have vanished, and one reason is the advent of social cognition. Of course, social psychology has always been cognitive in that its theories and research posit nonobservable variables that intervene between the observable stimulus and response. Even when the rest of psychology abandoned introspection and embraced behaviorism, social psychologists were busily measuring attitudes and inferences that could not be observed directly but were presumed to mediate between social stimulus and behavioral response. Recently an updated version of the cognitive approach has invaded every branch of social psychology, including the study of attitudes, trait attributions, first impressions, stereotypes, close relationships, and self-concepts. Techniques for the measurement and experimental manipulation of cognitions are ubiquitous. And there has been a change in theory corresponding to the change in method. It is not just that theories have been imported from cogni-