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Effects of Small Computers on Scientists

Scientists vainly struggling to catch up with their reading may greet with an unappreciative sigh the Organization for Economic Cooperation and Development (OECD) forecast that "in 1985–87, six or seven times the present volume of new information will be produced." Scientists may though, at least at first, be relieved to read in the same document that by 1987 "the degree of automation of information will approach a hundred times that of today." Thus machines, the OECD says, will do more of the work of coping with the avalanche of information. So far, so good.

The present new wave of computerization, leading to a growing use of mini- and microcomputers (*Science*, 20 December 1974), illustrates both the positive and negative potential of the kind of automation the OECD foresees. Inexpensive, versatile, compact, and easy to combine with other instruments, mini- and microcomputers are increasingly used to accelerate the collection and processing of information.

Indeed, in a world of growing bureaucratization, the miniaturized computer is a rare source of delight for the shift to compact computers allows a much greater degree of decentralization. Instead of feeding data into a central computer, every researcher, indeed soon every research assistant, may have one or more computers at his disposal or linked to his instruments.

Similarly, in a world of increasing shortages, budget squeezes, and inflation, tiny computers will make the processing of information cheaper and more accessible. And in a world rich in routine and rut, small computers will be able to take on many of the menial tasks scientists, or their apprentices, now must do.

There is, however, a catch. The very rapid turnabout time compact computers allow between obtaining readings on instruments as well as between data processing runs practically eliminates the time once allotted to examining the findings, reflecting on their implications, and evolving hypotheses. Now empiricists will be more sorely tempted than ever to keep shooting in the dark on the assumption that with enough shots some interesting reading or correlation will be hit. While no computer can stop a scientist from reflecting, with rapid response tools ready and waiting the temptation to "see what will happen," rather than evolve a suggestive theorem will be greater than ever. Increasingly, scientific work may be done by what is, in effect, a trial-and-error search, rather than a focused effort. And, in consequence, the findings may be an aggregate of data rather than confirmation of a theorem.

Such a development would be a latter-day repeat performance of the impact the introduction of prepackaged computer programs has had on some branches of the social sciences. There, the ability to use a prepackaged program to "analyze" a data set, say of the opinions of a random national sample of adults, often results in interpretations that have all the convenience but also the bite of a precooked, frozen TV dinner. This is because existing categories are used even if they do not capture well the variables under study. Thus, opinions are analyzed in terms of sex, age, income, and size of city, even if these correlate poorly with the issues at hand. Much to-do then is made over a difference of a few percentage points between subgroupings (say young versus old), while much greater differences would be found if more suitable but less commonly tapped variables (or combinations thereof) were teased out. Finding such variables, however, requires considerable intellectual, not mechanical, effort—less use of prepackaged programs and more of scientific creativity.

The solution is not to stop the evolution of inexpensive, versatile, indefatigable automated assistants. Perhaps one way to enjoy the benefits of compact computers without falling into their empiricistic clutches is to train graduate students to recognize the danger of allowing the computers to set the pace and direction of their work and the need to protect time for reflection. Also, partial automation of the higher order of data processing, developing theories and deriving hypotheses, may be advanced in the future so that these capacities may be used to correct for the empiricism the new generation of mini- and microcomputers seems to promote.—AMITAI ETZIONI, *director, Center for Policy Research; Columbia University, New York 10027*