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.

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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 cognitive psychology. Rather, the specification of mental organization and processes is seen not only as feasible but as necessary to the progress of social psychology as a field.

This volume is a cross section of the insights gained to date through the use of the cognitive approach, and it displays major progress. The authors report optimistically, but not foolishly so, about the utility of cognitive method and theory for understanding social interaction.

The first section of the book concerns the organization and representation of social information. Ostrom, Pryor, and Simpson review and explain memory measures that index clustering (the grouping of related items in a memory output). Hamilton contrasts the forming of an impression of someone's personality, a task that demands considerable organization of memory, and the memorizing of a trait list, a simpler task.

The idea of schema is a linchpin in theories of how we make sense of others. It refers to the mental representation of generic knowledge abstracted from experience, which then guides specific encounters. General knowledge accumulates about types of people and types of social events, and complex expectations based on such knowledge allow people to function in the social world. Taylor and Crocker skillfully grapple with the use of the schema idea as theory. Most schema research has consisted of loosely related demonstrations of schematic effects; Taylor and Crocker conclude that demonstrations alone do not make good theory. Hastie presents a thorough history and evaluation of the schema in cognitive and social memory research. His resolution of previously puzzling results rests on the suggestion that though schema-discrepant events attract attention, schema-congruent events are more easily remembered. Wyer and Srull focus on how people select a particular schema for the interpretation of ambiguous events. They conclude that a given schema stays on the top of the mental heap by virtue of its recency and frequency of application.

The second section of the book is concerned with dynamic factors in social information processing. McArthur's cogent review of the role of attention in this process starts from the standard social cognitive assumption that social perception resembles object perception. She raises an intriguing and implicitly anticognitive possibility, that the effects of attentional focus occur immediately upon perception of a stimulus and are not mediated by intervening cognitions. In contrast, Ebbesen suggests that explicitly cognitive mediators play a role in the process of making personality ratings of oneself or others.

The final four chapters in this section are concerned more with social interaction processes. In an emphatically social program of research, Snyder and his colleagues have engagingly and realistically demonstrated the ways in which social hypotheses become self-fulfilling. Ross also takes a social stand, in an elegant analysis of why most people abrogate more than their share of responsibility for any given group product. Chapters by Krauss and Higgins deal with strategic behavior in social interaction. Krauss contrasts the perception of objects with the perception of people, who attempt to manage the impressions they create. Higgins discusses the purposeful aspects of social perception and impression management, emphasizing the rules, mutual observation, interdependency, and negotiated consensus inherent in communication.

The book as a whole reaches no single consensus. These authors are not easily persuaded to compromise their highly individual perspectives. Each is a tough-minded critic of the emerging field, and indeed the volume concludes with a clear-headed chapter by Higgins, Kuiper, and Olson, setting forth the explicitly social omissions, such as individual history, emotion, and personal relevance, in social cognition.

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Cancer Cell Biology

Neoplastic and Normal Cells in Culture. J. M. VASILIEV and I. M. GELFAND. Cambridge University Press, New York, 1981. xiv, 372 pp., illus. $79. Developmental and Cell Biology Series, 8.

Cell culture has been a powerful technique for modeling the earliest steps in the development of neoplasia. This is so because many tumors seem to arise by stable mutational change in a single cell of the body, because many normal cell types grow well in a dish, and because many of the agents that cause tumors also cause simple cultured cells to become the progenitors of malignant cell lines.

This book aims to describe and discuss the comparative characteristics of the processes regulating cell proliferation, differentiation, and morphogenesis in normal and neoplastic cells in cell cultures. It begins with a 50-page introduction that describes the in vitro systems of transformation of fibroblastic cells by viruses and chemicals. The body of the book then deals with two major subjects. Cellular morphology in normal and transformed cultures, the authors' home ground, is covered through careful discussions of the cell structures associated with cell shape and locomotion and the changes in these structures attendant upon oncogenic transformation. The second major subject is the rather small set of growth-selective in vitro transformation assays now in use. These include assays for loss of anchorage dependence, density-dependent growth inhibition, and the requirement for serum factors. This part of the book could easily have been a mere list, but the authors have managed to put most everything in a logical order.

Unfortunately, no serious attempt is made to tie these two parts of the book together by hazarding a guess about why changes in cell shape and locomotion accompany the losses of growth control seen in the various transformation assays. The authors put their toes in the water with the observation that transmembrane receptors are necessarily immobilized whenever a cell pushes out a bit of itself into a pseudopod (pp. 91–92). They go on to speculate about how these immobilized receptors might "induce another set of cortical changes leading to anchorage of the surface in association with the microfilaments." Now, that might be the beginning of a lovely way to tie the abnormal actin organization and novel cell shape of a transformed cell to its ability to grow in the absence of anchorage, but the authors do not make the connection. Further, if they had recalled that some hormonal receptors are also transmembrane proteins, they might have been able to pull the serum-transformation assay in under this same cortical event.

The book is non-judgmental to a fault. For every generalization exceptions are quite dutifully listed, and for every description of an attempt at the construction of a working model of some set of phenomena equal space is given to the notion that all the phenomena at hand are indistinguishably proximal to some unknown causative event. This makes the book a far calmer one than, say, *Molecular Biology of Tumor Viruses*, edited by Tooze, but I wish the authors had taken a few more chances and made a few more bets.

One last observation. Unlike many other Russian works, which lumber