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In this January 1967 issue

Cover Photo This seven-year-old scientist at the experimental Oakleaf School, Pittsburgh, Pa., is timing marbles dropped into different solutions, such as water and vaseline, while he listens to recorded directions.

The Oakleaf Project for Individually Prescribed Instruction is operated by the Learning Research and Development Center, University of Pittsburgh. Results are being disseminated by Research for Better Schools, Inc., a USOE-supported regional educational laboratory. Photo by Leonard Schugar (Black Star).

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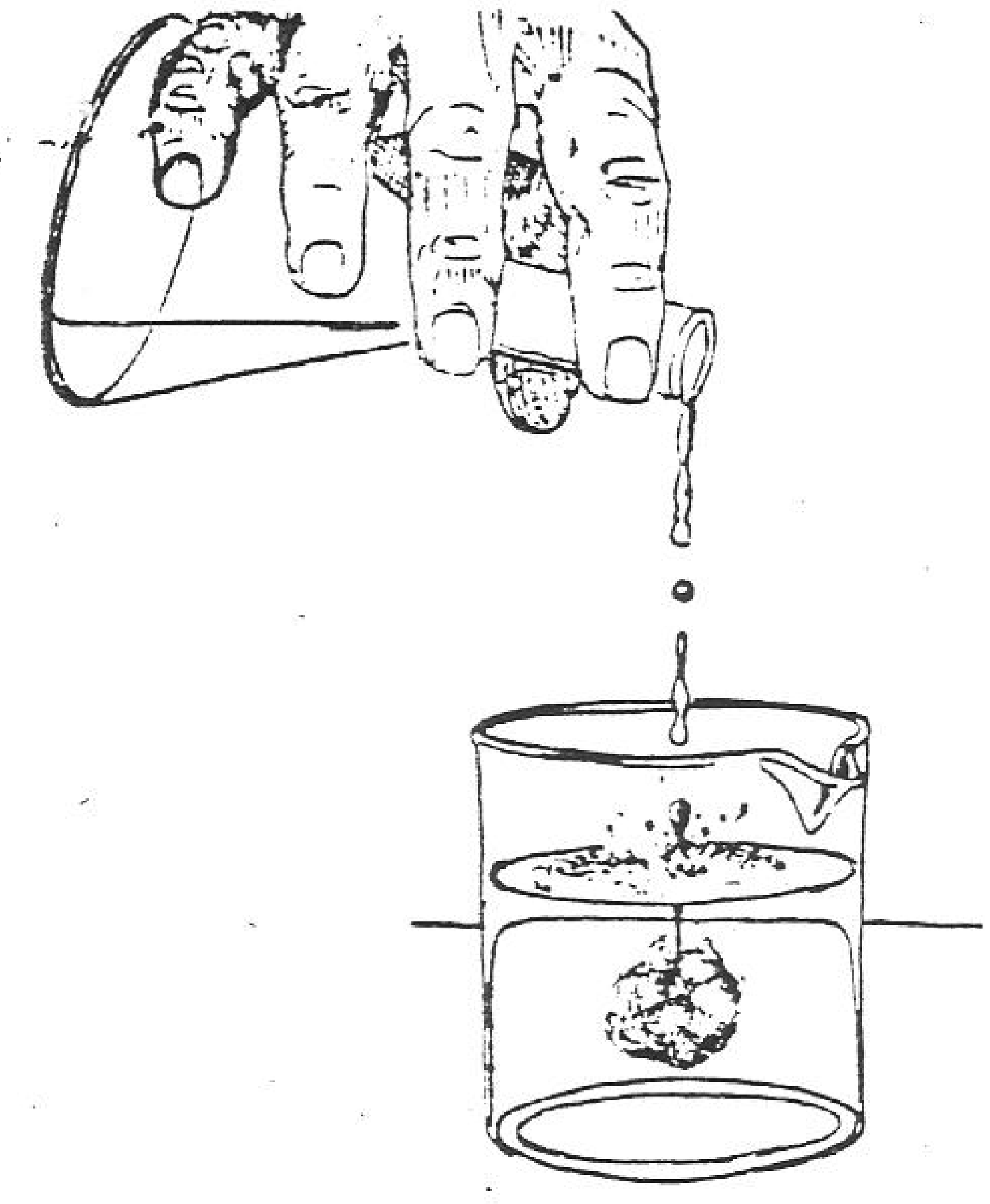

THE DOD: *Catalyst* *in* EDUCATIONAL TECHNOLOGY

By CHARLES L. BLASCHKE

THE technological revolution of our times has brought with it the capacity to solve the most difficult problems which modern society faces. And it has brought this challenge: Can our political creativity keep pace with the relentless march of science and with the mounting complexity of an increasingly urban society?"[1] When Congressman Bradford Morse made this statement last August, he touched upon the major problem facing the future of education: Can we develop the political innovations to effectively develop, evaluate, and utilize the technology which is capable of being produced for public education?

The use of the contract system by the federal government is becoming a crucially important tool in the resolution of this problem. Traditionally, in the United States this system was limited to goods such as pencils, papers, etc., rather than services. However, "The contract has now become a mechanism for securing a variety of services as well, including especially scientific research and development, policy planning, and the management of government facilities."[2] Actually, this policy instrument, now used to apply twentieth-century technology, can be attributed to our Western European forefathers. The very foundation of this country was based on a contract between the British Crown and a company of its creation chartered to provide a service.

The Department of Defense (DOD) is a logical focus for discussion of the relevance of the contracting system to education and training problems. It is the first large initiator and user of the contracting system. Furthermore, DOD conducts the largest single school system in the world. But most importantly for the future of education technology, as the Assistant Secretary of Defense for Manpower noted before 500 industrialists last June:

> To the extent that the DOD promotes innovation in education and training, it offers itself as a huge laboratory to facilitate translation of educational research into educational technology. This underlies our desire to work closely with research and demonstration centers in universities and the emerging educational industry.[3]

The potential impact of DOD on educational technology depends on several significant facts as well as a philosophy. The facts are built around the department's magnitude of procurement, its operations, its contracting procedures, its manpower capabilities, and its unique opportunities as a researcher, developer, and trainer; its philosophy could largely determine the extent to which the public interest in the future of education can be served.

The DOD School Program

DOD training in over 1,500 skill areas has an annual bill of $4 billion. The DOD sponsors 33 correspondence schools, the largest of which has an enrollment of 258,000 students; 90,000 individuals who enter the service without a high school diploma receive one or its equivalent each year. For its military dependents abroad, the department conducts schools for over 166,000 students in secondary education.[4] Of the 26,000 public school *districts* in the United States, only three have an enrollment over 500,000.

During his speech to the Veterans of Foreign Wars last August in New York City, Secretary McNamara emphasized that while the imperatives of national security make the Defense Department the world's largest educator,

> Those same imperatives require that it also be the world's most efficient educator. As a result, the Defense Department has pioneered some of the most advanced teaching techniques. Indeed, it has been in the van-

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guard of a whole series of innovations in educational technology.[5]

The technologies developed by the military service, often with the assistance of industry and educators, range from the "software" end of the spectrum to the "hardware," including many pedagogical techniques in between. Currently, over 600 courses taught in the services use programmed instructional tests. Programmed learning principles have been applied to closed-circuit television (CCTV) in courses like electronics fundamentals, reducing course time by one-third, accepting students with lower entry levels, and still achieving required job performance levels. In the Department of the Army, 23 schools and 17 training centers are conducting phases of individual training via CCTV. Research projects using computers for instructional purposes have been supported by the department since the mid-Fifties. Presently, over 10 courses at various service academies and training centers use computers for problem-solving and simulation functions in a classroom setting.[6]

The above facts are known to many educators and businessmen. Nevertheless, other unique aspects of the department underlie its greatest opportunity to influence the future of educational technology. This opportunity is tied closely to major problems confronting the development and diffusion of sophisticated educational technologies.

Fragmenting Decision Making

Over 56 bureaus within the federal government provide financial support for education and training; some 26,000 school districts plus hundreds of universities are on the receiving end. The political milieu of educational innovation also includes state agencies and administrators who attach constraints affecting the decisions which are made at federal and local levels.

At the federal level overlap is almost inevitable. Improving the quality of education is one of the missions of the Office of Education. Other agencies, however, look upon educational improvement programs as a "means" rather than an "end" (i.e., "providing the most effective national defense," "finding peaceful uses of atomic energy," etc.). Just as important, the legislative intent of Congress is often not clear. The overlap between the Office of Economic Opportunity's community action programs and the Office of Education's Bureau of Education for the Disadvantaged might or might not have been the intent of Congress; but the overlap exists and creates administrative problems.

Similar problems exist at the local level. When a school administrator proposes that some of the new educational technology be brought into his classrooms, he might be thinking initially about *maximizing* educational improvement; eventually, however, he finds himself attempting to *minimize* the resistance of teachers, taxpayers, parents, and the community in general. Federal administrators of demonstration and experimental programs are often plagued with a similar worry: If the experiment turns out badly, can the agency afford the political blackeye? Industrialists interested in creating new markets for their computer-based learning systems face similar questions: "Unless the equipment is completely debugged, can I afford to let a school system experiment with or use it?" And even if the equipment is technically ready for operation, "Can I afford to let my equipment be used by a school which doesn't have the skilled personnel to use it effectively?"

One can argue that the political pressures on all levels tend to weaken initiative to experiment and innovate. Yet this problem stems in part from a more fundamental weakness: our failure to develop standards to measure effectiveness in education. If such standards existed, we might move more effectively towards efficiency and imagination in public education. Administrators could judge how well students learn and reward "teachers" accordingly. School administrators could generate community support on how much "gray matter" was developed in the system rather than how efficiently dollars were spent on bricks and mortar. Federal R&D personnel would have some rational means of determining "how much better" one proposed technique is than another; and industry would then have an incentive to draw up quality proposals.

The effectiveness of the new technology, however, will not be determined in the laboratory nor through conducting surveys of the literature. Serious directed experimentation in natural settings must take place. The hardware technology and equipment used in a highly controlled but natural laboratory situation will be the means by which a new educational technology based on the process of learning will evolve.[7] Until measures of learning effectiveness are developed, rational decisions to experiment with and expand the use of technologies such as computer-assisted instruction will be minimal.

Adaptation of Research for Use

Our agricultural experience should have taught us one thing—if the time lag between invention and adoption is to be shortened, experimentation and demonstration must occur in natural settings with the potential user participating in the demonstration process. There are two aspects to this problem: 1) the research and development have to be in search of answers for the user's problems, and 2) research and development have to be directed.

One often hears that "the people in Washington or in the head office do not understand our real problems." The Regional Educational Laboratories (REL), created by the Elementary and Secondary Act of 1965, were established to alleviate this particular problem in public education. Although the effectiveness of the regional laboratories is still problematical, they have shown the diversity of existing users' problems. One early report recommended that REL support be given only to the development and demonstration of advanced technologies which could be used in a small rural school setting; another report took an opposing point of view. When the user's need as well as his direct participation in developing the solution are disregarded, the "NIH" factor (not-invented-here) is most likely to take its toll again.

Another and more formidable problem for both the research community and the federal government should be of immediate concern for industry. Who should perform the applied research and development of educational technology? Universities have traditionally performed this function through grants received on a no-questions-asked basis, jealously defending their right to university autonomy. Only in recent years when pressures on capacity led to costs greater than the authorized maximums for grants have a few begun to accept the contracting system. Largely because industry has developed both the managerial as well as scientific research capability, it has continually increased its share of federally funded applied research, to 47 percent of the total in 1965.[8] If the Office of Education intends to direct its applied research and development dollars, as the Associate Commissioner of Education has indicated,[9] it might well turn more and more to industrial concerns to perform this function.

Directing R&D raises another question: Can a project manager capability be gathered at the federal level to ensure that the questions asked are answered? A recent report to the Secretary of HEW found that the National Institutes of Health (NIH), one of the most successfully run *granting* agencies in the federal government, "lacks the people in number or in kind who are needed to staff an adequate structure for program management."[10] Much as in the biomedical field, the traditional granting system to universities in the field of educational technology has not required, and therefore has not developed, a type of individual with the experience, managerial capacity, and temperament to direct large projects using sophisticated technology in an effective way. Moreover, the question is not one only of dollars and salaries. Managers of R&D education projects in universities, where they exist, do not have the peer acceptance and career incentive that industry managers have.

Another question relates to the actual implementation of the solutions when discovered. As Commissioner Howe has pointed out to industrialists: "Like you, we sponsor the research and development, but it is up to the local school district to buy or not to buy the product."[11] Here the question becomes not one of technical but of political innovation. The lack of vertical integration from research to operational use has to be spanned not only for long-run efficiency but also so that experimental and demonstration programs can be conducted in the short run.

Proving Grounds

The "demonstration clause" written into every major piece of legislation proposing to use advanced technology to improve public service programs is one of the most important political innovations developed during the Sixties.* A major problem, however, is the failure to separate the demonstration "value" from the demonstration "effect." The "value" is concerned with the technique—how well did it work?; the "effect," with the problem of diffusion—if the new technique worked, how well did the *project* act as the catalyst to get schools and other users to adopt it? There is reason to believe that the Defense Department's impact could be great in both respects.

First, the department offers the opportunity to experiment. The military classroom and what goes on inside is not subject to the political pressures to buy locally, to instructor resistance, to parents' ultracautiousness, and other problems which often enter into a school administrator's decision to experiment or use new technology. Secondly, to the extent that new techniques have potential for training programs as distinguished from educational ones, it becomes easier to identify the terminal behavior required; hence the relative effectiveness of various techniques is easier to ascertain. Thirdly, the opportunities for controlled experimental design and for conducting longitudinal follow-up studies are superior to those in public education generally. For example, follow-up on the normally rejected individuals who are to be taken into military service under Project 100,000 will include the time period after they reenter the civilian economy.[12] As the PHI DELTA KAPPAN associate editor stated last October:

> Already, interested educators have written to the Secretary of Defense urging that sophisticated research be carried out, not alone to measure the success of the Army instruction but to identify the elements responsible for the success, so that a transfusion of these elements to the schools may be planned.[13]

There are many civilian counterparts of military education and training. Project 100,000 will be training young men substantially similar to those in the Job Corps, Manpower Development and Training Act programs, and in certain industrial training programs for similar types of vocations. The 327 secondary schools around the country for military dependents' children certainly have their public system counterparts. However, in those training and education programs which do not have directly related counterparts, the techniques of instruction have potential for adaptation for use in both existing and future school systems. The language laboratories used by the military services in the Forties certainly increased the rate of their diffusion into public education during the Fifties, either by demonstrating their efficiency to school systems or by reducing parent resistance. Many PTA members dur-

*For example, federal dollars for "demonstration" purposes exist in the Economic Opportunity Act of 1965, the Demonstration Cities Bill recently passed, and the Northeast Corridor Project for improving transportation on the Northeast Coast.

ing the Fifties were ex-service personnel who had utilized language laboratories successfully a decade before. Although the time lag between invention and diffusion in the military certainly needs to be reduced, it is less than that in public education generally.

Systems Procedures

There is much interest today in the application of a "systems approach" to education. Although clichés provide important functions in themselves, there is nothing really new about the concept. In fact, we have returned to the use of the scientific approach to method developed in the days of the Greeks, refined the techniques of implementation where possible, and in twentieth-century style christened it, sometimes with too much glory, "the systems approach." Its significance to education is that it forces the individual manager to define the problem precisely, note the alternatives available and their total costs, and choose the most efficient alternative according to performance criteria. Today its merit lies in its conceptual approach; for the future, the need to refine implementing techniques depends on our ability to define our objectives clearly, delineate our problems accurately, and, most importantly, develop criteria for measuring how much success we can get for how many dollars.

Since the early Fifties systems thinking has become increasingly "acceptable" to military planners, managers, and instructors, as well as to the industrialists who have done business with the DOD in training areas. Although systems "thinking" about education problems is spreading into other federal agencies, its use in DOD has already stimulated the development of procedures which will give the sophisticated technology an even break, initially, as a feasible solution.

First, total costs of training can be determined. In equipment-oriented training (e.g., missile systems), the additional costs of training maintenance personnel are traded off against the additional complexity of hardware, so that the total "womb to tomb" costs of the entire system are minimized. In general education and in formal technical training (e.g., electronics fundamentals), it is possible to determine the entire cost of bringing individual trainees to predetermined levels of performance. These costs might include housing, facilities, transportation, job time foregone while the individual was being trained, etc. The new computer-based educational technology will change drastically the concept of the classroom, the teacher, time, and even geographical location. It can become a feasible alternative only when the entire costs of traditional instruction can be presented before the decision maker, and the decision can then be made on a rational basis.

Secondly, the new technology is potentially useful in those areas in which reproduction costs are marginal. Large volume in terms of time, students, instructors, and other resources, plus stability of course content are necessary. The services have numerous courses, such as "military conduct" and "fundamentals of electronics," which fall into these categories. For example, almost 15,000 students take the latter course annually at Keesler Air Force Base alone.

Thirdly, while a systematic approach can be used to manage an entire training and education program, it can also be applied to a particular course, becoming what is called the "instructional systems approach." Job analysis, the first step here, is being conducted continually in the 1,500 defense skill training courses. Removing "nice to know" fat from training courses has resulted in both reductions and lower attrition rates. Although it is generally easier to determine performance objectives in *training* than in *education* programs, the expansion of this technique and the insights learned through its use can be invaluable for industry and for some portions of public education.

Fourthly, systems thinking is based on objectives stated in performance "requirements" rather than detailed physical "specs." By considering solutions in this light, more alternatives become feasible; receptivity to new ideas and approaches is heightened. For example, such an approach has revealed that in maintaining certain sophisticated weapon systems it was cheaper to use a replaceable "black box" rather than train an individual to repair the component equipment. In other cases, it meant that the computer could be used to locate and diagnose electrical faults and present on a cathode ray display the directions for an individual repairman with minimal skill training.

Lastly, systems thinking about weapons development required the development of a planning, programming, and budgeting system which apportioned dollars for the entire cycle from research to prototype development. As a result, DOD can plan for research and development projects requiring up to five years. Hence its planning structure is more conducive to the time-consuming development cycle of sophisticated hardware adaptations and curricula development than is the yearly budgetary cycle which most school systems are forced to follow. Some people have argued that the failure of schools to develop five-year planning horizons based on capital budgeting concepts is one of the major obstacles to the educational use of advanced technology.[14]

Skilled Manpower

Implementation of systems thinking in the DOD education and training programs required that capabilities be developed in at least three areas: 1) instructional programming, 2) project management, and 3) instruction. The small reservoir of skilled educational programmers has been noted by David Klaus, who stated after the establishment of the Instructional Systems Development Teams (ISDT) of the Air Training Command in the early 1960's that its 352 graduates doubled the number of skilled instructional programmers in the country at the time.[15]

A project management capability, discussed earlier, is no more important than the acceptance of the role. The manager must be given concurrent authority and responsibility with a budgetary flexibility responsive to the progress of the R&D program.[16]

But R&D project management and good instructional programming are meaningless unless the actual schools and training centers have an instructor capability to utilize the new techniques effectively. A recent survey of the Army's use of audio-visual devices found that over 90 percent of instructors had completed formal courses in instructional techniques and use of teaching aids.[17] Even though computer-assisted instruction is presently being used in only a few defense training courses, or portions thereof, such a capability could probably be developed there more easily and more quickly than in public school systems generally. The DOD was the first large single general user of computers.

Meaning for Industry, Education

For industrialists producing the new technology there appear to be two relevant markets: 1) that which can be created through inroads by computers into functions now being performed by teachers and the schools in general, and 2) the education market which can be created and stolen from existing "recreation" and "leisure" markets. In both cases there must be initial markets which will have all or many of the following characteristics: First, the atmosphere of the "market" (the pilot programs), has to be conducive of experimentation in natural settings so that the real effectiveness of the new technology can be determined; adverse publicity from experiments failing to succeed or from ineffective use by the "buyer" has to be minimized. Second, the size of the initial market has to be large enough to merit costly R&D efforts, so that if a program is proven successful, R&D amortization costs are small per unit. Third, all relevant costs must be easy to determine, so that the overall costs of traditional instruction can be weighed against those incurred through use of costly new technology. And last, the user must be able to apportion varying degrees of financial and/or other support over the entire time period from research to prototype development.

For the defense-aerospace companies, an industrial group entering the education market, another characteristic is important. Because of their relatively low financial bases and small marketing capabilities, those interested in diversification are turning to the defense support areas such as health services, food services, housing, and education to apply their problem-solving capabilities. To them defense training is a desirable initial market because of their experience and knowledge of defense operations as well as their limited marketing capabilities.

The above characteristics exist to varying degrees in defense training programs. Industrialists are looking to the defense training and education market, but not necessarily because of the great long-run market growth potential there; rather, it provides them a *limited market* in which they can demonstrate the effectiveness of their new techniques and thereby gain a foothold in the growing education market. Industry's interest in defense training markets can be inferred from its readiness to work with the National Security Industrial Association (NSIA), studying such training problems as standards of measurement and computer-assisted instruction, follow-up to the Engineering Systems for Education and Training Conference held last June. NSIA contributed to the success of Secretary McNamara's Cost Reduction Program, initiated in 1961. The fact that such a mechanism as NSIA exists attests to an advantage which DOD has over other agencies in working effectively with industry in seeking new solutions to old problems, formerly in the weapons areas but now in applying new technology to defense education and training problems.

INDUSTRY'S interest in defense education and training markets is no greater than the Office of Education's concern with the direction of industry's new move into education. Commissioner Howe hinted that there may be a need for a "regulatory agency" in the next few years to insure that high quality "software" and "hardware" is made available for public school systems. James Ridgeway noted in *The New Republic* that "the way in which the government awards initial contracts can determine whether the education business is competitive in 20 years or whether a few big companies dominate the market."[19]

The questions of standards and competition are related; the DOD could have an impact in both cases.

At the June NSIA conference mentioned above, J. Sterling Livingston said in his keynote address: "If the power to tax is the power to destroy, the power to purchase is the power to create. . . . What has been proposed this morning is that the Department of Defense use the enormous creative power of its procurement system to increase our understanding of the human learning process and to stimulate innovation in training."[20] While purchasing power can be used to "create" new goods, the mere use of performance specifications might be enough of an incentive for innovation.[21] Many firms which have developed radically new approaches are having difficulty as "problem-mongers" in finding problems stated in output performance requirements as opposed to "bricks and mortar" inputs.

While the DOD might well provide the opportunity to develop performance standards initially, a competitive industry will have the greatest long-run impact on the quality of goods bought and sold in the relevant education markets. Ridgeway was correct in saying that the way initial contracts are awarded will determine the structure of the industry. Federal use is often an outright stamp of approval or at the least indication of tacit acceptance of the worth of products or services. Few companies are proving the effectiveness of our fighting forces. In turn, we in the Defense Department are anxious to provide industry the opportunity to innovate in this endeavor. And the nation on the whole will benefit.[28]

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[1] "Managing the Public Business," August 25, 1966, introducing HR 17310, To Establish a National Commission on Public Management.

[2] Carl Stover, "The Government Contract System as a Problem in Public Policy," *The Industry-Government Aerospace Relationship*. Menlo Park, Calif.: Stanford Research Institute, 1963, p. 3.

[3] Thomas D. Morris, "Engineering Systems for Education and Training: Through DOD-Industry Collaboration," in *Proceedings of Conference on Engineering Systems for Education and Training*. Washington, D.C.: National Security Industrial Association, June, 1966, p. 11. (Henceforth referred to as *Proceedings*)

[4] *Ibid.*

[5] Robert S. McNamara, "Address Before the Veterans of Foreign Wars," New York City, August 23, 1966.

[6] For additional examples, see pp. 286-311 of Arthur A. Lumsdaine and Robert Glaser (eds.), *Teaching Machines and Programmed Learning*. Washington, D.C.: NEA Department of Audio-Visual Instruction, 1960.

[7] See Alexander Schure, "Adaptation of Research to Technology," in *Proceedings, op. cit.*, pp. 94-101.

[8] Report by National Science Foundation, "Federal Funds for Research, Development, and Other Scientific Activity," No. 6513, 1966, p. 33.

[9] See R. Louis Bright, "Office of Education Support for Education Technology," *Proceedings, op. cit.*, pp. 91-93.

[10] Report of the Secretary's Advisory Committee on "The Management of NIH Research Contracts and Grants," Office of the Secretary of HEW, March, 1966, p. 16.

[11] Harold Howe II, "Education and the Changing Technology," *Proceedings, op. cit.*, pp. 14-18.

[12] See a speech by Thomas D. Morris before the National Guard Association, Phoenix, Arizona, October 20, 1966.

[13] Donald W. Robinson, "Schoolmaster McNamara," PHI DELTA KAPPAN, October, 1966, p. 49.

[14] See Gus Rath and T. Struve, "Planning, Programming, and Budgeting in Education," *Educational Technology*, June 15, 1966. Saddle Brook, N.J.: Education News Service.

[15] See Gabriel D. Ofiesh, "Educational Technology in the Air Force," *The American Behavioral Scientist*, November, 1962, p. 62.

[16] See Chalmers Sherwin, "Measuring the Payoff of Research and Technology to Defense," *Defense Industry Bulletin*, September, 1966, p. 13.

[17] See Joseph Kanner, "Army Audio-Visual Survey Report," Department of Army, March, 1966.

[18] Harold Howe II, "The Realities of the Learning Market," speech before the American Management Association Conference on Education Realities, August, 1966.

[19] James Ridgeway, "Computer-Tutor," *New Republic*, June 4, 1966.

[20] Sterling Livingston, "Present Posture of the Education Technology Industry," *Proceedings, op. cit.*, p. 19.

[21] See Executive Office of the President, "Technology and the American Economy," *Report of the National Commission on Technology, Automation, and Economic Progress*, February, 1966, pp. 101-102.

[22] In the early Fifties when the semi-conductor was being developed, largely for military purposes, the DOD recognized its great potential nonmilitary use. As a result, rather than contract to one group to develop prototypes, it let over five contracts to various potential producers. Today, instead of a structurally noncompetitive industry, there are over 50 producers in this particular industry. See Arthur D. Little, "Patterns and Problems of Technical Innovation," *A Report to NSF*, September, 1963.

[23] McNamara, *op. cit.*

[24] See Emile Benoit, "R&D Convertibility with a Pentagon Transformer," *Columbia Journal of World Business*, Fall, 1966; Executive Office of the President, "Better Housing for the Future," *Report of the PSAC Sub-Panel on Procurement*, April, 1963; and Charles Blaschke, *Federal Procurement, an Instrument To Increase the Rate of Innovation* (unpublished paper for Seminar on Science and Public Policy, Littauer Center, Harvard University, May, 1965).

[25] Max Ways, "Creative Federalism and the Great Society," *Fortune*, January, 1966, p. 22.

[26] Executive Office of the President, "Better Housing for the Future," *A Report to the Panel on Civilian Technology*, 1963, p. 5.

[27] Quoted in *Defense Industry Bulletin*, July, 1966, p. 13.

[28] Roy K. Davenport, *op. cit.*, p. 13.

How Big Businesses Work with Schools For Special Training

U.S. corporations sponsor many forms of adult education, usually for job-related reasons. Some of them run their own schools; others subsidize attendance at technical schools and colleges. An example of the latter is the Ford Motor Company, which this year is sending 40 of its engineering managers to a series of nine monthly weekend seminars at Michigan State University. Another example is the Sandia Corporation of Albuquerque, N.M., which supplied the following description of its technical development program at the request of KAPPAN *editors.*

SEVERAL years ago Sandia Laboratory, an AEC prime contractor in Albuquerque, was faced with hiring an increasingly large number of technically competent people to perform its major task—designing and developing components and systems for U.S. nuclear weapons.

It soon became clear that employment candidates possessing a high level of education in certain key technical areas were few and far between. As a result, Sandia's Technical Development Program (TDP), a two-year graduate study program for engineers, was set up to ensure that recent college graduates hired as members of the technical staff would acquire background knowledge in analytical methods and basic scientific concepts required to carry out the laboratory's unique mission.

Since 1960, enrollment in TDP has been a requirement for Sandia engineers hired immediately after receiving their B.S. degrees in either electrical or mechanical engineering. TDP combines half-time work on Sandia engineering projects with up to four semesters of graduate study at the University of New Mexico (Albuquerque). Schooling costs, including tuition, fees, and books, are paid by Sandia. Meanwhile, the engineer earns a full salary and receives full employment benefits.

Developed by a joint UNM-Sandia committee, the TDP curriculum differs from the average master's degree program in electrical or mechanical engineering in that: 1) it provides more physics and mathematics; 2) it provides cross-training courses so that electrical engineers have some contact with graduate-level mechanical engineering courses, and vice versa; and 3) it bridges the school-job transition with an engineering analysis course on solution of technical problems peculiar to Sandia's operations.

Participants complete up to 36 graduate credit hours, at the rate of nine credit hours per semester. The minimum requirement for graduation from TDP is satisfactory completion of all required courses with an overall "B" average. Program participants accumulate credits toward, and in most cases obtain, a master's degree in electrical or mechanical engineering.

During the school term, the afternoon of each work day is devoted to university work, while mornings are spent on work assignments at Sandia. Emphasis in these assignments is on learning, although the participant is expected to perform useful work of a professional nature. The assignments are selected to provide a representative picture of the technical activities of the Sandia Laboratory, and to allow the partcipant to become aware of the interrelation of his department with other organizations.

It is probably too early to make definite judgments about the TDP payoff to Sandia. However, in November, 1966, four years after the program produced its first graduates, 196 engineers with unusually strong backgrounds in physics, mathematics, and other courses uniquely suited to Sandia's engineering requirements were on the roll—as a direct result of TDP. This talent would not be available at Sandia without the program, since it is still difficult to hire people directly with backgrounds comparable to those which TDP provides.