

in the United States have failed to replicate the reversal of calcium loss (NASA, Personal Communication, 1979). If the loss can not be ameliorated, extrapolation from available data indicates the colonists will become invertebrates after 20 to 30 years in space. The answer to this and similar questions may result in the colonists being called "limeys." The English ruled the seas for many years before they found out that limes stopped scurvy. They did not know why it worked, but it did. Similar spin-offs from research on calcium depletion in space may be helpful to earthbound problems, e.g., arthritis, rheumatism, and spondylosis.

The editors clearly recognize and state the problems that need to be solved and conveniently place these in the last chapter. I strongly recommend *Space Settlements* to psychologists and sociologists for supplementary reading in courses that relate humanistic problems to technology. The book would also be a joy to read for an appreciation of the knowledge that we have acquired in order to propose such a bold concept as space colonization.

Computer Power and Human Reason: From Judgment to Calculation

By Joseph Weizenbaum,

W. H. Freeman and Company, San Francisco, 1976
xii, 300 pages, \$6.95

Weizenbaum's book is difficult but rewarding to read. The book is a blend of the pathos of Query's guilt (Graham Greene, *Burnt Out Case*, 1961) and the gallows humor of a man who has not only created a Frankenstein, but observed the damage his creation has, and possibly will, wreak in the future. The guilt underlying this creation coupled with the astute observations of the people who are responsible for the rapid evolution — and psychological revolution — of electronic calculating machines presently being developed is explored. Just as *Zen and The Art of Motorcycle Maintenance* is only "nominally" concerned with motorcycles, Weizenbaum has, for good reasons, posed a number of subjective and intimately personal problems which he encountered while developing a computer program that "parodied" Rogerian Therapy (between a cathode ray tube and a human subject). What is more frightening is that Weizenbaum has seen the potential problems of computer programs developed in parts by a number of independent programmers. The mega-programs operating presently function as a large component of our national defense system. It is basic to the thesis of each of Weizenbaum's arguments that man is *more* than the rational, contemporary, totally

logical being used as a model by most, if not all, of the academic and business geniuses of computer technology.

The book, though well organized and written clearly, maintains a careful balance between the purely computational power of the new tool and the evil that exists — not within the tool — but within ourselves. The latter aspect, the abuses of computers, receives more coverage, but the impact of this prophecy is softened by attributing most of the problems to benign ignorance of the tool. Chapters Two and Three are intended to eliminate some of the mysteries behind the machinations that hold promises to a better life. Individuals who are unaware of computers will be able to follow the chapters with only minimal effort. It is significant to note, Weizenbaum states that Chapters Two and Three can be read at the end of the book. For people familiar with computing machines, I think the chapters can be left unread. The heart of the book begins with Weizenbaum's account of his own work in Chapter Four.

Weizenbaum's struggle of conscience began with his development of a computer program, initially called "Eliza" and later "Doctor," that was written to interact with a "Rogerian therapeutic" linguistic scheme. Although it is not surprising that the Rogerian format — the program extracts key words from the keyboard input and replies with a near mirror reply of the question (a "script") — yielded a paucity of linguistic information, the results of the human-machine interaction were unforeseen. Weizenbaum was also astonished by the reactions of professionals who viewed the conversational computer as a partial solution to the shortage of human therapists. He was faced by people who used the terminal and became so attached to it emotionally and personally that they became upset when he wanted to examine the transcripts of the dialogue. Indeed, the people who first used Eliza could not accept that the machine did not really understand them (even though they were told it was a very fixed, mechanical program). They thought that it truly empathized with their problems. The relationship of humans to non-verbal machines has posed interesting social questions to philosophers, social planners, psychologists, and automobile manufacturers on the nature of man-machine relationships. The questions are no longer of passing interest. The social relationship that can exist between a human being and a *verbal* machine appears to be qualitatively different.

The qualitative difference led Weizenbaum into conflict with individuals who would like to equate interactive word-processing capacity with a humanitarian goal of providing "therapy" to individuals with psychological needs. The idea, *in extremis*, would link thousands of computer terminals to a central processing unit, thereby fulfilling therapeutic needs and alleviating the shortage of well-qualified therapists (for continuing debate over the issue of computers as therapists, see *Science*, 1977, 198, p. 32; *Science*, 1977, 198, p. 354; *Science*, 1978, 199, p. 390; *Psychology Today*, 1978, 12(4), pp. 50-60; *Science*, 1978, 200, p. 998).

Obviously, a simpler solution to the shortage of qualified, efficient therapists would be to shoot the individuals in need of therapy until a healthy patient/therapist ratio is obtained. Another, less radical, solution suggested by a colleague would be to eliminate therapists. For without therapists, with their unproven methods, the treatment of people might make much greater progress. It is fairly obvious that one decreases the need for therapy by decreasing the number of available therapists.

Weizenbaum is more subtle, and too humane to entertain the idea of directly eliminating people in need of therapy. He does argue that the logic equating machine with man is totally destitute of an appreciation of what man is.

The logic of *homo ex machina* has led to the recent use of computerized mendacity by the Joint Chiefs of Staff during the bombing of Southeast Asia. Not only were the programs at the Pentagon rewritten to substitute Vietnam for Cambodia, but the explanations of the individuals who were entrusted with the veracity of the reports explained what occurred by blaming the computer: "It is unfortunate that we had to become slaves to these damned computers" (Admiral Thomas Moorer, Chairman of the Joint Chiefs of Staff, 1973, p. 239). The parallel between the Chairman's statement and the reactions of people who interacted with the Eliza program is quite strong.

The fallacy of relying totally on computerized therapy or information processing is caused by the total belief and unquestioning faith of many information scientists, humanists, and laymen in the ability of the scientific model to solve not only all problems given enough information, but to solve them at the best cost:benefit ratio. Weizenbaum attacks the strict mechanical view of man as being over-simplistic and unobtainable. In contrast to B. F. Skinner (*Beyond Freedom and Dignity*, 1971, Knopf), Weizenbaum believes man can *not* be treated as a multivariate system of zeroes and ones.

The addictive and mystical qualities that involve individuals with computing interactions are not restricted to people unversed in what the machine they work with does or how it functions. In one delightful section, many readers will recognize someone they know as a "compulsive programmer" or to use Weizenbaum's term: a "hacker." A hacker can be distinguished from an ordinary professional programmer in several ways. First, the professional spends more time in planning, flow-charting, and documenting than the hacker. More importantly, "The professional regards programming as a means toward an end, not as an end in itself." Behaviorally, the hacker — in contrast to the professional programmer — spends almost all of his time at the console, interacting with *the* program. The compulsive programmer is compared by Weizenbaum to the compulsive gambler. The hacker becomes so obsessed with the program that he has others bring him food and drink, sleeps on a cot nearby, and forsakes the world to the extent of not shaving or bathing. These "computer bums . . . are an international phenomenon."

It is understandable that corruption which occurs when an individual is allowed to create his own universe, of which he is the sole lawgiver, can lead to monstrous problems in large systems today. For example, the programs written for the defense systems of the United States were written by a number of different programmers over a period of many years. Weizenbaum contends that these systems are now beyond the understanding of any single individual. A few months ago, a "glitch" developed in the computerized antiballistic missile system. The event received little attention because it was handled by "middle-level" authorities. If Weizenbaum is correct, we should expect more glitches.

Weizenbaum's book is generally excellent. This reviewer has found nothing to detract from the book and can only supplement Weizenbaum's observations and logic. One of the major problems I have seen with the use of computers in health care delivery systems, in research, and in teaching is the idea that data are truths. All we have to do to ascertain the truths is to put the data in a machine and — given enough time (typically man-months) and sophisticated, esoteric, multivariate techniques — the truths will become self-evident. After several megabytes of data are collected, someone will push a button and the answers as well as the questions will appear automatically. Another problem often encountered is that some people, especially those in applied research, fail to appreciate the complexity of the questions they pose to the computer. For example, is Program A better for patients than Program B? The individuals who ask the question are primarily concerned with body counts, days in bed, costs per bed, and staffing costs. The questions represent an appalling ignorance of the importance of such variables as age, sex, and diagnoses. A third problem, one that could be remedied by a federal software bank, is the lack of accessibility to highly specialized programs. In other words, all federally supported research that results in software being developed could have copies of the programs on file that would be accessible for the cost of tape copying. It is obvious that some published research cannot be replicated because the programs are poorly documented, or the authors will not release them and thus avoid having their results replicated or extended by others working in allied fields. It is tempting to list names of individuals, who are well-funded and highly regarded, who refuse to release their programs.

In summary, Weizenbaum provides a needed humanistic and realistic view of computing machinery, and the magical world many people inhabit. This reviewer recommends three additional books which supplement and provide some alternative approaches to solving problems that require less keypunching and more thought: (1) *Exploratory Data Analysis, Volumes 1, 11, 111*, by J. W. Tukey, 1970, Addison-Wesley, (2) *The Modern Researcher*, Jacques Barzun, 1977, 3rd Edition, Harcourt-Brace; and (3) *The Abolition of Man*, C. S. Lewis, 1965, MacMillan Publishing Company.