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SCIENCE

The Fourth Revolution

The public has begun to resist further increases in the support of education. If improvement is to occur in teaching it must come from new approaches rather than from more of the same. It is ironic that there has been so little real progress in education and that the research and development effort needed to improve it have not been commensurate with the large total expenditure for education.

Nevertheless, we seem on the threshold of profound changes. Some of these have been discussed in a recent report of the Carnegie Commission on Higher Education.*

The report begins, "Higher education (and education generally) now faces the first great technological revolution in five centuries in the impact of the new electronics." The authors point to the growing use of electronic technology (computers, cable television, video cassettes) in many facets of education, including research, administration, the library, and instruction. The report predicts that by 1980 computers will have been generally introduced in libraries and that by 1990 they will have been generally introduced for instruction.

The report outlines some of the advantages for use of expanded technology in instruction. "It increases the opportunities for independent study and provides students with a richer variety of courses and methods of instruction" . . . "additionally it is infinitely tolerant and infinitely patient toward the slow learner." The new technology also seems to have good potential for off-campus instruction of adults. In view of these advantages and others cited in the report, the delay predicted in the introduction of the new technology seems long. Perhaps the authors have been influenced by two factors—their estimate of the inertia of higher education and their past experience with the deflation of overoptimistic claims for computer assisted instruction (CAI).

Until recently no single institution mounted a sufficiently large effort to be able to demonstrate both quality-effectiveness and cost-effectiveness of CAI. Most investigators employed small installations that were equipped with small computers that could not be cost-effective. Some of the medium-sized installations have successfully demonstrated that CAI has features which tend to make it superior to conventional teaching, at least for some subjects. A personal experience at Stanford convinced me of the value of CAI for teaching languages. I took a lesson in Russian from the computer. The degree to which the system demanded and captured attention was startling. Others have noted that CAI is particularly useful in teaching languages and in situations in which repeated drills are indicated.

Two systems of CAI are now under development and they are being backed on a scale sufficient to permit a realistic evaluation of its potential [*Science* **176**, 1110 (1972)]. The most ambitious and versitile of these is the Plato system at the University of Illinois. This project has had strong support in the engineering and development of new hardware and has drawn on talents of some 200 instructors of varying backgrounds who have designed courses for use with the computer. Ultimately, it is contemplated that one computer would serve 4000 terminals, some located hundreds of miles away. In the fall of 1973 a 2-year demonstration of the system, involving 500 to 1000 terminals, will begin.

The potentials of CAI seem to warrant more intensive effort in exploiting them. At the same time there should be critical and imaginative thinking about the likely impacts of the new technology so that possible adverse effects may be identified and avoided.—PHILIP H. ABELSON

* *The Fourth Revolution: Instructional Technology in Higher Education*, Carnegie Commission on Higher Education (McGraw-Hill, New York, 1972).