TECHNIQUES AND COSTS

I. Technology and Taxes

By WILLIAM G. HARLEY

THE INCREASING need to improve educational quality throughout the world has had many effects, but none more widespread than the growing attention being given to costs—how much does instruction cost, and what is the public getting for its money? Educational technology has become a central force in this emphasis because it offers a major opportunity for more effective and comprehensive use of human and nonhuman instructional resources.

To what extent can the efficiency of the use of these resources be measured? Can a school be said to operate efficiently and effectively if learning is not taking place? And what about cost? Can we apply a form of industrial cost accounting to education? There are some who have criticized the operation of education as if it were a business; and yet the real error may not be in using a business-like approach, but in transplanting it and not translating it. Raymond Callahan, in *Education and the Cult of Efficiency,* points out that "if educators had sought the 'finest product at the lowest cost'—a dictum that is sometimes claimed to be a basic premise of American manufacturing—the results would not have been unfortunate. But the emphasis has *not* been on producing 'the finest product,' but 'on the lowest cost.'"

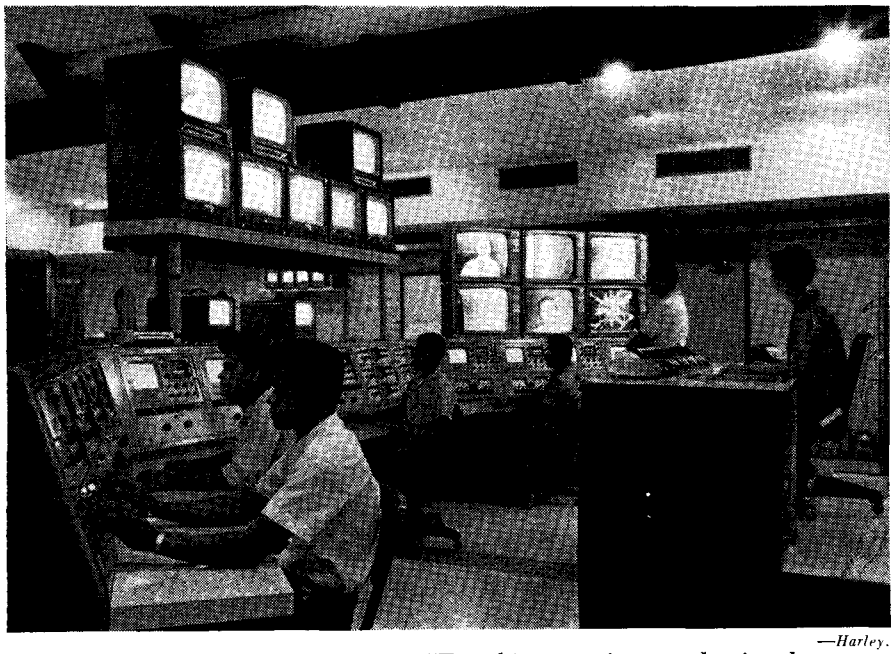
SOME of the difficulties we have encountered in producing our finest product in education derive from an inability to articulate not only what our product is but what we really mean by finest or quality. Further, while we have concerned ourselves with cost per student, this has not been comparable to the cost-per-unit figures of industry—the difference being that industry identifies the cost-per-operable unit. The true cost of an industry's output includes not only each unit's intrinsic development cost but also the cost of those units that did not pass quality control and had to be scrapped.

In education, however, we have been concerned with the cost per student taught (our input) and not the cost-per-student-learned (our output); yet we know that what is taught and what is learned are not synonymous. Accordingly, we have not been including the cost of our scrap (non-operable units)—students who cannot function in today's society—and therefore we do not arrive at the full cost of our education system. If we had, our actual cost-per-student figures would be many times greater than the relatively small $607 that is cited now as the national average. This broader and larger base should be the measure for evaluating potential means of bringing about efficiency in education. Accordingly, attempts to reduce cost should be aimed at increasing the number of "operable units."

Definition of our product, or objective, in education, then, must be concerned with the "student-learned." But what kind of learning? At one time it was felt by some that the role of education was to produce individuals with marketable skills. But what is a marketable skill today when it is said that an average individual will need to be retrained three times in his life because of automation—when we must educate for professions that do not yet exist—when most of the information that will be available to our children in fifty years has not yet been discovered?

AS the conditions of the time require us to look closer at the nature and meaning of learning in our dynamic society, it becomes clear that learning is a personal process, an individual acquisition of knowledge and development of insights based on an identification with the needs and demands of our environment. Learning is and always has been an individual process. The learner has not been sitting in a group of thirty or so at one end of Mark Hopkins's log. He has always been alone at one end of the log, and our real problems come from expecting our Mark Hopkins to straddle thirty or forty of those logs simultaneously, usually in circumstances where it is not possible for even our most able Mark Hopkins to straddle one log adequately.

Accepting the private and personal nature of learning enables us to consider a more modern definition of our "finest product," and to determine the real objectives of education in a modern society. But our better-defined objectives are also more complex, and the methods we use to reach these needs will, by necessity, have to be somewhat different from today's practices. The teacher will cease to be a source of inadequate and often outdated information and will become a mentor and a guide through the labyrinth of alternatives. We are fortunate that the technology that has accelerated



—*Harley.*

School TV control room, Samoa—"To achieve maximum value in education, technology must be capable of effecting comprehensive change."

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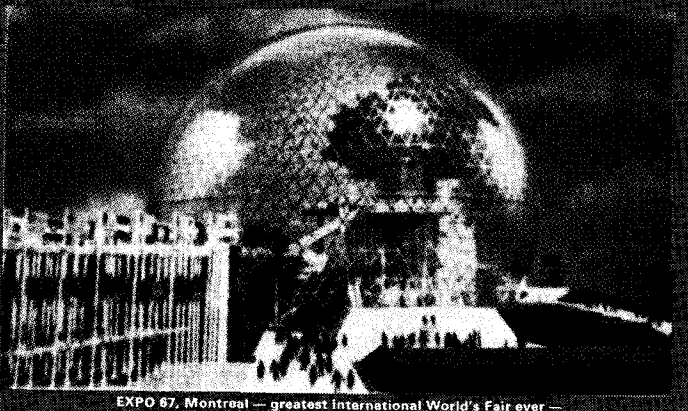

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many of the economic and social changes in our society can also be used to help us attain new ends. But the technology thus used must be *of* education and not *added to* education. Though most utilization of technology up to now has been of an additive nature, it has resulted in a subtraction of time from the teacher instead of giving him time to pursue the neglected human relationships of education. Such use of technology deals with education the way it is. It seeks to fit into the present system in a manner that adds resources without actually changing basic procedures, such as the student-teacher ratio, the role of the classroom teacher, the objectives of the instructional program, and the expected level of achievement in a given system. In this setting, electronic and mechanical gear will facilitate improved learning opportunities for some students, but not necessarily the extensive organizational and procedural changes nor the economic advantages necessary to a modern educational system.

To achieve its maximum value in education, technology must be capable of effecting comprehensive change. Where used to provide new instructional resources, it should relate to the specific objectives of the curriculum; if employed permissively and without relevance to the main purposes of a school, it will be inevitably wasteful and probably not worth the investment.

The school system in American Samoa illustrates how technology can be used in an enlightened way, and the benefits that can result [see "Classroom TV Comes to Samoa," *SR*, June 19, 1965].

The Samoa system was designed by the National Association of Educational Broadcasters at the request of Governor H. Rex Lee, and the Association has continued its involvement by recruiting all personnel for the system and providing general guidance. Lee, a distinguished career administrator in the Department of the Interior, was appointed Governor of American Samoa in 1961. He was appalled by the neglect he saw there, and outraged at the school system's obvious inadequacy to prepare the children for anything but a continuation of their submerged economic and social status. He determined that improvement in the general welfare of the islands' people would have to be based on a marked improvement in the quality of their education. A detailed study revealed:

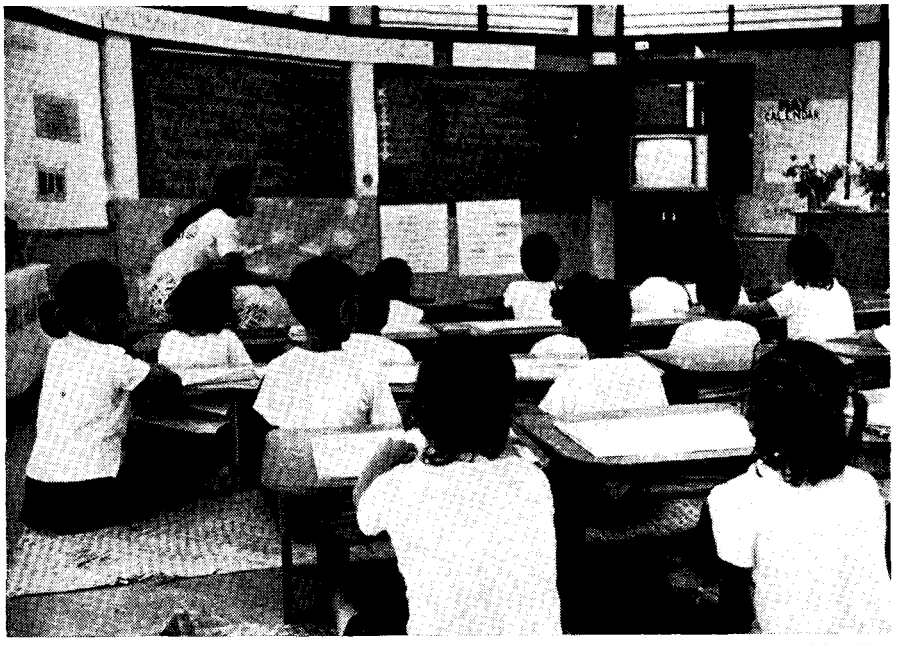
► A lack of clearly established goals for the schools and therefore a poorly defined curriculum.

► A failure to teach fundamental skills. The methods of instruction emphasized memorization with little attention to understanding (most class time was taken up by students chanting in unison responses learned by rote). All instruction was supposed to be in English but most of the teachers could neither speak nor understand it.

► There was overcrowding in the elementary and junior high school buildings, which were little more than thatched huts or poor imitations of American buildings.

► Textbooks and other materials, if available, were out of date and had little or no relevance to the experience or needs of the Samoan students.

► An ineffective teacher preparation and in-service training program resulted in poorly educated and prepared teachers.



—*John Alley.*

Samoan TV literature lesson—"Technology buys time . . . increased quality . . . educational services previously considered too expensive or in short supply."

The NAEB study team recommended a complete remodeling of the school system built around an instructional core of television. It was proposed that six television channels be used to serve Samoan children by day and adults by night. Television would transmit the basic content of instruction at all levels, with highly competent Stateside studio teachers acting as leaders. Samoan teachers in the classroom would precede and follow each lesson with reinforcement activities set forth in a guide.

Governor Lee had several alternatives:

1) He could immediately improve the standards by recruiting several hundred fully qualified teachers from the mainland. If such teachers could be found in this quantity, which was doubtful, they and their families would need adequate housing, transportation, and other services. The economic feasibility of this alternative was debatable. In addition, it would have required dismissal of several hundred Samoan teachers, many with twenty or more years of service.

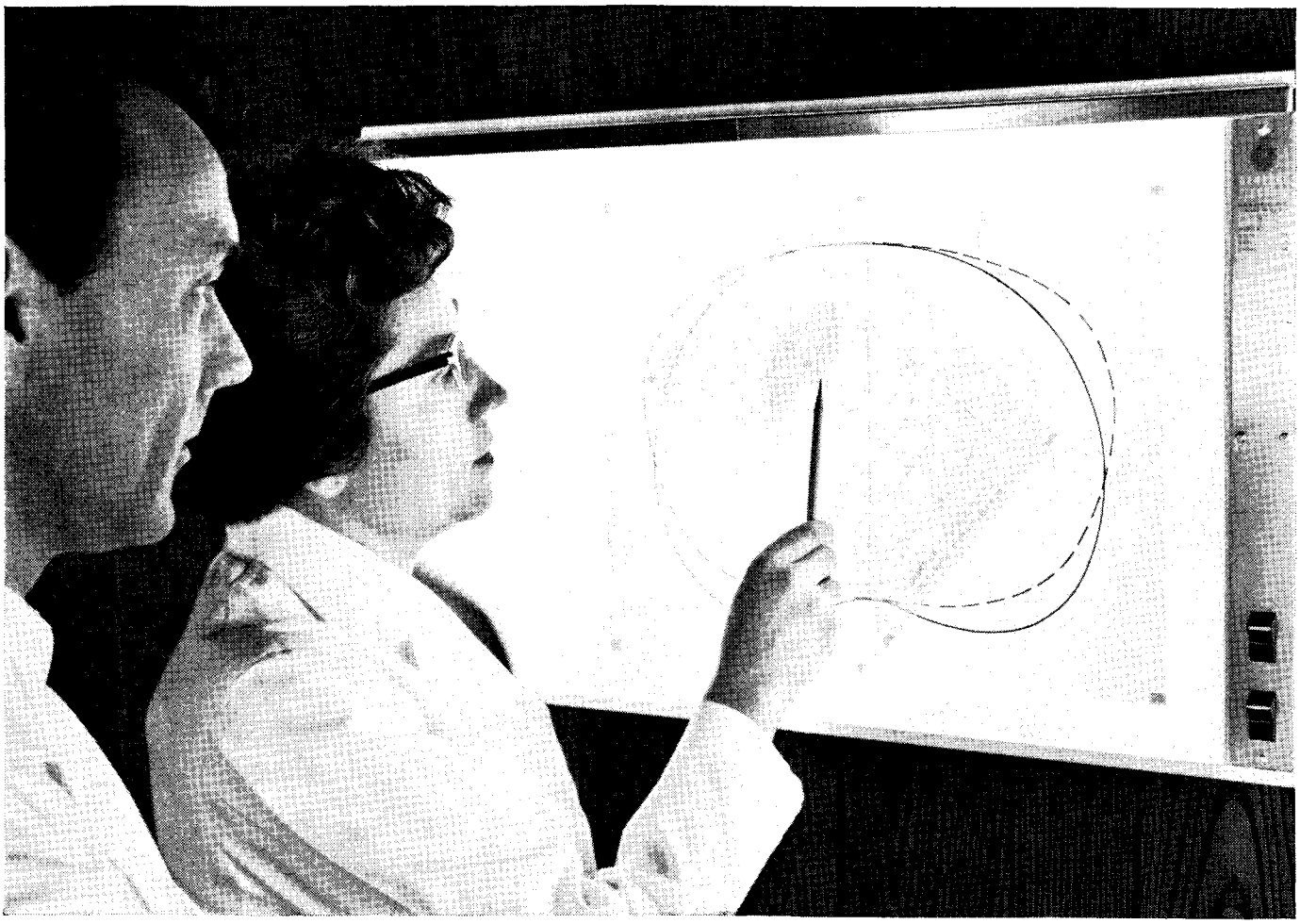
2) He could start a long-term program for training future Samoan teachers in the United States. This plan, while extensive, would have had little effect on standards for at least ten years, and probably longer.

3) He could apply technology by accepting the NAEB plan for the extended use of television to train the best of the existing Samoan school personnel as well as new teachers while upgrading the instructional system.

This third alternative was the one recommended by Governor Lee and accepted by Congress. About this decision, an independent study team from the International Institute for Educational Planning says in a soon-to-be published book:

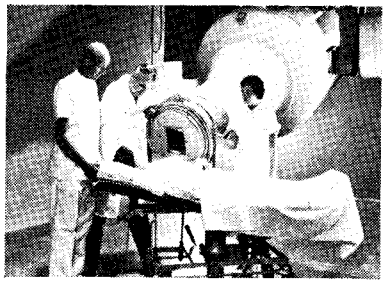
> It was a breathtaking decision. TV was not being called upon to supplement the on-going work of the classroom teacher or to help them do a bit better what they were already doing; it was being asked to share responsibility equally with them, help them do something quite different from the rote exercises they had most typically conducted, and, in fact, implement an abrupt and revolutionary change in the system—rote learning was to be replaced as soon as possible by problem-solving and individual study. The level of content was to be dramatically raised. Higher levels of performance were to be demanded of the students.

Thus the exciting thing about the



Target cancer: search and destroy!

On the wall is a "battlemap"—a cross-section diagram of a cancer patient's body. Pinpointed on the "map" is the target—a deep-seated tumor. Through the use of diagnostic x-ray equipment, a radiologist—a physician specially trained in the use of x-ray for diagnosis and treatment—has searched out the location and size of the lesion. Now he and the patient's other physicians plan the attack. His weapon: a 2,000,000-volt x-ray unit. ■ Before treatment can begin, the radiologist must perform a series of complex calculations requiring the utmost patience, knowledge, experience and skill; he must determine the precise quantity and quality of radiation to be used. His exacting job: apply the proper amount of radiation to the cancer site while minimizing the dosage to surrounding healthy tissue. The radiologist is aided in his calculations by an *isodose chart* superimposed over the patient's body-section diagram. The chart helps the radiologist determine how much radiation will be absorbed by intervening tissue and how much will get through to the target area. ■ Once the course of treatment is charted, the attack begins. Early discovery, followed by radiation therapy, can make it possible to arrest the cancer and return the patient to a normal life. ■ The supervoltage x-ray unit is only one weapon used by radiologists in the war on cancer. There are others—including radium, the powerful Cobalt 60, and other isotopes used in nuclear radiology. Stocking the radiologist's growing arsenal is General Electric— the Company that cares, and continues to care, by providing the medical profession with the finest, most advanced equipment for use in radiological diagnosis and therapy.



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Samoan demonstration is that it challenges the traditional slow pace of educational development, which depends upon educating and training all the teachers in a system. The Samoa plan was a bet that by building native teachers into a teaching team, and using television to multiply the effect on the most highly qualified teachers on that team, something new and dramatically different could be made to happen in the classroom.

While long-range analysis of the results of the new Samoan system is many years away, there is already empirical evidence of improving academic achievement, and obvious visual evidence of personal and societal improvement. All investigations and reports by outside agencies to date have substantiated this.

What about costs? Approximately $360 per child was spent in Samoa for the television hardware and construction of new school buildings, and it costs $380 per child to operate the school system each year. Again, we must consider the "product" that this buys—and one cannot compare Samoan costs to anything except the cost of the other alternatives for reaching the same goals—a completely reorganized school system, conceptual learning, and a highly qualified staff. Television technology brought an immediate increase in expenditures, but the result was rapid change and a stable system that avoided the impractical alternative of dismissing several hundred veteran teachers and waiting fifteen years to train adequate replacements. Thus basic, important, comprehensive changes were realized that will result in a viable educational system within the capability of Samoan resources.

We should seldom expect technology to result in lower absolute costs—equipment and personnel do cost money. When economies result, they are derived from the reduced cost of providing additional services—from the improvement in the quality of teaching and the level of learning; from the ability to shrink time and space, and from the sharing of limited resources. In Samoa, for example, the highly qualified teacher who develops and presents lessons to one youngster in the elementary school is doing the same thing for all others at a given grade. Most television costs, apart from those related to reception, are not governed by the size of the student population—a system of 70,000 students could be handled with approximately the same amount of administration as the present system of 7,000 students. Even if there were some increases, the comparative advantage would undoubtedly remain with the television-based system.

So while it is possible to say that media, comprehensively adapted to a school program, can result in savings, the economies will most likely occur in required future budgets. New curricula, new specialized teaching, new opportunities for learning—with these, the new media can make possible educational opportunity that would otherwise be impossible, at relatively economical levels.

The cost of technology, then, has to be assessed according to what it buys. Technology buys time—time for swift rather than slow change, and time to humanize education by allowing teachers to work more directly with students on an individual basis. Technology buys educational services—services previously considered too expensive, or in too short supply to provide equally to all students. Technology buys increased quality—quality derived from the impact of many minds applied cooperatively to instructional requirements. We have learned in Samoa that the cost of technology cannot be assessed in isolation. It can be assessed only as an integral part of the whole educational system, and the system cost as well as the system results are radically modulated by the integrated use of technology. This is perhaps more true of television technology than any other at the moment.

From the Samoan experience it seems clear that the more widely technology is used, the more people it affects, and the more it is integrated into the total system, the lower the unit costs will be. However, it also is evident that the Samoan system could not be lifted bodily and applied in a totally different context. The more sophisticated a school system is, the more difficult it is to integrate new methods. Nevertheless, there is reason to believe that modifications of the Samoan system and many of the collateral techniques being developed there can be successfully and economically applied to educational needs elsewhere.

II. The "Systems" Approach

By C. H. SPRINGER

Education, one of the primary ways to achieve both quality performance and equality of opportunity, is now understood also as a necessary national investment for an expanding society. It is not only a commodity to be consumed by the individual but an investment whose use brings returns both to the individual and society . . . it is the economist, interested in the development of resources, who points to the need for education in American society. It is not that national self-interest alone justifies education—education is a value for its own sake and enriches the lives of individuals—but rather it has become increasingly apparent that equal education opportunity is necessary to the maintenance of a free and prosperous society. In education, the human being benefits and so does the nation. The idealistic and the practical and the private and the public goals are one.

TEN YEARS AGO, the space age opened with the launching of Sputnik I. Since then, the finest minds and talents of the military and private industry have been marshalled in a collective effort to meet the challenge of the so-called space race. Though the race is still close, we have reached a position where our national resources are being developed and utilized to meet its difficult challenges.

We came to understand and ultimately solve the problems of these complex projects of men, machines, and operations by applying our collective talents to a "systems" approach. Organized innovation was the key. We refused to be bound by traditional, piecemeal solutions; we attacked the problems in a new, more disciplined way. The end products have been systems that meet the national objectives for which they were undertaken—national security and the peaceful uses of space. Moreover, this approach has produced a revolution in American technology with significant national economic benefits: new industries, new jobs, new insights.

It seems clear that the systems approach can also be a vital ingredient in achieving what Francis Keppel calls "the necessary revolution in American education." The revolution in education is not motivated merely by an idealistic vision, as some may think. Instead, it is dictated by hard economics. As Commissioner of Education, Mr. Keppel made this abundantly clear. He said:

The "systems" approach is an "economic" approach to education in the best sense of that word. It provides a rational method of using a given set of resources to produce a system capable of achieving a given set of objectives. Unfortunately, we have not fully crystallized our national objectives in education and probably never will. But as existing systems are analyzed and new systems are designed, we can hope to clarify these objectives.

A rational, systematic approach to education, I believe, can promote greater innovation because it produces continuous, dynamic modifications. And it will produce greater efficiency, because the precision, care, and attention