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TECHNOLOGY IN EDUCATION

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ECONOMIC PROGRESS

OF THE

JOINT ECONOMIC COMMITTEE

CONGRESS OF THE UNITED STATES

EIGHTY-NINTH CONGRESS

SECOND SESSION

JUNE 6, 10, AND 13, 1966

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TECHNOLOGY IN EDUCATION

MONDAY, JUNE 6, 1966

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC PROGRESS OF THE
JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m., in room S–407, the Capitol, Hon. Wright Patman (chairman of the subcommittee) presiding.

Present: Representatives Patman, Reuss, Mrs. Griffiths, Widnall; and Senators Proxmire, Javits, and Jordan of Idaho.

Also present: James W. Knowles, executive director; John R. Stark, deputy director; Donald A. Webster, minority economist; and Hamilton D. Gewehr, administrative clerk.

Chairman PATMAN. The subcommittee will come to order.

The Joint Economic Committee has been a pioneer on the subject of automation. We have followed this subject with close interest from the time of the Employment Act, and this committee, I am proud to say, has predicted many of the great changes that were brought about by automation.

It was 10 years ago that this subcommittee heard Vannevar Bush, who warned that Russia was graduating engineers at a rate twice as fast as ours and technicians at 30 to 40 times as great a rate. The effort that they put into education has been paying off in space.

Since that time, we have been concentrating more and more on education in this country. We recognize that it is a major factor in the productivity and growth of our economy. Public education involves expenditures of over $40 billion a year and another $25 billion is spent by private sources. The Federal budget for 1967 includes a total of over $8 billion for education and training. It is interesting to note that there are at least 15 different agencies involved in it.

Yet, in spite of the expenditures now being made, we are all aware of the need for great improvement in the quality and quantity of education. It is one of the basic needs of our Nation.

Our subcommittee, as is evident from the name, is concerned with economic progress. We are interested in exploring here today a substantial new development that has very important implications for education and for corporate investment. We know that billions of dollars are being invested by many American companies in the field of educational technology. This development has tremendous implication for our school systems. We need to know a lot more about it in formulating public policy. We want to know more about the way in which our industrial know-how is being adapted to the requirements of education in this country.

We are fortunate to have with us today four outstanding business executives who are in the forefront of these new technological advances and developments. I know that we are going to learn much from them. They are:

Maurice B. Mitchell, chairman of the executive committee and president of the Encyclopedia Britannica, Inc.

Mr. Mitchell, I know your associate, Senator Benton, very well. He was a most able member of this committee. We realize that your company has been doing some extremely interesting work in using computer and teaching machines and other technical devices to improve our educational system.

Robert E. Slaughter, executive vice president, McGraw-Hill, Inc.

Mr. Slaughter, your company, which has been a leading publisher for many years, and producers of excellent textbooks, has been very active in introducing new techniques to improve teaching

Launor Carter, vice president of Systems Development Corp.

Mr. Carter, I know that your company has been very active in advanced electronics developments for the air defense, as well as important civilian needs. We are very much interested in your observations on what is going on in the adaptation of new techniques to education.

Our fourth guest today is Mr. Harold Haizlip. Mr. Haizlip is a prominent educator who has already had a distinguished teaching career. At present he is an official of Basic Systems, Inc., where he is in charge of long-range educational planning, and the design of both products and services in the educational field. He will be here soon and we are anxious to have the benefit of his knowledge and experience.

I will ask Mr. Slaughter to lead off, to be followed by Mr. Mitchell, Mr. Carter, and Mr. Haizlip when he comes in.

Gentlemen, you may proceed in your own way. We are very happy to have you with us.

STATEMENT OF ROBERT E. SLAUGHTER, EXECUTIVE VICE PRESIDENT, McGRAW-HILL, INC.

Mr. SLAUGHTER. Mr. Chairman and members of the subcommittee, my name is Robert E. Slaughter. I am an executive vice president of McGraw-Hill, Inc., with administrative responsibility for corporate planning, personnel, and public affairs.

This statement is addressed to the subject of "Educational Technology—Developments, Promise, and Probable Directions."

Educational technology is as old as education itself. From its inception, some means or techniques of instruction and learning have been used, and in a broad sense these have constituted educational technology.

Educational technology has grown steadily in America since early colonial times. In more recent times, it received considerable impetus in the 1920's and 1930's from the development of 16mm. films and projection equipment, the advent of radio communication, and the introduction of workbooks and other printed materials of instruction that supplemented textbooks.

It was not until after World War II, however, and more particularly in the 1950's and 1960's, that educational technology took a

leap forward. At the same time educational technology became a subject of national interest and concern, as well as a subject of vital interest and concern to professional educators. The sharp increase in the prominence of educational technology has stemmed from social, economic, and political forces, as well as from a number of significant developments in the technology itself.

The social, economic, and political forces affecting interest in educational technology, and concern for it and with it, have included sharp increases in enrollments, with heavy demands on the supply of teachers and facilities; growing urbanization of population; sputnik and the connection of education with national defense; the proliferation of knowledge; technological change; lack of jobs and structural unemployment; early school leaving and youth problems.

More recently, these social, economic, and political forces have included the civil rights movements; the war on poverty; a new premium on individual excellence; and the aspiration and push for the Great Society. All of these forces, and others, have led to a new and pressing urgency of education, in school and out, and to the demand for expanded and more effective use of technology as a means of helping to meet this new and pressing urgency of education.

Coincident with the influence of these social, economic, and political forces on the urgency of education and the demand for expanded and more effective use of educational technology, there have been many significant developments in the technology itself—too many, in fact, to detail in this statement. There are some developments, however, that are so extraordinary in their potential contribution to education that they must be highlighted in any consideration of significant developments in educational technology. These include:

1. Open- and closed-circuit educational television;
2. Video tape recordings and equipment;
3. Computerized instruction and student testing, evaluation, and guidance systems;
4. Information storage, retrieval, and distribution systems;
5. Programed instruction;
6. Teaching machines;
7. Microfilm, and microfilm viewing equipment;
8. 8mm films, and printing and projection equipment;
9. Language laboratories; and
10. The systems approach to the development and utilization of educational technology.

The foregoing developments appear to offer extraordinary potential contributions to education. They must not obscure, however, the actual and the potential contributions of significant and established components of educational technology such as textbooks, workbooks, study guides, tests, paperbacks, monographs, encyclopedias, reference books, 16mm films, filmstrips, slides, transparencies, disks, magnetic tapes, and so on.

Along with the new urgency of education, the demand for expanded and more effective use of educational technology, and established and new and extraordinary developments in educational technology, there are two additional developments that bear significantly on the future of educational technology.

First, the Congress has passed a spate of education legislation that includes assistance for the purchase and use of educational technology,

and for educational research and development, much of which involves and will involve educational technology.

Second, the private sector interested in educational technology is expanding and is aggressively pursuing new developments in educational technology. This enterprise includes collaboration or working agreements among firms with complementary technology capabilities, as well as actual mergers of such firms and the formation of joint subsidiary corporations.

With all of the foregoing developments and conditions, it would seem that educational technology is poised for some real breakthroughs in its development and in its contribution to education. It promises:

1. To improve the quality of education;
2. To extend the quantity of education;
3. To obtain more flexibility in education organization and process;
4. To serve the high goal of equality of educational opportunity;
5. To help effectively each student to achieve for himself the full realization of his talent and capacity for education;
6. To relieve professional teaching personnel of teaching functions that can be performed by technology so that they can devote their time and talent to teaching responsibilities that require personal attention;
7. To assist students in engaging in independent study;
8. To deliver instruction where it is wanted, when it is wanted;
9. To extend and provide effective opportunities for continuing education for adults and out-of-school youth; and
10. To make possible, from the standpoints of personnel, facilities, costs, and convenience, the magnitude, the diversity, and the quality of education that will be demanded and required by a society that is fast becoming a continuous learning society and that is expanding educational opportunities and services downward, upward, and throughout the age range of our population.

In considerable truth educational technology is now fulfilling the foregoing promises of contribution to education. Yet, the potential additional contribution is enormous. The realization of that potential will depend upon several factors.

It will depend upon the soundness and explicitness of the purposes of education and the objectives of instruction. If these are ill-conceived and vague and fuzzy the criterion for the development and performance of educational technology will be weak.

The realization of the potential contribution of technology to education will depend upon the relevance of the particular technology to the fulfillment of the needs and purposes of education and the given objectives of instruction and learning. Devices and gadgets and materials that have no real relevance to achievement of the purposes of education and the objectives of instruction and leaning will soon be found out and will have no place in the educational technology of the future.

The realization of the potential contribution of technology to education will depend upon the perspective and successful development of systems of technology, in which each component in nature and function as a part of the system makes a synergistic contribution to the total result obtained by the system.

The realization of the potential contribution of technology to education will depend on the quality and amount of research and development effort that are put behind the development of learning theory; methodology; curriculum objectives, content, and organization; school organization, grouping, class scheduling, independent study; and the role of the teacher in the education process. It will depend upon the research and development effort put behind the planning and production of systems of technology.

It will depend upon the acceptance by teachers, and other professional personnel, of the technology and their qualifications to use the technology.

The realization of the potential contribution of technology to education will depend upon the participation and the cooperation of the institutions of education, Government, and private business and industry in pertinent research and development, in planning and producing systems of technology, and in obtaining their effective use in education.

Private business and industry is stepping up its interest and activity in the development of educational technology. Textbook publishing houses are diversifying their product lines. Today, they are in a real sense educational publishing houses, producing and marketing, in addition to textbooks and a wide variety of satellite and supporting printed materials, films, filmstrips, tapes, disks, transparencies, and other audiovisual materials. They are producing materials using the techniques and format of programed instruction, with the materials made available in independent printed form and, in some cases, for use with teaching machines. They collaborate with other agencies, including educational institutions, professional organizations, and broadcasting interests in educational television. They are integrating "software" materials with "hardware" equipment in order to provide an effective combination of technology. Rarely is the equipment of any use without suitable and adequate "software"; in fact, it is useful only when it is a piece of equipment that is designed for use independently of software, and this type of equipment is limited and will continue to be limited. The input or the "software" is a critically important factor in educational technology.

It is in part because of the interdependence of "software" materials and "hardware" equipment that a number of mergers of electronics companies and publishers have occurred, and other types of joint working arrangements have been put together. These mergers, joint subsidiaries, and other joint working arrangements appear to be, at this stage, largely research and developmental efforts at innovations in educational technology.

Of course, the need and the market for educational technology are growing rapidly, and funds for the purchase and use of educational technology are becoming more plentiful. This combination of circumstances is attractive to new sources of enterprise in the private sector in the educational technology field. It is also attractive to established sources of enterprise in the private sector, such as educational publishing houses and producers of audiovisual materials and equipment who have been responsible for many significant innovations in educational technology over the years, and will be responsible for many more in the future.

Substantial sums of capital investment will be required for research and development and the planning and production of new systems of educational technology. In addition, the producers and suppliers of educational technology must look forward to increased marketing, distribution, and service costs, not because the sale of educational technology will be more difficult, but because of the need to assist teachers and other professional educational personnel in becoming knowledgeable about newer types and systems of educational technology, and to supply continuing consulting assistance of professional quality to users of the technology. It is because of the substantial capital investment that will be required, among other reasons, that suitable and adequate copyright protection of the materials and media of instruction that are researched, developed, and produced must be provided.

Educational technology is not just destined to grow in the future. It seems likely to grow in certain directions. One unmistakable direction will be the development of educational technology on a systems basis, with close and direct relevance to the purposes of education and objectives of instructions and with a maximum contribution being made by each component of the technology to the end result obtained with the system. The system will include a carefully designed blueprint of recommendations and instructions for use of the system, and the claims made for the system will be supported by research and experimental results. As an example, McGraw-Hill Publishing Co. has published a system of programed reading materials prepared by M. W. Sullivan & Associates. These have been used experimentally with thousands of pupils, and the results, based on widely used testing and performance criteria, are available for the consideration of anyone interested in these materials, which use a new and significant development in educational technology, namely programed instruction.

As another direction in the future growth of educational technology, the use of computers in instruction and manipulation, retrieval, and distribution of information is destined to grow and to make a highly significant contribution to educational technology and the education process. The use of computers promises to have a profound effect on the time and place of delivery of instruction; on the organization, and scheduling of instruction; on independent study; on virtually the gamut of the instruction process, including testing, evaluation, guidance and the prescription and sequencing of learning.

Television, video tapes, and recording equipment, telephone line and satellite transmission, and other significant developments in the communication of sound, pictures, and data also promise to have a profound effect on educational technology and the education process. There is also the promise of significant development in the combination for educational purposes of computer technology with television, telephone line, and other means of voice, picture, and data transmission.

Another direction of educational technology in the future is the anticipated extended use of educational technology in education and training in private business and industry and in the home. Private business and industry now spend billions of dollars annually on education, training, and development of employees.

In all echelons of employment the need for in-service education and training will accelerate in the years ahead as knowledge proliferates; technology advances; job knowledge and job skills change; structural gaps in job requirements and job qualifications occur; and higher premiums are placed on excellence of job performance.

In addition, the need for education and training of employees in service-type businesses in handling of product lines of manufacturers, which are growing and will continue to grow in profusion for reasons of product innovation and competition, will accentuate sharply in the years ahead. Further, people engaged in the professions will be hard put to keep abreast of new theories and techniques and new products and services related to their work.

As our society becomes more and more of a continuous learning society, the demand for education and training in the home will accentuate. Newer developments in educational technology will find their way into homes in response to this demand and as a generator of the demand. These developments will range from flexible video tape materials, recorders and "black box" devices to computerized information systems and services.

As a part of the extension of educational technology into special and continuing education; into training and development in business and industry, and the professions; and into the home, there will be developed some novel schemes of materials and equipment packaging, merchandising plans, marketing procedures, and distribution channels.

In summary, educational technology is as old as education itself. It has grown steadily in America since early colonial times. In recent years, with the coincident development of a new and pressing urgency of education and significant developments in the technology, educational technology has taken a leap forward and has become a subject of national interest and concern; a subject of vital interest to professional educators; and an attractive field of business enterprise for the private sector.

Educational technology seems to be poised for some real breakthroughs in further development and in more extended use in education. The "pay dirt" from these breakthroughs will come in the increase in the capacity of our education system and other resources to educate the population of the Nation on a continuous basis at quality and quantity levels that meet the requirements of a dynamic, growing society. It is unlikely that educational technology will reduce total dollar expenditures for education, but in consideration of the quality, quantity, diversity, and continuity of results to be obtained, educational technology can obtain them less expensively than they can be obtained through any other means.

In closing I wish to thank the Joint Economic Committee for the privilege of appearing before the Subcommittee on Economic Progress as a representative of industry active in the field of educational technology.

Chairman PATMAN. Thank you very much, Mr. Slaughter.

Senator Javits?

Senator JAVITS. Thank you very much, Mr. Chairman.

Gentlemen, I am deeply interested in having your testimony here today. I will have two representatives of my office here to observe it.

I must apologize for not sitting through the hearings myself, but I have other committee engagements this morning which have high priority which I must keep.

I am grateful to you, Mr. Chairman, for having these hearings.

I would just like to make one or two observations, which may be helpful in this testimony.

I am in a unique position, Mr. Chairman—since I am also the ranking member on Senate Labor and Public Welfare which ties into all the aids to education—elementary, secondary, and higher education. I might call to your attention the fact that the Federal Government is now spending about 10 percent of everything spent on education at these levels in the United States—State and local—amounting to $30 billion a year, and the Federal Government now is putting up $2.8 billion in fiscal year 1967. That has been reflected in the very extraordinary way in the matter of audiovisual supplies and equipment, and the like. That has had a 57-percent increase between 1964–65 and 1965–66, from $119 million spent in the public schools to $187 million in round figures, and today it just about doubles what it was in 1962–63, as an indication of the fact that the Federal Government's help has been very heavily an encouragement to this kind of progress.

My basic point, Mr. Chairman, is one that this is growing and that it should grow more. I thoroughly agree with Mr. Slaughter, and I assume that the other gentlemen will say the same thing, or much along these lines, but I would like to point out that we have this problem: We have not yet adequately tied in the profitmaking industry, and I believe that we should. I believe the profitmaking industry is capable of public service.

I have an example of that, Mr. Chairman. The Radio Corp. of America, which comes from my own community—and we always know our own community best—has assigned 15 of its top engineers and scientists to deliver weekly lectures at our high schools in Brooklyn, which is a part of New York City, on nuclear physics, jet propulsion, and space technology; and 8 other companies have now pooled their resources with the Radio Corp. of America to make the program a regular part of the program of studies of contemporary science in the New York City high schools. And George Champion, chairman of Chase-Manhattan Bank, has recently urged that this process be accelerated and that business, as he says, should compete with Government by setting up, and I quote his words, "beachheads of excellence." I would, therefore, utter the expectation, Mr. Chairman, that American business in all of the local communities, not just New York City where it has had a little beginning, really, considering the consequence and the diversity of industry in New York which is relatively small, should think in terms of cooperating as a public service in the public high schools and institutions of higher education to add measurably and on a much more accelerated rate than the Government could ever obtain the personnel services, which have not increased as materially as the mechanical aids in order to make, what you say, Mr. Slaughter, meaningful—that is, it is the softwear—to be equal in quantity and quality to the hardware upon which great progress has been made, because you gentlemen have an interest in selling it.

I do not mind if the services are coupled with an interested sale—that is a legitimate American incentive, but the fact that the services will be rendered by an enormous pool of technology which is available to American business, which can be of immeasureable help in accelerating this process. And, as we all in the Joint Economic Committee know, that within 10 years we must double the professionally and technically trained force in American business, so that it will be twice what it is today, and it is absolutely essential that it be started. I believe in automation, but I believe in compensating labor for the automation. I hope that labor will not stand in its way, because we will compensate for it, in my judgment, as we should, to the limit of our resources.

Chairman PATMAN. Thank you very much for your very interesting and helpful statement. We appreciate your statement very much.

We will ask the witnesses to confine their statements to about 15 minutes each, so that we can give the members of the subcommittee plenty of time to ask questions, and in the event that every point is not brought out that you desire be brought out, you can extend your remarks in the record to include those points, or bring it up before the end of the session and discuss it.

Mr. Mitchell, will you proceed, please?

STATEMENT OF MAURICE B. MITCHELL, PRESIDENT, ENCYCLOPEDIA BRITANNICA, INC.

Mr. MITCHELL. Mr. Chairman and members of the subcommittee, I appreciate your earlier comments about Senator Benton, who is also in Washington this morning, having returned from his assignment to the United Nations as the Ambassador there to UNESCO, and is testifying before another committee in behalf of the approval by this country of the Florence Agreement. I am happy also to have the benefit of Mr. Javits' comments which are very pertinent, indeed, to the subject here, and to follow Mr. Slaughter, who has provided a broad background for this whole subject.

And I note with some interest that Mr. Slaughter has done something for me, which I forgot to do for myself in my own statement—he has referred to the existence of encyclopedias which I find, on hasty examination, I ignored completely in my statement.

Let me say that I am Maurice B. Mitchell, the president of Encyclopedia Britannica, Inc., and I am here in this capacity. I am here also as a private citizen who has had the opportunity before to address committees of Congress in behalf of educational progress, and I take great satisfaction from that opportunity. I am here as the father of three children who are in school, one a student of law; one, a 13-year-old student in the seventh grade, and one, a 10-year-old student in the fifth grade.

I am here also as a former school board member in my community, and a member of the Illinois State Junior College Board which is now engaged in the development of the master plan for education that has been approved by the Illinois State Legislature and is now being put into effect. My fellow citizens in Illinois hope that over the next few years, a grid of commuter institutions of higher learning can be superimposed across the face of that great Midwestern State. Thus,

I take the matter of education not simply as a vital social and economic activity, but as a highly personal one. I cannot be quite as sanguine about the future prospects for certain technological development painted by Mr. Slaughter, because I suspect that we are going to have to take a very much more aggressive view in this whole field of the development of educational technology in the classroom if we are to produce the changes that seem so desirable and necessary. I will comment also on some portions of Mr. Slaughter's statement.

Let us assume that by some highly selective catastrophe, all the schools and universities in this country were destroyed last night. Our task now is to build a new system.

Would we recreate the present educational system? Would we use the present assortment of architectural, administrative, curriculum and teacher-training assumptions? Would we install the same instructional materials and teaching practices?

This assumption and the questions it raises get to the heart of the problem that is so troubling to thoughtful citizens today. It is useful because it sweeps aside those who are reactionary and romantic about education and overleaps the vested interests, the short-term opportunists, and the apologists. It exposes questions that must be answered if we are ever to open our educational system, as we have almost every other vital area of our society, to the great opportunities of the present half-century and the unlimited vistas of the future.

The American economy was built around the railroads in the last half of the 19th century, around the automobile in the first two-thirds of this century, and it will be built around education in the balance of the century.

Thus this discussion of the modernization of our educational system is long overdue. We are, as the chairman has noted, presently spending over $40 billion a year on its maintenance and development; the totals continue to rise sharply and will do so for many years. The intense interest shown in education by the American public is reflected not only in its willingness to pay the bill; it is evident in the relatively new interest in every aspect of the matter shown by the press, by industry, by citizens' groups, and by the Congress. It is now proper to say that education of the right kind is the national purpose of this country. It is on the way to becoming a global objective.

As to whether we would rebuild our schools and universities in their present image, the answer is clearly "No." Education is said to be the mirror of a society. Our schools do not reflect ours. Where the blame for this lies is not pertinent at this time; our objective now must be to get from our schools what we need to survive and prosper—in freedom and dignity and happiness—in the present and future worlds.

To achieve this we are going to have to do these things:

1. We must now initiate studies leading toward a far better understanding than we now possess of the function and future structure of our school systems. We must try to establish objectives, subject to adjustment as time passes, that will enable us to relate present actions with ultimate goals. We do not have such a program at the present time. Industry would describe this as a research and development program on an extensive and continuing basis.

2. We must develop methods that will make it possible for our educational systems to adopt and benefit from innovation and discovery—in all related fields, including the fields of technology and communications—as quickly and as easily as our industrial and commercial sectors. We have this curious anomaly in our present world of innovation and invention—industry and commerce depend on these forces and thrive on them: our educational systems receive them with unbelievable slowness and frequent hostility.

It is in this latter area—innovation, including the evident opportunities offered by our burgeoning technology—that there is a deep discontent with the educational sector. Why is it that industry and commerce welcome and support modernization, innovation, and the new opportunities they clearly present while our system of education so often seems to avoid them and at best, explores them with agonizing slowness? If the people themselves are so clearly responsive for example, to modern communications and devices—films, television, tape recordings, and even computers—why aren't the schools?

At this point it may be useful to take inventory of the innovational area in education, with emphasis on technological opportunities. What is really available and what problems and opportunities do these developments pose?

Communications.—This century has been a period of immense improvement in our communications systems. We have developed motion pictures, recording techniques of all kinds, wired and wireless communications systems of great sophistication, television, and a variety of related tools and techniques. We can take pictures with personal cameras that develop themselves in 10 seconds; we can bounce signals off outer-space satellites to reach around the world with instant TV; we can even tape-record television programs and other moving pictures in our own homes.

The general public uses these instruments with great frequency. They have changed our lives and our expectations. Everyone takes pictures or is photographed. Nobody thinks of the telephone—even direct dialing across the Nation—as a luxury. Records, tapes, hi-fi are commonplace in our homes. The addiction to radio and TV listening and viewing is an old story. All these influence the way we live and what we know. They inform or misinform, educate, sophisticate, and motivate all of us.

All of today's technological advances in communications are available to the educational system. How are they used in our schools?

Motion pictures.—The first sound motion picture for classroom use were developed in 1929. That was 37 years ago. In the intervening years, the medium has developed greatly—there are now vast numbers of films covering everything from the most intricate and dangerous scientific experiments to the living habits of all the world's peoples. The resource is almost limitless in its ability to broaden the horizons of teachers and students. Yet, despite the recent gains by virtue of increased availability of funds, films are rarely used to anything approaching full potential. Only a fraction of the Nation's students and teachers have access to them under proper conditions. The real job of integrating them into the instructional system has hardly begun—at the present rate one must assume another 40 years may pass before this occurs.

Television.—This medium stands today as perhaps the most expensive and disastrous single failure in the history of educational technology. It takes no vivid imagination to realize its unlimited potential as a teaching tool. In addition to its obvious applications in the classroom, it appears to have major implications for the educational needs of those who are beyond school age or have left school.

Millions have been poured into educational television—by the Government, by the foundations, by business and industry, and by the people as individuals. Yet it is today a deeply disappointing, puny, unimpressive, and minor instrument in terms of its real potential in bringing the advantages of modern communications technology to the educational process.

Where films have at least shown steady, if slow, growth, it appears to many that educational TV is on the way to ultimately joining educational radio as a miniscule factor in the classroom. Despite some early successes with both media, they are not likely to assume their proper image under present conditions. In this single area, an unbiased and forthright examination of what has happened and what has not happened seems to be urgently needed. Studies of this kind are now in progress, but unless they can fit radio and television into a framework of long-term visualization of a functionally integrated educational system, they will be of little value. We do not need any further exhortation in behalf of educational TV and radio; just a program that will work. In the meantime, this must be considered to be another potential benefit from modern communications technology that has not been fully utilized.

Textbooks and printed materials.—The misleading term "softwear" has been coined for these basic teaching and learning materials by the flood of industrial firms recently arrived in "the knowledge industry." Yet—and this is an important reservation in any estimate of technological resources in education—the so-called "hardware" rarely has teaching or learning value in itself and serves only to make the presentation of actual content (the task of the "software") easier to achieve. There is now a growing technology that will change the conditions under which books are printed and used.

Ever since man invented movable type and the printing press—as far back as the 15th century—everything of importance and value has been associated with the printed word. Our books are the depository of all that man has learned and all that he has had to say since that day when Gutenberg printed his historic Bible. The advantages of the book do not need reporting: it is a tool for individual study as well as group learning—inexpensive, flexible, adaptable, and versatile. There have never been enough books available to the Nation's pupils in school, and great segments of our population live in conditions of chronic shortages of library facilities. Only recently has there been an increase in school libraries themselves, and the present situation is grossly inadequate.

Although some will consider printed materials to predate the modern era of technological development, it can also be argued that few other products of this period of innovation can be used effectively until and unless we have maximum availability of textbooks. Again, despite recent gains stimulated by Federal funds, this fundamental teaching tool is in inadequate supply.

Meanwhile, impact of modern technology is broadening to include many aspects of the creation of textbooks and other printed materials. It is not unreasonable to assume that encouraging innovation in this field may produce the most rapid and significant gains. Certainly any hypothetical rebuilding of the Nation's school system would proceed on the assumption that printed materials in some form available on a scale far larger than in the past, would be a cornerstone.

The textbook and associated printed materials have been affected by the knowledge explosion. The new technology in this field is designed to overcome the problem of quicker obsolescence, of the tendency of facts to change more rapidly than conventional revision cycles have permitted in the past. Where rapid obsolescence is a factor, less expensive, easily disposable books are essential. Large areas of today's curriculum are concerned with subject matter not found in traditional textbooks—world affairs is a good example—and methods for adopting and using nontext publications, rapidly produced, delivered, and abandoned for newer materials, are being developed.

In a visually oriented world, new approaches to illustration are essential and much has been done to create new methods to deal with this aspect of books.

Many developments in printing technology tend toward the computerization of typesetting, the use of incredibly high-speed photographic methods to speed composition and layout, the automation of some printing processes formerly done by slower means, and major improvements in methods of illustration and printing.

The electronic dissemination of text materials is now a reality. Retrieval of a single page of text from a remote library source, using existing resources such as television transmission lines and receivers, is quite possible. Delivery of printed materials to home or classroom by these means was demonstrated long ago. The use of satellites to extend the range of such transmission is in the advanced planning stage.

All of this suggests a rate of improvement that can hold great promise for solving school problems if effective means are developed to take maximum advantage of what is being done.

Other technological aids.—Newly developed instruments of communication with major educational implications are arriving in large numbers. Overhead and other special purpose projectors, devices for tape recording and playback, instruments that can read aloud in association with printed presentations—these and many others await a status beyond the airy gimmickry with which they are often dismissed. Again some master plan approach to evaluating such products of modern research and development and getting them put to use must be launched if we want them in our teaching systems.

Programed Learning, Computers, Systems

In the past decade, based on research originating over 30 years ago, great strides have been made in new techniques of self-instruction. Most of these fall under the heading of "programed learning" and because in some instances apparatus was used to control the method of presentation, they were identified as teaching machines.

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There is little question but that in this one area of newly developed instructional materials and techniques we have come upon a development of major importance throughout the entire reach of our educational process, in schools and universities, in industry, in specialized locations and situations (job retraining, culturally deprived, etc.) and in the home.

Programed instruction permits education in terms of the abilities and pace of the individual student. He becomes a personally involved learner instead of an overt spectator. The gifted learn quickly and move on, while the slower learners are still permitted to finish without unproductive and often harmful competition.

Most programed learning can be presented effectively and inexpensively in conventional formats—printed books of various kinds. Some textbooks combine conventional presentation with programed sections. The use of hardware is sometimes desirable, and much work is being done today to improve programing techniques and presentation equipment.

Programed learning strikes hard at the very heart of some well-established educational traditions. It suggests that group or lock-step learning in the conventional classroom is often unnecessary and sometimes undesirable. It makes possible the measurement of learning by achievement instead of on the basis of time—a year of algebra versus algebra until you've learned it (often in 12 weeks)—and thus upsets many administrative and other traditions in our schools. Yet these and other conventions must now be reexamined, and often abandoned, if this and other such developments are to play their part in a modern and effective educational system. Only a fraction of today's students and teachers have ever seen a programed learning unit.

Computers.—The computer is an instrument not yet fully measured in terms of its ability to improve and update our systems of teaching and learning. It is clear that it can be used to deal directly with students, in school, at their desks, under conditions that may be a great improvement over present methods in many subject areas and learning situations. It is an obvious aid to administrative efficiency in the operation of educational institutions. It has seemingly unlimited application in information storage and retrieval, in libraries and even in home devices. In this latter field one can easily imagine a home information center, as common in future homes as today's TV and telephone, able to bring a wide array of teaching and information services into our living rooms.

No serious effort has yet been made to incorporate the computer into basic planning for future (and present) schoolhouses. It is the subject of much talk and little action. In recent months, the computer industry has announced its intention to enter the knowledge industry, and although this would seem at first glance to be a forward step, the reverse may well be true. The history of this frontal attack on the classroom by hardware entrepreneurs has often been a sad one, and the evidence litters the attics of schoolhouses across the country, in the form of gadgets that looked good but failed because machinery itself is not a substitute for true teaching ability, because content and not presentation apparatus is essential to learning, and because no machine is worth anything in a classroom unless teachers

and students have proper and continuous training in its use. Without this kind of thoughtful and responsible planning—which should include a long-term assurance that they will not quit the field if it does not produce the kind of quick high-profit so dear to stockholders—the hardware contingent now clamoring at the gates can do immeasurable damage to the potential for technological advancement in our schools.

Some educators have a favorite line: "Tried it—didn't work." This is the certain fate of shallow penetration by the technologists into education. It is at least one reason for the failure of educational TV. But a properly developed penetration can be of great value, and should be encouraged.

Systems.—One great opportunity for our schools lies relatively untouched—the development of systems for teaching and learning based on our newer knowledge and technical resources. Thus each entry into the knowledge business tends to be a specialized one. The movie projector people make machines. Others make films. The textbook publishers tend to ignore the existence and possible use of films and assume that their books and the teacher are the beginning and the end of learning. The tape recorder people live—and produce and sell equipment and materials—in their own closed world. The educational TV people assume that nothing has ever been produced of value to the classroom until they create it for their own cameras.

This produces waste and duplication, and, even worse, a learning system far below today's potential. It is axiomatic elsewhere in our world that systems, the integration of various useful components in a manner that allocates to each its most seemly and effective task, produce a result far better than the arithmetic total of the parts. Little or none of this is presently taking place in education today (some of us are now moving in this direction, but on a limited basis and with no assurance that we will be well received) and not much is going to happen until and unless some force not now in existence steps in to do the job of planning and integration that the whole educational enterprise needs so badly.

I have not gone more deeply into many aspects of the technology available to our educational system because my colleagues on this panel are certainly equipped to discuss their own fields in greater detail. I would hope that they would agree that we would indeed build today's educational system in a far different mold, from top to bottom, than the one we are presently struggling to adapt.

There can be little disagreement about our present situation with regard to the use of available modern technology (and the encouragement of further technological and technique investigations). Here is how it seems to stand today:

1. We have no present workable process by which developments in the technology and/or technique of teaching and learning can be expedited from the design stage to the classroom on a large scale.

2. No workable system now exists which automatically converts developments in related fields into instruments for improved educational practice.

3. No means yet exist for the large-scale modernization of our educational system; assuming a willingness on the part of the educa-

tional establishment, there just isn't the recognition today that it really needs anything but a lot more of the same.

4. Little is being done to deal with a large and growing assortment of problems; technical, philosophical, administrative, which grow out of some presently planned improvements in education.

5. No serious evidence of progress exists in the critical area of broadening the base of the educational system to meet the needs of that part of the population beyond the ordinary age for schooling. Little is being done here to use newly available techniques and instruments.

6. No nongovernmental institution or organization now exists that is providing respected leadership in long-range educational planning. Our progress into the future is haphazard and uncharted, with the waste, duplication, and lack of effectiveness that is characteristic of such groping.

It is heartening to see the Joint Economic Committee of the Congress expand its concern into the field of potential improvement in and modernization of education through the acceptance of new developments in related fields. It is clear that progress in education cannot be assigned only to educators and educational institutions, associations, or committees. They need the broader perspective, the support, and often the prodding of the rest of the community.

It was the advent of sputnik that catapulted the Federal Government into the effort to get our schools rolling ahead after a decade of distress and inadequacy. The great ground swell of popular demand that followed provided support for President Johnson's programs to provide further means and encouragement in many areas of great need. It seems entirely reasonable that this committee, concerned with the opportunities for education to gain from the very technology that has made us a leading nation in the world brainpower struggle, should now address itself to the encouragement of planning that will make this possible.

Victor Hugo once said: "Nothing is more powerful than an idea whose time has come." It is a good description for the idea that we should now take steps to examine the reasons for our failure to move the benefits of our great research and development facilities into the classrooms and libraries of our great schools and universities.

Mr. Slaughter, of course, referred to textbooks and printed materials. I would only add that there is a great technological development taking place in that field. We are now learning how to vastly expedite the process by which books can be rapidly revised and reissued.

We are developing low-cost, highly flexible kinds of published materials. These are critical breakthroughs at a time when knowledge has a shorter life, when the half-life of an engineering degree, for example, may be 10 years (which means that an engineering degree, in terms of the validity of the facts that were learned in earning it, may be worth 50 percent of its original value 10 years after graduation). The problems of publishing textbooks include those of keeping current with the flood of new knowledge that continues pumping into our informational system. In some of the publishing areas there are already being used high-speed technologies—we are, for example, learning to spray type on acetate plates as one sprays paints with an air gun. We are developing high-speed printing processes with

a capacity far beyond anything we have had before. We are learning to do kinds of illustration work that are vastly superior to past standards.

There are many other developing technological aids, but they will remain in the so-called gimmick stage, until some comprehensive planning makes it possible to consider the process that will move them from the field of development and use outside of education, which now characterizes their place, into the school field itself.

What I have said in a general sense—and I have elaborated further in my statement on this—is that we have what appears to be an inadequate theory in the educational sector with respect to innovation. Innovation moves quickly and effectively in most other fields. It is axiomatic in business that the day you install a new high-speed automated device, you start spending money in research and development to obsolete it, because you know that your competitors will match it, and you also know that the modernization of your manufacturing facilities is critical to your success.

It is axiomatic in farming that if somewhere in a laboratory someone develops a better seed strain, produces a kind of wheat that will weather the winter better, or a kind of corn that eliminates current problems with the growth of corn, that seed concept moves right out of the research laboratory, through a testing stage, and right into the ground, and we eat that corn a short time after it has been developed.

We have no such theory; we have no comprehensive planning method; we have no set of procedures that similarly transport the products of American technological development in the whole broad field of communications—including all of those that Mr. Slaughter made reference to—into our school system. I submit that if we are going to modernize the school system, if we are going to give our students the benefit of 20th century instruments for a 20th century education, we are going to have to do the kind of research and development and planning that makes this possible.

Thank you, Mr. Chairman.

Chairman PATMAN. Thank you, sir.

Mr. Carter, you may proceed.

STATEMENT OF LAUNOR F. CARTER, SENIOR VICE PRESIDENT, SYSTEM DEVELOPMENT CORP.

Mr. CARTER. Mr. Chairman and members of the subcommittee, I am Launor Carter, a senior vice president of the System Development Corp. of Santa Monica, Calif. SDC is an independent nonprofit corporation that specializes in the application of information technology to projects that serve public purposes.

SDC's technical activities include the design and development of computer-based information management systems, the design and conduct of training programs, and the application of such techniques as system analysis and simulation. The corporation's clients include the Department of Defense, the Air Force, Army, Navy, and more than 40 civilian agencies of the Federal Government, State and local governments, and other not-for-profit public-serving organizations.

Our interest in the applications of technology to education dates from 1958, the company's first full year of operations. At that time,

I was manager of the department concerned with the development and application of system training techniques for the Air Force's manual and SAGE computer-based air defense systems. I subsequently became manager of SDC's research and technology division where our early work in exploring the applications of technology to education was initiated as a logical extension of the work we were already doing in training. It may also be of interest that while on leave of absence from SDC, I was Air Force Chief Scientist (from July 1962 through June 1963) and continued to serve as a member of the Air Force Scientific Advisory Board. Last year I headed the SDC study group that examined the national document handling systems for the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology. The application of information processing technology to libraries will have important implications for school libraries, but time does not permit considering this problem.

We particularly welcome the committee's examination of technology's potential in education. We believe it is vital that those concerned with charting our country's future be fully aware of the revolutionizing effect the new technologies may have on many areas of our society, and perhaps no area is of more critical importance in our national life than education.

RECENT DEVELOPMENTS IN THE APPLICATION OF TECHNOLOGY

A number of developments in recent years indicate the range of interests involved in the application of technology to education.

Industry is becoming involved in ways that extend beyond the manufacture and sale of equipment. Among examples of this involvement is IBM's acquisition of Science Research Associates late in 1963. SRA develops and publishes psychological tests and new types of educational materials in basic subjects for elementary and high schools. Since becoming an IBM subsidiary, it has been developing course materials for use with an IBM computer system. Xerox established an educational subsidiary called Basic Systems, Inc., in May 1965 and more of this development will be presented by Mr. Haislip. Also in 1966, Time, Inc., and the General Electric Corp. collaborated in the formation of the General Learning Corp. The new firm will create and market educational materials, systems and services in the United States and abroad. These few examples are mentioned only to indicate the degree of involvement of some of the country's largest industrial organizations.

The Department of Defense has been in the forefront of many of the technical advances made during and since World War II and at present is accelerating its exploration of the applications of the new technology to the vast educational and training programs of the military services. As I mentioned earlier, SDC's own involvement in the education field stems from its work in developing the system training program for the Air Force manual and SAGE computer-based air defense system.

STP, incidentally, is itself a good example of complex technology being developed and applied to a problem in training. Our initial experiments with laboratory crews in a replica of an air defense radar

site enabled us to develop new methods for training crews to achieve remarkable levels of performance under stress. We were able to extend these training methods first to real Air Force crews in individual radar sites, then to the multiple sites of an air defense division, and ultimately to the entire network of the North American air defense system. Special equipment was devised—in fact, a whole computer-based system was developed for producing the materials—manuals, scripts, programed magnetic tapes, special films, and an assortment of novel training aids—for the so-called package air raids that are the integrated training materials for this program.

State governments are also increasingly active in the application of technology to education. For instance, statewide educational data processing networks are being established in New York, California, and Iowa. In New York, plans are being considered for the establishment of the first regional data processing center in Rockland County, a project, incidentally, on which SDC has worked. SDC was also involved in the development of California's overall master plan for the establishment of a network of regional data processing centers throughout the State to service local schools. Assisted by a recent grant from the Ford Foundation to the State university, the Iowa educational data system will gather comprehensive, continuous information on school operations and pupil performance for the entire State.

Another significant development is the formation of the Inter-university Communications Council (EDUCOM) which was announced in mid-1965. A nonprofit corporation made possible by a $750,000, 5-year planning grant from the Kellogg Foundation, EDUCOM began as an association of eight institutions—Duke University, the State University of New York and the Universities of California, Illinois, Michigan, Pittsburgh, Rochester, and Virginia. There are now 37 members with about 100 separate campuses to be linked in a communication network for the purpose of sharing new techniques. Every accredited college and university in the United States is being invited to join.

EDUCOM is concerning itself with all information-processing activities, including, computerized programed instruction, library automation, educational television and radio, and the use of computers in university administration. A primary function is to disseminate reports on the state of these techniques and to establish task forces in areas of critical development. It is contemplated that actual computer based communication networks will be established. Task forces are already at work on the feasibility of nationwide networks for transmission of educational data, the formulation of educational methods and on the problems posed by copyrights and patents.

The development of new technology for education—new methods for presenting information and for instruction—was stimulated by the training problems encountered during and in the years immediately following World War II. Microfilm came into use for easier storage and access to educational materials. Films and associated audiovisual aids were developed and used successfully. With significant support from the Ford Foundation, educational television networks were introduced. Language laboratories were developed as a result of the problems of teaching foreign languages during the war. The most recent application of technology to education is the

use of computers. Because SDC was one of the early pioneers of this application, and since I am most familiar with it, I think I can best describe this development by reviewing some of our own work in this field. However, it may appear that I am slighting the important contributions being made by many other industrial organizations and university research centers. It should be emphasized that there is a large community of technically oriented researchers contributing to this field.

SDC'S CONTRIBUTION TO COMPUTER-BASED EDUCATIONAL TECHNOLOGY

SDC has been investing a major portion of its fee income in a research program since 1958 when our first self-sponsored projects were begun. One was concerned with the use of computers in medicine and the second with their use in education.

In addition to our own funds, we have been assisted by support from many sources, particularly the U.S. Office of Education, the National Science Foundation, the Air Force, the Office of Naval Research, and the Advanced Research Projects Agency.

SDC's earliest work in education was an attempt to transfer the skills and technology we had developed in the training of military personnel to the purposes of public education.

One of our first efforts dealt with computer-based individualized instruction. We used a Bendix G–15 computer—the first of our teaching machines—which we tied into a slide projector and an electric typewriter. The student sat in front of the typewriter and typed his answers to multiple choice questions that were projected onto a screen. The computer program processed the student's answer, immediately fed back to him whether it was right or wrong, and on the basis of the program stored in the computer, moved the student to more advanced material if his answer was right or to remedial material if it was wrong—a technique called branching. The purpose of this procedure is to insure that students from varying backgrounds will all achieve desired educational standards.

While this early system turned out to be too small—it would only accommodate one student at a time—much of our work with it served as a foundation or provided direction to many current projects in the field of computer-based educational research at such centers of learning as the University of Pittsburgh, the University of Illinois, and Stanford, and even at IBM.

More recently our research has also led us to apply computers and our resources in system technology to the areas of student counseling, administrative and curriculum planning, and educational information processing. The results of work in these areas are very promising.

To give you a more specific idea of the function of computers in education let me illustrate in some detail SDC's four major areas of educational interest: computer-assisted instruction, computer-assisted counseling, simulation for planning, and administrative information processing.

COMPUTER-ASSISTED INSTRUCTION

Our original single-student teaching machine was expanded to include 20 student stations with an input device for each, new monitoring capabilities for the teacher and a larger computer. This

facility was given the acronym CLASS, for Computer-Based Laboratory for Automated School Systems. CLASS incorporated recording, display and analysis capabilities to test improved instructional materials and techniques.

We have since completed a substantial number of studies in this laboratory. One of the first things that became apparent was that the potential advantage of computer-assisted instruction was limited by the quality of the instructional material. It's a comparatively simple electronic task to branch a student having trouble to remedial material. It's quite another thing to design remedial sections that will correct his difficulty. For this reason, much of our work has emphasized research on the design of sound instructional material. We have been interested in identifying the critical elements that govern its effectiveness. In our studies we have made comparisons of different response modes, different frame designs, different learning reinforcement procedures, different teacher roles, and different sequencing methods.

As a result of this research, we are now applying the techniques we have developed in two areas. One is a project exploring the possibility of improving the teaching of applied mathematics by computer assistance and the other is a program for computer-based instruction in statistical inference. Our earlier extensive experience in evaluating the techniques of instruction has also led to a research project examining methods of teaching foreign language.

The chief advantage we foresee in the teaching of applied mathematics by computer assistance is that the drudgery of lengthy, routine calculations can be lifted from the student and completed by the machine. By carefully designed programs, the scope of material covered can be extended, and many more problems can be solved in a given length of time. This allows the student to spend his time more profitably on the techniques of problem formulation.

The statistical inference program, which is being conducted in conjunction with the department of psychology and the School of Education at UCLA, is designed to improve teaching of this subject to future research workers in education.

The teacher prepares the students in prerequisite topics such as probability, descriptive statistics, and the use of the computer as a statistical tool. The students are also given assignments in associated reading material. When these prerequisite assignments are satisfactorily completed, the students then begin to work independently with the computer. The students at UCLA use the SDC programed materials at remote "student stations," that is, at teletypewriters located on campus that communicate with the powerful central computer at our headquarters in Santa Monica.

This remote time-sharing capability is most important to the general feasibility of computer-assisted instruction. If automated methods are ever to be implemented on a wide scale, the most economical method promises to be time-sharing systems by which individual schools can have easy access to central computer complexes, through remote stations. Time-sharing is a fairly recent development in computer technology. It allows many users at different locations, who may each be using a different computer program, to work simultaneously with a single computer. Incidentally, SDC and MIT

were the first organizations to produce large general-purpose, time-sharing systems.

The student working on the statistical inference program with the computer receives a graded sequence of statistical problems. For example, he may be given a problem in which he must apply the proper statistical tests to determine whether two methods of instruction differ in effectiveness. In response to a query the computer will present, via teletype printout, the samples of data for the two groups. The data can be either prestored or it can be generated to represent given population characteristics. The student must choose an appropriate technique for testing the hypothesis that the two groups of data were from the same population. He may simply use the computer as a desk calculator or he may select from a library of statistical routines to have the computation done automatically. If he is having difficulty, he can call in a question-answering routine. He may then ask his questions by typing in natural language, e.g., "How do I calculate a standard deviation?" or "What is meant by confidence interval?" and will receive typed-out English answers to his questions.

A diagnostic routine is also available which will branch the student who is having difficulty to remedial material or will send the student to appropriate pages in his reading material. After the student enters his analysis of the problem, the computer will then solve the problem using the technique recommended by the instructor and will compare the instructor's solution with the student's. The student will then be presented with information describing the actual population and with an evaluation of his solution. Subsequent directions for the solution of that problem or the next problem in the series will then be presented.

As students become proficient at choosing appropriate techniques for estimating population parameters from sample data and in testing hypotheses they will be given instructional material covering a special computer language which is designed to enable the nonprogramer to readily acquire computer programing skill. The students will then be scheduled on the machine to code and check out their own computer programs to perform statistical computations.

I mentioned earlier our work on the problem of teaching foreign languages. In its 1961 session, the California Legislature made instruction in a foreign language mandatory for all students in the sixth through eighth grades beginning with the 1965–66 school year. The implementation of this law has been severely hampered by the general shortage of qualified foreign-language teachers.

In cooperation with the California State Department of Education, an SDC research team has been conducting a statewide field test, involving 60 elementary schools and 1,800 pupils, to gather information on three methods of teaching Spanish: (1) instruction by television, consisting of 3 weekly 20-minute telecasts, with classroom followup by the regular elementary teacher two times a week; (2) programed instruction; and (3) instruction by a qualified foreign-language teacher working with a commonly used audiolingual course of study.

The team's intent is to determine how well each course achieves objectives set for it under various conditions and to gather detailed information concerning the problems and costs of installing each program.

COMPUTER-ASSISTED COUNSELING

Many routine tasks of information collection and analysis that have been considered human tasks have proven to be appropriate for automation. In 1964, research financed under our corporate program with assistance from the U.S. Office of Education led to the development of a computer-based counseling system that will, among other things, conduct an automated counseling interview.

The University of Oregon and the Palo Alto School District cooperated with SDC in the initial research. A program was developed to record the preinterview and interview interactions of an experienced high-school counselor with a number of ninth grade students. Analysis of the recordings indicated that between 70 and 90 percent of the counselor's behavior could be simulated in these tasks. A model of the counselor's decision rules both in appraising a student's records, and his behavior in the interview were defined for simulation on a computer.

Two programs were written—one to review the student's record and provide the counselor with an appraisal automatically and another to conduct an automated interview with the student. The automated portion of the system operates as follows: the student sites at a computer-linked teletype and receives a logically developed sequence of interview questions. For example, after a number of interactions, the computer may print the following question on the student's teletype: Do you plan to continue your formal education beyond high school? If the student types no, the next question he will receive on his typewriter might be: Which of these is most like what you plan on doing after high school? 1. Join a military service; 2. Go through vocational job training; 3. Enter an apprenticeship; 4. Get a job; 5. Decide later. After the student selects one of the alternatives the computer then asks an appropriate question to continue schedule planning.

The selection of each question depends both on the student's previous answers and on the information about him that has been previously stored in the machine. After a number of questions and answers the interview will terminate in a schedule of suggested courses that is uniquely tailored to that student. Thus students will be aided in selecting their subjects by answering a series of questions presented by the computer. This system should relieve the counselor of such routine work and at the same time be sufficiently sensitive to extraordinary responses so that the student needing expert help will be directed to the counselor for individual attention.

To help the counselor in preparation for either an automated or live interview, programs have been written which use the same rules as an experienced counselor in analyzing the information in the student's cumulative folder. This program was designed to simulate a specific counselor who was asked to "think aloud" as he analyzed 20 student cumulative folders prior to counseling interviews. Analysis showed that most of the preinterview logic, as well as the interview itself, is specifiable and capable of being programed. The preinterview program accepts data similar to that which is normally found in the cumulative folder such as grades, aptitudes, test scores, and biographical information. By making various comparisons of these

data, the program prints messages for the counselor which are unique for each student. Messages regarding different students might be:

1. Student's grades have gone down quite a bit. Ask about this in interview. Possibly there are personal problems.
2. This student should be watched closely. He will probably need remedial courses.
3. Student is a potential dropout.
4. Should be headed for college. Encourage student to explore widely in academic areas.
5. Low counseling priority. No problems apparent.
6. Student should improve verbal skills. If not, student may not be able to attain desired academic goals.

In continuing the application of information processing technology in vocational counseling under field conditions, our study team is now in the process of conducting an extensive survey of vocational guidance practices at a substantial number of vocational education installations, including State employment agencies and private and municipal vocational guidance projects.

When the survey is completed, a sample field site will be selected for a detailed analysis of counseling procedures, and then a computer-based man-machine counseling system will be developed by a team that will include the counselor at the selected field site.

The computer-based system will have a data base containing student information, with an input-output system for updating and retrieving information. Computer programs in the system will provide appraisals of student data, interviewing procedures, tracking of student performance and indentification of students who are experiencing difficulty. The computer-based information processing programs will first be developed in SDC's research and technology laboratory and then installed at the field site for system testing.

Eventually many of the computer-based techniques will be integrated. The data from the instruction program may be an input to the counseling program. The output of the counseling program may serve as an input to a flexible scheduling program. All these programs would use a common data base which could be queried or modified by teachers, counselors, and administrators. A monitoring program will automatically keep track of student performance. It will identify students who are experiencing difficulty and alert the appropriate teacher or counselor by visual alarms or printouts.

COMPUTER-ASSISTED PLANNING

We are concerned also about the practical logistic problems that will accompany the innovation of individualized instruction.

The task of educating children for life in a sophisticated society goes far beyond instructional techniques. Although great strides have been made in the development of educational methodology and technology during the past 20 years, the formal organization or structure of education has remained relatively constant despite obvious weakness in its ability to adjust to instructional innovations.

A major reason for this lack of change is the complexity of designing school organizations that efficiently accommodate modern instructional media. An innovation such as computer-assisted instruction,

for example, if used on a large scale in a school, has implications for the organization of the whole school. By providing a means of effective self-study, it may allow students to progress at their own rates. It provides a means, and even suggests the need, for breaking away from the lock-step system of advancing students once or twice a year. However, when the full range of factors involved in an organizational plan is considered—the spatial arrangements, the student-scheduling problems, the versatile and effective use of teachers, and other resources—the problem of design becomes overwhelming.

At his present level of capability for designing school organizations, the educator formulates a relatively simple plan, tries it in a real school, observes the problems as they arise, and attempts solutions on a piecemeal basis. There has been no way for him to foresee all the major consequences of his plan before he puts it into effect.

Simulation has been a field of special interest to SDC since its organization. It has been put to extended use in training and exercising our air defense systems and shows equal value in many other areas of corporate activity—among them educational planning. Complex institutional innovations are not only conceptually overwhelming, they are often very expensive. With simulation it is possible to try out potentially hazardous or expensive procedures or radical innovations without harmful consequences. Simulated time can be accelerated, relative to real time, allowing us to anticipate consequences of various procedures in a few minutes which may have normally taken a full year.

A computer simulation vehicle has been developed in our laboratory that makes it possible to study the effects of new methods or new organizational arrangements as if they were actually installed in a school.

To construct this simulation vehicle, we first made a survey of the Nation's high schools to identify those demonstrating creative approaches in the use of innovation. Five schools were then selected to serve as subjects for analysis and simulation studies of specific organizational features.

We recently completed a study of one of these schools using this simulation vehicle in which we simulated the progress of 100 students of widely varying aptitude in an individualized algebra course. The simulation was based on data that represented actual students in the operating school. The passage of the students through the course, receiving instruction individually and in small groups, being tested, getting help from the teacher, and being referred to the counselor, was simulated entirely on the machine. The results led us to conclude that the school's procedure for grouping students was both inefficient and impractical. It appeared inefficient because of the time a student had to spend waiting for a group to form, and impractical because as students spread out over time the number of groups increased and the size of each group decreased. Demand for instructors soon exceeded their available time and students were spending too much time in nonproductive waiting. These conclusions were subsequently verified in the school being simulated, and design recommendations that had been made on the basis of the simulation results were successfully adopted by the school.

As school populations grow, administrators are forced to make rapid changes in space, staff, and equipment. They must also make complex

planning decisions based on limited information to prepare their schools for the years to come.

It is here that computer-based simulation techniques are also useful. With them we can project population growth, the increase in the number of school-age children, the number of school facilities that will be necessary to house them and the size of faculties to teach them, to list but a few of the factors. With simulation models the administrator can be given a clear picture of the demands that will be placed on his school and can therefore make intelligent planning decisions based on a wealth of pertinent information.

COMPUTER-ASSISTED INFORMATION PROCESSING

As enrollment in our Nation's schools continues at its current high rate and as at the same time demands for higher quality in education sound from many directions—from students, parents, government, industry, and from educators themselves—teachers and administrators are all but overwhelmed by the increased information flow connected with this expansion. Computer technology provides tools that enable them to cope with their difficulties.

SDC has, for example, designed educational information processing systems for the Rockland County, N.Y., schools and for Quebec's Ministry of Education that process the usual data associated with school management: budgets, payrolls, accounts payable and receivable, inventory of supplies, and property management.

In addition, the computers in the systems handle pupil personnel data, attendance records, registration, class schedules, progress reports, transcripts, grade-point averages and rank in class of pupils, medical and dental records, and the results of the many testing programs children are put through during the course of their education.

SDC has also developed the MASTER (matching available student time to educational resources) system for secondary school class scheduling.

Traditionally, the task of matching time, instructors, courses, facilities, and students constitutes considerable effort and expense in any educational institution. Since this task is usually done manually by educators, it amounts to a misuse of professional time and an impediment to improved educational practices. Many current educational practices of questionable worth are dictated by administrative convenience due to the restrictions of manual methods of scheduling. Much opportunity for a selection of courses suited to the individual student is lost, and any innovation allowing students to advance according to their achievements is likely to create a scheduling nightmare.

The MASTER system has incorporated a number of computer programs and punched card procedures into a system for class scheduling. The system allows maximum freedom for policy decisions and for special alterations to be incorporated in the school's schedule.

Consultation and support services on the use of MASTER have been provided in California to the Covina Valley Unified School District and for Santa Monica schools.

We are also about to use the MASTER scheduling system to develop and test a simulated extended school year schedule for a secondary

school and a junior high school with a total enrollment of over 6,000 students in a feasibility study for the New York State Department of Education.

With computer assistance not only can administrators cope with their mountains of detailed routine work, they can also do it faster and better. They are, in fact, freed from the purely routine tasks and thereby able to devote their energies to the work that requires distinctly human abilities—the decisionmaking functions that can't be handled by machines.

There is also another aspect of our work that I believe is of significance. Institutions of higher learning frequently have a computer complex on campus that has usually been installed for research purposes. Colleges and universities are learning to view automatic data processing equipment as a resource to be exploited as thoroughly and efficiently as possible. As a result many have undertaken comprehensive programs to open the computer to all administrative and academic departments on campus and to students in doing their course work. Not only major universities but many smaller colleges are using computers.

SDC has completed a study for Amherst College in Massachusetts which analyzes the information processing requirements for the college, both immediate and long range. The study emphasizes the need to integrate administrative, instructional and academic research services into the system. The SDC team assisted the college in writing a master plan for the orderly growth and development of its data processing facility. The study also reports on the implications of the college's cooperative arrangements with other educational institutions. We are now doing a similar study for the University of New Mexico.

Such integrated information processing systems, opening up the computer complex to all aspects of school life, have begun on college campuses, and the advantages and implications of using such central complexes to support elementary and secondary school operations are obvious. We believe that an integrated system featuring computer applications for instruction, counseling, scheduling, and administrative planning lies ahead for all schools.

PROBLEMS IN APPLYING NEW TECHNOLOGY TO EDUCATION

Associated with the promise of this new technology for improving our educational system is a series of compelling problems which may slow down the application of technology. Indeed, the education system has considerable inertia; technological change must be regarded not as a revolutionary process but as an evolutionary one. One problem is the well-intentioned resistance to the introduction of technology into the educational process that stems from concern that it will dehumanize a very human process. In part, this is based on the notion that teachers will be replaced by machines, that education will be automated and the human, personal, and individualized quality and purposes of education will be lost.

What is often overlooked is that the human quality and the genuine personal touch is often lost without automation. Fifty-four million young people, one-fourth of our total population, are now in our

schools. Projections of school enrollment to 1970 indicate that college attendance will nearly double and secondary schools will increase their enrollment by nearly 50 percent. The problem of student numbers is compounded by the perpetual shortage of teachers. The Department of Labor estimates an annual shortage of 8,400 elementary and secondary school teachers. The USOE estimates the shortage of 90,000 college teachers with doctorate degrees by 1970. The need for reeducation of adults as a result of the obsolescence of their skills, another effect of the dynamic technological changes of the last two decades, is a further strain on our educational system. Specialists are predicting that most people beginning their education today can expect to need retraining for a new vocation two or three times in their lifetime.

Technology will assist and support many education functions, thus increasing the productivity of the teaching force and freeing them of the multitude of clerical, recordkeeping chores and the elementary task of simply presenting information for student consumption. This can restore the personal touch to the educational process. One teacher confronted with 30 or more students is in no position to give individualized instruction except to a few of her many pupils.

I hope it is clear from the description I have already presented of SDC's work in this field that the new technology can offer an enrichment of both the individual student's education and the professional role of teachers.

Another major problem is the difficulty in getting educational research applied. The traditional assumption is that there is a fairly smooth sequence from research through a developmental phase to the utilization of results. More and more evidence is being accumulated to show that this sequence is very seldom followed in actual practice and that special efforts must be made to assure that the results of research or new developments are carried through to application in a school setting or, for that matter, in most other applied situations. This need was recognized at the national level, when the Congress passed the State Technical Services Act of 1965, which will provide Federal assistance to States, helping them acquire necessary documentation and information to assist their local industry in applying the results of federally sponsored research and development.

We have begun to realize the special importance of the innovator and leader in transitioning from research to application. There are many successful research people who develop theories and demonstrate their validity, but then do not carry their application forward. In these instances the fruitfulness and utility of the idea becomes lost until some person picks it up later in connection with some new project.

In large organizations, there are frequently procedural and organizational difficulties relative to the transition from research to development and to application. Often these functions are assigned to different major divisions of an organization on the theory that ideas developed in research will be picked up by a different group of people who will transform these ideas into an advanced development that will in turn be applied in some other part of the organization. It appears thar considerable management and organizational flexibility is required, along with much crossing of organizational lines and management hierarchy, to carry forth successful developments.

Similarly, with respect to funding, large organizations, and particularly the Government, are constrained to develop budgets and administer funds under fairly rigorous financial procedures. However, this tends to inhibit the needed flexibility for development of new research. Studies indicate that the funds used for various research and development activities often did not come from the logically expected budgetary category. Rather, the leaders of new developments tend to find their funds wherever they can and to have little regard for formal funding authority. While this is disruptive of both management responsibility and neat accounting practices, it may well be one of the prices to be paid for effective research and development activities.

Another area critical to the application of new knowledge in education has to do with communication. From the evidence we have it would appear that the formal publication of new findings does not by any means assure that the results will be expeditiously translated into a useful school development. Rather, the indications are that informal communication is by all odds the most important method or technique for transmitting ideas from one environment into a different one.

Perhaps more important, however, is the requirement that innovations must be given credible demonstrations in the sense that they must be demonstrations in the ordinary school setting, carried out by regular personnel and not by specialists who come into the school situation and then leave.

The Federal legislation establishing the regional education laboratories may have been one of the most significant educational advances of our time because it helps assure a proper development and demonstration of the credibility of educational innovations.

The primary purpose of the regional laboratory is not to undertake research per se, but rather to develop products and procedures that are of proven effectiveness and to facilitate their introduction and demonstration in various real school situations. The regional laboratories greatest service will be arranging for credible demonstrations of new techniques. The regional laboratory can stimulate local school personnel to try out new ideas and innovations to determine if they are applicable in the actual school situation and then use these demonstrations as examples for application in other school settings.

Another problem which may retard the application of technology is reflected in the concern of educators about the increasing participation in education by product-oriented industry. There has been concern in the past about the fact that the textbook a publisher produces for school use can be a strong determinant of what students end up studying. The marketing of a host of new teaching devices and other educational materials has renewed the fear that commercial competition will influence educational objectives, policies, and the content of specific courses. Unfortunately, much of the new material on the market is inadequately tested. We cannot expect commercial publishers or manufacturers to produce thoroughly tested materials since they work in a competitive environment and their retail prices must absorb all the costs of development and testing. Often selection authorities use subjective criteria in choosing new material. Until objective evaluations are demanded, training mate-

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rial which proves unsatisfactory after use will continue to be a problem and may improperly retard technical development.

There is the additional danger that sales-oriented organizations may involve the schools in a repetition of the experience with the language laboratories. After school districts established these facilities, they often discovered that they had purchased only an initial capability. Frequently, they lacked the funds to carry the additional costs for developing and testing instructional materials, and for the necessary technical staff to maintain and operate the laboratories effectively.

Innovation-minded school systems that adapt new technology find themselves confronted with still another problem—the scarcity of trained personnel to install, maintain, and supply backup support for the new methods or equipment. Computer-based systems for education require the same kinds of technical personnel that industry and the Defense Establishment need for their computer-based systems and the schools are frequently at a disadvantage in the competition for such experienced and expensive personnel.

If the new instructional and data processing systems are to be effective, coordination among school districts is necessary both to avoid duplication of effort and to insure compatibility of the systems from one district to another. Attempts to achieve coordination and adoption of common practices among independent school districts are likely to be viewed as a violation of local autonomy. Clearly the role of the Federal Government in this area is particularly difficult.

CONCLUSIONS

While the potential impact of technology on education is very great, it would be unwise to slight the many problems that must be overcome. Historically, the schools and traditional methods of teaching have been slow to change but new forces are rising which presage an acceptance of many of the innovations previously detailed. In the last 20 years the United States had experienced a technical revolution—television, jet aircraft, satellite communication, and particularly the computer. Barely 15 years have passed since the first really successful high speed computers made their appearances. The present generation of Americans is growing up with this new technology and learning to live with it and to expect it. I feel confident that as a new generation of professional educators assumes responsibility in the schools and as school boards change their composition, we will see an acceptance and welcoming of technology in education. That time is not far off.

It should not be implied that some technical innovations have not been adopted by the school. Educational television and the use of films have had their impact but these techniques have generally been absorbed into the traditional classroom regime. I feel confident that information processing and the use of the computer will have a more profound impact. This impact will probably make itself felt in the following sequence:

(*a*) First will be the use of computers for research and computational assistance in colleges and universities. The National Science Foundation has just issued a report showing the large number and sizable

investment involved in university computer centers. The day is not far off when every respectable college and university will have a computer center as routinely as they now have libraries (which, incidentally, will soon be automated).

(*b*) Second, many institutions of higher education and a sizable sprinkling of secondary schools now use computers for logistic and accounting purposes. They are used also for registration, class scheduling, and grade reporting. The routine personnel functions are becoming computerized. It will not be long until every large educational establishment either has its own computer or has access to one through time sharing.

(*c*) Third, as professors, secondary school teachers, and school administrators become accustomed to the computer they will accept more and more intimate involvement of the computer in the educational process itself. Soon student counseling for scheduling and advisement purposes will be largely computer based. It will be appreciated that much counseling is routine in nature and that the computer is more effective at routine tasks than people are. Counselors will have their time freed for the student with unusual counseling needs of an advisory or emotional character.

(*d*) Finally, computer aided instruction will come into its own. While computers are involved now in course work at some colleges, they have not made a wide impact on instruction. As new techniques are developed, as computer costs decline, as the public generally becomes familiar with computers, we will see their widespread use as a basic instructional tool. When this happens, many other educational practices will be affected: graded classes, age-placement practices, student-teacher relationship, facility use, etc. Because so many facets of school practice will be influenced by computer aided instruction, it will be slow in coming to maturity, but I confidently predict that in the next 20 years computer aided instruction will have a greater impact in education than all the other uses previously discussed.

In the last 20 years the United States has experienced a technical revolution—television, jet aircraft, satellite communication, and particularly the computer. Barely 15 years have passed since the first really successful high-speed computers made their appearance. The present generation of Americans are growing up with this new technology and learning to live with it and to expect it. I feel confident that as a new generation of professional educators assumes responsibility in the schools and as school boards change their composition, we will see an acceptance and welcoming of technology in education. That time is not far off. Thank you, Mr. Chairman.

Chairman PATMAN. Thank you, sir.

Mr. Haizlip, we have about 15 minutes for each witness, so that the members of the subcommittee may ask questions at the conclusion of the statements.

We are delighted to have you with us, sir, and you are now recognized to make any statement that you desire to make before the subcommittee.

STATEMENT OF HAROLD C. HAIZLIP, ASSOCIATE DIRECTOR OF EDUCATIONAL PLANNING, AND DONALD A. COOK, DIRECTOR OF EDUCATIONAL PLANNING, BASIC SYSTEMS, INC., AN EDUCATION SUBSIDIARY OF XEROX CORP.

Mr. HAIZLIP. Thank you very much, Mr. Chairman, members of the subcommittee, and guests.

I consider it an honor for the company which I represent and for me, personally, to appear before this subcommittee. It is most promising and exciting to us that the Joint Economic Committee is conducting these hearings. It is our strong belief that all types of resources, Federal and local, corporate and individual, are needed to improve education, an enterprise that is the very embodiment of out country's promise.

I am Harold C. Haizlip, associate director of educational planning at Basic Systems, Inc., an education subsidiary of the Xerox Corp.

The occurence of a hearing such as this testifies to the general awareness of the growing significance of technology for the field of education. If technology is recognized as the application of principles from one or more sciences, to the solution of a given set of practical problems it follows that the sciences drawn upon may be quite various. In solving a set of practical problems, knowledge is taken from whatever source is useful. Less widely recognized is the fact that technology—or several technologies—may affect the same practical field in several different ways. I would like today to distinguish broadly between the technology of communication and a technology of education itself.

COMMUNICATIONS TECHNOLOGY

Many components of modern technology important in the educational enterprise are in fact parts of the technology of communication. As early as 1928, F. Stuart Chapin [1] began to detail the transforming effects of the "revolution in communication," whose main effects he classified under four aspects: (1) an increase in expressiveness, or the range of ideas and feelings which can be transmitted; (2) swiftness, or the overcoming of space; (3) permanence of record, or the overcoming of time permitted by permanent records and archives; and (4) diffusion, or the access of the information of the culture of all classes of men.

Communication, as represented by new channels and media and the electronic systems which make them effective, extends the range of stimuli and materials to which student and teacher alike may be exposed and draw upon. In each type of medium, special adaptations serving the specific aims of education are developing: time-lapse photography shows biological growth in compressed form, while slow-motion pictures capture rapid physical and chemical events for careful study. Other variations of communication technology may reduce the time required for the teacher—or student—to create or to obtain and use a given display, as when a teacher makes a transparency minutes before class, casts it on an overhead projector, and writes in soft pencil

[1] Chapin, F. Stuart. "Cultural Change," New York: The Century Co., 1928, pp. 279-311. The fourfold scheme employed by Chapin, was actually developed even earlier by Cooley in 1912.

upon the image so displayed. This great enrichment of the variety of materials available, and increased information about and access to new material is having, and will continue to have, huge impact upon the potential for education. The rapid rate at which such techniques are diffused raises the hope that learning will be as easily disseminated. But it is not enough to lead the learner to new stimuli—or, in the modern mode, to lead the stimuli to the learner; for such exposure does not guarantee the right response—or, for that matter, any response at all. With modern methods of communication—the technology of transmission and display—we can present almost anything. But how the learner will behave in the face of such stimuli remains another question. A science of behavior might provide us with a technology of education.

The Practice of Education

The deficiencies of the current educational process are so familiar that we take them for granted, and they are difficult to describe in a fresh manner. But let us briefly review by observing some consequences of the fact that almost no student is lucky enough to have his own tutor, as Alexander the Great had his Aristotle. A student who wants to learn must share his interactions with many others, and moments of true exchange are therefore rare. Teachers faced with large classes are forced into compromises and ineffective behavior. Some teachers ask only trival questions, despite the resentment this procedure generates. Others play favorites and call only on those who know the answers. Thus at times the bright student answers dutifully, participating in a hidden collusive process which seems to imply that he has learned where no one else could. And even other teachers do no more than monitor a roomful of pupils at work on a drill because it is easier to detect inactivity, mischief, or cheating than reward steps in new learning. The very logistics of the role strain it in the direction of punitive discipline.

Under such circumstances, students usually obtain more significant exchanges with other students, and a solidarity develops in which the teacher is a common enemy. The value system which develops and is maintained by the student culture comes to include restriction of academic output—the academic equivalent of the slowdown. The high achiever is the "curve buster"—the academic equivalent of the rate-buster in industrial piecework, and he suffers a similar fate at the hands of his fellows.

The breakdown just described is intensified by several processes in our culture. One is simply the increasing number of students in contrast to the projected supply of teachers, with the inevitable increase in the number of students per teacher. A second is the rapid change and expansion in most subject areas. It is making it difficult for teachers to have an adequate grasp of the subject matter. As students are more exposed to alternative sources of knowledge through popular media such as television, even if it is not "hard" knowledge it becomes clear that there are many things which their teachers do not know. This gap is more serious when teacher and student are from different social or class backgrounds. Failings on the part of the teacher weakens his power as a model to be emulated and from whom approval must be sought. The labor-management relations of the

knowledge factory then becomes class warfare. In the big city slum schools, where such problems are at their worst, the teacher is in turn victimized by an impersonal, dehumanizing, and suspicious administration. The resulting game playing, under scrutiny from forces above which may punish but never reward, has been repeatedly described in recent years by Paul Goodman, Christopher Jencks, Edgar Friedenberg, and others.

A description as admittedly stark as the above may make one wonder how the educative process has ever worked. The answer to the question is not simple in its details. We need only note here that, to the degree that it has worked, it has done so in a haphazard, unpredictable, and inefficient manner. A nation can survive with a high birth rate and a high death rate, as long as the quality of the individual life is not a matter of concern for all. But a more effective and reliable system must develop if each life is to be adequately fulfilled.

To develop this effective and reliable education system the relation between input and output, between investment and return, must be radically altered, as it has been in agriculture, medicine, transportation, and communication. The process of instruction itself must become subject to a degree of automation. The required "industrial revolution in education" was foreseen by E. L. Thorndike and Sidney L. Pressey in the 1920's, but the school realization awaited an account of behavior which could permit the duplication of the one-to-one transaction of the ideal tutor-student relationship, and for that matter, surpass it both in both power and detail. That account is beginning to be available, and the first fruits of an applied technology of instruction can now be given preliminary assessment. The background and development of the study of the science of behavior cannot be described here. Instead, we will consider programed instruction as an example of the way principles from a science of behavior can be applied to education.

Behavior Science Applied: Programed Instruction

The term "programed instruction" is perhaps the most widely used designation for a new and rapidly developing field. It involves the application of the science of learning to the tasks of teaching, training, and educating.

The methods of this new field rest upon a number of principles of learning which have been widely known, but never before brought simultaneously into operation in a systematic way. Research in testing had shown that when tests are scored automatically, learning is improved if students find out their scores immediately after each question. At the same time, applied research in military and industrial training had paved the way for the use of automatic devices to individualize training.

But the systematic foundations of programed instruction awaited a workable account of how man learns, which could be applied to the design of technology of instruction. Primary credit for this step must go to experimental psychologists, and in particular to B. F. Skinner of Harvard University. Studying the learning process under carefully controlled conditions, Skinner and his colleagues established

important principles which apply to all learning. The first of a series of papers describing the practical use of these principles was published in 1954,[2] and since that date the field of programed instruction has made rapid strides of great and continuing promise.

At the heart of the method is the conception of human behavior as an orderly process which can be studied and understood in detail by the methods of natural science. This conception led to intensive laboratory explorations in the development and maintenance of increasingly complex forms of behavior. It soon became clear that it was possible to design complete "learning environments" in which behavior could be brought to a desired final product through a series of graduated stages. In each stage the key process is to arrange a situation such that the behavior then occurring produces consequences or effects which will bring the learner to the next stage. The design of these stages and effects is at the heart of all approaches to programed instruction.

Let us look at what happens when a student learns from a self-instructional program.

1. First, he masters information in small steps. Each "frame" of a program presents a carefully sequenced unit of information, such as a definition, rule, example, or illustration, which builds tightly on the preceding materials.

2. Second, the student utilizes this new material in making an active response. The frame which teaches also asks him to complete a sentence, select a correct alternative, give an example, or complete a diagram. Making this response is not difficult in itself, but it guarantees that attention will be paid to the significant information in the frame.

3. Third, the student is presented with immediate confirmation or feedback in the form of the correct answer. In a teaching machine, the correct answer comes to view when a knob is turned; with a programed textbook, the student turns to page to reveal the correct answer on the next page, then proceeds to the following frame. (In some versions of programed texts, sliding masks are employed to reveal answers one at the time.)

This technique permits new learning to be reinforced or rewarded within seconds when answers are right. In the rare cases where a wrong answer is given, it is corrected before learning proceeds on false premises. The seamless blend of learning, using, confirmation, may take place 60 to 100 times hourly for each student.

4. All good programs are not only carefully designed and produced, they are tested on actual students and then revised. When errors accumulate, the program is in error, and a study of the wrong responses will reveal the problem. Changes are then made, either in the troublesome frame or in earlier frames which eliminate the problem.

5. Programs which have been developed in the careful manner described may be mastered with a low error rate for each students, while at the same time achievement on comprehensive examinations increases to new levels. Program writers with growing experience in testing and revising programed material can now produce excellent

[2] See bibliography at end of article.

programs after only one or two stages of test and revision. Such programs show error rates ranging from nearly zero and about 10 percent, teach well and efficiently, and are seen as lively and interesting by the student.

One aspect of the technique of programed instruction has been widely misunderstood, and this misunderstanding has found its way into many published programs. It is not making the active response which is in itself responsible for the effectiveness of programed learning—nor is it being right. Getting the right response should require the student to pay attention to the significant material to be learned in each step. Many programs have been produced which do not observe this rule. Instead, responses are solicited which the student can make—and get right—without paying attention to the critical material being presented. It has been shown[3] that students learning from such poorly prepared programs earn low scores on later tests—they do about as well as when learing from conventional instruction. When well-prepared programs are used, however, results on later tests are much better. This distinction between good and poor programs is of great significance, and illustrates the importance of an understanding of the behavior changes which take place in effective learning before we can reap the benefits of an automated technology of learning.

6. Since programs are self-pacing, each learner advances at his own best rate. In contrast to fixed pace of the traditional classroom, slow learners don't fall behind, and rapid learners aren't bored and idle. The same 800-frame program which one student (IQ 138) finished in 6 hours, required 15 hours for a slower student (IQ 105) to finish. Yet both scored 100 percent on the same final exam.

Classroom teaching, whether by conventional lecture or by novel and exciting stimulus media, invariably addresses a hypothetical average student, who may in fact not exist. The rapid learner is held back, while the slower learner—who may nonetheless be a good student—is dragged forward too quickly. Few students have a chance to respond in any given session, and the teacher may favor those who are most likely to give gratifying answers. In contrast, programed instruction is learner centered, encouraging each student to work at his own best rate. Such individualization permits the student to pause for reflection without penalty. The total instructional cycle—increment, question, response, feedback—may take place dozens or even a hundred or more times an hour, matching or even surpassing the effect of a personal tutor.

Applications of Programed Instruction

If we examine the four major educational and training institutions in American society—the government, the military, public and private education, and industry—we can trace a significant impact left by new and more effective instructional methods on each.

In 1965 the American Management Association published Gabriel D. Ofiesh's "Programed Instruction: A Guide for Management" (New York: American Management Association, 1965), which includes case histories of applications in 35 major companies, industries and organi-

[3] Holland, J. G., Research on programing variables. In Glaser, R. (ed) Teaching machines and programed learning: II: Data and directions. Washington: National Education Association, 1965, pp. 66-117.

zations, all reporting innovative training methods developed and installed over the previous 5 years.

The major studies agree in showing one or more of the following effects:

1. Time saved in reaching a given degree of mastery.
2. Increase in the average degree of mastery of subject matter.
3. Major gains for the potentially low achiever—that is, more uniform and high results for the group, with the greatest change shown in a raising of the low end of the distribution.
4. Rapid completion by the best-prepared students, especially if the technique of "expressing" is used—in which diagnostic checks are inserted in the program and learners are allowed to skip portions in which they are well prepared.
5. Decentralization of instruction. For example, programs have often been mailed to a dispersed sales force and completed on a decentralized basis—with consequent reduction or elimination of travel, administrative, and instructor costs.
6. Lower requirements for instructor training. In many cases, instructors have been dispensed with altogether. In others, programs have been administered by relatively unskilled personnel, while experts have been reserved for conferences addressing the more advanced and sophisticated aspects of the course.

In an Air Training Command study of programed instruction in the U.S. Air Force, 46 courses were programed and compared with conventional instructional techniques. In 35 of these comparisons, *both* an increase in achievement *and* a saving in time were observed. (In six cases, time was saved but some achievement lost; and in five cases there was an achievement gain but more time was required.) (Ofiesh, pp. 68–70.

American schools and colleges are currently using programed instruction on an experimental basis in several thousand classrooms. Teachers generally use programs as supplementary instructional material, as remedial or background instruction for students who lack adequate preparation in some aspect of the prerequisites for the course, or for students who can profit from special enrichment.

In 1962 and again in 1963 the center for programed instruction surveyed 14,000 school districts concerning their use of the new teaching materials. In that 2-year period, the percent of schools returning the forms who reported at least some use rose from 11 to 36 percent. The degree of use as a part of the regular curriculum increased over the period studied.

In schools where programs are being tried out, considerable variations in effectiveness are reported. These variations may be interpreted in the light of the following trends:

1. Programs are currently gaining widest acceptance in the junior high school and high school grade range, and in science and mathematics areas. This trend reflects the relative ease of gaining consensus as to worthwhile teaching goals in these areas.
2. Although some very long programs have been produced, current activity favors the short unit devoted to a basic topic which can be flexibly assigned. This preference may be in part due to the administrative simplicity of installing a 5- to 15-hour unit within a prestructured course, and in part to the desire for caution on the part of teachers.

3. The large majority of work is being carried out with the programed text format, as opposed to programs in machines.

4. Consonant with the trend in 2 and 3 is the use of programs as homework, at least at the junior high and high school level. For younger students—in the fifth and sixth grades, for example—programs are used under supervised study conditions in the classroom. The logistics of this mode of use can interfere with other activities in the classroom. Schools of the future may have self-study carrels or study rooms designed into them, so that given assignments can be completed at the student's own pace *between* classroom discussions, laboratory exercises, and conferences.

5. Most use of self-instructional programs is still on a trial, pilot project basis. This fact reflects more than the newness of the field and the uneven quality of available programs. It also reflects unsolved problems of educational administration. For example, many schools now experimenting with programs for "remedial" or "enrichment" purposes are using *the same program* for both purposes, although clearly the students involved in the two groups are very different. The decision springs not from a clear identification of the appropriate target population, but from a wish to leave the "main stream" of scheduled classroom instruction undisturbed. Programs are used only where they fit in most easily, where student time is unscheduled.

Detailed comparisons show that programed instruction has matured far more rapidly in industry than in the schools. By and large, the programs used in industry are superior to the programs being used in the classrooms. This is due to the fact that industry has obtained most of its programs from experts. Unlike the schools, industry has the funds to purchase the services of the leading commercial programing companies, and even to hire its own experts. The schools on the other hand, are dependent upon what the open market offers. Most American publishers, in attempting to satisfy the imminent demand for programs, have tried to procure programs by the same methods they use to procure textbook manuscripts: by making a contract with a university teacher. Since an individual cannot produce a program of high quality without adequate financial and technical backup, the results have generally been disappointing. Programs of high quality for the schools will doubtless begin to appear when the market demand has become sufficiently strong to justify the type of financial investment currently being made in industrial programing.

Before the potential benefits of a fully automated technology of learning can be realized, however, other changes will be required as well. These changes lie in the spheres of the administrative organization and budgeting process in the public school system. I shall return to this theme in a few moments.

Related Developments in Instructional Technology

Many who may be familiar with the specific learning materials described as programing or teaching machines are not aware that they are derived from a point of view about learning which is far wider in

its application than the programs themselves would suggest. This may be especially true for those exposed only to the poorly constructed programs which exhibit the superficial characteristics of the method—small steps, active response, and so on—but whose construction is not based upon carefully stated objectives, a behavioral analysis of the learning process required, and a teaching strategy based upon that analysis.

In the meantime, other developments in the field of automated learning show a widening of the approach to learning as something that happens when behavior leads to effects in the environment. The Responsive Environment (or "talking typewriter") of Omar K. Moore illustrates what can be done when an environment is instrumented to respond to the behavior of young children to generate verbal behavior. Keyboards, speakers, display screens, are programed in a broad sense so that hearing and seeing, singly or in combination, lead to writing and speaking, speaking leads to seeing text, and so on in every combination. The extraordinarily advanced and sophisticated levels of reading, writing, speaking, and literary composition exhibited by the children in Moore's model schools have established new standards as to what might be achieved—not in the unusual case—but on a predictable basis.

Moore's work makes the point that the concept of a programed environment is not restricted to learning in a paper and pencil situation for students who can already read and write. Behavioral methods can establish these foundation behaviors with a high degree of automation. Such learning environments will require heavier instrumentation than the portable form of the programed text, and the fixed costs per installation will be greater. On the other hand, the behavioral return on investment is also very much greater for the automated production of early verbal skills.

Finally, I would like to comment very briefly, Mr. Chairman, on some of the problems and opportunities which we feel are created by this approach to education and technology.

Some attempts are also underway to design automatic teaching systems for preverbal and perceptual skills, such as matching to sample on the basis of color, size, form and shape, number, sequence, and so on. Exposure to programs in such areas is likely to produce wide effects in young children which would be seen in early reading readiness, a richness of perceptual behavior, early curiosity and interest in noticing many aspects of the environment, and so on. If current evidence collected by Benjamin Bloom and others is correct, a program of stimulation in early years may have permanent effects in establishing the levels of intellectual development which the growing person can attain.

It is not surprising that many of the new approaches to more effective learning should be applied to children and adults from culturally deprived and illiterate groups. Hope runs high that where traditional methods have failed, new methods may succeed. Applications of more effective teaching methods to the problems of remedial education have received increasing attention in the last several years, and with results of great promise. A number of studies concur in

showing that the learner with an underlain learning history stands to profit greatly from programed and similar methods. He is the learner who needs greater practice in actual responding before he can think it out for himself, who has been deprived of the experience of being right in intellectual challenges and so feels the full impact of frequent confirmation, and who may most appreciate the chance to learn at how own pace, freed from the pressures of group scheduling and competition. The concept of educational disadvantage has sharpened out interest in preschool programs which may raise the level of skills and readiness of those from slum backgrounds when they enter the school system. Such experiments are promising, but it would be unfortunate if we succumbed to the temptation to draw erroneous conclusions from their success. One such misdirection would be the conclusion that new technology of learning is only useful—or most useful—in remedial areas (as Paul Goodman implies in "Compulsory Miseducation"). This view sometimes follows from an association between new approaches to learning and an image of "mechanical, rote" or otherwise debased teaching method, and is reinforced by a vague humanist conception of significant learning as "sometimes higher" which cannot be analyzed. Furthermore, attempts to apply new methods to teaching more advanced and complex skills are just in their infancy. The next several years should bring an improvement in the range and level of instructional programing in many areas, but also a proliferation of devices, toys, games, simulation procedures, and other automatic, or partly automatic, systems for shaping and developing enriched patterns of behavior, perception, and skill. From the point of view of what might be possible, we are all culturally deprived.

Problems and Opportunities

As increasingly effective and sophisticated forms of automated teaching move out of the learning laboratory, through the experimental school, and into the world at large, a number of problems will present themselves and a number of opportunities will arise. As usual, problems and opportunities are related. Some, which can be already identified, are worth mentioning at the present time.

Scheduling.—The fact that students complete assignments at individualized rates means that the classroom, with teacher present, is not the appropriate setting for automated learning. Self-study cubicles will be required, where students check out assignments and complete them on their own. If these are more fully automated, performance records can be produced and returned to the teacher. Classroom time can then be devoted to more advanced work and discussion, launched from a common foundation, by a teacher who has in front of him a diagnostic record of group and individual performance on yesterday's self-study assignment. The linking of automated teaching systems with computer systems for recordkeeping and analysis is already under study in a number of arrangements.

Teacher role.—The trend away from the role of the teacher as the source of all knowledge to that of leader, diagnostician, counselor will continue. In other words, features of more mature learning will appear earlier in the school system. This shift will produce a demand

for teacher training and retraining—not only in grasp of subject matter—but in role and self-concept. In the long run a stronger and more satisfactory profession should emerge.

Options.—The individualization of instruction means more than the differences in learning rates. Individual differences in remedial needs, areas of supplementary interest, and other factors will be forced to the surface by a system which takes individualization seriously. Current classroom groups cannot respond to this variety. There needs to be a significant increase in the number of options offered by any given educational system. More than this, the basis for deciding among those options—perhaps shared by teacher and student alike, as is the goal of counseling—must be provided by a more responsive diagnostic system than currently prevails. Among other things, this means more sensitive, objective, and accurate assessments of student achievement at any given point along the way. Fortunately, the operational statement of behavior objectives required to design effective teaching sequences should help in the development of this requirement.

Assessment.—The assessment of achievement will play a role beyond that of diagnosis. In an increasingly mobile society, the clear identification of stages in student progress will permit behavioral definitions of equivalence to be developed. When students move from school to school, the label "2 years of algebra" will be replaced by a specific set of algebraic skills which he can be shown to possess when entering the new school—regardless of where or how they were acquired. Current schemes for advance placement can then be generalized throughout the school system.

Decentralization.—As books and films have led to the decentralization of sources of knowledge, so the new technology may hasten the decentralization of the educational process. The implications for home study and for occupational and professional training and retraining are obvious. In a world in which most of us should be in school at least part of the time, it would be advantageous to have that school or its equivalent available anywhere, any time, at least some of the time.

Facilities design.—We may presume that the elementary school will not vanish as a physical reality, for the school performs significant social functions which are not easy to decentralize. But plant design will need to change to accommodate the various types of space—classroom, lecture hall, self-study cubicle, laboratory, audiovisual resource room—which flexible scheduling and educational supplements require. The limiting nature of boxlike facilities and other rigid patterns of space utilization is already recognized and many new schools embody a new "modular" architecture. Study groups such as the Educational Facilities Laboratory recognize the significance of automated teaching technology for building design.

Economics of Automated Education

Cost analysis of industrial usage of programed material suggests that initial costs in the preparation of new teaching material may be heavy, but final gains are great. Gains to industry accrue not only

due to reductions in educational costs themselves, but in payoff effects such as better quality service, fewer breakages, increased sales, more rapid startup of a new installation.

The type of analysis suggests that one of the reasons for the leadership exhibited by industry in the adoption of new training techniques is that a return-on-investment analysis can be conducted by the industrial establishment, which is familiar with the concept of amortization of costs over a period of several years, and with the identification of monetary value to long-range results. Public education, on the other hand, thinks primarily in terms of carrying costs, such as teachers' salaries and plant maintenance; the investment in educational materials themselves is a small part of the educational bill, and furthermore represents a purchase in which fixed and variable costs are lumped together.

Full utilization of the potential of new instructional technology on the part of the school system will require a shift to a different accounting approach, in which instructional investment is separated into fixed costs, amortized over time, and the carrying costs of material which is consumed. Such a shift will go hand in hand with the design of educational plant facilities which will permit such methods to take full effect: buildings which allow flexible scheduling, variable classroom size, and greater utilization of learning resource centers such as individualized study cubicles, audiovisual labs, and so on.

In hastening this change, an analysis of the return on educational investment in economic terms may be of value, but it might be unfortunate to carry the analogy with industry too far and to make only that case in which economic returns can be identified.

I have attempted, Mr. Chairman, to point out what we consider major points at which there are possibilities and, indeed, problems in the advancement of technology as it relates to education.

I thank you.

Chairman PATMAN. Thank you very much.

I have a question to each one of you which I will not ask you to answer now, but I will ask you to please answer it when you look over your transcript. It will be in the transcript.

Mr. Slaughter, your references to social, economic, and political forces suggest that the effectiveness of our educational system has lagged behind social and other developments. Is this a correct inference? Is our educational system relatively less effective than it used to be?

If you will answer that for the record, sir, I shall appreciate it.

Mr. SLAUGHTER. Social, economic, and political forces have taken shape and matured at rapidly accelerating rates in recent years. The primary purpose of education in a democratic society is to respond to change rather than to create it. Because of the nature of this primary function and because social, economic, and political change has occurred at such accelerated rates in recent years the gap between education change and development and social, economic, and political change and development has widened. I think it is correct, therefore, to infer that the effectiveness of our educational system has lagged behind social and other developments.

I do not believe, however, that our educational system is relatively less effective than it used to be in the achievement of the objectives for which it was intended; on the contrary, I think it is relatively more effective in achieving the objectives for which it is intended. Our educational system is not, however, up to the level of the requirements of new social, economic, and political change and of a dynamic, growing society. It is to narrow this gap, and narrow it substantially, that educational technology offers so much promise of contribution and assistance.

Chairman PATMAN. Mr. Mitchell, there have been a large number of mergers recently in this field of educational technology. For the most part, these involve large publishers and larger companies in the electronics field or in communications.

Do you think there is a risk that our educational system will become dominated by large, powerful companies?

If they prepare the questions and they are distributed on a mass basis, would it not decrease the independence of our educators throughout the country?

(No response to the foregoing had been received for the record by time of publication of these hearings.)

Chairman PATMAN. Now, Dr. Haizlip, I would like for you to answer this one, please, for the record.

I have the impression that the introduction of teaching devices and machines in the schools has often been an adaptation of instruments and equipment initially or primarily designed and developed for other purposes, such as commercial business offices.

Can you cite some outstanding developments of new teaching instruments invented or created specifically to meet the needs of the schools and to improve the effectiveness of the schools?

In other words, can you give examples of important innovations which are the outgrowth of a specific concern for improving the production and effectiveness of our educational processes and practices?

Mr. HAIZLIP. Whether or not it is important that a mechanical device employed in education was designed expressly for that purpose, depends upon the nature of the device and the uses to which it is put. Computers, for example, employed in education, are no different from computers employed elsewhere, since all computers process data according to the decision rules built into the program. Whether scheduling the most efficient pattern of course sequences, or scoring test results and reassigning students into various groups, distinct programs are employed in each case. These programs embody the decisions which must be based upon the wisdom of the educator.

A slightly different case arises with devices whose main function is that of display. Slide and overhead projectors, movie equipment, tape recorders, and the like have had wider application in commercial, entertainment, business and industrial training, and military training, than in the public school. There is probably no reason for this other than the slowness of the schools to respond to new possibilities. Their use in the public school is now increasing significantly, and special modifications are appearing to enhance their effectiveness.

The language laboratory, for example, includes mechanical and control provisions which allow a student to hear his own spoken response and compare it with an ideal model or example stored on the tape. This feature represents a modification of direct pedagogical significance, and brings the system close to the technology of programed instruction. Once again the design of the teaching sequence is critical.

The third case is the teaching machine itself. The early models designed by Skinner and his associates were aimed expressly at the interaction between learner and subject matter, and are not adaptations of a device with another purpose. Many commercial models of such machines were tried out. These early models encountered many practical problems in actual use: (a) small spaces for student answers restricted the range of programed style; (b) variations in design in different commercial models meant that each type of machine was compatible with only a few available programs (much as if different phonograph companies produced models with different turntable speeds, so that each could only play those few recordings available at that speed); (c) use of machines in standard classroom settings failed to provide for the administrative problems posed by self-pacing; and (d) the programs available were too few in number, poor in quality, and unsystematic in serving curriculum needs, to encourage wide use.

None of these difficulties is intrinsic to the principles underlying programed instruction and teaching machines. Widespread and effective use—such as phonographs have achieved in the last few decades—will require more flexibly designed machines, some standardization of format between various commercial models and the design of programs, administrative rearrangement in classroom and self-study time, and careful analysis of curriculum requirements. These changes, however, are precisely those called for by every other aspect of the educational revolution. As they are achieved, the way will be opened for a new generation of devices, superior in effectiveness and far wider in the variety of behaviors they can teach, than those which have appeared to date.

Chairman PATMAN. Now, Dr. Carter, I would like for you to answer these questions, please.

What is the trend in education costs? Is cost per pupil rising rapidly?

Will automation and instrumentation and associated technological developments result in increased or decreased ratios of teacher-to-pupil?

Will developments result in increased proportions of backup staff; and, if so, what kinds of staff?

What directions of change in personnel and staffing requirements do you anticipate over the next 20 years at the several levels of education?

Mr. CARTER. Fortunately, there are fairly extensive statistics on the trends in educational costs and the cost per pupil. Secretary Keppel, in his recent book "The Necessary Revolution in American Education," has assembled relevant data which are reproduced in the following two tables.

Gross national product related to total expenditures [1] for education: United States, selected years from 1929 to 1964

Calendar year	Gross national product	School year	Expenditures for education	
			Total	As a percent of gross national product
1929	$103,095,000,000	1929–30	$3,233,601,000	3.1
1931	75,820,000,000	1931–32	2,966,464,000	3.9
1933	55,601,000,000	1933–34	2,294,896,000	4.1
1935	72,247,000,000	1935–36	2,649,914,000	3.7
1937	90,446,000,000	1937–38	3,014,074,000	3.3
1939	90,494,000,000	1939–40	3,199,593,000	3.5
1941	124,540,000,000	1941–42	3,203,548,000	2.6
1943	191,592,000,000	1943–44	3,522,007,000	1.8
1945	212,010,000,000	1945–46	4,167,597,000	2.0
1947	231,323,000,000	1947–48	6,574,379,000	2.8
1949	256,484,000,000	1949–50	8,795,635,000	3.4
1951	328,404,000,000	1951–52	11,312,446,000	3.4
1953	364,593,000,000	1953–54	13,949,876,000	3.8
1955	397,960,000,000	1955–56	16,811,651,000	4.2
1957	441,134,000,000	1957–58	21,119,565,000	4.8
1959	483,650,000,000	1959–60	24,722,464,000	5.1
1961	520,109,000,000	1961–62	29,366,305,000	5.6
1963	589,238,000,000	1963–64	[2] 35,900,000,000	6.1
1964	628,699,000,000	1964–65	[2] 39,000,000,000	6.2

[1] Includes expenditures of public and nonpublic schools at all levels of education (elementary, secondary, and higher education).
[2] Estimated.

NOTE.—Beginning with 1959–60 school year, includes Alaska and Hawaii.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education, "Biennial Survey of Education in the United States," "Statistics of State School Systems"; "Financial Statistics of Institutions of Higher Education"; and unpublished data. U.S. Department of Commerce, Office of Business Economics, *Survey of Current Business*, August 1965.

Total and per-pupil expenditures for public elementary and secondary education: United States, selected years from 1919–20 to 1964–65

School year	Total	Total expenditure per pupil in average daily attendance
1919–20	$1,036,151,000	$64
1929–30	2,316,790,000	108
1939–40	2,344,049,000	106
1949–50	5,837,643,000	259
1951–52	7,344,237,000	313
1953–54	9,092,449,000	351
1955–56	10,955,047,000	388
1957–58	13,569,163,000	449
1959–60	15,613,255,000	472
1961–62	18,373,339,000	518
1963–64	21,444,434,000	562
1964–65 [1]	23,106,854,000	587
1965–66	25,801,995,000	641

[1] Estimated.

NOTE.—Beginning in 1959–60, includes Alaska and Hawaii.

Source: U.S. Department of Health, Education, and Welfare, Office of Education, "Statistics of State School Systems, 1963–64," and "Fall Statistics of Public Schools, 1964 and 1965."

The figures of the increasing cost of education as a percent of gross national production reflect both the increasing costs of educating an individual pupil and also the much greater increase in number of students attending school as a proportion of the total population. The

figures on cost per pupil have risen quite significantly, but need to be reduced to reflect the inflationary factor between 1920 and 1966.

The remainder of the question tends to be dependent on a number of assumptions about the introduction of technology. Since I believe that technology will have a considerable impact in the next 20 years, I also believe that the composition of the educational staff will undergo considerable modification. At the present, the educational staff tends to be relatively flat in hierarchical structure; that is to say, there are a large number of teachers within a given school system, all of whom are engaged in quite similar activities and tend to receive relatively similar pay. As technology is introduced, this flatness in structure will be modified and there will tend to be more differentiated roles for educational personnel. The ratio of teachers in face-to-face instructional contact with students will decrease, but the total number of personnel concerned with instruction will remain relatively constant. Associated with the decrease in face-to-face instructors will be an increase in technical personnel for guidance, achievement assessment, subprofessional level instruction, audiovisual services, programing services, and equipment maintenance and operation. Since I envisage a significant change in the total mode of instruction, I do not look upon the non-face-to-face personnel as simply backup but rather all of these people will be involved in significant parts of the total instructional system.

With regard to the change in staff requirements in the several levels of education, I believe there will be relatively little change in higher education, somewhat more change at the junior college level, and a quite significant change at the secondary and primary level.

My confidence in the above projections is not high, since as I indicated in my prepared statement, there are significant problems to be overcome before technology will be extensively introduced into the school system. The above statements are based on the assumption that significant amounts of technology will be introduced, as I hope and believe they will be.

Chairman PATMAN. I believe, Senator Jordan, you are next.

Senator JORDAN. Thank you.

It is, indeed, a very interesting presentation of the problem that we all recognize. I think that we are all agreed that we live in a rapidly changing world. I think that we are all agreed that our educational systems are slow to change with the demands of changing times.

The question that I would pose to all of you is:

You make the assumption that applying the new technology to education will improve the quality of education.

I think that assumption, to make the record clear here, should be examined very carefully.

Technology can present facts, techniques, and the like, but is this really the heart of what our education should be in the high schools and the undergraduate schools and colleges?

Would you comment on this as to the whole question of the quality of education, each one of you, starting with Mr. Slaughter?

Mr. SLAUGHTER. I think that you have raised here a very fundamental question, Senator. As I attempted to say in my statement, one of the first requirements for the improvement of education is for

a proper determination of the purposes of education and of objectives of instruction. Until such time as this is done, and done very explicitly, it is not going to be possible for us to develop systems of educational technology that produce the desired results. I believe, Senator Jordan, that these purposes and objectives must be determined by the public, by professionals and, particularly, by professional educators and not by business interests engaged in educational technology.

We cannot, however, divorce ourselves entirely—I am speaking here of the business interests—from some responsibility for assisting in this process.

Proceeding from that point, Senator Jordan, I believe that when we speak of technology as improving the quality of education we must realize that there are many facets of the quality of education. I think it would take some time for us to define what we really mean by quality of education. I think we can concede that educational technology helps with the exposition process, with the factual dissemination process. This, in itself, will help those who are personally engaged in the educational process, teachers and other professional personnel, to do more with other qualitative aspects which, I think, are of great interest to you. Therefore, I feel that in this overall approach to education, which will include technology as one component, we will be able better to improve the quality of education.

Senator JORDAN. Thank you, Mr. Slaughter.

Would you care to address yourself to the same subject, Mr. Mitchell?

Mr. MITCHELL. Senator Jordan, yours is not an uncommon question. Some people still feel that there is a mechanistic (and even immoral) character to technological development and the social activities that grow out of it. They feel that learning, for example, is a very personal experience. They see machines as depersonalizing teachings and learnings, as displacing the teacher. I do not agree. I think that you have to separate education into at least two components: the learning of facts and the learning that is built upon those facts.

Modern math may be a good example. One must still learn, first, the old, unchanging number facts. (I am living with a 10-year old at the moment, and when she comes in the front door with her homework, I often go out the back door.) You have to know the multiplication tables; you have to know the sums of numbers up to 9 and 90. There is not any magic system that anybody has ever figured out that will eliminate those. That is undiluted fact learning. My 13-year-old is studying geometry, with its dependence on theorems. He has to to know those cold, hard facts. That is rote learning and it does not require great skill from his teachers. It does lend itself to machine and self-teaching.

We spend a great deal of money on the salaries of good professional people to perform this service, simply to communicate the facts. If technology did nothing but free them from those tasks of rote teaching, we would take a giant step forward. We would then free them to do what teachers do best, to teach the children and not just the subjects, the facts.

Wherever we can use our new technology to help our costly professionals do a better job, we can improve both the results and the

economics of both teaching and learning. And we now know that we can. That is the first component.

The other is related to the fundamental purpose of all education which is to develop intelligence, to teach people how to think and how to learn by themselves—something they must do all the rest of their lives. It seems to me that in many of the new technological approaches to education the opportunity to do this is clearly evident.

A child who sits in the classroom and sees the President of the United States being inaugurated, feels that she is there. She is having an experience that she could not get in any other way, an experience that may teach her something about the democratic process that nothing else can do as well.

A child who is given a chance, through the magic of the motion picture, to see inside the heart and watch the valves opening and closing, stops to verbalize and begins to think of the human body in meaningful terms.

You can tell a child that a caterpillar turns into a butterfly, and identify that as "metamorphosis." That is a long word. A child will not know what the word really means, until you show him that process in time-lapse photography. Then a big word like "metamorphosis" gets to be just another ordinary word to the youngster in the third grade. Can we say that this technology increases human understanding instead of just teaching facts? Of course.

The programed learning device is not a machine that bores a hole into one's head into which you put a funnel and then pour in the facts.

It is a technique to let you discover and learn for yourself; it is designed to make you think for yourself, to learn for yourself, to exercise that muscle in your mind that is frequently disconnected in a classroom.

I think it is poor generalization and typical of the kind of negative statement often made about modern technology in education to say that it simply communicates facts. It goes far beyond that. And, indeed, it is because facts tend to have been communicated at the expense of the development of the individual's thinking process that the technologist and the educational and experimental psychologist began to study this question. They have humanized learning in many ways.

Senator JORDAN. Dr. Carter?

Mr. CARTER. I would like to associate myself with Mr. Mitchell and Mr. Slaughter. I think that the point cannot be made too forcefully that it is very important that all children achieve competence in basic skills. If you look at the problem of student dropouts, in the underdeveloped areas, the problem of reading and verbal skills become of prime importance. You do not get quality of education—I think you used that term—until one gets rather beyond the handling of these basic skills.

So many children do not get the basic skills. I believe that we have not done a good job in this area. Technology can help in that.

I would like to emphasize, as Mr. Haizlip said, that a lot of learning materials have come on the market which have been the parroting of textbooks or other things and not well developed, not soundly tested. There has not been a demonstation that, indeed, these things do help, and I think that there is a great danger that there will be a

proliferation of so-called advanced technology without a true demonstration of its efficacy.

Senator JORDAN. How do we ascertain that there will be good quality in the techniques and the technologically advanced systems that are offered? How do we hold to high quality—how do we build to high quality?

Mr. CARTER. If I can give an example.

Senator JORDAN. Yes.

Mr. CARTER. We started out being somewhat naive, believing that if we could build a computer-based teaching machine we would get better learning, and we compared the traditional second- and third-grade reading methods against the machine method. The results showed no difference. The average teacher did just as well as the machine. We tried to examine this: In theory, you ought to be able to do a much better job with the individualized instruction, with the more flexible material, et cetera. And it turned out the real reason was that the quality of the materials we had in the teaching machine were not good enough, and we spent about 3 years trying to identify the characteristics that make for quality programs, and we think we have identified a lot of these. You have to make comparisons between the program that is being developed by giving it to a group of students and comparing their performance with another group taught under somewhat traditional methods and demonstrate by tests that one technique is indeed superior to another technique. The attractiveness of gadgetry, if you will, requires that the producer of such materials goes through this laborious and painstaking technique of demonstrating quality.

Senator JORDAN. Thank you.

Mr. Haizlip?

Mr. HAIZLIP. Senator Jordan, in the beginning of my statement, I attempted to distinguish between the technology of communication and a technology of education. It is our feeling, as witnessed by the theme of my remarks, that quality of education cannot necessarily or only be defined in a few terms, we must look at each youngster in a classroom as an individual and measure "quality of education" in terms of our ability to move him successfully, efficiently, and hopefully, inexpensively from the point at which we bring him into a learning situation to another point which is presumably a desired outcome for that youngster. For us, this raises a primary task: to define our objectives for individual learners and for groups of learners and, indeed, for our society. We feel that more often than not, these objectives currently are described in ways which reflect the process rather than the outcome of teaching and learning. Very often we describe the objective of an educational program as one of providing an enriched stimulating environment. But, in fact, we feel this environment is necessary as a means to an end, and not necessarily as end in itself. From my point of view the objectives of education are what you want to teach, described in terms that we can measure rather than in process terms. I do not know that we have applied this discipline to learning as generally as we would like; thus, working with and for public and private educators, this is where we can make our greatest contribution.

Senator JORDAN. Thank you.

My time is up, Mr. Chairman.

Chairman PATMAN. Mr. Reuss?

Representative REUSS. Thank you, Mr. Chairman.

I would like to ask the members of the panel for their views on research and development in education programs. Public and private research and development in such fields as health and agriculture are very broadly developed now. What can you say about research and development in education? Is there enough? Is it after the right goals? How would you compare the research and development emphasis generally?

Let us start the other way this time. I will ask Mr. Haizlip first.

Mr. HAIZLIP. Thank you. I had begun to relax, thinking that there would be three replies before mine, and, therefore, that I would have ample notes to draw upon from the comments of the others as well as my own.

Nevertheless, I would like to say that I think though there has been a considerable amount of research in education, it is still insufficient. I think we have done a great deal of research in teacher training. We have done research in curriculum. We have done research in pedagogy and other aspects of learning. But unfortunately too often we have not taken the additional step of integrating the isolated research which is being conducted. Furthermore, as we noted earlier the research which is done too often overlooks information available from those most involved—the teachers. Education-related research carried out under "laboratory conditions" does not always reflect the realities of the classroom.

Finally, research has not been done on as large a scale as is possible or desirable. We educators very often live, in our schools systems, on a day-to-day or at most a year-to-year basis. Our resources are severely limited, though this is changing with some of the recent changes in legislation. But basically, there have not been adequate financial resources for daily school operations, to say nothing of the paucity of funds for research. To the absence of financial resources and the other conditions which would enhance research must be added the enormous problem of the unavailability of time for teachers and administrators to participate meaningfully in research projects. But I think that, too, is a condition which will be vastly improved through the availability of increased Federal and other funds for research.

Representative REUSS. Dr. Carter, would you care to add to that?

Mr. CARTER. Yes; I would.

Representative REUSS. Or to subtract from it?

Mr. CARTER. I think that you have brought up two very interesting examples: medicine and agriculture.

If you will look at both of these, there has been long-range and continuous research, with large support; not only that, it has been organized in special research organizations, like the National Institutes of Health for the medical, or the agricultural colleges. They have had a deliberate demonstration program. We have not had that in education, to speak of. It has been individual people looking at individual educational developments. There has not been the concentrated effort in research.

I think that the recent program of the U.S. Office of Education has been a real step in that direction. I look forward to your support of that sort of program which, I think, will be very helpful in the future.

Representative REUSS. Mr. Mitchell?

Mr. MITCHELL. For a long time I have had the suspicion that one of the most useful pieces of research we could do in education would be a study to determine why nobody ever uses the research that is already here. There is a mountain of research. We need much more, but we must also learn how to use it. I'm afraid we haven't.

On the other hand, some educational research tends to be very superficial. A great deal of it follows the fads of the moment. If it becomes fashionable to say that the curriculum is out of date, everyone rushes out to study curriculum change; then they rush off to study teaching methods, the computer, and other new attractions. The product of this is, of course, a kind of spastic, unconstructive groping which gives us unrelated chunks of data that seem to have value but which are not created as part of any long-range plan designed to help direct us to where we want to go in the future. In business we set 20-year goals, then ask: "What do the present trends in technological development suggest?" And we work with that.

Much of the research that we see today is not really research at all. A great deal of the foundation-supported research is essentially a demonstration of what the foundations have made up their minds about in advance. Many foundations use grants to promote ideas, rather than prove them. And the foundation grant is all around us, as a modern status symbol.

My associate, Mr. Fadiman, jibes at that with the paraphrase of a current whisky advertisement: "While you are up, get me a grant."

The net result of some of this loose use of grants for research is that while we have the use of foundation funds, they are, actually buying tacit recommendations for philosophies of education which the boards or the membership or the staffs of the foundations themselves have decided to support.

A good deal of our research grows out of Ph. D. work while some of the doctorate work in specialized fields leaves a great deal to be desired, and research standards are not always the highest, much of it is of value and more of it would be useful if it could be planned against an understood objective.

My feeling is that we will improve this situation when we organize our research under a single broad, long-range, purposeful activity, and pay for and accept research that fits into the patterns of investigation which it suggests.

Commissioner Howe is beginning to do this in the U.S. Office of Education by setting up consulting teams. This seems to be leading toward a common approach to that problem.

I think much more has to be done. I think that industry should be permitted to participate in this research as a part of a total on-going project, rather than in support of individual hardware or highly specialized interests of its own.

Representative REUSS. Mr. Slaughter?

Mr. SLAUGHTER. Mr. Reuss, I shall answer briefly in the interest of time and, also, because of my deep-seated personal conviction about the question.

I believe, sir, that the most serious handicap to the long-range improvement of education in America is the lack of adequate resources for research. This is, in my judgment, a real serious paramount problem in the future of education, and unless we are able to do a first-rate, adequately financed quality job of research in education, much of what we are talking about today will really not fulfill the intent and the purpose of it.

Representative REUSS. Thank you, Mr. Chairman.

That is all.

Senator PROXMIRE (presiding). Mrs. Griffiths.

Representative GRIFFITHS. What is your estimate of the cost of adequate automated systems?

Mr. SLAUGHTER. Are you addressing that to me?

Representative GRIFFITHS. Any or all of you. I want to ask one more question.

Mr. SLAUGHTER. The answer is not available. It would require precise definition and research.

Mr. MITCHELL. It seems to me to be a fair business assumption that if I could be allowed to run the school system as a businessman and modernize and automate it, then, assuming objectives as good or better than those we are now getting in terms of results, I could stabilize educational costs, get a higher degree of efficiency from the professional personnel on a long-term basis, and, ultimately decrease the cost of education on a per pupil basis.

Representative GRIFFITHS. With what capital investment?

Mr. MITCHELL. That is a difficult question to answer. I would guess that the capital investment within any short period of time, assuming that an increase in the production of the devices that would be used would cut their costs, would be well within the range of the financial means of the average community school. You have the same problem in this respect that you have in private aviation, for example. After the war, you will remember that it was thought that a private airplane would be within the means of anyone, at a price that would be as low as the price of a motorcycle or an automobile. It still costs you $20,000 or $30,000. There has not been the proliferation of use, and we don't get the cost benefits of mass production.

If you have widespread use of computers in schools, I would guess that you could ultimately put a computer in a school basement for about $1,000.

Representative GRIFFITHS. Then, to ask you another question: You have already pointed out the difficulty—Mr. Carter has—of obtaining the use of this equipment. What is the cost of training people to use it?

Mr. MITCHELL. If we could or would take some of the present training, which is not very effective anyhow, and address it to training of this kind, I think that within the framework of the same cost, you would get teachers trained to use modern means.

Representative GRIFFITHS. And what is being done to train people in this?

Mr. MITCHELL. Hardly anything.

Representative GRIFFITHS. Would you not assume that since you do not have anybody trained now that it is going to cost some-

thing, regardless of that—that there will be a tremendous cost to begin with, to teach these people to use the equipment, to train them someplace? Would you not assume so?

Mr. CARTER. Yes, I think so. It is a very broad question that you ask. You will have to cut it up into pieces in some way. There is a report which the National Science Foundation put out quite recently, prepared by Professor Rossiter of the University of Wisconsin, on computers, their utilization and cost in institutions of higher education. My remembrance is that he recommends that there be subsidy at the rate of $50 million a year for this purpose. I may be wrong, but that is my remembrance. That is just the universities, and most of the people in the profession think that is too little, that it will not do the job. I, myself, think that we will be a long, long time before we have $1,000 computers in the basement.

A computing system such as would handle, say, a school system with, let us say, several thousand students, and would handle a fair amount of the instructional material as well as the costing and the administration and the scheduling, and all of that sort of thing, the capital investment in that kind of a computer runs well over half a million to $1 million. It is still a ways away before many schools can afford such computers.

Representative GRIFFITHS. Unless you have everyone trained at the local level, using the computer, so that you are setting up individual lessons, as the chairman pointed out, you may be buying in reality from a business concern, if you do not do it this way, and the Federal Government supplies the money, then you are going to run headlong into the question that the Federal Government is controlling education. What is what?

Mr. CARTER. If I may?

Representative GRIFFITHS. Surely.

Mr. CARTER. I think this is a very interesting issue. And the only answer that I know to it is the multiplicity concept, that you have to finance essentially competing systems, but if you do then one has to have some kind of criteria as to what are the merits of one system versus another system, and that means a tremendous amount of research and demonstration.

I happen to be on the board of the Education Testing Service which recently set up an organization to help industry evaluate newly developed techniques of this nature, and we look upon this as an extremely serious problem. You want to keep industry honest, to give school boards some real criteria as to how they can make these judgments and still not have a monolithic system.

Representative GRIFFITHS. That is right. Of course, it could be said that some of this will be actually a propaganda machine. It could very easily become a propaganda machine, operated by the Federal Government. I would have great difficulty with that. It is a very delicate question, I would say. I have to be on my way. I will leave some questions for you to answer in the record. I cannot resist saying, however, that when Mr. Haizlip was pointing out that these individual learning cubicles mentioned, I felt that one machine could be sold to every teacher, that is one that could be sold to every teacher would be one with a seatbelt. It would overcome a lot of teacher resistance.

My questions are:

Some students do well under one system of instructions, others do well under another. Are not the new system of people not making the same mistakes as the old system people made—that they all are alike, that all students are alike. Is it not the first step in instruction to classify students by the approaches to learning to which they respond best? Could teachers do this? Do the machines do it?

This question is addressed to Mr. Carter:

You referred to the shortage of teachers ready to work with the new techniques and equipment. Have you or others assessed the magnitude and other aspects of the teacher-trainee needs that are already in sight if these technological developments are to be maybe effective? Would this be primarily in-service or pre-service training? Are teacher-trainee institutions adjusting to these needs?

This is addressed to Mr. Mitchell:

You spoke of failures to realize the educational potentials of radio, television and sound motion pictures. Are these failures owing primarily to economic factors or to other considerations? Your general thesis appears to imply that organizational and other kinds of inertia are a major factor.

(Responses had not been received from Mr. Carter or Mr. Mitchell by publication time.)

Senator PROXMIRE. Thank you. Mr. Widnall.

Representative WIDNALL. I would like to ask the panel are the new teaching devices useful in teaching the arts and humanities, the social sciences, or are they primarily geared to science, math, and the languages?

Mr. SLAUGHTER. In any particular order?

Senator PROXMIRE. Go right ahead.

Mr. SLAUGHTER. Mr. Widnall, I think the answer to your question is "Yes", provided that your concept or your definition of the devices is adequately broad and diversified. I feel just a bit uncomfortable when we talk about automating the school system or the classroom when, as a matter of fact, we do not know what we mean when we speak of an automated school system or an automated classroom. It could be any one of a good many different things. But to illustrate, Mr. Widnall, let us assume that we are using films, which are a part of educational technology, in the teaching of art. These can be a very fine medium for the purpose; they can be very effective.

On the other hand, another type of technology may be particularly useful for exposition or for teaching facts, as it were.

So it seems to me that you can select from the array of technology available today something that can do almost any kind of job that you wish done in education, not completely, but something that will assist the instructor in doing the job. Thus, I believe it is possible to select certain kinds of educational technology to assist in teaching art or the humanities, as well as to assist in skilled building and fact dissemination.

Representative WIDNALL. How would you teach them an appreciation and understanding of history and our cultural heritage and political processes?

Mr. SLAUGHTER. I believe one of the important factors in teaching history and political processes is to surround students with the kind

experience, the pertinent experience that they need in order to understand history, in order to understand our cultural heritage and political processes. Often also their environments are so limited that they are unable to draw on their personal experience for this purpose. Furthermore, it is difficult to get it off the printed page of textbooks. Therefore, I think that films are very useful in teaching history and our cultural heritage and political processes.

Representative WIDNALL. Of course, if we continue in the direction that we are going right now with the one-party system we will not have to teach the political processes.

Is there a danger that overemphasis on technology may divert researchers away from the important aspects or education in the humanities?

Mr. MITCHELL. May I?

Representative WIDNALL. Yes.

Mr. MITCHELL. Since I am involved in both sides of this matter, it is a particularly interesting question to me.

Many of us who responded years ago to the problems raised by sputnik, realized that there was a great shortage of physics teachers, that the curriculums in the sciences were changing rapidly and we launched crash programs to catch up with the new curriculum developments and the new teaching materials. We felt at the same time that the humanities areas might be neglected. Some of us, my associates first among them, even launched humanities programs of a very advanced style, despite the fact that science held the spotlight.

I do not think that you will find that the people of this country, who have their roots deep in a liberal arts tradition, will be likely to abandon this highly personal and emotional approach to existence; and, therefore, you will not find the humanities abandoned by the schools.

With respect to what you are really driving at, which is whether automated instructional devices are standing in the way of achieving this goal, I think that you have to break that up, too.

The psychologists who do programed materials say that if there is a common body of agreement on any subject matter, on the set of facts, that it is very easy to teach these facts with a learning device. If there is great disagreement about the content then you pose problems: All you can do is to dramatize the disagreement.

There are creative arts, such as composing music, which cannot be taught by teaching machines. Yet they can teach the basic tools of the art. They can teach you to read the scales, to read the keys of the piano. They can teach you what notes do what and what effect they have when used singly or in groups. Really, the possession and mastery of a creative art rests upon your ability to grasp these basics. You cannot be a painter unless you know your colors. You cannot be a musician unless you can read music, and the new devices can teach these basics.

Representative WIDNALL. I have been bothered very much in recent years by the fact that it seems that one thing that we are getting away from completely in the evaluation of man as a part of the entire scheme of things is commonsense. I do not think that any computer shows that up or ever will. I am afraid that many corporations today miss getting very fine people in their employment, because they run

some IBM cards through the machine or some Xerox cards through the machine, or whatever kind of cards you are using, and they just interview certain people. In the same way that the Civil Service today has been setting up some of the most ridiculous requirements for some of the lesser jobs, such as for the maintenance of a school today, where one is not interviewed unless he has had a high school education. I am not talking about the school curriculum, but running the orderly process of keeping the building in order.

I had a great experience a number of years ago in the appointment of a postmaster. I was criticized highly for it. It was in a first-class post office. I was able to have appointed a gentleman with 4 years of formal education as postmaster, who had a tremendous amount of integrity and honesty and commonsense. Today he is about the best postmaster in the State of New Jersey. The only reason that I could appoint him was because he could take an oral examination, while the lower grades for postmaster, second-, third- and fourth-class, required certain requirements in basic education. He could get a higher job with a lesser education than those who were getting the second- and third- and fourth-class postmasterships.

There are many, many people today who are barred from consideration purely and simply because of the fact that commonsense and integrity and honesty are not taken into consideration. I think we have lost something by that—lost it very badly for the sake of the so-called efficiency in choosing personnel. I would hope that we would get a little bit away from the machines in some areas, in order to take into account human qualities, and to give them proper evaluation.

Are you familiar with the speech that Vice Admiral Rickover made the other day? I want to get a full copy of it to read it. One of the quotes was that we set ourselves above nature. There are men worshiping the machine, worshiping the people who know how to control the machine. They can get away with most anything today, because the other people do not understand the control of the machine. I think that this could, also, happen in the educational field. In order to be modern you have to have so many machines or your school is downrated and is not accredited, because it does not have a certain machine in it.

I just hope that as we get into this where we do have a need because of the explosion in school population, that we are not just going to pass up the things that go with human understanding and the interchange of a free flow of ideas, rather than just talking to a voice box somewhere.

Mr. SLAUGHTER. May I be permitted to comment at this point?

Representative WIDNALL. Yes, indeed.

Mr. SLAUGHTER. I think that the point that Mr. Widnall has made is a very excellent one. I would like to emphasize that educational technology is a means to an end and not an end in itself. I get back to the point that I attempted to make in my statement that a primary need here is to determine the purposes of education and the objectives of instruction. And this should be a subject of research. I feel that once this is done and we adhere to the purposes and objectives, admitting they are going to be dynamic, they are going to change as society changes, then we should undertake to tailor our education to

the fulfillment of those purposes and objectives and not to concentrate on educational technology per se, but simply to look upon it as the means to an end, as a means to help us fulfill those objectives and purposes. And it is just one means; it is not the entire means at all.

Representative WIDNALL. I think this is a very good statement in connection with this. Mrs. Griffiths was pointing up something that is going to be extremely important in this field, that is, whether or not teachers are being trained to use the new technology with greater efficiency. And I would hope that we do not go into a mass use of this before those who are going to use it have a full understanding of its capabilities and of the ways to use it. We are doing a little bit of that now it seems to me with medicare, saying that the whole population is to have medicare, and then find that we do not have the facilities for it. They are sort of starting to panic now as to where you will put them, where the hospitals are going to put them, whether you will have enough doctors and nurses.

We should, certainly, have a pretty clear understanding as to how we are going to use this and who will be using it, whether we have the right people to use it before we go into the wholesale purchase of these new and fine machines that are being manufactured.

Mr. HAIZLIP. Before underscoring Mr. Slaughter's remarks, I would like to return for just a moment to the question which Mrs. Griffiths raised immediately before leaving. I wanted to say to her and to other members of the subcommittee that I think it is necessary, when talking about the costs of applying technology to education, to consider the individual and society outcomes for which we are striving. We must also realize that the large, perhaps disproportionally high costs in the area of technology can be amortized over time. Most important, the value of these expenditures is best determined by measuring the cost amortized over time in terms of the result, that is the changes in the learner. Though I cannot tell you what the cost of a technological system would be—it is my opinion that the failings of our current education system give us no choice but to experiment with a number of different ways of applying technology to education, studying the costs over time, but looking, primarily, at the changes in our population as a result of the dollars spent. Since our society demands that more and more people be educated at higher levels, we have no choice but to spend our research funds to discern the most economic way of achieving this goal.

Secondly, I would like to address myself to the comments that have been made regarding your question. Mr. Slaughter has pointed out educational technology is a means to an end. And these are ample instances in which the technology of communication has enabled us to transmit, to record, to present information successfully in a number of different ways.

The question that yet must be answered is not only how shall we present this information, but what information do we want to present—what types of behavior do we want the learner to have in his repertoire.

Technology can help us in transmitting a great deal of information. I think that as teachers our function is to help youngsters make associations and comparisons, and perform all other types of tasks which we believe are relative to the learning process.

Mr. CARTER. May I respond, sir?

Representative WIDNALL. Yes.

Mr. CARTER. I would like to say that I like your example of the postmaster who had 4 years of education and yet did a very good job. I think that is what we all like to see.

It seems to me that by the use of automated techniques and the use of objectvie criteria, whether written or oral, through testing programs, we can hopefully break out of the lock-step requirement that a person must have an eighth grade education or whatever it may be. We may ask rather, what does he know, what is he able to do, and not how does he meet the formal criteria.

I believe these automated techniques will lead us in that direction, rather than in the reverse.

Representative WIDNALL. Thank you. That is all.

Senator PROXMIRE. I would like to get comments first from you, Mr. Mitchell, because I think that you were the first one to bring it up, although it has been the subject of discussion for the last few minutes and, that is, whether or not we are dehumanizing the educational process. Dr. Tschirgi, dean of planning for the University of California, had this to say—and I would like to quote this—his statement as to those who are frightened of machines, and to get your comments. He says, "A book is an inanimate, unresponsive friend at best, yet love and attachment are well recognized emotions to be displayed toward books. Why should it be surprising, therefore, that a reactive, facile, responsive computer may also generate a form of affection in its human users? Is it any less comprehensive to imagine a generation with nostalgic memories of one's old computer-tutor than to have cherished remembrances of ivy-covered walls?"

Is there a real feeling among some of these gentlemen that instead of looking back on Homer and Aristotle, that you think of 01790 and what fun you had in working with it?

Mr. CARTER. I think we have alluded to that question. We tend to forget technology is really a very broad term, and when you listen to Beethoven's Fifth Symphony, you have an emotional relationship to it even though it is on a tape recorder, and there you are using technology. Maybe you would like to hear the orchestra in person. Maybe it would play it a little better. But that impact continues on through.

When you see a film or a slide of great works of art, you are using technology, but you still have the work of art there.

The number of people who can experience this is many. And there are very few that can go to Paris and see the Mona Lisa.

Senator PROXMIRE. That is clear and true. What I am referring to is the quality of the machine—the responsiveness, whether it stays with you. And it seems to me that this kind of thing can easily change a human being. You may not be aware of it at the time, but you may get a kind of dependence on the machine, an affection for it that is quite different from simply the fact that a television film on art can be such as to put you in communication with the art itself.

Mr. CARTER. I am trying to generalize this whole problem and to point out that we become dependent upon cars, for example. There are many things that we cannot do without a car. We could not have the kind of civilization we have today without a car, without

rapid transportation. We could not be here. Has that dehumanized things? It has changed things. It has modified things.

The computer, likewise, is changing a large number of business practices and defense practices. To think that it makes them worse, I think, is far from the case. It has made it possible to do things that we could not do before, because we did not have the information or the resource which we now have at our hands. I think that will be the same in education someday.

Mr. MITCHELL. That was an interesting quote. I would like to offer you a short one in return. It is a story told by Lord Todd, the British chemist, at a conference of his colleagues. He related the story of the civilization of some thousands of years ago. The people lived in the warm lands, covered by streams fed by glaciers far to the north. They supported themselves by spearing fish and by trapping tigers.

The glaciers moved south. The lands became cold. The tigers left and sediment from the glaciers choked the rivers. Still, the people remained.

Before the advent of the cold weather the people had prospered and in their prosperity they felt that they should embellish their society and they set up a school system. In that school system, quite logically, they taught the spearing of fish and the trapping of tigers. Then the cold came and the fish left and the tigers left. The people of this area now survived by snaring eel and hunting bear. And they prospered again. They went back to examine their school system. They asked the headmaster what he taught. And he said, "I teach spearing fish and trapping tigers." And they said, "Well, do you not teach snaring eels and hunting bears?" He said, "Well, of course, if you want a technological education; but for a well-rounded education I prefer the classics." [Laughter.]

Mr. SLAUGHTER. May I inject this brief comment, please, sir? I think that we shall, indeed, have to become conditioned to these pieces of technology. And we shall become more expert and more skillful in their use as we become familiar with them and as we learn to use them. Therefore, I think that in time we can put these pieces of technology into proper perspective.

To me the significant thing is that technology will help us actually to be more human than we could be without technology. It is going to make it possible for us to have some human experiences that we could not otherwise have. I don't believe that we could obtain for ourselves and especially in a dynamic, growing kind of society, with knowledge prolifering so rapidly, through any other means the depth of human experience that educational technology will help make possible.

Senator PROXMIRE. I think that we are on the side of automating and improving our society, if automating it is the best means to do it, the most efficient and the most effective means to do it. At the same time, I think that it is most desirable that we be aware of some of the pitfalls. After all, it has been a long, long time before Congress became aware of the real dangers of the automobile. Just within the last several weeks Congress has come to this knowledge. And we are just beginning to protect ourselves a million or more auto deaths later, against this.

Let me ask you about another quotation. This, incidentally, is from an article in the New Republic by James Ridgeway which I would like to have included in the appendix. (See p. 269.) I think it is a most stimulating article. And it seems to take issue with what you said about the cost. Ridgeway writes:

> Despite such enthusiasm, widespread use of computers as teachers is a long way off. The machines still are clumsy and very expensive. IBM's 1500 series costs from $6,000 to $12,000 a month to rent for a computer that can handle 32 children. There are few inspired programs that are published in books, let alone interesting ones for computers. It costs as much as $10,000 per hour of instruction to write, test and revise a good program, and it may well take 3 or 4 years to do the job properly.

Is this an inaccurate assessment? If so, it seems that it is a long, long way off. You are talking about something that would not have very great application to the American school system for several years.

Mr. MITCHELL. It seems to me that it is the chicken and the egg situation. In my house I used a machine that I had borrowed, which consisted of a television receiver and a tape recorder and a camera. I put the family on television, tape recorded them, and played it back. That same apparatus cost $50,000 some time back. It sells today in very limited quantities for $1,300. You have a 40-to-1 ratio there in a very short time.

Senator PROXMIRE. Over how long a period did this take place?

Mr. MITCHELL. I can remember the video tape recorder of 6 or 7 years ago, when—you paid $44,000 for a video tape recorder and it was beyond the wildest dreams of a householder that he would have one in his home. Now for $1,300 one can indeed have a video tape recorder, complete with camera, in his own home. Soon the cost will drop even lower—you and I are going to be able to buy one for $300 or $400, what we might pay for a television set. Ultimately they will cost even less.

You cannot answer the computer question until you state how many school districts there are in the United States, and in how many of those school districts you can effectively use computers and what the delivered cost would be of that volume of apparatus produced against that size market. You are looking now at a highly sophisticated, very intricate device, manufactured in limited quantities for a limited, generally exploratory, and investigational purpose. It is very difficult to extrapolate from that.

I do not know what Mr. Carter's company would tell you would happen if you ordered 100,000 computers, and what they could deliver them for as compared with the million dollars it would cost now. If they could set up an assembly line to produce them and to take full advantage of the economics of mass production, the costs would be far lower.

Senator PROXMIRE. That raises another question. Mr. Ridgeway continues:

> Big companies which are diversified enough to stay in the race 15 or 20 years are the ones most likely to succeed in education. IBM seems sure to be a leader, their spokesmen speak conservatively about computer-assisted instruction. At the very best they say, computers can perform simple drills in subjects like arithmetic and spelling which will help take a bit of the load off people. IBM hopes to sell 12 of its new systems over the next 2 years.

And then to skip down, the article says:

> Thus, the outlook for making a fast buck is not good. In their eagerness to stake out a claim in the education market, businessmen have invested close to half a billion dollars within the past year or so. Yet they are shooting at a market that is at best worth $1.5 billion a year—including textbooks.
>
> This market will need to be expanded, partly to make more money and because the systems approach won't make any sense unless business can get into and influence areas that now are controlled by the educators.

So that, so far as business is concerned it is likely to be an industry for big business. It seems to me that you gentlemen offhand do represent either big business units or associations which are closer to big business.

Mr. MITCHELL. Mr. Slaughter and I are veterans of the hungry days. I chuckle at the figure of 20 years. My business will be 200 years old in 1968. And the chairman of it insists that as president I plan 100 years ahead. So, perhaps, the short term and long term are widely different things. I doubt that big business will really dominate education. It is a business that is easy of entry, but it requires a great deal of patience. It has traditionally delivered a rate of return that is so low that I rather suspect that it will he highly discouraging to stockholders of some of these big companies. I think you will find that some of this penetration will diminish when, for example, companies like Xerox do not have mammoth profits to divert from taxes to diversification.

Senator PROXMIRE. But it is a big business area where you can have the time to do this.

Mr. MITCHELL. This is an area that requires patience, that will require waiting for returns that may be very slow in coming, that requires persistence to stay with experimental activities until they have gone through the development cycle. That has not, in the past, met the response and profit standards of big business. There is also a great premium here on creative ability, which is by no means a big business domain.

Senator PROXMIRE. The contention here is that it will require capital, and an ability to sustain capital losses over a period of years and that would seem to be logical.

Mr. SLAUGHTER. May I comment, please, sir?

Senator PROXMIRE. Yes.

Mr. SLAUGHTER. Publishing in the future will be both big and small business. Again, as in the case of educational technology, you have a problem of sorting things out and trying to identify what you are addressing yourself to.

In publishing there are going to be certain aspects that will require enormous research and development effort and, in particular, those aspects involving big systems of technology. That is where the big capital investment will be required.

Senator PROXMIRE. And where the efficiency is, too.

Mr. SLAUGHTER. I beg your pardon?

Senator PROXMIRE. That is where the efficiency is, by and large, where the real improvements will be able to be made so as to have information accessible to many people for a lower cost and a more convenient way.

Mr. SLAUGHTER. A good deal of the efficiency will be there; yes. That is the object of your system of technology. But there are many

other aspects of publishing that will continue to lend themselves very well to small business. Let us take trade publishing, for example. There will always be a place for the innovator in trade publishing; for the man who publishes a very promising book or two which in turn converts his small business into a successful enterprise. Let us take, as an example, Grossman Publishers, Inc., which publishes Ralph Nader's book, "Unsafe at Any Speed." Here is a small concern that has published a title that has become a best seller and this, in turn, will surely contribute to the growth and success of this publishing enterprise.

Senator PROXMIRE. I am not sure that is true. My wife wrote a book called "One Foot in Washington," and the publisher sold out the first printing in 15 days, it was the best seller the publisher ever had, but he is no longer in business. [Laughter.]

Mr. SLAUGHTER. But, Senator, I think, also, that in the instance of educational publishing there is room for the innovator. Take, for example, Basic Systems, which Dr. Haizlip represents. This firm was started by a small group of professionals specializing in programed instruction, a new innovation. I think that, perhaps, their business may have achieved something on the order of a million and a half to two million dollars in sales. It is now part of Xerox, serving as a subsidiary of the corporation for the development of systems of educational technology. But Basic Systems was established by a small group of innovators who organized themselves as a small business.

Senator PROXMIRE. But in order to continue they had to sell to Xerox or to become affiliated or combined with Xerox. This is the efficient way to move ahead, to have a big business operation to make it really go.

Mr. HAIZLIP. Since I was not on the staff when Basic Systems was acquired by Xerox, I cannot speak definitively regarding the factors which promoted this action, but I know Xerox is interested in developing a capability which will enable them to contribute to this field of education. That is, to assist educators both in the United States and abroad.

This effort will include not only the kind of work that Basic Systems has done with public and private schools, but other quite different efforts. We are about to announce a Legislative Information Service. With the massive extension of Federal aid and concomitant opportunities for people at the State and local levels to acquire funds, there seemed to be a need for a service which could help people implement better programs in their local communities. The Legislative Information Service will contain a Directory of Federal Programs which informs the States and subdivisions about the ground rules of available programs. It also will include a monthly report on major issues in education and in social welfare.

Finally, it will include an inquiry service which will assist subscribers with project information problems arising from, or centering in, Washington. This is another instance, we feel, of the way industry can provide a meaningful service which will enhance the quality of educational service throughout the country. It is not simply the size of the corporation which motivates entering into this field.

Mr. CARTER. It seems to me that big business has been in the educational field for a long time. The textbook publishers spend a

surprising amount of money to bring out, say, a high school algebra text. I remember talking to a friend in McGraw Hill who said that they spent on the order of $2 million in getting out the textbook, the work books, the tests, the preliminary try-out, the promotion, and so forth, before they really got a good algebra text for the secondary schools.

And if you look at the recent acquisition where IBM paid in excess of $60 million for a concern, and Xerox paid a sizable amount for Basic Systems, and Time-Life just put $37,500,000 into General Learning Corp.—I do not see how you can escape the idea that fairly large sums are involved.

Senator PROXMIRE. Let me ask along that line another question. Would not this technology tend, also, to be another force in making our schools bigger and bigger? We know that there are already reasons why high schools and grade schools, that is, the small grade schools and small high schools, have fallen by the wayside and that the larger schools have replaced them, so that if you introduce the computer here and they have their own computers, it seems to me that you would get into a position where big schools have even a greater advantage. Once again there are human elements in the smaller school in association with the faculty and that kind of thing, which are most desirable, but this new technology may erode that.

Mr. CARTER. If I may, sir. It seems to me that there is both a yes and a no answer to that in a way. For instance, in California, up in Richland we have, I think it is seven, school districts which have combined together to use a computer for their grade reporting and their test scoring.

Senator PROXMIRE. That is a good alternative, so that you still have the identity of the school remaining.

Mr. CARTER. That is right.

Senator PROXMIRE. But you use the computer for all of them for those purposes?

Mr. CARTER. Yes; with time sharing which is really a phenomenal development in the computer area so that much of this will be possible. So you can still maintain, I think, the degree of individuality and still use a centralized system for many services.

Senator PROXMIRE. Did you want to comment?

Mr. HAIZLIP. I would like to comment on that. I think your question raises another question: Is the size of the school or the district itself necessarily important to the learning which takes place within it? I think that in conjunction with the application of technology, as we have described it here, a crucial variable determining how much learning takes place is that the youngster must undergo very, very rewarding experiences, and that the teacher is necessary to this process. The teacher will still have many important functions, and a part of this is the identification modes that take place within a small school. Furthermore, from the point of view of neighborhood identification, small schools are significant. The question is whether neighborhood identification enhances or in any way seriously affects the learning process. I think the more we deal with learning itself, without total concentration on the conditions which enhance learning, the better off we are and will be.

Senator PROXMIRE. Of course, there is the feeling that there are advantages in small schools and colleges, compared to big schools

and colleges. There are advantages, too, in the others. Certainly, with people who are much quieter and less outgoing it is better to work closely with the faculty members. The one-room schoolhouse was, in a sense, ideal for that, although terribly deficient in many other ways.

To get away from this and to get into a situation where you have a larger school, you seem to lose the individual relationship which has been most gratifying, I think, in the experience of many of us.

Mr. MITCHELL. May I just say that I think that the questions we have been listening to here, and the nature of this discussion, simply dramatize the dilemma and underline the importance of research and intensive examination of the outcomes of various options that do seem to exist in this whole field of education. On the one hand, we recognize that there are inadequacies in the present system. We recognize opportunities in what seems to be developing in the field of technology. We tend to overemphasize the computer and look past existing opportunities within the more commonly available technologies. Some one, some time, sooner or later (unless we lurch into one of the negative outcomes that has been suggested here), is going to have to organize this whole body of possibilities and begin to plan systematically with an eye toward what we want to achieve. A main goal is surely the use of the best of our modern techniques for better communications in teaching and learning. These produce changes in traditional methods and institutions. They will introduce new sources of supply, new cost factors, new relationships. These are the problems we face. There are others. We seem to be moving toward a world of greater leisure time, of relative freedom from work, of freedom from many other threats and fears. If we are going to be free from work as we think of it now—an all-consuming activity—what new kinds of skills will we have to have to enable us to use the opportunities that then present themselves?

John Platt, formerly of the University of Chicago, now at Michigan, has written a very thoughtful paper on this subject in which he suggests that by virtue of all of these things we have done for and to ourselves we may be standing on the threshhold of what he calls the era of man. We may be free of many of the fears which have plagued and tormented us since the beginning of time, such as disease and the fear of survival and the inability to cope with the elements. We may now have come to the time when man can afford to examine himself and find his real function on earth.

If that is an ultimate future prospect, and it seems like one, somewhere, somehow, somebody has got to begin to put a perimeter around these opportunities and these problems and developments and try to produce some sort of general guidelines along which we can move toward a better world of education. Otherwise, we will just move at random, zigzagging in an expensive, wasteful way.

Senator PROXMIRE. Should that be done by the Congress?

Mr. MITCHELL. I would not suggest that it be the Congress.

Senator PROXMIRE. Should that be done on a voluntary basis?

Mr. MITCHELL. It would be useful if a large part of it were done on a voluntary basis. Certainly, nothing suggested or implied here is designed to encourage congressional appropriation on behalf of this sort of planning. Congress has already provided much in the way of tools and leadership.

Senator PROXMIRE. The Congress could develop standards.

Mr. MITCHELL. I think that the Congress should encourage the development of standards and call attention to them. And this particular committee which is so deeply concerned with the economic development of the country should do everything it can to dramatize these problems, to highlight the opportunities, to encourage and to bring in interested people, to try to find a community of interest and a community of skills that will move our educational process in the right direction.

Senator PROXMIRE. You made, Mr. Mitchell, a startling statement when you said that educational TV is the most disastrous teacher failure that we have had. It is disappointing. We have poured millions of dollars into it. And I take it from what you have said that you are referring to the classroom use of educational TV.

Mr. MITCHELL. Yes.

Senator PROXMIRE. Were you, also, referring to educational TV that has its own channel, that operates in many of our cities, educational TV that is used to some extent by the commercial networks in the mornings, on Sunday? They usually take those educational programs and present them then.

Mr. MITCHELL. Setting aside the commercial activities which, I think, by and large have had a much larger audience but have been less consistent and do require somebody with acute insomnia to participate, you can separate what we call educational TV into two categories—instructional TV for classroom use and educational television for the general public.

Senator PROXMIRE. The reason that I raise this point is that you raised this point and then let it drop. You did not do anything about it. Congress is involved in a big educational program.

Mr. MITCHELL. I have some sympathy for the Congress and myself. None of my children have been in a classroom where there is educational TV. It is my feeling they have been deprived. It is my feeling that this powerful medium should be properly developed for effective use. It has not been so developed.

Senator PROXMIRE. Perhaps the people would rather watch Batman.

Mr. MITCHELL. You cannot watch Batman in a classroom. You have a captive audience. Something constructive must be done with TV that takes into account good teaching practices and the valid techniques for the use of audiovisual materials. It seems reasonable that this is a goal that could be achieved. I, for one, am greatly disappointed at the general standards of educational TV. Teachers by and large have not associated themselves with it, and for good reason. The programs it has produced are far below the level of its real potential. It has not made the contribution to education that it could have made.

Senator PROXMIRE. You are saying then that your criticism is not with the failure of the schools to use it, but with the failure of the educational operation to be sufficiently attractive, so that they will use it.

Mr. MITCHELL. I think that it is clearly that.

Senator PROXMIRE. What should we do about it?

Mr. MITCHELL. I think that a hard look at what TV is now doing and has failed to do is clearly in order. We should then examine these

failures against our original hopes. We should set up sensible criteria for performance on the part of educational TV and insist that it meet these criteria.

Senator PROXMIRE. It seems to me that this is an ideal area for financing by the foundation, to put on pilot programs.

Mr. MITCHELL. There is now, under Dr. Killian, a major study commission which is quietly examining this whole problem of why educational TV has not gotten off the ground, and perhaps, they will develop something. I regard that, at least, as a promising possibility, but it is about $80 million late.

Senator PROXMIRE. Is that underfinanced at $80 million?

Mr. MITCHELL. I think that we have overspent $80 or $100 million on educational TV, in terms of the return we have had from it. It has a very short life cycle. It will get a lot of public attention in particular areas of the country in its initial stages, and then collapse after the newness wears off. It seems to me that it is lurching toward the fate of educational radio. Radio should have been and could have been a great asset to the classroom. It could be a national system, an intercommunity system for contributing in rich ways to teachers and children in the classroom. It has never been developed. I think this is worth close examination and study. There is a great resource here. We have put a lot of money into it, and nothing very constructive has come from it.

I gave a commencement speech at the Chicago Junior College where 1,200 graduated, and 61 of them had never been in an institution of learning to get their degree. They stayed home and got their degree via television. This suggests the potential of educational TV. How many high school dropouts have we got, how many people who never got a high school or junior college degree who would love to be able to participate in that experience, using television? What opportunities are there in classrooms that we are not capitalizing on?

Senator PROXMIRE. Are you satisfied that the results are reasonably satisfactory on the part of the students who did not go to the class who have learned this at home?

Mr. MITCHELL. Yes, I took the trouble to talk to many of those students and they were highly motivated. There is a need for this and it should be met. I must say that it baffles me and concerns me why it has not been more effective with these kinds of expenditures and with these kinds of potential resources. Here is a problem, right upon us, that will not wait for the computer. It is right here. The towers are sticking up in the air, the facilities exist, the medium exists. Yet it just sputters like an outboard motor with water in the carburetor. It is a colossal flop.

Senator PROXMIRE. Do you see any prospect for educational television on the commercial networks or on the educational TV networks that go into the homes—do you think that can be improved?

Mr. MITCHELL. The CATV, the community television system, represents a potential educational TV resource that has not been explored. I think that pay TV should be explored. One might explore or examine the possibility that our educational television stations should be permitted to charge people, using some sort of a pay system in their homes. This would solve one of their problems, that is, adequate income to support this kind of service.

I think the commercial networks could do a great deal more in education. I think that they are misreading the willingness of the American people to improve themselves. "Batman" is a poor substitute for learning more about world affairs, about things that are critical to our survival.

Our own association with the National Geographic and an insurance company that joined to put on a program on CBS–TV that ran four times—four full documentary programs, based on exploration and expeditions supported by the National Geographic, is interesting. The programs were accepted with some reluctance by the network; no network likes to have a 1-hour program in the middle of prime nighttime, knocking out the regularly established program. Three of the four times that the program was on, it had the top rating and the largest audience of any program on the air at that time. And when it finally came up against Batman it reduced Batman's rating by about 30 percent.

Senator PROXMIRE. That alone is a great national contribution. [Laughter.]

Mr MITCHELL. It suggests the interest in education that is latent in the American public and is being ignored and underestimated by TV.

Mr. HAIZLIP. Mr. Chairman, I think that Mr. Mitchell's remarks underscore what is becoming the theme of the panel's remarks today, which is that as advantageous as the development of a technology of communication—such as educational television—may be, it does not solve the problem of the need for a technology of education. Even if we develop faster, more swift means of transmitting stimuli of whatever sort, the question still remains: what is the purpose of that transmission; what kinds of behavior are we trying to provoke on the part of the learner? I think that when we started with educational TV, we focused upon it as a means of communication, rather than as a communication device in the classroom. As a result we simply transmitted pictures of typical classroom activities, without previously discussing and designing a more crucial aspect of education, that is, determining the objectives in terms of student behaviors.

Senator PROXMIRE. Thank you very much, gentlemen. This has been one of the finest panels I have seen before this committee. It has been excellent. It has been in an area we have rarely ever touched. Also you gentlemen have made a very substantial contribution. I want to express my compliments to you and my appreciation.

The subcommittee will stand in recess until Friday, June 10, when we will meet at 10 o'clock.

(Whereupon, at 12:45 p.m., the subcommittee adjourned to reconvene Friday, June 10, 1966, at 10 a.m.)

TECHNOLOGY IN EDUCATION

FRIDAY, JUNE 10, 1966

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC PROGRESS OF THE
JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room S–407, the Capitol, Hon. Wright Patman (chairman of the subcommittee) presiding.

Present: Representatives Patman, Widnall, and Senator Proxmire.

Also present: James W. Knowles, executive director; John R. Stark, deputy director; Donald A. Webster, minority economist; and Hamilton D. Gewehr, administrative clerk.

Chairman PATMAN. The subcommittee will please come to order.

The witnesses who appeared before our subcommittee on Monday outlined some very interesting developments in applying technology to our educational programs. They also voiced a good deal of concern about the fact that all of our efforts are not well coordinated. Some of these witnesses felt that we were failing to realize the advantages of our great technological potential.

Today, we will hear from four distinguished educators who are not only familiar with the problems and requirements of education, but they are deeply involved in studying new methods, new techniques, and new equipment to further the effectiveness of our educational systems. They will give us the benefit of their knowledge on this most important issue; namely, the possible effects of these new developments on education.

Gentlemen, we appreciate your coming here. All of you are in a position to give this subcommittee a good deal of help by reason of your outstanding work in the field of education.

We have, as our first witness, Dr. C. Ray Carpenter, research professor of psychology and anthropology, Pennsylvania State University.

He will be followed by Dr. John Folger, Director of the Commission on Human Resources and Advanced Education, National Academy of Sciences.

Following Dr. Folger will be Dr. Robert E. Glaser, professor of education and psychology and director, Learning, Research and Development Center, University of Pittsburgh, and the final witness scheduled for today is Dr. George E. Arnstein, National Education Association, Washington, D.C.

Dr. Carpenter, you may proceed in your own way. My understanding is that we will limit the oral testimony to 15 minutes, in order to provide sufficient time for discussion. You may put a longer

statement in the record, however, if you feel that it will improve your position by adding to it, and you are therefore at liberty to do so. In other words, you may extend your remarks if you so desire in the record.

All right, Dr: Carpenter, we will hear from you now.

STATEMENT OF C. RAY CARPENTER, PROFESSOR OF PSYCHOLOGY, PENNSYLVANIA STATE UNIVERSITY

Dr. CARPENTER. I am C. R. Carpenter, from the Pennsylvania State University. I am representing both the field of professional education and research and the Association of Higher Education. I am hopeful that I can be of some use to your subcommittee in the very complex field of educational technology and the question of expanding this educational system of ours to an unlimited extent to meet the needs of the country.

I realize that we have a very short time limitation and, therefore, I am submitting supplementary documents.

The first is from a paper of mine entitled "Research on Instructional Television," which I prepared for a conference on "The Economics of Educational Television, held at Brandeis University, May 23–26, 1963. I am submitting a few copies of this paper for the use of your staff.

I reviewed, in that paper, the extensive research on educational televised instruction.

I reported the general finding that is very well known that in educational technology there are a great many options—television, radio, films and programed instructions, et cetera, which are just a few of the things that might be selected and put into combinations to do specifically defined educational jobs.

In this city in August of 1963, I read a paper to the International Congress of Psychology entitled "New Technologies in Formal Education: The 'Mass' Media of Communication." In that paper I reviewed some of the developments that this country, Japan, and Italy had made. I remarked at that time the slowness with which modern technology is being accepted in education, but nevertheless pointed out some conspicuous and dramatic applications—the United States, Japan and Italy. For example, in Italy, where more than 100,000 people are being taught to read over the television system; and in Japan, 96 percent of the school systems have educational television receivers and special programs. They are far ahead of us in some respects, in spite of the economic differences.

The next paper that I am submitting for the use of the staff is one which was prepared for the President's Commission on National Goals. It has never seen the light of day, so far as I know you have prior use of it. This paper consists of a series of inhibited ideas as to what technology might do in the total context of the educational system of this country. I would like, with your permission, to review several paragraphs from that document.

Quoting from a document that I shall submit for the record:

> The industrial revolution of the 19th century has bypassed (in large part) 20th-century education. The recent (last 25 years) significant developments in communication sciences and arts, although very appropriate and of proven

usefulness for education, have been applied only peripherally and inconsistently to institutionalized education. Developments in communication have revolutionized other areas of national effort, like those of defense and security, but they have had little real effect on formal education.

I think the main point is that the technologies have some effects, but I am talking about a significant educational effect on the total system. The proportion of the uses of advanced technology is relatively limited relative to the total mass.

The second paragraph, which is paragraph 10 in the basic document, reads:

A systematic analysis of educational functions at all levels and for all kinds of educational activities is needed to determine which of these functions can be performed best by whom and by what specific means. Subsequently, it can be determined by operations analysis how and with what combination of electronic media (along with other facilities and resources) can and should be employed for greatest economy and effectiveness.

Now, these quotes will give you the flavor of the kinds of contents that are presented in this document which I prepared for the national goals statement. And, incidentally, that statement deals with the goals, but it does not deal as specifically as it should with the means of achieving these goals. It seems to me that this subcommittee has a wonderful opportunity to suggest some of the means of achieving the national educational goals.

I have here a fairly succinct definition of the task which will lead into some questions of where the educational technology or the technology applied in education might be used. I define this task as being: to provide opportunities appropriate to our society for each person to learn what he needs to know, and what he has the right and abilities to learn, wherever he lives and whatever the time or condition of his life.

Now, this enormous whole job that I have referred to immediately in this paragraph might be thought of as an unlimited enterprise. When I prepared this paper I do not think I had conceived of an enterprise which is completely unlimited, but education, I contend, is one of those. It is in education that you have research producing research, and you have learning advancing, and the more you have of it the more you need of it. It is an unlimited economic and professional and social enterprise. This may be a point for some interesting discussion.

In paragraph 21, I refer to three words which are almost taboo in academic circles. I do not use them when I am talking with faculty people: efficiency, productivity, and profits or products. There is an interesting conflict, it seems to me, in the academic world and economical world. These are indispensable concepts in the economic world, the industrial world, but they are not very useful on the academic scene, and I raise the pointed question: Do we really want efficiency in education? Is this not one of the areas where we tolerate luxury and something that perhaps we should protect from the application of economic analysis?

This is not my view. I am raising the question.

In paragraph 24 of the basic paper, I point out a sequential analysis procedure which I would like to see applied with all objectivity in the educational system. The elements are first the function, the per-

formance of whatever is serving the function, the results, the general social consequences, and finally, the cost.

It is precisely in the area of cost analysis that the economics of education is not very satisfactorily developed. I raise the question as to why this is so. It seems to me that it is so, because we do not have a measurable end product. We do not have that which corresponds to product or profit. We may assess, of course, credit units, but this is not the product. The product consists of the change of behavior of the people in the educational system, and we do not have adequate measures of this to give an index of costs.

In paragraph 26 I raise the question of what it is we are talking about in the way of technology. We are not just talking about programed learning, television, or instructional films; we are talking about a whole wide spectrum of extremely important technology relative to education which is one of the major enterprises of the country. We are using fantastic amounts of building materials, facilities that go into these of various kinds, and I do not need to describe these. I would hope that these hearings do not focus too much on the ill-defined area of technology known as audiovisual technology, for we are talking about something much broader that ranges from air conditioning or internal climate control to national systems of educational and instructional television.

Now, the real problem is to select the combinations of the technological components that can be put together into an educational system to do the jobs that need to be done.

I refer briefly to the question of the college dropouts. Heretofore, we have been talking most about high school dropouts. It is estimated that about 10 percent per annum of college students drop out. What about the "Why"; what are the reasons?

In paragraph 31, I would like to take the opposite position from Mr. Mitchell on Monday when he argued that the market is so slow, because of some mysterious resistance on the part of the academic people. I would call to your attention, Mr. Chairman and members of the subcommittee, that this may be the result of a lack of time perspective; that is, when we look at the status of universities and school systems in 1900 compared to the present, or of 1925 compared to now, there are fantastic differences; probably differences that outweight any comparable differences for any other comparable period in history, and I would like, if we had time, to go into some of these comparisons.

For example, the computer is now a standard part of the landscape of universities. We talk about them and they are accepted. The use is simply limited by the amount of investment which the university or the college can make. We might examine how computers have been introduced and why. We might examine the role of the National Science Foundation in introducting computers. What did NSF do to "cause" this to be such a successful operation?

There are a very large number of other examples. I have been given the information that there are more than 10,000 language laboratories in the schools of this country. In 1958, there were about 37 such laboratories. I propose that this development is a direct result of the National Defense Education Act of 1959.

Direct dial systems are being accepted, program learning is being accepted, and, slowly, television is finding a place.

I would like to raise the question and not answer it: What are the factors which account for the slowness with which the devolvement of technology is accepted into education? Who is responsible? I think that this responsibility is shared by a great many people, including businesses and industries, and we might look, for example at which is limiting the acceptability of a great many materials that are on the market, from the point of their educational usefulness.

On the other side, we have plenty of room to study the problem of innovation from the point of view of formal educational institutions.

I conclude this brief statement by suggesting that we urgently need to formulate a set of recommendations which are consistent with the opinions, judgments, and evidence submitted in these hearings. And I will do everything that I can to help formulate these recommendations.

(The prepared statement and other documents mentioned by Mr. Carpenter follow:)

PREPARED STATEMENT OF C. R. CARPENTER

I am C. R. Carpenter, a research professor, psychology and anthropology, of the Pennsylvania State University. I am serving this year as an elected President of the Association for Higher Education, National Education Association of the United States. The Association for Higher Education has a membership approaching twenty-five thousand faculty members and administrators of the Nation's colleges and universities.

For fifteen years I have been actively associated with programs of research and development which have had the purpose of assessing and applying the so-called "new" and "mass" media, especially sound motion pictures, television, and associated equipment and materials, to the solution of education and training problems. I have been most interested in the improvement of university instruction.

The research and development programs have been sponsored by the Office of Naval Research, the Army, the Bureau of Naval Personnel, the Fund for the Advancement of Education of the Ford Foundation, the Carnegie Corporation, and most recently by the United States Office of Education.

I am hopeful that I can be of some assistance to the Joint Economic Committee in exploring the broad and complex fields of technology, and in particular communications technologies, and the even more complex field of the modernization of higher education. During our discussions and from this statement it will become evident that my experience has been in advanced or higher education, but I am also interested in programmatic research and in educational planning for states and regions.

In respect for your time limitations, I request the privilege of submitting a written statement for the record. In addition, I am pleased to submit a relevant paper of mine entitled "Research on Instructional Television." This paper was submitted for a Conference on *The Economics of Educational Television* held at Brandeis University, May 23–26, 1963. The full conference report may be of use to the Committee.

I reviewed briefly for this conference the extensive research on educational televised instruction compared with direct or conventional instruction, and reported the widely known finding that the effects on formal course learning are about equal. It was concluded, therefore, that in terms of instructional effects, television is an option which can be considered in selecting the means and strategies for solving training and instructional problems on many levels of our educational systems—elementary, secondary, and higher.

In this city, August 24, 1963, during the XVII International Congress of Psychology, I read a paper under the title of "New Technologies in Formal Education: The 'Mass' Media of Communication." I reviewed outstanding examples of technological developments in the United States, Japan, and Italy. I remarked about the slow rates of acceptance of new technologies by educators, particularly in higher education, in all countries. I dealt with the communication media and educational requirements, and reported the results of an experi-

ment, sponsored by the U.S. Office of Education, on the development of programed instructional materials which was presented to students by means of printed text, strip-film, television, and by a teacher. All methods and materials did a good job of teaching college freshmen the new mathematics and English composition. I am submitting a few copies of this paper for the use of the Joint Economics Committee.

I recorded in 1960 for The Presidential Commission on National Goals some uninhibited general thoughts and ideas on the potentialities of available communications systems and their applications in education. On reviewing this document in preparation for these hearings, it seemed to me that copies may be useful for your Committee, and I am, therefore, providing for your use twenty-five copies of this document. The concepts have not been reviewed elsewhere. Permit me to quote several short paragraphs from this document:

"The industrial revolution of the 19th century has bypassed (in large part) 20th century education. The recent (last twenty-five years) of significant developments in communication sciences and arts, although very appropriate and of proven usefulness for education, have been applied only peripherally and inconsistently to institutionalized education. Developments in communications have revolutionized other areas of national effort, like those of defense and security, but they have had little real effect on formal education."

"A systematic analysis of educational functions at all levels and for all kinds of educational activities is needed to determine which of these functions can best be performed by whom and by what specific means. Subsequently, it can be determined by operations analysis how and with what combination of electronic media (along with other facilities and resources) can and should be employed for greatest economy and effectiveness."

The document has many suggestions for action that are as relevant to getting the whole educational job done today as in 1960.

The report on National Goals dealt only obliquely with means of attaining them and to a very limited extent, indeed, with the involvement of the great and crucial communication systems, communications technologies, and media enterprises of the Nation. There is now a need, may I suggest, for a national study of where and how technologies of many kinds, but especially of the publishing and electronic communication industries, can advance and help accomplish the unlimited tasks of formal and informal education.

What is that whole task?

It is to provide opportunities appropriate to our society for each person to learn what he needs to know, and what he has the right and abilities to learn, wherever he lives and whatever the time or condition of his life.

Again, let us confront the question that should be asked and answered: How is the *whole* national job of expanding education and training to be done and by what combination of means?

I would agree that the well-known and mammoth dimensions of the tasks of education and training, on all levels and in all dominions, are so enormous that traditional institutions operating in traditional ways cannot do the jobs. The problems of transportation were not solved in this country by increasing the number of prairie schooners and ox carts. We must introduce new approaches in order to solve new educational problems. Surely merely expanding what exists is not an adaptive adjustment, and rationally the use of communication technology, appropriately designed and applied as can be determined by systems analysis, constitutes one set of resources which should be employed throughout education.

Our educational accomplishments should not be limited by the observed strengths or the inadequacies of our present formalized and structured educational systems.

The technically well-equipped universities are not being accused of dehumanized instruction because of automation and technology in education. The classical traditional institutions which have more students than are finding challenging opportunities for their energies and abilities are the ones that stand accused.

I have referred to education as an unlimited enterprise. Even with a constant population, education would be unbounded because research spawns more research, learning thrives and grows on successful scholarship. New and complex problems are discovered constantly and they require new and advanced solutions. Knowledge is true only for its limited time and it must be continuously revived and re-ordered. Therefore, education can use unlimited investments of resources of all kinds, including people of the best competencies using the most advanced

technologies of many kinds that are appropriate to the constantly enlarging tasks of education.

It has been observed in the report of the National Commission on Technology, Automation, and Economic Progress, under Chairman Howard R. Bowen, that the relationships between economics and education are complex. Good educational systems are prerequisite for a high level of economic performance. Such a performance, however, advances education. Constantly, therefore, education is or should be a major sector of an economy. When advanced technologies are applied, the interactions of the economic and educational processes are intensified and made even more complicated. Studies of these complex relationships will challenge economists when the significance of education and a nation's economic performances are realized.

For what direct purposes should modern technologies like those of computers and media of communication be developed and applied in education? What are the gains and advantages? Usually new equipment is introduced into industry or business to increase efficiency, productivity and profits, or to modernize for new products, to compensate for deficiencies and shortages of labor or to satisfy local ordinances and legal requirements. Why should the technology of education be modernized?

More pointedly, do we really want education to be efficient and productive? The stereotypical academician resents both terms when they are applied in education. We may wish to raise this question during our discussions.

It would seem that already educational costs exceed most authoritative estimates. The added cost factor, especially on the level of higher education, is the loss or reduction in earnings of students while they are students. Include this factor, and costs of our educational operations will approximate expenditures for defense and security. How can modern technologies affect costs?

Economic analysis of educational costs are irregular and limited. Each major institution keeps somewhat different sets of books. Furthermore, analytical sequential analyses of educational operations are rarely done. The function / performance / results / general consequences / costs series of analysis cannot often be completed because of the lack of a measure of the results or the product value of educational investments and efforts. Given this condition it is not surprising that economic analyses of the efficiency factors for media, enlarged libraries, language laboratories, etc., have not been made.

What technology are we discussing? Surely the Joint Economic Committee will wish to assess the full wide spectrum of modern and advanced technical materials, equipment, activities and people, and the operations for introducing these effectively into the means and methods, manners and mores of schools, colleges, and universities.

Educational technology includes publishing; books, especially textbooks, but millions of other kinds of printed materials as well. The number of journals and periodicals increases monthly on an already large base. For example, in the area of chemical engineering related to petroleum research there are estimated to be 5,000 journals. Included are new technologies which are so ubiquitous as to be overlooked by even scholarly symposia. Some of these are the telephone systems, teletype and facsimile reproductions. Most large school systems and universities operate large printing and print reproduction shops. Shall we include interior climate control machinery, or acoustical systems and acoustical design features of classrooms? What about the modern and advanced equipment for lighting laboratory, classrooms and study spaces? Computers are in, at many places and in many ways, but what about the electron microscope and similar research and study apparatus? Should we consider new equipment used for rapid measurements and analysis in physics, chemistry and the life sciences? Scientific photography, in a very wide range of kinds and types, invites attention of the economists of educational technology. Then come the electronic media; television, radio or telecommunications in a wide variety of forms. Finally, to end a list which is almost endless, there are the audio-visual facilities which have come to characterize the American classroom, projectors, screens, models, etc., all of which need logistical support from photographic and graphic studios. In brief, when we discuss educational technology we are referring to a vast array of different kinds of apparatus and equipment with some combinations useful for teaching and learning, and some combinations useful for research and for many general purposes.

A major educational technology problem is that of selecting combinations of "gear" that are best suited for the functions to be served. The indicated approaches are those of systems studies and operation analysis applied both to

educational operations and to the design characteristics of apparatus and equipment.

Lacking the suggested objective and systematic analysis of needs, functions and how they are to be served, by what equipment and what people, there are evident serious faults that amount to a prevailing mystique of technological solutions to educational problems and a prevailing mystique of the humanistic solutions to instructional and learning problems.

I need not review for this Committee in detail some of the major educational problems for which technologies are needed as parts of the strategies of their solutions. Providing fourteen years of education and training in schools and institutions provides plenty of room for massive applications of technology. Adapting education to cultural and individual differences cannot result from wishes, laws or even adequate funds; solutions to these problems require both the application of advanced technology and the development of very new ways of managing learning and creating favorable conditions for specific learning to occur. The estimated 10% per annum drop-out of college students may be equally wasteful as the high school drop-out question that has received national attention. The training and retraining of women in their homes offers interesting possibilities for the instruments of radio and television. Demonstrations have been made of possibilities in Great Britain. The so-called problem of leisure, early retirements, less work time may provide conditions for uses of technology that may also develop a needed theory and art of leisure in an achieving society.

We can call the roll of other major problems where technology could be used: The problems of libraries or the storage, retrieval and use of information procedures, the matching of the competencies and characteristics of people with jobs—a project that is being explored by the Association for Higher Education—improvement and extension of continuing education and arranging a marriage between printed course materials and electronic communications, development of superior instructional materials by empirical creative productions and validation, etc.—there are hundreds of other such problems.

It is the fashion to lament the slowness with which appropriate technologies are accepted and used by educators. Perhaps we lack a time perspective on this problem. Please note the following examples of rapid acceptance of new technologies and ask the question of why were these accepted: Computers are generally accepted and used in the management of institutions and in research. They are now parts of the academic landscape. Why? What role has the National Science Foundation played to stimulate widespread acceptance and use of computers? Note the high costs and extraordinarily rapid rates of antiquation have not retarded the purchases and uses of computers. Language laboratories have become symbols of prestige for American schools, due perhaps to aid from the National Defense Education Act of 1958 and to good salesmanship on the part of electronic industries. There have been approximately 10,000 of these laboratories installed in the last seven years. Now with aid from The Higher Education Act colleges and universities can, as is usually the case, follow the schools and install language laboratories. Incidentally, none of these is as good as should be the case. Educators are great users of telephones and dial access information and instruction systems are expected to become standard items in the near future. Interior climate control in Southern regions is accepted as part of building plans and costs. It is reported, I believe by the Educational Facilities Laboratories, Inc., that about one hundred instructional auditoriums or large classroom buildings are being constructed. These represent advanced departures in attempts to provide favorable conditions for large class instruction. A popular theme of planners is the "learning resources centers." The development at Florida Atlantic University and Stephens College are two examples of this kind of new technological development.

There are studies needed for many aspects of the problems of economics, automation and education. Among these studies are the following: 1. Operations analysis methods for jobs, functions, people and equipment in different educational settings. 2. Studies resulting in design models of methods and procedures for using technologies to develop improved instructional-learning materials. 3. Studies of factors favoring and opposing the introduction of modern technology as regular parts of educational operations. Studies should be conducted both from the viewpoints of industry and education.

In conclusion of this very brief introductory paper I would suggest that there be developed a set of consistent recommendations for industry, government, and education derived from this series of hearings on technology, automation and economics of education.

THOUGHTS ON AVAILABLE COMMUNICATION SYSTEMS (ESPECIALLY RADIO, FILMS, AND TELEVISION) AND THEIR RELATIONS TO USES IN EDUCATION AS MEANS OF ATTAINING NATIONAL GOALS, BY C. R. CARPENTER, JUNE 13, 1960

Whatever our national goals, and however they are defined, their attainment will require:

(a) Improvement of the quality of our educational products,

(b) Great expansions of our present educational systems,

(c) The uses of available resources and technologies not now adequately employed in the fields of education, and

(d) The invention and development of new and creative approaches to the solutions of difficult and new educational problems.

It seems to be impossible to meet the rapidly increasing demands being made on education and to adequately expand our educational enterprises merely by using traditional approaches, conventional buildings and facilities, and old methods of employing educational personnel. New dimensions of educational problems require extraordinary and new solutions.

The industrial revolution of the 19th century has by-passed 20th century education. The recent (last 25 years) and significant developments in the communication sciences and arts, although very appropriate and of proven usefulness for education, have been applied only peripherally and inconsistently to institutionalized education, Developments in communications have revolutionized other areas of national effort, like those of defense and security, but they have had little real effect on formal education.

A basic requirement of education in a democratic society is: Appropriate opportunities shall be provided for each citizen to learn what he has the need for and right to know.

Our present educational systems, even if expanded greatly, cannot satisfy this basic requirement without using the fullest potentials of the new media such as radio, films, tapes, television, as well as print in many new forms.

A systematic analysis of educational functions at all levels and for all kinds of educational activities is needed to determine which of these functions can be best performed by whom and by what specific means. Subsequently, it can be determined by operations analysis how and in what combinations the new electronic media, along with other facilities and resources, can and should be employed for greatest economy and effectiveness.

The distributive functions of the new media, as they now exist and can be developed, are especially capable of reaching ("providing learning opportunities") for our expanding population from the present base line of 180,000,000 citizens. These media if properly used can make large strides toward providing for each citizen:

(a) Accumulated knowledge of the centuries,

(b) New knowledge as it is discovered,

(c) Information and instruction needed for making adaptations to a rapidly changing society,

(d) Formal instruction beyond the capabilities of present educational systems,

(e) Skills training for better living can be provided for millions of people in their homes and communities,

(f) Information and guidance for career and professional developement, and

(g) Information needed by all responsible citizens in making decisions about the conduct of a complex democratic government.

A forceful argument could be made for the proposition that this nation has misappropriated (and underestimated) the vast potentials inherent in radio, motion pictures, television and related media. These potentials have been invested disproportionally in advertising and entertaining efforts. We have grossly neglected using the potentials of these and other media for centrally important and constructive educational purposes. We have debased the public images of the communication arts. We have mis-assigned invaluable national resources in the form of wave bands and channels. It is imperative, therefore, from the point of view of education to correct this situation at the earliest possible date.

Inventions and developments of the 20th century have given us a practical and new language—pictorial communications. We need to learn to use this language and its media carriers for the central purposes of education. Here we need to capitalize on the spatial reaches and the time-spanning potentials of the electroni-

cally transmitted pictorial language. We need to employ in education their characteristics of immediacy, realism and speed of transmission. They can greatly multiply a single source of information or instruction by distributing the original to millions of people who are widely dispersed geographically.

The new media also greatly extends the possibilities of person-to-person communication and extends the uses of speech and print.

Therefore, education has high stakes in the new media, stakes largely unrealized by professional educators, for employing the new media optimally for solving some of education's crucial problems.

Plans for the achievement of national educational goals of the United States must appropriately include the new "mass" media because by using them many kinds and levels of instruction can be made available to the people of the nation "at minimum cost and maximum convenience." Furthermore, by using them:

(a) The best teachers in any field, from this or other countries, can be made widely available to those who would learn.

(b) Superior instructional resources and methods can be employed.

(c) Opportunities for appropriate learning can be made available democratically to all citizens, rather than only to the restricted and selected elite now being admitted to over-subscribed schools, colleges, and universities.

(d) The new media provide a possible means of solving simultaneously many aspects of both the "quality" and "quantity" problems of education.

The primary functions of the new media of communication are relevant to the achievement of national educational goals because:

(a) The focusing of large amounts of resources and efforts on the production and programing of courses of study promises a possible "breakthrough" in the quality of instruction.

(b) The media can record, order and store for use when needed great ranges of learning and cultural materials.

(c) They can repeat programs as required to teach to desirable levels of mastery of subject matter.

(d) These materials can be duplicated, multiplied, reproduced and distributed as required to achieve complex and varied educational objectives.

(e) The media can be used to guide, encourage and promote excellence of learning for people who are in schools and higher educational institutions, for those who have completed formal courses and for those people who are excluded from educational institutions.

By means of recorded programs it is possible to reach out over the entire nation and the world for instructional materials which are not normally available for educational purposes. We can bring to the school and classroom, to the home and to the community, authentic and real events in history, government, science, and engineering. We can reflect the real world within the classroom where what is taught is so often perceived by students to be remote from reality, abstract and sterile.

Television is an instrument of education which creates a window through which the citizens of the nation can observe and come to understand the form and substance of education. Also, through the window of television, pupils and students can observe the real world to which they must learn to adjust. Thus, the public myths about education and abstract academic misconceptions of reality, and of the practical world, may to some extent be corrected.

Population increases, the growing complexity of our society, the rapid expansion of knowledge, the demands for increased skills, the imperative requirements for excellence in education and professional performances; all of these would seem to require the maximum and appropriate uses of modern systems of communication (the "mass media") in order to implement the concepts of our basic documents, especially the Bill of Rights, relative to the education of people for living in a democratic society.

Modern systems of communications and their correct application provide a potential means of internationalizing education to an extent not hitherto feasible. The exchange of programs and linkages across national boundaries could importantly advance international understanding, facilitate the learning of different languages and provide a rapid and effective means for sharing broadly both cultural and scientific advances. The new media, especially radio, applied for education in emerging regions like Africa could be one means of helping these peoples leap forward from primitive societies into the contexts of 20th century society.

It is imperative that the Federal Communications Commission, supported by other cognate government agencies, review and modify existing rules and regulations for broadcast radio and television channel assignments:

(a) To provide nationwide and entirely adequate channels or broadcast bands for justified educational purposes.

(b) To balance the assignments of the nation's broadcast channel resources between commercial and educational interests.

(c) To establish policies and procedures which will encourage, facilitate and promote rather than obstruct the use of both broadcast and closed-circuit television for educational purposes.

(d) To provide for the international linkages and cooperative operations of broadcast facilities, and for the exchange of programs and cultural resources.

It is recommended that appropriate governmental and educational agencies (perhaps through the American Council on Education) working with top management of radio and television networks and national organizations of stations, review the "public service" obligations of commercial broadcasters. One objective would be to determine whether *more time, better time* and the better educational uses of "public service" time could not be arranged. Such an analysis, if done objectively, may show that it is in the mutual interest of education and commercial broadcasters to commit more and better time to truly educational programs either on a sponsored or "public service" basis. If negotiations fail, it may be necessary to review the legal requirements for "public service" programing of commercial interests, and perhaps to write new laws and regulations or to enforce those already in effect.

An analysis should be made of the motion picture industries. This should be done by public spirited and fair minded leaders of the film industries working objectively and cooperatively with several distinguished educators. The objective of the study would be to assess the actual and potential resources of the motion picture industries which could properly and feasibly be re-directed and made to serve the fundamental needs of national education. The study group should develop broad comprehensive plans with specific recommendations for actions for using the potentials of professional film production to assist in the achievement of national goals. The precedence for this action would be the contributions of the film industries to the military training programs during World War II.

The Federal Government, working with state and local authorities, should take all necessary steps, including financial assistance, to establish and operate nationwide networks of both radio and television. The operation of these networks should be for serving the *critical* and *appropriate* educational needs of the nation. The national networks should be linked with and consist of regional, state and local subsystems. In addition, linkages by both cables and microwaves should interconnect school systems, colleges, universities and professional schools for the purpose of sharing basic *high quality* instruction. Multiple broadcast and closed-circuit channels and facilities should be provided in areas of large populations when programs serve legitimate educational purposes. Video tape or other new media should be used as required in the production, storage and distribution of instructional programs.

Laws and regulations should be changed or drafted and enacted which will permit the use of regularly approved educational budgets for purchasing and operating communication systems, facilities, and instructional programs.

Regulations governing the building and equipping of school, college and university buildings should be changed to accommodate to new electronic communication systems. All educational buildings should be constructed to be very suitable for the reception and use of remotely originated radio and television programs, for instructional films and other auxiliary communication devices relevant to education.

During the decade of the 1960's the possibilities should be visualized of having several airborne transmission sources blanketing the nation with basic and essential instructional programs.

Furthermore, before 1970 it may be feasible to use communication satellites for educational programing of courses of instruction, and thus provide a means of distribution which avoids the complexity of ground stations, microwave links and cables.

The antiquation and replacement of educational facilities should be scheduled just as this is done in modern industry or business.

It is proposed that a strong and well staffed organization of dimensions appropriate to the magnitude of the task, be established and operated for the purposes of identifying, locating, procuring, editing, organizing, reproducing and making ready for distribution the vast resources of films, pictorial materials, sound and video tapes which now exist and are being produced at a rapid rate, but which are

not feasibly available for educational uses. The search for these learning resources would be worldwide and not restricted to the United States. (This organization could possibly be a branch of the Library of Congress.)

It is recommended that 4 or 5 regional educational production centers be established in the United States with the necessary personnel, buildings and equipment for producing the needed instructional programs for both formal (institutional) and informal (technical, professional, adult and continuing) education. These production centers should have the capabilities of producing instructional materials of the highest quality and in adequate quantity. The production of these centers will be given national and international distribution as needed to achieve our educational purposes.

Wherever the new media are now being used, the one great need is for the improvement in the quality of programs of information and instruction.

Achieving national educational goals by employing appropriately new instrumentation will require the selecting and training of new kinds of professional educators, who ideally would combine the qualities of the best teachers and educators with the best of the talented men and women who are now committed to the production of entertainment films, commercial radio and television programs. Hence, educational centers for training these new professional educators should be established immediately by distinguished forward-looking universities. The number of centers and the number of people in training should equal estimated demands for the graduates (my guess is an average of 100 per annum for the next 10 years).

Programs of teacher training now operating throughout the nation rarely include orientation and the training of teachers for cooperating in the use of new communication systems as a principal means of instruction. Therefore, it is imperative that programs for training all teachers should include elements or units which instruct them in the potentialities, limitations and modes of operating these systems as well as the probable necessity of their extensive use in the near future.

It is of critical importance to select and train to advanced levels those exceptionally capable teachers who will produce instructional programs for wide distribution.

Investments are needed in research and development with the objective of inventing and designing new and appropriate instrumentation, apparatus, equipment and improved facilities specifically for purposes of instruction and learning. These investments will pay high dividends. Equipment which is modern and functional in design and which is so constructed and used as to apply learning principles in school and college classrooms and laboratories is rare indeed. There is a special need for new equipment in classrooms for receiving and effectively presenting to students instructional materials transmitted by television and radio, but the same need exists for the educational uses of films and graphics. Optimum learning environments need to be created. Therefore, $5,000,000 per annum should be invested in grants through the National Science Foundation for purposes of stimulating the development of new instrumentation for teaching and learning.

The distribution of instructional materials, including those for the new media systems, will require (a) a complete national distribution service with depositories in regions, states, cities and communities, or (b) distribution services and functions must be added to existing and new libraries. It is recommended that the latter, (b), alternative would be best provided libraries can be organized, librarians properly trained for the additional work and funds made available for the necessary expansion of libraries, buildings and facilities. Present audio-visual libraries throughout the country should be amalgamated with public, school and college libraries.

The instructional materials and learning resources of museums should be made more widely available than at present to the people by the use of television and films.

The National Defense Education Act of 1958 should be continued and expanded. New titles should be added to support specific action recommendations. Furthermore, provision should be made in the Act for research, experimentation and demonstrations of how the new media, and other modern educational resources, can be used in the most effective and appropriate combinations with conventional methods, procedures and printed materials.

New Technologies in Formal Education: The "Mass" Media of Communication by C. R. Carpenter

Purposes. The main purposes of this paper are: 1. To outline possibilities of 'new' developments in communication technology and give examples of advances involving 'mass' media, with special emphasis on television. 2. To state the problem of the highly developed communication technology, its appropriateness for education and learning, but the limited extent of its present use in education. 3. To report some general results of research and developments in the fields of mass media and of emerging educational technologies. 4. To make suggestions about the possible integration of programed learning and the use of the 'new' media. 5. Finally, to estimate the needs for research on complex human learning.

Scope and Emphases. This discussion is discursive and broad in perspective. It is intended to be provocative, and challenging to the imaginative thinking about the possibilities of meeting the vast and rapidly increasing educational needs of the world by effectively managing and using available and modern 'mass' media of communication. The emphasis is on applications and actions rather than on analytical and controlled research. However, reference is made to the general results of research; questions are stated that may challenge further research; and a plea is made, finally, for expanded and improved research of many kinds and on many levels in the area of complex human learning.

Definitions. The hybrid interdisciplinary fields of an emerging educational technology require definitions of the main terms of the subjects being discussed. Many of these terms are very ambiguous, have pluralistic meanings in different contexts, and are often grossly misused. Hence, a few definitions, if they can be accepted, should facilitate our mutual understanding.

Technology means the applications and advances made as a consequence of the use of scientific knowledge, methods, and research in a field of an endeavor. The concept of technology, therefore, in addition to referring to the apparatus or facilities, includes the activities of developing, adapting, introducing, and systematically evaluating applications in the field of formal education.

By media is meant the materials and equipment systems through which stimulation, forces, or influences act to some effect, or through which or by which something is accomplished. Media are, therefore, the substantive means by which an effect is transmitted or produced. The qualifier "mass", in mass media, refers to diffusion or distributive possibilities for reaching large numbers of people and the program coverage over space and time. The media under discussion for education can be conceived of as carriers of information or of stimulus materials.

Often the media are confused with the information, stimulus materials, or programs carried by them. For example, many research reports on the effects of radio, films, and television attribute the effects to the media and associated instrument systems, whereas the effects actually result from the stimulus materials that are mediated, their organization and characteristics and the interactions or transactions with people who perceive the stimulus materials.

The very generalized term, education, is variously used. For this discussion it is desirable to define education as follows: It is the activity of arranging and regulating conditions which increase the probabilities that desired learning behavior will occur in individuals and populations. Thus, the term education is, by this definition, essentially transformed into the psychologically more meaningful concept of learning or changes of behavior.

Examples of Technological Developments in Education

The National Educational Television Center in New York has associated with it about seventy-five television stations, and an increase to one hundred is estimated for the period 1968–1970. Expansion has been stimulated recently by the provision of thirty million dollars in federal matching funds for educational television facilities. Soon the United States will be blanketed, therefore, by a new tape-connected television network committed to serve formal education, to a limited extent, but mainly for general educational and cultural purposes.

In September 1963, the Midwest Airborne Television organization will fly for the third year a transmission plane to broadcast formal instruction from video tape to within reach of 13,000 schools and educational institutions of a region that includes all or parts of five midwestern states. About five million pupils and students will be physically under the distribution cone of the transmitter plane. Two channels will be employed this year but it is planned eventually to use six channels for simultaneous broadcasting for six hours of each school day.

A cable network interconnects most of the schools of Washington County, Maryland, for distributing up to six programs of instruction simultaneously to students in classrooms. A similar model is used at Anaheim, California, where one course of instruction is available to as many as 500–1,000 pupils. South Carolina is developing a state-wide cable network which insures that the same stimulus materials are provided to all the schools of the State. Four closed-circuit television installations at the Pennsylvania State University have the capacity to serve at one time a total of about 4,500 students.

Both in Texas and in Oregon about six colleges and universities are interconnected and share televised courses which are developed, supervised, and used on a cooperative basis. In Chicago a complete curriculum for the first two years of college is made available throughout the broadcast area. State and regional networks are being developed slowly throughout the United States.

During the past five years, two commercial television networks of the United States have demonstrated, for the whole nation to see, the possibilities of the distribution of selected, exceptional, and formal courses of instruction for which universities have provided supplementary services and awarded academic credit. These programs are being discontinued by the networks (11, 2).

There are also dramatic examples of instructional television and radio technology being used in other countries. In Japan, The Japanese Broadcasting Corporation, a quasi-governmental educational and cultural network, operates on a budget equivalent to one hundred million United States dollars a year. At an early date 95 per cent of all the schools in Japan will be served. In Italy, an estimated 100,000 people are being taught to read with instruction mediated by both television and printed materials. The national educational network in Italy is also being developed importantly for elementary education, especially for the small isolated schools, and supplied with especially prepared course materials, distributed by printed materials and by television.

The United States Department of Interior and the Administration of the Trust Territories are establishing in Samoa a three-channel system of television which will be used to provide comprehensive formal instruction for the schools of the Island, not as auxiliary aids, but as the principal means of accomplishing the total educational job.

Communication satellites are being developed and tested. Telstar, Relay, and Syncom are the species names of experimental models which the United States Government and private industries, perhaps later in cooperation with other nations, will surely develop into an international communication system. Whether or not any of the vast potential communication power will be reserved and used for formal educational purposes is an issue which should already have been resolved.

Significance of These Examples. These developments illustrate applications of communication technologies which have evolved so rapidly as to be revolutionary. The examples also illustrate the possibilities for employing different media for formal instruction. The examples do not, however, reflect the limited extent to which the technology of radio, film, tape recordings, and television is actually used in the total educational and training enterprises. It is estimated that only about one percent of the total formal educational activity of this Nation involves in any way the uses of the so called 'new' mass media. [1]

In Europe, as well as here, the logistics, strategies, and tactics of education are largely locked into traditionalized molds which are very resistive to innovations and changes, however necessary these appear to be to meet the massive and rapidly increasing needs and demands of education. Everywhere there are high social and professional barriers to the introduction into the educational systems of "new" communication technologies even though these are developed, proven, and available. Thus, the evolution of a new, modern, and advanced technology of education is only beginning to emerge very slowly (5).

Slow Acceptance of New Technology: This introduction of modern communication technology into education is on a token basis in the United States. It is significant that the serious debate in Great Britain is on the issue of using television for commercial purposes, for the possibilities of importantly extending the uses of radio, television, films, and video tapes, and other recordings into formal instruction, except on a supplemental basis, are only being considered to a limited extent and by a very few British educators. The Canadians have progressed only to the stage of debating possibilities of the "mass" media for

[1] The one percent estimate is made on the basis of the estimated percentage of costs of media relative to the total costs of education, and on the total student credit hours of instruction and the percent of this total in which media are thought to be involved.

formal learning, and are engaged in holding conferences. France has a national television network available for instruction in the schools of the Nation, but the programs are supplemental to regular instruction and can be accepted or rejected by the schools of the provinces. Elsewhere there are even more serious instances of cultural lag.

All-India Radio will soon blanket 70 per cent of the population of India, in some areas with two channels. The magnificent and expanding radio facility of India is predominantly used for entertainment and general cultural programing. The serious and extended use of radio for literacy training and for advancing the learning of common languages is neglected in a country where these educational accomplishments are crucial to national economic and social development. India's number and volume of film production are second or third in rank in the world, but the use of films for formal instruction is vaguely understood, particularly by most Indian educators. Hence, the employment of film and other media technologies is neither being realistically planned for nor built into the expanding educational system.

When new educational technology are viewed in a worldwide perspective and in terms of the overwhelming dimensions of the needs for education in all areas of the world, and when the influences of the more on the less developed countries are assessed, an observer is led to wonder if, indeed, the more developed countries are not exporting and propagating antiquated educational systems into the rapidly developing countries. For example, literacy is assumed to be necessary for technical training. Extensive and appropriate training of many kinds could be accomplished at the non-literate levels by the correct use of radio, films, and television.

Furthermore, while the great continent of Africa is being blanketed by short-wave radio broadcasts which are being used in the contests for world influence and power, copies of traditionalized European and American educational systems and practices are being transplanted and only moderately adapted to the conditions and needs of the people of Africa.

Some Significant Questions. There are four major questions which are congruent with the theme of this discussion thus far:

1. Granting that, during the last quarter century, revolutionary developments have been made by science and engineering in the fields of communication technology, what conditions or social forces have favored, and what forces have opposed, the application of this technology in education?
2. Observing that some examples of exploratory advances have been made in applying modern communications technologies in education, why has the scope of applications been so limited relative to the great needs and rapidly increasing demands for education and training?
3. Why are the results of scientific and technological developments, many of which are spawned and nurtured by educational institutions, neglected or even rejected as communicative forces for instructing and learning in formal education?
4. Why, in both large and small countries, in the industrially mature and immature nations and regions, where efficient and extensive communication facilities already exist, are they not used in due proportion for educational purposes?

These are some of the questions which should be of interest to behavioral scientists who investigate social processes and complex problems of national and international significance. The crux of the problems under discussion seems to lie in the area of social change and in the regulatory processes of the development and acceptance of adaptive innovations. On a practical level the problems are to design strategies of social action which will accomplish the modernization of the technologies of education.

Research and Development. The problems and possibilities of *Graphic Communication and the Crisis in Education* were provocatively reviewed by Miller, et al (6) in 1957. In this book, we used the film and film research to illustrate the possibilities of technology of the mass media for meeting mounting educational requirements and for applying a system of learning theories and principles to the educational problems of the United States. The evidence used and the logic employed are equally fitting for radio and television, and indeed for many other media.

The recently developed approach and concept of using selected and appropriate combinations of different media and modes of communication integrated into a total functional system could not have been described when *Graphic Communication and the Crisis in Education* was written. This systems approach was outlined on the basis of considerations of operational analysis of teaching, media, and

learning in 1958 and briefly described in *New Teaching Aids for American Classrooms* (7). This book, edited by Schramm, gave a general review of research results on the so-called 'new' media, especially television, and of the implications for improving teaching and learning.

Another book also edited by Schramm (8) and published in 1962 was entitled *Educational Television: The Next Ten Years.* This book accepted the fact that the available research evidence was adequate on the effectiveness of television for appropriate educational functions. It moved on to describe, in considerable detail, the requirements for building television into the new educational technology of the Nation.

These reviews of research and of theories reflected two phases of intensive work on two of the media under consideration, films and television. There was a decade, roughly 1948–1958, of rather extensive research and development work on the characteristics and variables of sound motion pictures, and how they could mediate the functions of instruction and learning. Another period, beginning about 1956 and continuing, is one during which the potentialities are being explored for using television in education. (1) No really comparable research efforts have been made for radio. In fact, however, few educational developments have been more extensively explored by research for application possibilities than has television.[2]

A wide range of different types of research has been sponsored and conducted but the greatest emphasis has been put recently on comparative studies of media-methodologies or on what may be termed quality-control research, and on research and development for finding and for applying the means to solve important practical problems in education.

Results of Comparative Studies. This is not the place nor the time to review research results in detail. However, general results of comparative studies and their implications for a new technology in education are pertinent for this symposium.

Stickel (10) completed in 1963 a very critical review of the results of studies which have compared conventional or direct teaching with televised instruction. Two hundred and fifty studies of this problem were analyzed. Ten of the two hundred and fifty met very strict criteria of experimental design. None of these studies yielded results which showed statistically significant differences between direct instruction and televised instruction when televising the instruction was the experimental variable. Twenty-six other studies were qualifiedly accepted by Stickel even though they had limited faults of experimental design. Twenty-two of these twenty-six studies showed no statistically significant differences, and four showed differences favoring televised instruction. The remaining two hundred and fourteen studies often had some importance as demonstrations and explorations, but they could not be accepted for purposes of assessing the effectiveness of television as a condition affecting learning.

The general conclusion is strongly supported, therefore, that when televising the instruction is the only experimental condition, and when all other contingent variables are properly controlled, no measurable differences in student learning occur between direct teaching and teaching done through the medium of television. Furthermore, this finding seems applicable to a fairly wide range of subject matter or courses, and over levels of education which include secondary schools, colleges, universities, and adult education. The finding can be generalized over a fairly wide range of methods, excluding those necessary for fully developing perceptual motor skills, and excluding those which require intensive interactions of the teacher with students. The experiments with television have especially emphasized lectures, lecture-discussions, and lecture-demonstrations.

Practical Implications of the Studies. The following are the practical implications of extensive comparative research, in which television is the experimental condition: The special capabilities of television can be used to distribute and multiply units, courses, and curricula of instruction for large numbers of students. Television as a transmission system has the capability of handling very wide varieties and qualities of auditory and visual stimulation, and these stimulus materials can be so organized and controlled as to produce many kinds of desired learning responses. All of the potentialities of television, and of other carriers

[2] The research lines on films, television, and to some extent on radio was initiated by the Office of Naval Research, at the Special Devices Center. Also, important contributions to the field have been made by research and development on instructional materials, equipment, and methods both by the Army, especially by the Human Resources Research Organization, and by the Air Force. The Fund for the Advancement of Education of the Ford Foundation and Title VII of National Defense Education Act have supported and significantly advanced research and development of the 'new' media as applied in formal education.

of information which can be used through television, provide the means for selecting, organizing, distributing, and presenting stimulus materials with greater precision of controls of displays than can be done in most conventional instruction. The effects on learning depend predominately on the characteristics of students and the characteristics of the content; the ways in which it is organized, the interactions (or 'transactions') between the stimulus materials and the learners, their responses, and the reinforcements of the learning responses. The effects on learning of television, per se, except in special cases, compared with all other factors affecting learning, are incidental and minor.

Well controlled comparative studies have used the same instruction; the same teacher(s), content, and content organization, and methods as the quality-control standard with which televised instruction has been compared. Usually the quality of the involved instruction has been far above average. The results of such studies would be very different if comparisons had been made with the results of the average teaching over the full range of instruction available in educational situations. Furthermore, the broadcast media could make it possible to provide instruction, especially in some subjects, where it is not possible to provide such instruction by other means. Finally, it should be realized that the channelling of conventional instruction through radio, films, or television is not the best possible way to use the media for stimulating learning. Thus, the necessary quality control studies of relatively effectiveness are no longer needed. The problem now becomes that of determining how the media can be used, singly and in combinations, to meet the full and stated requirements for learning.

Furthermore, the possible iconicity or the realism of speech, and visual communication of television and films may make it possible, for example, in countries like those of Africa and India, to train large numbers of people in necessary skills without first teaching them to read, or of requiring reading as a condition for learning the skills that are needed.

The standards involved in conventional instruction are quite easily attained by televised or mediated instruction. The lecture and lecture-demonstration, as generally employed in American education, and indeed throughout the world, are as notoriously ineffective as these methods are ubiquitous. The reasons for the low effectiveness, efficiency, and productivity of lectures, lecture-discussions, lecture-demonstrations, and a wide range of other widely used educational methods are becoming known. Skinner (9) has given reasons for the lack of efficiency of conventional instruction and has proposed, in this symposium, improvements in learning by means of programed instruction applying the concepts of operant conditioning.

Generally, the challenge to the development of a 'new' technology of education is to create those conditions which have high probability for insuring that desired kinds of learning will occur. For psychologists, the problem is to apply what is known with fair confidence about the structure and organization of knowledge, about the rates and patterns of intellectual growth, about sensory-perceptual processes, about cognitive organization, intellectual powers, and their regulation, about the dynamics of affectivity, emotionality, and motivation, about goal oriented behavior and levels of aspiration, and about the reinforcing and interfering effects of socio-cultural environments on learning.

Research and development work has clearly shown the possibilities of applying some facets of these bodies of knowledge in and through the 'new' media as new technologies of education are expanded. The complex requirements of this work, however, cannot be reduced to simple formulae. Nor can all the educative conditions be provided or mediated by radio, sound motion pictures or television, however broad the bands are for carrying different modes of stimulus material and information. The media under discussion have limitations that are well known and must be accepted; they have special capacities which are also well known and should be utilized in education.

The Media and Educational Requirements. There are some requirements of education relative to which the mass media are especially appropriate. These requirements exist in almost all nations of the world. They are the requirements for educating very large numbers of people through basic levels and for encouraging the continuation of their education throughout most of the entire life cycle, for training some people to very high levels of proficiency, and for doing all these things rapidly and efficiently. Relative to these requirements, the "mass" media appear not only to be appropriate but also to be essential.

The basic fact is this: The great dimensions of the educational tasks, occasioned by enormous increases in populations and the growth of the sciences and tech-

nology of the modern world, simply cannot be accomplished by the tradition-bound educational approaches, nor by educational institutions as they are now organized and operated. The dimensions of the requirements are so great that, however extensive the expansions in kind of our present educational institutions and organizations, the whole job cannot be done by them. New approaches, new patterns of education, new means and new goals need to be invented, developed, and applied. New technologies of education, in which the "mass" media are fully and appropriately exploited, should be included as components of the total educational systems.

Programed Learning, "Teaching Machines" and the "Mass" Media. The crucial general problems in the development of new technologies of education, assuming commitments to use the new media are these: 1. The selection, organization, and production, in appropriate sign-symbol modes, of the stimulus materials or content. 2. Selecting and using appropriate combinations of the mediating modes, media, and facilities. 3. Distributing and presenting the stimulus materials to learners under conditions which maximize the probabilities that desired learning will occur. 4. Providing for appropriate learning responses, their assessment, and their reinforcements. 5. Establishing and achieving stated performance standards. In brief, part of the job is to provide the means for applying the known facts and principles about complex meaningful human learning.

The development of "programed learning" approaches, methods, and techniques represents a special case of the application of a special set of behavior theories to learning behavior. The main contributions of this development seem to be in specifying the requirements for selecting and organizing the content (or stimulus materials) for instigating relevant learning responses, and for providing for systematic reinforcement and assessment of learning responses. It is precisely in these areas that there are both needs and great possibilities for improving the effectiveness of instructional media programs. Therefore, the development of programed learning should be merged with the application of the "mass" media for instigating and regulating learning.

On the one hand, programed learning approaches provide new patterns for the production of programs for radio, films, tapes, and television; approaches which are very different from conventional teaching and from entertainment, general education, and cultural programs. Not only conventional teaching methods but also the usual media production formats are known to be very inefficient for stimulating and regulating many kinds of learning. The organization and presentation of stimulus materials in programed formats in media productions emphasize the necessary interactions between the stimulus materials and the learners. Such programs make it possible to eliminate much of the inefficiencies of the intervention of teachers between the materials to be learned and students. Thus, very advanced types of programed media productions are suggested. What is the evidence that this can be done?

Report of an Experiment. After two-and-one-half years of research and development work on the possibilities of integrating programed learning with television, my colleagues and I at the Pennsylvania State University are prepared to recommend that, for many kinds of learning, the programing of stimulus materials ought to be done for instructional media productions, including those for films, radio, and television.

We have found that the integration of programing and the media can be accomplished by experimentally regulating the rates of development of the content, and by predetermining the average pacing rate that is required for relatively homogeneous populations of students. Television can be employed for presenting the stimulus materials and for mediating reinforcement functions. Print or electronic "feedback" systems can be used for responses and record functions. (4)

Extensive comparisons of four different means of presenting a fully programed algebra course and a supplemental course in English grammar showed no statistical significant differences among the four methods and media. The media used were programed books, a simple type of teaching machine, film strips with projection, and closed-circuit television. Thus, the possibilities seem to be very promising for mediating programed materials by television, supplemented by print and other modes of reciprocal communication.

Some acceptable reduction in effectiveness of this approach compared with individualized instruction may need to be accepted and balanced off against the advantages afforded by the media in producing, storing, distributing, and presenting the instructional materials to very large numbers of people. But, the broadcast media can be used to reach learner populations which are widely dispersed

geographically. The gains in the efficiency and productivity of the suggested merger, depending on utility rates, or populations served, can be tremendously greater than the efficiency of individualized instruction.

The possibilities are suggested, also, by our research, both on television and language tapes, that programed instruction can be used with radio, especially for language learning. Various forms of film, audio and video tape media can also be utilized. Especially, it seems promising to use combinations of different media infunctionally designed systems of instruction.

In addition to print, electronic response and "feedback" or reinforcement systems are being developed for use as auxiliary equipment with radio, films, tape recordings and for both closed-circuit and broadcast television and radio.

It is possible that the introduction of teaching machines is an unnecessary and inefficient alternative to the development and adaptation of print and the "new" media for implementing the essential requirements and characteristics of programed stimulus materials.

The Needs for Research on Complex Human Learning. The research which has been done on media has been predominantly of the developmental and applied kinds. This has been useful and necessary for demonstrating the potentialities of modern communication technologies and for showing how they may meet the vast educational needs of the world. To some extent, also, the research has speeded up the applications of these technologies in some areas of education. However, research problems that are fundamental, even when the communication media are involved, must deal with basic theories of knowledge and the organization of subjects and tasks for learning. Basic problems also involve theories of perception, of cognitive and of many intellectual factors. Many other problems in the behavioral sciences require far more extensive and systematic research of the highest order of excellence. Basic research on meaningful complex human learning and the formulation of new and refined statements of the principles of learning, which will have more validity than those that are already formulated, are required as an essential part of the development of a new, successful and advanced technology of education.

The uncertainties and confusions about most existing learning theories and their lack of practical usefulness, as these are understood by the educational practitioners and teachers, may be a principal cause for the great gulf which exists between the highly developed communication technologies and the slow and inadequate uses of them in education.

As a result of a thorough study in this Country of the needs for research and development work in the area of complex human learning, I have suggested that about $100,000,000 a year should be invested in a sustained systematic research effort on the problems of meaningful complex human learning. (3) The proposal requires the establishment of a national complement of learning research centers. The Congress of the United States has authorized the United States Office of Education to take the first step toward establishing six Learning Research Centers during 1963–1964. A new technology of education can be no better than the valid knowledge on which it is based.

Another main cause of the gulf is that the science of human learning either does not exist or has not been adequately applied to the problems of preparing the instructional programs and of using the media most effectively and efficiently for educational purposes.

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(Additional contributions by Dr. C. Ray Carpenter appear in the appendix.)

Chairman PATMAN. We will expect you to comment after the other witnesses have been heard.

Thank you.

The next witness is Dr. John Folger.

STATEMENT OF DR. JOHN FOLGER, DIRECTOR, COMMISSION ON HUMAN RESOURCES AND ADVANCED EDUCATION, NATIONAL ACADEMY OF SCIENCES

Mr. FOLGER. My name is John Folger. I am Director of the Commission on Human Resources and Advanced Education of the National Academy of Sciences. This Commission is engaged in a major study of supply and demand for college-educated persons in all fields, and the statement which I will introduce is directed at the question of whether supply and demand problems have exerted a pressure for the introduction of technology in the past and whether they are likely to introduce such pressures in the future.

In other words, will the shortage of teachers require the addition of technology to do jobs that we do not have people for? The paper briefly reviews the rapid enrollment growth at the elementary and secondary levels during the past decade when about 14 million students were added to the elementary and secondary schools in this country. The paper points out that the teachers to provide for this enrollment growth came from two sources: First, recent college graduates who provided 70 to 80 percent of the new teachers added in the last decade and (2) returning, reentering teachers who filled 20 to 30 percent of the vacancies.

I point out that during the last decade, there has been an improvement in the qualifications of elementary and secondary teachers according to data supplied by the National Education Association; the elementary teachers without a bachelor's degree declined from about 35 percent in 1954 to only 15 percent in 1964.

I also point out that there has been a slight improvement in the teacher-pupil ratio in the last 5 years, although, in general, this has been a fairly stable relationship.

Then, I point out that in the next decade the schools will grow at a slow rate and that the number of teachers needed during the next decade will be slightly less than half the number that have been added during the last decade.

And then I point out the fact that in the 1960 to 1965 period, about one-third of all college graduates were needed to enter elementary and secondary teaching, but that in the next decade this percentage will decline to only 20 percent by 1970, and 16 percent by 1975, so that the conclusion you can reach for the elementary and secondary schools is that there will be larger supplies of qualified teachers in relation to the demand, and if there have been any shortage pressures that have existed for the introduction of technology into education, they will be less in the next decade than they have been in the past.

This, of course, says nothing at all about the need to introduce technology into education to improve the quality of education.

We make a similar analysis for the supply and demand situation for college teachers. There was an increase of about 2.2 million college students in the decade 1955–64, but in the coming decade we anticipate about 3.8 million additional students, so that the colleges will grow more rapidly in the next decade than they have in the past.

And we also point out that this growth has been made possible in the last decade by somewhat greater use of part-time and graduate student personnel to carry out the teaching functions and by an increase in the number of pupils that each faculty member handles, from about 15½ in 1955 to about 18 in 1965.

And we also point out that the supply of graduates with doctor degrees is increasing rapidly, but the requirements for college faculty are increasing even more rapidly in the period up to 1970, but after 1970 the supply of potential college faculty members will be much greater in relation to demand than it has been at anytime during the past 5 years or in the next 4 or 5 years.

So, the conclusion for the colleges is similar to the conclusion for the elementary and secondary schools but at a different time point, that is, after 1970, the supply of potential college teachers in relation to demand will be much better than it has been in the last decade. The conclusion is that the teacher shortage pressures which might introduce pressures for technology will be less in the next decade than they have been in the past, so that whatever pressure the teacher shortage has exerted will be less in the period after 1970 than it is now.

(The prepared statement submitted by Dr. John Folger reads in full as follows:)

PREPARED STATEMENT OF DR. JOHN FOLGER, DIRECTOR, COMMISSION ON HUMAN RESOURCES AND ADVANCED EDUCATION

In the early 1950's the prospects for obtaining enough qualified teachers for elementary, secondary, and higher education were so poor that educational technology which could allow each teacher to teach more pupils was seen as a necessary development. The Ford Foundation, for example, was especially concerned about the teacher shortage, and supported a number of studies and

demonstrations of television, teacher aides, and other approaches to stretching scarce teaching resources. It was easy to conclude from these activities that the teacher shortage made the introduction of technology necessary.

This statement will examine the proposition that teacher shortages have created pressures for the introduction of technology to education by examining both past trends in teacher supply and demand and projections of future supply and demand. Since the trends and problems are different in higher education than in elementary and secondary education, the two will be examined separately.

SUPPLY AND DEMAND FOR ELEMENTARY AND SECONDARY TEACHERS

During the 1955 to 1965 period the number of elementary and secondary pupils increased from 34 million to 48 million, an increase of 14 million in a decade. The teachers to provide for this enrollment growth, and to meet the even larger demand for replacement of persons leaving teaching, have come from two sources. First, recent college graduates who have filled 70 to 80 per cent of the vacancies, and second, former teachers (mostly married women) who are re-entering teaching as their family responsibilities permit. The returning teachers have filled 20 to 30 per cent of the vacancies each year, and by utilizing both the new college graduates and returning former teachers the schools have been able to staff for the enrollment growth and at the same time make some improvement in teacher qualifications.

The number of teachers without a college degree declined during the last decade. The National Education Association has reported that elementary teachers lacking a bachelor's degree declined from 35 per cent in 1954 to 15 per cent in 1964. While these estimates are based on a partial sample, Census statistics for the 1950 to 1960 period also show an improvement in the educational qualifications of teachers.

The rapid growth of enrollment did not cause a rise in the number of pupils per teacher. The number of elementary pupils per teacher declined slightly from 28.7 in 1959–1960 to 27.8 in 1964–1965, and the number of secondary pupils per teacher has remained fairly stable at 21½ in the same period.

While some communities experienced great difficulty in obtaining teachers, and some specialized types of teachers have been in short supply, the national supply of teachers has been adequate to fill the classrooms and to continue existing patterns of teacher utilization.

In the next decade from 1965 to 1975 the Office of Education projects a growth of about 6½ million pupils, less than half the growth of the past decade. This will lead to some reduction in requirements for new teachers, but because replacement of persons leaving teaching creates between 60 and 75 per cent of the total demand for new teachers, the smaller enrollment increases of the next decade will have less effect on the demand than might be anticipated.

Each year between 1960 and 1965 between 125,000 and 150,000 college graduates became teachers. The college graduates of 1960 to 1965 who entered teaching were about a third of all college graduates, as shown in Table 1. These estimates of new teachers are lower than those prepared by the U.S. Office of Education, because experienced re-entering teachers have been excluded from the new teacher group. The exclusion of the re-entries permits a more valid comparison of the supply of teachers from the colleges with the total group of bachelor's degree graduates.

Elementary and secondary education have dealt with the teacher supply problem not by using technology to replace teachers, and not by the use of subprofessional assistants, but by making it possible for the married woman with children to combine a family with a career. Teaching provides more attractive working conditions for the married family woman than any other major professional occupation, and as a consequence a substantial part of the teachers needed to staff the growth of the schools have been recruited from married former teachers who have re-entered the profession.

The past sources of supply for teachers are likely to prove adequate to the future growth requirements of the profession. Even when the additional 88,000 teachers estimated by the Office of Education to be required by the Elementary and Secondary Education Act of 1965 are included, the number of new teachers to be supplied each year by the colleges, as shown in Table 1, will be no larger than it has averaged in the past five years. Since there will be a very large increase in the number of college graduates between 1965 and 1975, the proportion of all

college graduates needed for teaching will decline from about 33 per cent in the early 1960's to about 20 per cent in 1970 and about 16 per cent in 1975.

There will be larger supplies of qualified teachers in relation to demand for teachers in the next decade than there have been in the past decade. If there have been any teacher shortage pressures for the introduction of technology into education, they will be less in the next decade.

It may be important to introduce technology to improve the quality of education, but quantitative factors of supply and demand will not provide pressure for the introduction of technology into the elementary and secondary schools.

SUPPLY AND DEMAND FOR COLLEGE TEACHERS

During the decade 1955–64 college enrollment increased from 2.7 million to 4.9 million, an increase of 2.2 million students. During the decade 1965–74 the Office of Education projects an increase in enrollment from 4.9 to 8.7 million, an increase of 3.8 million students. Unlike elementary and secondary enrollment trends, college enrollment will grow a great deal more in the coming decade than it did in the past decade.

Full time equivalent faculty for instruction numbered about 157,000 in 1954–55, a faculty member for every 15½ students. Full time equivalent faculty had increased to 276,000 by 1964–65, a faculty member for every 18 students. Regular full time faculty members make up about 80 per cent of the full time equivalent staff, the other 20 per cent of the instructional load is carried by part time faculty, temporary faculty, and graduate teaching assistants. These figures exclude faculty for research, for extension, and for non-college credit instruction.

If a faculty member for every 18 students is to be available, the full time equivalent instructional faculty will have to increase to 401,000 in 1970 and 483,000 in 1975.

What are the prospects for meeting these needs for new faculty and for replacement of faculty dying, retiring, or leaving teaching for other occupations? They appear to be no better in the 1966 to 1970 period than they have been in the last five years, but will be considerably improved in the 1970 to 1975 period. Table 2 shows an estimate of the number of regular full time faculty in four year colleges and universities who were added in the last two five-year periods. A three per cent annual replacement rate is assumed which produces an estimated total number of new full time instructional faculty who were added in the 1955–65 period of 112,500, and an estimated demand of almost 200,000 in the 1965–75 period.

The estimated additions in the 1955–65 period are consistent with other evidence presented by Allan Carter that the per cent of regular faculty with Ph.D.'s has not declined in the last decade and with evidence that 50–60 per cent of Ph.D.'s each year have entered college teaching.

The figures in Table 2 are much smaller than those prepared by the Office of Education because no attempt is made to include the demand for junior college faculty, part time faculty, or graduate students in the totals, nor is any attempt made to include non-instructional faculty. With the exception of faculty for administration and faculty for research, most of the groups excluded from Table 2 do not usually have a doctor's degree, and do not compete for the doctor's degree output. The figures are also smaller than those of the Office of Education because a three per cent annual faculty replacement rate was used, rather than the six per cent used by the Office of Education.

The ratios of new teachers to Ph.D.'s indicate that in 1960–65 qualified faculty were difficult to obtain and the 1966–70 period will also be difficult for the recruiters. In the 1970–1975 period the ratio of doctor's degrees to faculty requirements will be much more favorable, both because the rate of growth in college enrollment will slow down, and because the output of Ph.D.'s will be expanded tremendously. Nearly 2½ times as many doctor's degrees will be awarded in the 1970–1975 period as were awarded in the 1960–1965 period.

Colleges and universities have met the staffing problems of rapid growth with different solutions than the elementary and secondary schools. Larger numbers of students per faculty member and a slight increase in the total share of instruction provided by graduate students and part time faculty have enabled the colleges to handle the additional students. Technology has probably played a very minor role in the changing faculty-student ratio; most of it can be attributed to larger enrollments in each institution which allow more efficient class sizes, and to the overall pressures created by inadequate numbers of new college teachers.

The supply of college teachers in relation to demand will be much more adequate after 1970, largely because the supply is expanding very rapidly. Whatever pressures enrollment growth has exerted for the introduction of technology into higher education will be less after 1970. The quantitative analysis of college faculty growth ignores any needs to introduce technology as a means of improving the quality of college teaching. In light of the preceding analysis, improvement of the quality of education would seem to be the major rationale for introducing technology into education at any level.

TABLE 1.—*Percent of bachelor's degree graduates entering elementary and secondary teaching, 1960–75*

[In thousands]

Year	(1) Total bachelor's degrees	(2) New entrants to teaching from college	(3) Percent that new teachers are of all degree recipients
1959–60	364	124	34.1
1960–61	370	130	35.1
1961–62	388	132	34.0
1962–63	415	137	33.0
1963–64	466	153	32.8
1964–65	502	161	32.0
PROJECTED			
1966	518	169	32.6
1967	546	148	27.1
1968	645	150	23.2
1969	707	154	21.7
1970	738	150	20.3
1971	747	144	19.3
1972	810	145	17.9
1973	837	145	17.3
1974	881	140	15.9
1975	921	150	16.3

Source: Projections of bachelor's graduates made by the Commission on Human Resources. Degrees exclude 1st professional degrees in medicine, law, social work, and other fields where the 1st professional degree usually follows the bachelor's degree. Projections of entrants to teaching made by the Commission on Human Resources. They exclude the experienced teachers reentering teaching and are lower than the Office of Education estimates for this reason. Projections include Office of Education estimates of the demand created by the Elementary and Secondary Education Act of 1965.

TABLE 2.—*Increases in full-time instructional faculty in degree-granting institutions in relation to increases in doctor's degrees, 1955–75*

Period	(1) Faculty added for enrollment growth	(2) Faculty added for replacement	(3) Total	(4) Total doctor's degrees	Ratio, col. (4) divided by (3)
1955–60	25,000	18,000	43,000	44,800	1.04
1960–65	46,000	23,500	69,500	59,300	.85
1965–70	80,000	31,500	111,500	96,700	.87
1970–75	50,000	37,500	87,500	147,000	1.68

Source: Faculty projections made by the Commission on Human Resources include only full time instructional faculty. Faculty for research, administration, extension, and all junior college faculty are excluded. Replacement needs are based on 3 percent annual rate of faculty loss, ½ the rate used by the Office of Education. The faculty student ratio is projected at a constant 18 to 1, approximately the current ratio. Projections of doctor's degrees by the Commission on Human Resources are higher by about 20,000 than Office of Education projections for the same period.

Chairman PATMAN. Thank you. You have concluded, sir?
Dr. FOLGER. Yes, sir.
Chairman PATMAN. Our next witness is Dr. Robert E. Glaser.

STATEMENT OF ROBERT E. GLASER, DIRECTOR, LEARNING RESEARCH AND DEVELOPMENT CENTER, UNIVERSITY OF PITTSBURGH

Mr. GLASER. My name is Robert Glaser, and I am professor of education and psychology at the University of Pittsburgh.

I am also director of the Learning Research and Development Center at the University of Pittsburgh, and I represent, I would say, an increasing group of individuals who have been trained in scientific pursuits, in my case experimental psychology, and who over the past 10 years or so have begun to devote their energies to the important endeavor of educational research and to research and development in educational technology. More and more of these kinds of people are joining the national research and development centers and the regional laboratories which are springing up in various parts of the Nation.

Since our R. & D. center is concerned with the problems of the schools of today and perhaps puts even more thought into the schools of the not too distant future, I would like to give you my feeling for some of the trends which might influence the schools of tomorrow, will also influence educational technology, the educational business, and so forth. And I say this in the context of what you are well aware of; the great mergers and jockeying for position that is going on among major industrial concerns, equipment manufacturers, and publishing houses to get together in some way, and to discover what is appropriate for them to do—the appropriate technology, the appropriate entrance into, and the appropriate product to produce for the educational market.

I want to talk about, very generally, three things: One is the methodological, technological changes that might influence the practice. Two, some of the groups in our population that will probably be influenced as educational improvements are made; and three, maybe one or two cautions about all of this.

First of all, it seems to me that there are three main things going on that will influence the shape of education tomorrow. One can be called the increasing emphasis in our democratic society on the individualization of education and the individualization of instruction. It has been the educator's goal for many years to adapt educational systems to the capabilities, requirements, and needs of the individual, but under the pressure of doing a lot of educating, classroom structures have developed with large groups of individuals who are taught in some sort of a mass fashion. Educators have not been entirely pleased with this, and their writings constantly suggest that educational systems can be built to adapt to individual needs. If an educational system becomes one which adapts to the average, then, as you well know, it loses effectiveness in educating the extremes above and below the average, and this raises questions of instruction for the disadvantaged, the gifted, and so forth, because of the rather rigid system that does not adjust to individual requirements. With the increasing personalization of education, schools will undergo a change in procedures, tools, and techniques. These changes are going to reshape the classroom, reshape the way teachers are trained and

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reshape the way in which publishers and people that produce products for education have to build things for more individual adaptability.

To be a little more specific about this, individualization will require much more recordkeeping of the student's progress than it is possible for a teacher to do in a large class, and this is going to require tools for the teacher which will have to be something in the way of electronic data processing. Textbooks and materials of that kind, which are usually built with whole classes in mind, will now be much more oriented toward those aspects of education which can be provided for self-study and for producing real educational change in the student; how do you build a "book," so that you can, at the very first part of the book, find out what the student knows and what the student does not know, and then teach him appropriately. We certainly cannot assume that standard books and presently available materials are effective enough educational devices to home in on the student's requirements. This is a sort of emphasis on adapting education to individuals, to give all individuals a thorough education based on where they have to begin, that is going to influence education and it is my first point.

The second point, in methodological and technological changes that will influence education, is the whole context of automation and computers. This has two main parts.

In the first place, the use of automation, if you will look at what happened in the case of military consoles, where the military had found it necessary to provide information to people who have to watch the skies or people who have to monitor other systems, led to ways of providing information and ways of communicating through TV or scope pictures or special sound devices. There are now ways of providing information to individuals which are somewhat an advance over the invention of Gutenberg, and we ask ourselves: Is it possible, by using these kinds of devices, to provide the student with a much richer world so that he can see things in contextually rich ways, through many different avenues, through different senses, and can begin with special controls to manipulate his subject matter world. For example, when you learned your algebra, you learned from a book about manipulating an equation, and you did it on paper. It is possible now, and not very expensive, for a student to be shown the curve of an equation on something that looks like a TV tube; he can manipulate variables and parameters of the equation on a typewriter in order to see "before his very eyes" how the curve changes when he does certain things. Let us provide the very exciting world for the learner, and it is possible that wonderful things will occur. The new ways for the learner to communicate with his subject matter are going to come about.

The other point is that the computer is a tremendous recordkeeper and can provide more information to the student than ever before so that he can make much more intelligent decisions about himself. The educator is provided with more information on the student than he has ever had before so that he can make very effective educational decisions. It is much better to make decisions when you have a lot of information that is compiled quickly for you. So this sort of thing will be done. As you know, there are computers that do course scheduling, bus routing and the like, for the schools.

The third main point pertains to another recent phenomenon in education which I cannot go deeply into here. In the past there have been some influxes of the sciences and technology into education. But now under Government help and the impetus of our modern society, more people with scientific backgrounds and technological backgrounds are looking into education. Scientists, physicists and psychologists, are beginning to write things not only for colleges but for little children, and people who have been interested in studying behavior are beginning to worry about the application of the knowledge of their disciplines to education.

All of this is going to result in some sort of change, and, probably, will result in a job specialty called an educational technologist. This will make a kind of a job available and force a kind of individual to be trained who would almost be something like an engineer or a medical technologist who will work with a physician or a scientist in getting their work done.

Do I have a few more minutes?

Chairman PATMAN. Yes, sir. Go ahead.

Mr. GLASER. So, this area, this new job area, I think will emerge and will influence education.

What areas of the population will be influenced when this occurs?

It seems that the first things that will be influenced are those areas that have public high priority. The public high priority seems to be one that first off will emphasize those individuals in our society who live in environments that for some reason or another deprive them of certain advantages, so that there is going to be, probably, an initial impact of the new technology of education on what we called our disadvantaged groups. Probably, this will occur, first, because these groups have been neglected and are now more reachable because of the new technology with emphasis on individualization and which, of course, opens a special market for industrial people.

Also related to this is emphasis on young children and early education. Again, this is, probably, being pushed because it is an untapped market. We have not done much in early education, and it is easy to sell things at this level, but this is going to have to settle down, because there are resistances on both sides. It is good to train children early. We do it in schools and we sell things to the home, but I am sure that there will be the resistance of people who will say: "Well, maybe it is a little too early."

Another group that is going to be influenced quickly relates to the tremendous problem of vocational and professional education because of the way things are going now, and because we all feel rapidly obsolescent in our schooling. It is a phenomenon of our times to feel obsolescent. Somehow or other, the parties of the new technology of education will have to update vocational and professional education for adults. Education is going to be an increasingly continuing factor. It cannot be otherwise, because knowledge moves so fast.

Then, I think, lastly, after these two tremendous problems, we will finally make more and more impact on the general public schools, and maybe after that we will even influence the universities. Our colleges and universities may know a lot about what they teach, but they think perhaps, that the methods by which they teach cannot be influenced in any way, so they are the tough nuts to crack in many ways.

Some of the cautions involved, as educational change gets rolling in the future, are things you are well aware of and, probably, in which you are better qualified than I; these relate to all of the checks and balances of the marketplace. I am sure that as new things get invented and new things get sold we are going to have a lot of chromium put on the packages, and the influence of chromium, as to its effectiveness in education, needs to be analyzed.

There is also the problem of a check and balance which would have to be introduced in terms of a consumer education. The best that I can say about consumer education is that, if you will remember, after World War I, the psychological test came into prominence, and at that time anybody could sell anybody a psychological test. Well, over the years, the psychologists and the educators developed standards for psychological tests. I am holding no brief for psychological tests. They have their virtues, and they have their faults, but I want to make a point about the historical development of their use. Different professional societies around the country developed test standards. The standards were taught in colleges of education, so that the colleges of education now have courses in educational measurement. And many educators know that you can buy a test nowadays that is accompanied by a manual which has something to say as to its effectiveness, as to its reliability, and they read those things before they buy the test.

There is no such corresponding thing when you buy a textbook, when you buy instructional materials of any kind. I think, more and more, as we learn about the instructional design of things to teach with (contrasted to things to test with), that we will develop, as the technology becomes well developed, this sort of check and balance. Professional training for the educators who use these things, and certain standards for their production, will emerge.

The industry, as I see it in education, will go forward. We have the hardware people on the one side. You have the publishers, who have the big educational market on the other side. The hardware people get into trouble, like they did in the early days of teaching machines, when they were ready to sell the teaching machines, but had nothing in the teaching machine that would teach. The publishers have the market but in between there is something which we call "instructional systems design"—a rational process of developing effective, efficient instructional systems.

And in between this hardware development and what the publishers have been doing is going to develop, I think, a field of instructional technology which is going to consist of special groups who know how to test and check educational products for their effectiveness in producing educational change: systems engineers, curriculum writers, course evaluators, and so forth.

This whole thing is very much in the process of emerging, and it is difficult to make many predictions about it. I would like to submit an article of mine entitled "The New Pedagogy" which states more succinctly these trends in educational development.

Chairman PATMAN. Thank you, sir. You may do so.

(The article referred to follows:)

The New Pedagogy, by Robert Glaser

If one sets his sights on the shape of pedagogy and instruction in the schools of tomorrow, and tomorrow is not the distant future, what can be said about the forces that will influence educational systems? Here, I would venture some opinions about my expectations. I will suggest three areas for your consideration: (1) the individualization of instruction; (2) computer-assisted instruction; and (3) psychologically-based instructional design.

INDIVIDUALIZATION OF INSTRUCTION

By the individualization of instruction I mean the adaptation of instructional procedures to the requirements of the individual learner. The theme of individualizing instruction is a very old one in education, and much lip-service is paid to the psychological fact of individual differences in abilities and styles of learning. Educators, however, continue to struggle with the problems of meeting each child's educational needs; in the elementary school, serious attempts are made at grouping within the classroom, and recently the ungraded elementary school has attracted considerable attention as an opportunity to provide for a greater degree of individualized instruction. Efforts like ungraded elementary schools will undoubtedly continue and will be important as attempts to tailor education to the individual child. However, other solutions are clearly needed if we are to approach anything like our ideals for individualization of instruction.

The problem of adapting to individual differences in education has been analyzed by Lee J. Cronbach of Stanford University in terms of several patterns; these patterns which I shall describe are probably not mutually exclusive and range from historical, to present, to future possibilities.

Pattern one assumes fixed educational goals in a fixed educational treatment. Individual differences are taken into account chiefly by dropping students along the way. Tests are used to decide which students should go faster and be imbued with higher-educational aspirations. The social theory involved is that every child should "go as far as his abilities warrant." In this case, a weeding-out process, reached earlier or later by various individuals, is assumed.

A variant of the pattern I have just described, which can be called "adaptation within a pre-determined program," is to permit an individual to stay in school until he masters, or at least learns to a specified criterion, certain essential and common educational outcomes. This procedure has never been followed in any pure form since it would extend the education of some youngsters until they are oldsters. It is practiced, however, in the old policy of keeping the child in the first grade until he can read his primer, and in the more recent non-graded primary unit which some children complete in two years and some in four.

This first pattern of adaptation has two variants then: one in which the duration of instruction is altered for an individual by sequential selection and weeding-out, and the other in which the duration of instruction is altered by training to a fixed criterion. In both of these patterns the educational goal for each student is essentially the same, and the instruction provided to students is fixed.

A second pattern of adaptation to individual differences is to determine for each student his prospective future role and provide for him an appropriate curriculum. We see this system in operation when students are channeled into academic courses, vocational courses, or homemaking courses; or in the decision to give the vocationally oriented students one kind of mathematics and the academically oriented another kind. There is an obvious danger in setting differentiated goals, e.g., differentiating mathematics so that it is the exclusive possession of a selected class while other classes are drilled on formulas useful to shopkeepers. Adaptation to the individual by this second major pattern of "matching goals to the individual" is also operating when a student selects his major field of study in high school or college. Adapting to individual differences by this second pattern assumes that an educational system has provision for optional educational objectives, but within each option instruction is relatively fixed.

A third pattern of adaptation to individual differences attempts to teach different students by different instructional procedures; within each of these instructional treatments there is a minimum fixed sequence of educational goals which must be mastered. This pattern of adaptation can be implemented in a variety of ways: at one extreme a school can provide one fixed instructional se-

quence and students are pulled off that track for remedial work, and then, when the damage is repaired he is put back into the general track. At the other extreme, an instructional program can provide detailed diagonsis of the student's competencies—his learning habits, achievements and skills—on the basis of which a unique prescription is made for a course of instruction specifically tailored to that student. In this latter procedure, some students might learn on their own by discovery, some learn by more structured methods, some learn by reading, some by listening, etc.

Between these two extremes, toward the direction of the latter, lies the kind of adaptation to individual differences that will probably occur in the near future. The quality of the system which is developed depends upon the answer to many research and practical implementation questions. Research indicates that in the presence of inadequate information, it may be best for teachers to follow an average treatment for everybody and not attempt to differentiate on the basis of unreliable information; but with reliable information and techniques for making an instructional decision, effective student differentiation is possible. The entire question of the interaction between the characteristics of the student at a particular point in his learning and the methods of instruction is raised. An additional problem is practical determination of the costs and operating techniques that will make the differentiation of instruction suitable to the practical school administrator and to the training of the teacher.

The differentiation of instructional techniques on the basis of individual-differences variables is an ideal which will demand detailed analysis that intertwines the methods of experimental psychology and psychometrics. Proof will have to be forthcoming that the selection and devising of instructional methods does indeed interact with student differences so that their achievement in seeking a given educational goal is significantly greater than if an average best method were employed.

There are two principal problems in researching and developing systems for implementing individualized learning: (a) the psychological study of the interaction between individual difference variables and instructional procedures, and (b) experimentation in school systems with strategies for adapting to individual differences. This latter includes the development of appropriate administrative procedures, teacher training, and especially the development of appropriate instructional materials (including computerized classrooms) and testing instruments.

The best way to get on with the first problem, i.e., study of the interaction between individual differences and learning patterns is to do controlled experiments which involve the analysis of student histories of response to subject matter as a basis for assigning future instructional procedures.

The second problem involves innovations by school administrators in the effort to produce a school environment which is highly responsive to the differences among students. What would such an individualized system look like? Each student would be placed at his achievement level within a particular subject matter, and his instruction would proceed from that point. Student performance would be carefully tracked and monitored so that information would be provided about his style of learning, his rate of learning, and his subject-matter mastery. Information would be provided about the necessity for more detailed instruction and about attained proficiences which require little additional teaching. With the provision of detailed information about student learning progress, the teacher would provide instructional decisions in the form of prescriptions for the student's subsequent learning steps. This would be accomplished in a school organization permitting individualized learning to proceed in the absence of conventional class boundaries. The teacher would no longer see the student as a component of the class but an individual on a continuum of achievement. Materials would be provided to maximize the student's self-instructional capability and to provide the teacher with a rich resource of materials for differentiation among students.

Automatic data-processing methods would be necessitated by the large amount of information obtained for each student and required for effective instructional decisions by the teacher. Instructional decision-making in the writing of lesson prescriptions would become an increasingly important role of the teacher. He would not assign lessons grossly to a group, but would be flexible on the basis of the differential information provided to him.

In building such a procedure, specific technical problems are abundant. For example, how does one evaluate the effectiveness of individually prescribed instruction? How does one grade and evaluate students in such a learning situa-

tion? What are the technical problems not only of student evaluation but of test construction, materials development, and teacher training, for such a system?

COMPUTER-ASSISTED INSTRUCTION

The second area influencing a future pedagogy is the use of the computer for instruction; and when I say "for instruction," I preclude the very important influence of large-scale batch data-processing which consists of record-keeping in a school, a school system, or on state-wide basis, and also such things as school scheduling, data-bank functions, budgeting and accounting, inventory control, prediction of enrollment, school summary statistics, and so on. In contrast, I refer to the fact that during the past ten years there has been considerable growth of interest in programmed instruction and teaching machines, and that also during this time, there has been a rapid development of computer technology. To date, for the most part, there has been only sporadic interplay between the teaching machine and computer developments, but concern is accelerating along these lines. This will be especially true in the light of individualized instruction, since it appears that it will be highly impractical to provide the amount of instructional material, the number of teachers and assistants, the close monitoring of student performance, and the data-processing required for adapting to individual differences *without* calling on computer capabilities. Two aspects of computer-assisted instruction are of interest: 1) the console or station where the student interacts with the subject matter and 2) the analysis of student performance for wise instructional decision-making.

With appropriately designed student consoles, a computer on-line station can provide a rich environment for the student. New ways can be provided for him to interact with and manipulate subject material as he works with it; for example, by means of a cathode-ray tube which looks very much like a small television screen, letters and numerals can be generated directly by the computer; the student can control these with a standard typewriter keyboard. He can also use a device such as a light pen to move objects on the screen. A young child might manipulate a number line on a cathode-ray tube; he might trace letter patterns to learn handwriting. For spelling lessons the typewriter can accept only the correct spelling of a word and prompt him as he makes errors. A high school student might learn about the algebraic representation of an equation by manipulating different parameters on a keyboard, which change the slope and intercepts of a curve displayed on the cathode-ray tube. A college student in a qualitative analysis course in chemistry might analyze various materials in a simulated laboratory by indicating his reagents on a keyboard and getting a picture of the solution or precipitate that might be obtained in the actual laboratory.

What I have just said is the general propaganda by those of us interested in this field, but there is even more fascinating and hard work involved in the second aspect, that is—the specific problem of instructional decision-making. As the student learns, the system must prescribe the next instructional step on the basis of information about the student's immediate and more long-term history. An instructional strategy is built up on the basis of the student's performance.

Consider the following: we have a subject matter broken down into sub-objectives that the educator decides to teach the student; for each sub-objective a test has been constructed to assess the behavior defined by that objective. We also have defined a set of alternative instructional steps which the educator has provided for teaching each sub-objective. We have then sets of teaching materials which we need to prescribe and present to the student in some order. This order is determined by the instructional decisions made by the teacher, by the rules we build into the computer, or by a combination of teacher and computer rules. The interesting question involved is how the teacher makes instructional decisions on the basis of student performance and whether he can be assisted by building some of his rules into the computer. (This is somewhat analagous to saying that we build certain rules into a test in order to score it, and the teacher or counselor then uses this test to make decisions about the student.)

Of course, when such decisions are made, we have in mind certain criteria which we are trying to optimize. Many things can be considered as important criteria, to name a few: a high score on an achievement test, the largest increase between a pretest and a posttest, the time taken to reach a certain percent correct, performance on a retention test given some months after learning, performance on a test of novel instances of the concept being learned, and the ability and willingness of the student to learn similar concepts on his own and in his own way.

The important question for research is how the history of student performance is to be taken account of and what criteria of performance are to be emphasized. The variables involved are several: first, the extra-instructional history of the student; these are long-range existing individual differences, such as aptitudes and learning styles; second, the more immediate instructional history, or those measures obtained in the course of instruction which summarize learning status at any point in time; and third, decisions about the next learning step. Efforts to examine instructional decision-making rules will involve intensive research concerned with the empirical determination of the interaction between long-term history effects, measures over the more immediate course of learning, the teaching characteristics of a lesson, and the stated criteria for learned performance.

I have spent a little time elaborating what I consider to be an especially interesting problem to be faced in the development of computer-assisted instruction. There are others, such as the development of computer languages which make it easy for the designers of a curriculum to put their course in a computer system without being forced to become minor expert computer programmers. Such problems obviously require study and development, but the solutions certainly appear to be not impossible.

Two more items should be mentioned in reference to computer-assisted instruction, and then I can move on. First is the point that a significant use of computer-assisted instruction is in the design and development of instructional materials. It is reasonable to assume that in the future, a mathematics or reading curriculum will be developed and validated on the basis of feedback data obtained about how well certain aspects of the course teach certain objectives. If certain parts of a teaching sequence do not teach well, then data can be obtained on student learning to indicate how these teaching sequences are to be revised. A computer-assisted instructional system can provide a means for rather immediate and detailed analysis of learning records for curriculum revision.

The second item is that in addition to the tutorial and drill-and-practice aspects of a computer instruction system, it is further possible to envision a student station which is essentially an interrogative information-retrieval unit. Here we would like to have a capability which enables the student to freely construct general questions to which he can get reasonable information. The student might like to ask "What were the reasons for the depression in the early nineteen-thirties?" or "Why did Booth kill Lincoln?" Such systems which can provide to the student information in complex matters are certainly, at the present time, difficult to consider feasible; but it does seem possible, through a thorough analysis of the types of questions which might be asked, that progress can be made toward the recognition of a question by a computer program. The central problem seems to be not that of providing the answer, nor of storing the information appropriate for the answer, but rather that of recognizing precisely what question is being asked.

Finally, in mentioning computer-based instruction I have done a direct disservice if I have conjured up any images of *1984* and cold, metallic automation. On the contrary, I suspect that efficient use of these tools will permit more time to be devoted to humanitarianism—time which we seem to be in danger of decreasing.

INSTRUCTIONAL DESIGN

I turn now to a third aspect of pedagogy of the future, perhaps somewhat more difficult to say succinctly. It concerns the emergence of a unique specialty called educational technology or instructional design. To elaborate further: The use of modern science in the interest of society has become an important obligation of our times. This is true no less in education than it is in medicine and engineering. As increasing knowledge is accumulated in psychology and the behavorial sciences in general, a foundation will be provided for a growing scientific and technological base for instructional practice. The translation of scientific knowledge into practice requires extensive applied research and technological development. However, at this point in time, an entity to carry out the function of instructional design and development hardly exists. If a person (or organization) carried out such a function, how would he begin to work, and in what sort of conceptual framework would he carry out his job? I would like to guess at and discuss such a framework and describe some of the concepts that an "instructional designer" might use in thinking about his work. The tasks he must perform involve the interplay between theory, research, and application. I shall mention not application as such, but some aspects of the necessary research and development which can eventually lead to innovation and redesign in instructional practice.

First this psychologist-instructional designer would analyze the subject-matter to be taught—reading, mathematics, or what have you. He would analyze

representative instances of subject-matter competence in terms of the nature of the material and the kinds of responses the student makes to this material, e.g. memorizing, concept learning, or problem solving; he would further analyze the structure of the subject-matter, perhaps in terms of its conceptual hierarchies. Second, our instructional designer would turn his attention to the characteristics of the students to be taught. He would need to determine the extent to which the students have already acquired some of the things to be learned and the extent to which they have certain predispositions which might facilitate or interfere with new learning.

These first two steps conceivably provide some information to the educational designer about the existing pre-instructional behavior of the learner and the target performance to be obtained. The designer must now proceed to get from one state to the other. This sets up his third task. This task consists of guiding or allowing the student to go from the preinstructional behavioral state to a state of subject-matter competence. This requires the construction of teaching procedures and materials that are to be employed in the educational process. As part of this process, he must take account of motivational effects and the ability of humans to generalize and extrapolate, by providing conditions which will result in the maintenance and extension of the competence being taught. Finally, the educational designer must make provision for assessing and evaluating the nature of the competence and kind of knowledge achieved by the learner in relation to some performance criteria that have been established.

To many present-day educational practitioners this description of the process of instructional design may sound harshly technological, and indeed, perhaps some elegance has been lost in analysis. But presumably, once basic techniques are constructed, the teacher can use the tools of his profession with undertanding, artistry, and sensitivity.

The design components that I have just described are: (1) analyzing the characteristics of subject-matter competence, (2) diagnosing preinstructional behavior, (3) carrying out the instructional process, and (4) measuring learning outcomes. Time and dry technicalities hinder me from going further, but I can refer you to two chapters which describe in detail these components:

R. Glaser. "The Design of Instruction." In J. I. Goodlad (Ed.), *The Changing American School: The Sixty-fifth Yearbook of the National Society for the Study of Education*. Chicago: University of Chicago Press, 1966.

R. Glaser. "Toward a Behavioral Science Base for Instructional Design." In R. Glaser (Ed.), *Teaching Machines and Programed Learning, II: Data and Directions*. Washington, D.C.: National Education Association, 1965.

As changes in educational technology occur, it is likely that they will result in certain changes in school operation. First, the role of the teacher will be restructured. It seems likely that the teacher will be able to become more concerned with individual student guidance and individual progress in addition to his role as a group mentor. Second, the educators' goal of the individualization of student progress based upon student background, aptitude, and achievement will come closer to realization by school reorganization and the adoption of new practices. Third, instructional materials and devices supplied by industry will come under close scrutiny as to their instructional effectiveness (just as tests come under close scrutiny with respect to reports on their reliability and validity). Fourth, mastery of subject-matter competence will be easier to attain for a larger number of people in our schools, and tests which measure progress toward mastery will become important aids for the quality control of educational excellence. These developments, necessarily based on a developing body of pedagogical principles, should advance teaching toward the status of a profession nurtured by underlying behavioral sciences which are becoming increasingly relevant to the educational process.

Chairman PATMAN. We will next hear from Dr. Arnstein.

STATEMENT OF GEORGE E. ARNSTEIN, DIRECTOR, PROJECT MATCH, NATIONAL EDUCATION ASSOCIATION OF THE UNITED STATES

Mr. ARNSTEIN. Mr. Chairman and members of the committee, my name is George E. Arnstein, and I have been invited to testify on behalf of the National Education Association of the United States.

I am currently director of Project MATCH, a set of initials which stands for Manpower and Talent Clearing House. We are trying to design a system leading to better manpower utilization. Specifically, we are spending a modest grant by the Esso Education Foundation to see if we can inventory vacancies in colleges and universities and if we can also inventory professors and their special skills, in order then to use a computer to match men (and women) with job opportunities. MATCH is sponsored by the Association for Higher Education, a department of the National Education Association.

As you can see, this kind of development can have a major impact on our scarce human resources, can improve productivity, and is a potentially fruitful application of modern technology to education.

I suspect, however, that I have been asked to testify today because of my prior experience with the NEA project on the educational implications of automation, a pioneering inquiry begun in 1961 under the first of a series of grants from IBM.

Let me note rather quickly that our emphasis in the NEA automation project was on social impact and not especially on teaching machines. In those early days of the project we frequently received the suggestion that we ought to fight fire with fire, or, to put it differently, that automation and technological change are causing problems of obsolescence and therefore we ought to use automation to harness the forces of technology to overcome the effects of obsolescence. This is probably good advice, and I am happy to know that Rober E. Glaser is part of our panel this morning, because he has helped to edit two volumes of materials on Teaching Machines and Programed Learning which have been published by the Department of Audio-visual Instruction of the National Education Association.

Dr. Glaser has been one of the innovators in this field, which is slowly making the transition from relatively simple gadgets, hardly worthy of the name "teaching machine", to the complex and sophisticated experiments with computer-assisted instruction now underway.

As you know, thanks to rather intensive efforts by Government and industry and universities, there is tremendous interest in this area, great activity, and relatively unknown results. Let me elaborate on that.

Let's assume that you are the dean of a college or the assistant superintendent in charge of instruction and your boss has told you to "get with it" to introduce computer-assisted instruction in your schools. You will find, to your horror, that there is no major single source of information, no reliable agency which keeps track of all of the experiments and demonstrations underway.

I get inquiries about automation in education—and telephone calls—and I try to provide answers. The result of this state of affairs leads me to make this generalization about the use of technology in instruction, but I have to hedge the point, because somewhere in these United States there may be an exception: There is not now in existence, anywhere in the United States, a tested, validated, usable computer-assisted teaching program which is economically competitive with "live" teachers.

There are short sequences, and there are experiments, but there are no packaged programs which can be recommended, bought, and used the way we buy textbooks, test batteries, or motion pictures.

There are, on the other hand, hundreds of college deans and superintendents of schools who suffer from guilt feelings because they think they ought to be using this computer-based will-o'-the-wisp in their schools.

I am confident that what is now a will-o'-the-wisp will soon become a potent and effective teaching force and that computer-assisted instruction will, in due time, become economical and widespread. There are some interesting and promising experiments now going on, but it is extremely difficult to pinpoint this type of information because of the lack of a central clearinghouse.

As an alternative, of course, we ask our colleagues, and that's what I did with a draft of this testimony. There were several question marks in the margin, several doubters, several suggestions, but not a single nomination or example of computer-based instruction now in normal use in an American school or college.

It is this lack of information which must be overcome by means of a new mechanism which might be something like the Science Information Exchange which tracks science but not educational research projects. What we need today is to use the computer to keep track of computer-based experiments and experiences. We need to create some order as a means of enhancing our research efforts and productivity. The result will be a common pool, a sharing of experience which is entirely proper in education although it might not be proper in business. After all, competing Wall Street houses may be expected to safeguard the exclusiveness of the software behind their computer-based performance records, stock analyses, and other mysteries, but education is a noncompetitive enterprise where we ought to benefit from each other's experience.

Without making any invidious comparisons, I do want to note that we have three nationwide television networks but that the educational channels are not interconnected because they cannot afford it. Instead, they have to rely on the mails; this makes ETV look laggard when in fact the ETV stations are merely paupers (relatively speaking).

We, as a nation, have made tremendous efforts in research and development on which we are now spending at the rate of about $22 billion per year (while in 1940 we spent only about $1 billion). Some of this effort has been going into education with some interesting applications—language laboratories, educational television, magnetic tapes, experiments in computer-based instruction, and some of the other things mentioned by other witnesses last Monday and earlier today, especially in Dr. Carpenter's statement.

In the area of administration, the applications have been even more startling—student personnel records on punch cards and computers, teacher personnel data, class scheduling, and documentation.

The same is true in many other fields and so it happens that we can get instant stock quotations but we cannot get comparable references to scholarly publications. We can get immediate airline reservations, including the choice of chicken or seafood, but we have no remotely comparable network to keep track of existing educational films or research results.

My real point is that innovations cost money, especially if they are to be validated and tested. And then it takes more money to stimulate effective use.

Now, significantly, there have been innovations in education which made much progress when they were fairly inexpensive but have slowed down as they became more complex and costly. For example, there is fairly widespread use of optical readers or scanners to score tests. The Stanford-Binet intelligence test, which is an old standby has been redesigned so that it can be scored by scanning machines. Even there, the cost tends to be high, especially in investment rather than in operation.

Accordingly, there have come into existence a variety of pooling arrangements, sometimes within a county, sometimes statewide, and sometimes there is a service center which can maintain and operate the machinery which no single school or college could afford, or, for that matter, could fully utilize.

In the profitmaking sector of our economy there is a good deal of competition and it would be unreasonable to expect a pooling of information between, for instance, two competing Wall Street investment banking firms. (It might also be illegal.) But in education we badly need a pooling of information and we don't have it or we have it only very inadequately. Accordingly, I propose the establishment of a major clearinghouse, a data bank, something we might call the Bureau for Educational Technology and Administration (BETA) until somebody comes up with a better name.

I'll describe some of the proposed functions of BETA in a moment, but let me use a dramatic illustration of the need. The question—to which there is no definite answer—deals with computer-based instruction and whether it is being used in the United States, other than on an experimental basis. I suspect that the answer is negative, that there is not now in existence, anywhere in the United States, a tested, validated, usable computer-assisted teaching program which is economically competitive with "live" teachers. There are short sequences, and there are experiments, but there are no packaged programs which can be recommended, bought, and used the way we buy textbooks, test batteries, or motion pictures, along the lines described by Mr. Glaser when he was discussing tests a few minutes ago.

I have to hedge just a bit on this statement, because there may be a computer-based program in normal use in a school or college, but I have been unable to find out where. There are, on the other hand, hundreds of guilt-ridden deans and school administrators who think they are out of step, who think they are behind the times because they are not using a computer-based program in their own classrooms.

If we had something like BETA they could consult a central source which would provide suitable answers. For that matter, this committee, sometime in the future when it may wish to reexamine this question, could ask the question and get a better answer than it is getting today. It also could ask BETA for the best people to serve as expert witnesses.

These efforts, however, have been haphazard, and the time has come to call for a new agency which can serve as a clearinghouse or a data or a service bureau. I'll call it the Bureau for Educational Technology and Administration (BETA) although that's not the best possible name. I can describe its purpose only in general terms, for this is not the place to go into detail and, quite frankly, there has not been enough time before my appearance here today to prepare an

inventory of BETA's functions. In fact, the preparation of this type of inventory will be a necessary next step.

Let me illustrate a major function of BETA by citing a letter I received a few weeks ago from Harry T. Larson, whose familiarity with computers is reflected by the fact that in 1961 he edited a special issue on computers of the Proceedings of the Institute of Radio Engineers.

SANTA ANA, CALIF.

DEAR DR. ARNSTEIN: * * * I am sitting on a Citizens' Committee working with the local school administration, considering the possible use of computers to improve certain aspects of our planning. We are seeking information on computer programs that have performed school bus routing problems. * * *

The Committee is also studying the possibility of computer use on—

Future school location planning;

Assignment of students to particular schools;

Planning numbers or types of classes at each school.

If you can provide leads to anyone who has used computers on these problems, I would appreciate it.

(S) HARRY T. LARSON.

Here is an example of the kind of civic interest in our schools that is constructive and welcome. My colleagues and I receive many letters along these lines and we manage to come up with some answers. The trouble with those answers is that they are incomplete, accidental, and serendipitous because there is no central file, no clearinghouse, where this kind of information is accumulated. Neither the NEA, nor the U.S. Office of Education, nor any of the new laboratories, nor any of the computer firms have this capability.

The Association for Educational Data System, located in the NEA building, has a proposal for a National Center for Educational Data Processing for which it seeks funds, and I consider this an important step in the right direction, but the proposed Bureau for Educational Technology and Administration would be even broader than that.

In broad strokes, BETA should discharge the following functions:

1. BETA should serve as a registry of all ongoing educational research so that there will be a central file. In short, this might be patterned after the Science Information Exchange, although I would prefer to have it go a step further by accumulating the results of completed research projects. It may sound incredible, but there is presently no such catalog of complete research, certainly not in a form which is readily accessible and frequently updated.

2. BETA should serve as a giant, indexed and cross-referenced locator file of computer programs and other software. It should function as a catalog showing the sources of the software, not necessarily as a library which has all of the items in stock. The crucial lack today is not so much physical access to the reel of magnetic tape or the deck of cards as the means of locating the suitable program, preferably with a report as to the quality of its performance. It is this evaluation by previous users which will greatly enhance the type of locator file here under discussion, for without the evaluations, the reports from previous users, we will be condemned to repeat past mistakes over and over again. Evaluations, especially on a systematic basis, will be expensive, precisely one of the reasons why they have not been made.

3. BETA should serve as a referral center so that, in the absence of a suitable program, BETA can refer a dean or a superintendent to a

suitable business firm or agency which may wish to work out specifications and then undertake the new assignment. Suppose there is no suitable computer-based bus routing program; shouldn't BETA come up with two or three suggested agencies which will want to "invent" one? Once it has been invented, the program should become part of the reference file described under (2) above.

4. BETA should tabulate all inquiries, especially those it cannot service, so as to provide guidance for needed allocations in future research and development. By providing a focal point for relevant inquiries, BETA would become a resource to indicate areas of genuine and immediate need. By using modern information storage and retrieval methods, this should be a highly useful byproduct of its service-oriented operations.

5. BETA might be a logical place to maintain an up-to-date file of consultants, not in the form of printed directories or even 3 by 5 cards, but in the memory of a computer which can be interrogated over a telephone line. The present state of affairs simply will not do, as was demonstrated by the publication, early in 1966, of a "National Register of Educational Researchers." This project was funded by the U.S. Office of Education and is subject to the overriding criticism that its contents, by the time it went on sale, were approximately 2 years old and obsolete. (For details, see the review scheduled for publication in Phi Delta Kappan, June 1966.)

There are other tasks, and the list needs refinement, but this is enough to indicate what we need and how we might go about it.

We have also given some thought to the sponsorship of this kind of clearinghouse, and it seems to me that BETA should be a private, nonprofit corporation operating in the public interest. A Federal BETA might be suspect, especially in a delicate area like education with a long tradition of local control.

There are various things that are peripheral but have some bearing on BETA. For example, the Association for Educational Data Systems has a proposal which is seeking foundation support to establish a computer file which is similar to my second point, but the AEDS proposal is much narrower than the kind of clearinghouse I have described here.

Even the "National Register of Scientific and Technical Personnel," a computer-based file of biographical information about thousands of specialists, funded by the National Science Foundation, is not sufficiently flexible, in my estimation. In any event, it covers only a part of our spectrum of specialists and we need to expand it into other disciplines or have BETA undertake it for education and other fields not covered by the NSF operation.

It is in this area of computerized records that I have been working for the past few months. Specifically, I am about to write a final report on a feasibility study in which our Project MATCH will call for a huge expenditure to produce a voluntary inventory of all professional manpower in the United States. Because it will be voluntary, it will be necessarily incomplete. If we were to charge a registration fee it would discourage some eligible members and thus would be still less complete. Only a registration fee, however, can offer a promise of making this kind of inventory self-supporting.

So, rather ineluctably, we are driven in the direction of a nonprofit service bureau, supported by either a foundation or through Federal funds.

There probably are many other functions which BETA could discharge, but we need not enumerate them here because there is another, related problem which should be discussed in this area of educational technology and communications.

We must tackle the problem of standards. I realize that this tends to provoke visions of Federal control, of Big Brother, when all I visualize is a certain amount of order to be established on a voluntary basis.

Let me illustrate with a triumphant accomplishment of the automotive industry a few years ago. It seems every State used its own discretion in the design of license plates and this raised havoc with the stylists who design automobiles. They wanted to provide a suitable recess to house the license plate, but they couldn't get a standard size hole. After lengthy negotiations, all of the States agreed on a standard size and the stylists were able to come up with suitable recesses in the bumpers of our cars.

Even more impressive is the voluntary adoption of standard time zones. In the old days, before 1883, localities kept their own time; this led to much confusion, especially with the increase in travel and communications. The railroads accordingly introduced and adopted standard time in 1883, and the Naval Observatory began to send out standard time signals after that. This furthered the common use, and it was only in 1918 that Congress passed the Standard Time Act.

It may come as a surprise to you, but there are no agreed definitions, no standards, to describe a teacher, a child, a student, a part-time student. There is no agreed version of course descriptions and thus no compatible educational statistics. I can still recall a news conference held by a former Secretary of Health, Education, and Welfare (who is now a distinguished university president) in which he reported that the estimated shortage of classrooms had declined from 140,000 to 130,000 in 1 year. (My figures are from memory and only approximate.) He quickly added that this was no cause for rejoicing, for more than half of the apparent improvement could be attributed to a change in definition of "acceptable classroom" by the chief school officer in one of our Southern States.

One of the functions of BETA then would be to convene appropriate panels, to propose voluntary definitions and criteria, and to serve as a clearinghouse for their use. If we can agree on a Federal standard for aspiring, if we can agree on a voluntary SAE rating for motor oil, surely we can travel the same road in education so as to facilitate the use of technological innovations which thrive on compatibility.

This kind of cooperation is needed in education, especially in the area of educational data processing. Take MATCH, the project in which I am currently engaged. If we really hope to match people (professors and professionals) with job vacancies, we will need a standard vacancy description and a standard biographical description of the candidates. Neither form exists, although every placement office of every university has its own version and each of these versions seeks to secure substantially the same information. I am happy to report that last week, half a dozen of us spent 2 days in a hotel near

Chicago in which we sought to establish a standard vacancy form and a standard biographical form, for without them the whole matter of machine input becomes enormously complicated and even more expensive than without standard forms.

The lack of standards, of criteria, of agreement, of compatibility has frustrated many desirable advances in the use of computers, optical scanners, educational television, and numerous other technological inventions.

In rather incomplete terms, this is how I see the need for better communication in education, without any attempt to control or restrict the instructional process or to limit the powers of local governing boards. It is through an agency like BETA that we should get better use of our present human resources, some of which are in very short supply. We should also get better use of research already accomplished, and we should get a better idea of needed research and demonstrations and experiments.

Assuming there is agreement as to the need for this type of Bureau for Educational Technology and Administration, there arises the question of who and where and how it shall be sponsored. One possibility is the U.S. Office of Education, although there will always be the suspicion of Federal control. It was hard enough to persuade the Congress to enact various constructive programs of Federal aid to education without raising anew the specter of Federal control.

Beyond that, BETA also should handle other inquiries, for items ranging from lists of books which might go into a basic school library to a list of accredited colleges and universities. Traditionally, we seem to feel more comfortable when educational decisions like these are handled by reputable, responsible private organizations, operating in the public interest, rather than by the Federal Government directly.

What is new here is that in the past these activities were relatively inexpensive or could be supported through fees, as demonstrated by the Educational Testing Service or the College Entrance Examination Board. What we need now is much larger, more expensive, much more complex—and eventually much more useful. It may be possible to devise a suitable schedule of fees, but much ingenuity will be needed to devise this, and it will produce additional delays. It seems to me entirely appropriate to use Federal funds in support of this type of operation, especially because all of the users will be nonprofit agencies like schools and colleges.

In discussing BETA, I have dealt with it as if it were a single monolithic agency, when in fact the same functions could be performed by several agencies, sometimes operated by existing organizations, sometimes through new mechanisms created for the purpose. What has happened is that there has been inadequate support for these services and so it happens that we have no central file or locator service for nonbook materials—motion pictures, TV programs, magnetic tapes, slides, maps, and the like. There are several film libraries in the United States now using computers for cataloging and for storage and retrieval systems when it probably would be simpler if there were a central cataloging service.

In the Office of Education, of course, there is ERIC, the Educational Research Information Center, which is a step in the right direction. But when we compare ERIC with Medlars, the Medical Literature

Analysis and Retrieval System, we can draw some unhappy conclusions as to both the timing and the financial support for two comparable efforts to create some order out of the plethora of paper on which we seek to transmit research findings.

The watchword among the hardware people today is something known as total information system which, parenthetically, usually means something less than total but a good deal more than most of us can get out of our present files and old-fashioned storage systems. We need a determined effort in education to collect, index, organize, and disseminate the information, research results, and other data we already have. Through this kind of system, we will quickly uncover major gaps in our knowledge in addition to those gaps we already know about. We will be able also, to eliminate a tremendous amount of duplication, a process known among my colleagues as the invention of the wheel which goes on and on and on when the same manpower should be devoted to the improvement of the wheel or the planning of the next breakthrough.

I realize that this testimony does not go far enough—I have not enumerated all of the areas where we need to collect and organize information nor have I been sufficiently precise in describing the kind of organization or agency which could and should carry out this challenging and difficult task. I am certain, however, that it will be cheaper to make funds available now to channel and direct our flow of data, punchcards, information, and research than to be inundated by the continuing flow of monographs.

Let me go back to where I started. We do not now have anything like the Bureau for Educational Technology and Administration. Were there such a clearinghouse in existence, we could inquire of it whether there is a usable computer-based program and how the harried dean or supervisor can acquire it. As matters now stand, it is not really safe to assert that we have usable computer-based instruction in the United States today, or to deny it. About all I can put in my outgoing mail is that there is none, to the best of my knowledge.

And my best knowledge is not good enough when a good computer-based information storage and retrieval system could do it better.

There is a fairly new Interuniversity Communications Council, EDUCOM. Dr. Carpenter recently attended a meeting and can tell you more about this attempt to provide a data link between university members of EDUCOM. This will be a computer network dedicated to the sharing of modern techniques.

The Office of Education has a system called ERIC. That is the Educational Research Information Center, which is not computer based, but seeks to assemble bibliographies and related data. I am not saying this critically, but I do suggest this does not go far enough, is not broad enough in its scope but should grow.

In the medical field, there is Medlars. This is a sophisticated system for which the Public Health Service is currently seeking funds in order to rewrite and update their computer program. We do not have anything comparable in education.

The Smithsonian Institution operates a Science Information Exchange which, again, keeps track of all scientific research in progress but it does not store the research results. I suggest that we do not have anything like this in education, and when we set up a new

system, possibly along the lines of BETA it should be more sophisticated than the older SIE. Similarly, there should be a reference to COSATI, the Committee on Scientific and Technical Information of the Federal Council for Science and Technology, with potentially important benefits for libraries, including school libraries.

Essentially, I am suggesting that automation and technology have created problems and that one advice we have received is to use automated learning to speed up and improve the teaching process. That may yet come true, and the computer-based instructional process may be the wave of the future. For the present, however, I suggest that we use the computer in the area of information storage and retrieval, in indexing and information processing as an effective means of dealing with change.

Chairman PATMAN. Thank you very much. We are very grateful to you for your fine testimony.

Each of you has made a great contribution to this study. I believe that these hearings will be very much in demand. In fact, 11 years ago, I had the pleasure of conducting the first investigation and study on automation, and Dr. Vannevar Bush was our principal witness. Br. Bush, as you remember, had as much to do with atomic energy than any person at that time, and, incidentally, we are meeting in the Atomic Energy Committee committeeroom. We brought out some very interesting information at that time. It obviously interested a lot of people.

Dr. Bush said that we were backward in education, that we had to do more, and he referred to the fact that Russia was doing more in an educational way than we were. He cited a couple of instances. In engineering, he said that the Russians were graduating more engineers than the United States. In 1955, we were only graduating 50,000 technicians, and the Russians were graduating 1,600,000, or 32 times as many, and in interrogating Dr. Bush, we discovered that the Russians required people in different occupations, particularly in their services, their armed services, to go to night school, to go to school when they could, and they had a greater potential of that type of education. I think it has been demonstrated as true from subsequent events that they had that.

I want to comment very briefly, and then I want to ask Dr. Carpenter to comment on what these other gentlemen have said. I do want comment on the idea of a data bank. That impresses me very much, in addition to many other points in today's testimony.

I realize that we have engineering basic data banks, and we have blood banks and we have serum banks, and we have savings banks, and we even have piggy banks. We have all kinds of commercial banks and financial institutions, and data banks would certainly be as important, if not more important, than any of these, because, basically, right now, education, of course, comes first. I am particularly impressed with that.

I think you mentioned that one of the requirements would be private operation—that industry would administer the data bank and that it should be on a nonprofit basis. The National Education Association would meet those qualifications, would it not?

Mr. ARNSTEIN. Yes, it would.

Chairman PATMAN. That is fine. I share your views, that it should not be a Government organization; if possible, to avoid it. I agree with your statement that it should be nonprofit.

Mr. Carpenter, I wonder if you would mind commenting on the testimony of these other gentlemen?

I have about 10 minutes' time, from the time that I started, and you can take 3 or 4 minutes of that time, or more, if necessary, because I know that you could use it better than I could.

Mr. CARPENTER. I am not sure of that. I shall comment, not so much perhaps in detail on what was said, but on what was stimulated in my own brain by what was said that might be useful to the committee.

I think it is very important here to look at a promising picture in terms of the national complement of research and development centers in educational laboratories now being established throughout the country. For the first time we have the beginnings of means commensurate with the difficulty of the problem. We have advanced basic and applied and developmental research much farther in many other fields than in learning and in instruction, and here I think we have conceived of a possible mechanism, if we can build it, which has a possibility of answering some of these questions that we have long presumed to know about but have not really known the correct answers. I am delighted to have Dr. Glaser here representing one of the first of these research and development centers. His operation is relatively small in relation to the regional educational laboratories which come later and are, I think, going to be an interlocking network with the research and development centers.

I would suggest, without the expectation of action for the next 5 years, another kind of national complement of centers. These would have to do with the interface between the public interests and industries and businesses and produce very high quality instructional materials in systems or combinations. We would, therefore, expect the textbook people to become a component part of a much larger effort to produce, not only textbooks but the materials that go along with the textbooks that are needed to do a specific educational job. These materials would be tested before being marketed, and, therefore, I will not elaborate on it, because Dr. Glaser has already indicated the possibility of having standards established for instructional materials just as we have standards for other products.

In my paper, I referred uncertainly to the concept of the unlimited educational enterprise. I think that to use the standard or even nonstandard concepts of teacher-pupil ratios locks us into a kind of a calculation that might be somewhat misleading. It seems to me that the more proper question is: What do we need of teachers, but also what do we need of various other ways of doing the educational job? It becomes quite clear, I think, when we use a systems design approach to the solution of educational problems that we consider all of the means, the materials, the apparatus, the equipment, the communications systems, the teachers and other kinds of people who are needed to do different kinds of jobs in the teaching-learning situation.

We have the possibility of developing and using far more technically trained people, technologists, if you wish, in the teaching situation. For example, at Penn State, one of the largest components of use of

television and broadcast television is in what might be called the engineering of education.

We have projected upward the concept of the elementary teacher inappropriately to the secondary level, and, certainly, inappropriately to the higher educational level. We seem to think that a man can do all of the jobs necessary in the preparation of the materials, the presenting of the materials, the examining of students, et cetera. I think we are rapidly moving into another approach: I think the systems design approach is good and invites consideration along with modern terminology.

I would next comment on the possibilities of interinstitutional connections and cooperation. We have, historically in this country, developed the concept that a university or college had to be separate and complete and autonomous, and this has led to an enormous amount of duplication. It seems to me that we can rapidly change those expectations as exemplified by EDUCOM. I cannot elaborate on this program, because of the lack of time.

Chairman PATMAN. My time has expired. You will be allowed time later on to speak.

Mr. Widnall.

Representative WIDNALL. First, Mr. Chairman, I would like to compliment the panel on their fine presentation. I think that I am very fortunate in being part of the committee hearing these witnesses and the ones that we heard the other day. It is extremely interesting as a subject, this subject that we are trying to develop. I appreciate very much what has been given to us by all of you here today.

You indicated that the supply and demand for college teachers would be in better balance by 1970. Will you break this down into the various areas as to the supply of teachers in math and in the sciences, whether it will be adequate, and whether the same would be true of the social sciences, and the like?

Mr. FOLGER. I do not have the detailed breakdowns. There are some areas where continuing shortages will probably exist, and others in which the supply will become adequate much more rapidly. What I have presented here is not an attempt to get into the details of the picture field by field. We are working on this as a part of our study. I think that in most of the arts and sciences, in those areas, the improvement in supply and demand will occur, because the supply is growing very rapidly in all of these areas, that is, the supply of people with advanced graduate degrees.

Representative WIDNALL. I am thinking of the relationship that we need in the various areas such as math and science. You know there has been a tremendous emphasis on this in education. It has been somewhat neglected in the humanities field. You feel that there are enough being trained in the humanities now to take care of the need as it develops in the future? I think that the emphasis will come back more to that in the next few years.

Mr. FOLGER. The principal difference between the humanities and the scientists is that nearly all of the people who graduate with doctors' degrees in the humanities go into teaching, in the order of 85 to 90 percent and very few of them go into any other activity, whereas in a field like chemistry, only one-fourth to one-third of the chemists with advanced degrees will go into college teaching. The supply is likely

to be more adequate in the humanities in relation to the demand in teaching than it is in the science field.

Mr. WIDNALL. A long and neglected area is adult education. Many adults today, because of changes in society, require more education to stay ahead. What are we doing for these people? What has been developed along this line? What should we do? How can you or technology help in this area?

I would like comments from all of you, if you want to give them.

Mr. GLASER. You can take an example from some of the work that is going on in the training of physicians, in updating them in medical practice. Through the use of television and through the use of packaged courses, and through the use of telephone conversations between lecturers and evening meetings of people who have special interests. A group of people in a particular trade who want to learn some new work in their field through the means of telephone line, talking to a lecturer some distance away, it is possible to bring education conveniently to places where people meet in the evening or meet during the day. So, that is coming along—coming along slowly, but it is coming along.

Representative WIDNALL. That is being done in some places now?

Mr. GLASER. The answer is "Yes," but on a small scale. I mean you cannot find large instances, but this kind of thing is being started. That is what I am saying, and I am pointing out the possibilities for something that will probably increase.

Representative WIDNALL. Would you like to comment?

Mr. CARPENTER. I would like to refer in this connection to a very interesting working conference that was held by the British Broadcasting Corp. and the University of Sussex in Great Britain. One of the documents I am making available to the committee includes a report of this conference. This document reports that 150,000 women are being retrained, after rising their families, through the use of materials and media including radio and television. This is an example, I think, of a beginning of what can be done for continuing education by means of the broadcast media.

We have not mentioned radio as much as I think we should, for this is a neglected and useful system for education.

Mr. ARNSTEIN. With adult education there is a problem of which we became more aware recently because of the war on poverty. Adult illiterates in the United States are in the neighborhood of 11 million. To reach them, some television programs have been used and they have been fairly effective. We tend to forget that the usual approach, the printed word in newspapers and billboards, cannot reach illiterates because they cannot read. Therefore, television has been tremendously effective in catching their attention in the first place and then sustaining it, because you can use both sound and the visual picture to reach adults in the privacy of their living room without embarrassment. Many illiterates, of course, do not wish to expose themselves and do not wish to admit that they are illiterate.

I am thinking of Operation Alphabet which was produced by the Philadelphia public schools. This was a rather effective series of 100 videotapes and has been lent out to other school systems for their use. This series of programs was designed specifically to teach adults, and to help them overcome illiteracy.

Representative WIDNALL. Do you have any comments?

Mr. FOLGER. No.

Mr. GLASER. One further comment, on technological advance. Technological improvement is a means for self-study through television or self-study kits or teaching machines. It is somewhat aversive for the adults who do not desire to go into classes and get education and display their ignorance. The self-help packages are somewhat on the increase. I suppose that his is a future thing that will increase.

Representative WIDNALL. In recent years, the pressures on the educational process have come from the high birth rate. In the past years there has been a very sharp increase in the population. It seems to be leveling off at the present time. If that is true, does it not mean that in the future the primary pressures will not be on the elementary and secondary schools but on the colleges and in the area of adult education? Does this not primarily occur because everyone will be in school much longer now than 4 months? What does this imply for educational plans?

Mr. FOLGER. Your conclusions are correct, that the major growth in the next two decades will occur in college and postcollege and extensions of specialized vocational technical programs to adults, and to student dropouts, with the possibility of the extension of the school system downward. The schools, as we have known them, that is, grades 1 through 12, will grow at a relatively slow rate until at least 1980.

Representative WIDNALL. My time is up. Thank you.

Chairman PATMAN. We will get back to you later. Senator Proxmire.

Senator PROXMIRE. I want to join my colleagues in commending this panel. It has been very excellent and stimulating, very interesting. This is a new field for us. Many people view it as more of a field for the Education Committee than for the Joint Economic Committee.

I think it is most important that we consider the economic implications of this, because it becomes so enormously important.

All of the stress that we have had in the Congress in the recent years has been on the desirability of increasing more and more our resources in education. I have bought this a thousand percent. I thought this was a very wise thing. And that the only really important resource in any country is the skills and the abilities and the characters and the morale, and everything else that flows from that. At the same time, I think, Mr. Folger, you raised the question, and some of the other gentlemen perhaps implied the same thing, that we may be coming to a point where we can be a little more discriminating in the investment of enormous amounts of money that Congress is anxious to push into these programs.

Last year, for example, the Congress authorized sums something like two to three times more than the administration requested for education. We are very proud of an educational Congress. We are not funding it this year because of the Vietnam war. It is the feeling that when the war is over we are going to do this, that it is one of the ways we are going to compensate for an economy that has not been able to provide as much as is demanded, and it will be necessary to put terrific emphasis on education later. I suggest that within the next

few years, we might possibly be coming to a situation that we really need. You do not say that at all; you simply say that we are going to diminish possibly the shortage. That was the implication. It seems to me that this is not a good possibility with the terrific emphasis on education. It is perfectly proper with an increase in teachers' salaries, that we get more people going into this particular area. There may come a situation where we do have a surplus of teachers.

Do you think that there is really any possibility of that?

Mr. FOLGER. I noted and discussed the point that the teacher-to-pupil ratio should not be considered as rigid in any way. One thing we can do is to get the public schools equality with the private schools, instead of 30 pupils to 1 teacher, to cut it down to 10 or 15 or something like that. The other approach would be to improve the quality of the teaching force.

Senator PROXMIRE. That would not be true for the quantity of teachers who will be pouring out of our system.

Mr. FOLGER. About a third of college graduates have gone into teaching in the last 5 years. Only a minority of these people have a degree in education. A majority of them have a degree with a major in some other field, but have taken enough education to get certified to teach, so that in a sense a teaching career represents an option for the college graduate. Do they go into teaching? Is this the most attractive alternative available to them?

Senator PROXMIRE. If I may interrupt at that point.

There seems to be a maximum of attraction in other areas because we do have a shortage of skills, shortage of labor supply of all kinds.

Perhaps, in another few years, with the tremendous productive growth of our economy, with the huge expansion in plant and equipment, with 1½ million more people pouring into the work force each year. It seems we might have more people, not less, wanting to go into teaching.

Mr. FOLGER. Another thing about teaching: If you will look at how people make up their minds about what they are going to do, teaching is an area that they come into relatively late. Teaching picks up recruits from people who said they were going into science or social science. Part of this, I think, is a recognition that this is the most realistic opportunity for employment that the people have.

I would say that unless the economy continues to grow at a rapid rate, there will be a number of college graduates who will have to settle for jobs that do not particularly attract them.

I do not foresee any possibility of unemployed college graduates if we produce more college graduates than the labor force as it is presently constituted requires. They will simply push out people with less education, because they will be more desirable candidates for the jobs.

Senator PROXMIRE. Of course, the economists are often wrong; but most of them indicate that they do not expect the economy to grow with anything like the rapidity it has in the last few years. There are many reasons for the terrific increase we have just had. If economic growth does slow, it seems to me that there are two consequences: One is the possibility of qualified people wanting to be teachers without the opportunity available; two, as you indicate, a very interesting diminution of the pressure for economizing on

teachers by using technology as a substitute for teaching, and, therefore, less economic demand in this area—obviously, a qualitative demand for all kinds of technology, but less economic demand—to substitute a television teacher or some other mechanical teacher for a live teacher.

And then we come to the other point which was raised by a man named Ridgeway, writing in the New Republic a short time ago, in which he said that he thought maybe the educational technologists have oversold themselves and the public. They have invested about one-half billion dollars in this field in a year, and that the maximum market that they can expect is about $1,500 million. By far the most of what we are spending in education goes into teachers' salaries and construction. We can expect more to go into technology. But the field may not be as good economically as indicated. Do you have some comment on that?

Mr. GLASER. In relation to your remarks about shortages, there is at the present time, and will be for some years to come, a terrific shortage in research and development people for education. All of the things that have happened to education, and the increase in Government funding for R. & D.——

Senator PROXMIRE. By "R. & D.", do you mean research and development people?

Mr. GLASER. Yes.

Senator PROXMIRE. You are talking about a relatively very vital and important area, but in terms of the hundreds of thousands of teachers—would this be an important point?

Mr. GLASER. I want to make a special point about this, that is, it is not as large as the number of teachers, but it is a special point that can influence education to this extent: Education has been deprived of significant research and development. It is beginning to get it now. There is a shortage of our R. & D. people around the country, both for Government-sponsored work and otherwise. Industry now is going to require such R. & D. people. And this source of people is almost nonexistent now. There will be a tremendous shortage in this area. It is these kinds of people that will introduce the criticality into education that you are asking for.

You say: Are we spending money without evaluating priorities and evaluating tested projects?

Senator PROXMIRE. That is wonderful. I hope that we can do it. But the judgment is often so subjective. I am concerned about the possibility, because of the great emphasis in education, that we may waste a lot of money. Some of the fringe courses, like domestic sciences and physical education courses seem wasteful. Building swimming pools or fancy dormitories—you have all seen them in your own States—seems too elaborate. This could easily become a serious problem in a relatively short time. Do you think that they can introduce priorities here that will be helpful to us, or do you think this is too subjective and subject, perhaps, to political pressure?

Mr. GLASER. I think the kind of things you mention, expenditures for those kinds of things, are the subject of political pressure and particular whims and things that people like to see. There is a lot of innovation in building new buildings, innovation in television, innovation in new methods of education, innovation in designing all sorts of things

which are sizable expenditures. Teachers and educators and administrators over the country are now innovating things, because that is the thing to do, to innovate and update education, but innovation and updating of education is not necessarily progress and improvement in education. To the extent that the whole network of R. & D. centers that the Government is funding is in on the examination and evaluation of what is going on and the use of the evaluated data to make some intelligent decisions, this is really what is going to help you decide where the money should go. What are the potentials? What are the payoffs? What is useful to do now? What is useful to do later? I think that the evaluative factor that is possible from the R. &. D funding money that is going in will be the thing that will make these adjustments.

Senator PROXMIRE. Thank you. My time is up.

Chairman PATMAN. I want to read some questions in the record, in the hope that you gentlemen, each of you, will comment on them when you look over your transcript.

In Monday's hearing, it was brought out that if we want to realize the true potential of technology in education, we will need the participation and cooperation of educational institutions, private industry and government, in planning and systematizing the application of technology. At the same time, there does not seem to be any coordinated mechanism for doing this job.

Do you have any ideas about what might be done regarding this need?

Do you think educational efforts would be productive if the schools used more equipment and instrumentation? If so, what measure of productivity do you employ? Would you emphasize the number of individuals who are taught and achieve an acceptable grade, or the quantity of instruction material which they cover in a given period of time? Is the quality of the educational product involved in evaluating productivity? If so, how is quality brought into the calculations? How is it identified and weighed?

I have seen references to the need "to get more education for the dollar." What are the prospects for reducing unit costs through automation?

Do you think increased investment in research and development and in capital equipment for education will pay off in discernible (or measurable) economic returns? If so, what is likely to be the form or the character of the payoff? For instance, would the result be lower cost per pupil?

In your estimation, is research and development given as much emphasis in the field of education as in other broad fields of individual and social behavior, say health and medicine, communications, transportation, or agriculture, for example?

Is the potential of research and development as great in the field of education as in these other areas?

What aspects or avenues of research and development in education need more emphasis in your estimation?

In our hearing on Monday, testimony indicated that we are not succeeding in translating the benefits of our great research and development to our teaching, our schools, and our libraries. This seems

to be the case, even though large sums of money are being invested in technology. Will you comment?

If you gentlemen will comment on those questions for the record, it will be very much appreciated.

Mr. G. E. Arnstein's Replies to Questions

The clearing house (BETA) advocated in my testimony should help measurably to create some order, some voluntary coordination without stifling diversity or creating forced conformity. This leads into the next question.

Yes, the schools would probably be more productive if they used more equipment and instrumentation, but I am not sure that we have adequate techniques to measure productivity and I am even less sure that it is a good idea to measure productivity. Education, after all, has two aspects: vocational and liberal. The vocational part may be measurable but the liberal part—especially important in a democratic society—should not be related to productivity.

At the same time our school would benefit from better equipment, starting with the elimination of unsafe classrooms, some of which are in legal use only because we have grandfather clauses exempting them from modern safety regulations. Of course we should use films more than we do, and we should have better means of getting them into the classroom. Let me illustrate by citing something that is technically feasible and might be cheaper than our present way of scheduling films, except that it will take a major capital investment which most schools can't make.

Sooner or later we will see the decline and death of the school film library. Typically this is a collection of teaching aids, 16 mm films, either downtown or at the county seat. At the request of the teacher, some clerk confirms a booking, sends the film by truck or messenger to the school and so on. This is expensive and inefficient. Instead we will have a central projection room which will be linked by closed circuit television to the classroom and teacher who requested the booking. It seems clear to me that this will become economically feasible before long for there are no technical obstacles even today. This means, among other things, that the little red schoolhouse can have the same level of film services as an urban school with a large student attendance.

This also serves as an example of possible savings through automation, but note that this is in the area of administration and services so as to enhance and enrich the instructional program, rather than to have the instructional program delivered by machines.

Of course (to turn to the next question) we need more research and development in education, even though the school should not be subjected to measures of productivity. A school and a factory are different in many ways. They also have similarities—payrolls, scheduling, personnel selection, in-service education, building construction and maintenance, inventories, and first-aid stations. Technology has been used and needs to be used even more except that schools are noncompetitive and thus should do more pooling of computers and programs and film libraries. Macys may not tell Gimbles, but Arlington County certainly ought to tell Alexandria and Falls Church—and, in fact, has a federal grant to plan this kind of cooperation. I don't know if this is research, but it certainly is development and it is a good thing.

As for research and planning and thinking ahead, the Air Force created the Rand Corporation, but there is nothing comparable in education. Granted, some of the defense-oriented "think tanks" have also thought about education, but this was a sideline, something they did when the defense needs seemed to reach a plateau or threatened to decline (especially before Viet Nam became as large a problem as it has been for the past few months).

Is it really necessary to invoke some external threat, some menace from abroad to get a comparable effort in educational research? Did we really get the National Defense Education Act of 1958 only because of the shock of sputnik?

I realize this is the Joint Economic Committee, and I do not want to make light of economic growth, economic returns, and our defense needs. All of these require more funds for educational research and development, but in addition we also need education for its own sake, regardless of productivity.

Of course there is a tremendous potential for R&D in education, but what we need are not only money, but the assurance of long-term support.

The payoff, (to use Mr. Patman's phrase) in my opinion, should come not necessarily in the reduction of costs per pupil but in the enhancement of our human resources. This is reflected in the title of a publication by the Chamber of Commerce of the United States: *Education, An Investment in People.* On a more systematic basis, there is *Education and Economic Growth* by Harold M. Groves (Washington, National Education Association, 1961) in which the author notes that while "no one has been able to unravel cause and effect, there undoubtedly is a relationship between education and economic growth." (He then goes on to point out the difficulties of measurement and the waste of manpower.)

The Congress has been generous, especially in recent years, in making federal funds available, but it has not always provided necessary continuity. When a requested appropriation is in doubt until the last moment, this often has repercussions at the point of consumption where the project director and his staff spend unnecessary time worrying about a possible lay-off (because the funds may not be renewed because of delays in appropriations, and he may even go so far as to explore alternative places of employment.)

Further, there is the great cost of longitudinal studies. If we really want to know whether Headstart will make a difference in the future competence or employability of its "graduates" we will have to keep track of these Headstart alumni over many years—ten or twenty seems like a reasonable number. This kind of longitudinal study needs to be launched right now but who will give assurance that the research team can look forward to uninterrupted support for the next decade or two?

Project Talent is one outstanding example of an attempt to do this kind of study, including the horrible side-effect that you can't even evaluate this kind of study until it has many years under its belt. It's too early to tell whether Project Talent has been worth it or not; after all, it is less than a decade old.

For the record, there is the classic study by L. M. Terman on the constancy of Intelligence Quotients. His experimental group over the years came to be known as Terman's Termites, but this is an exception rather than the norm, attributable to lack of funds, lack of long-term commitments, and also possibly to lack of initiative on the part of researchers who may find it easier to undertake relatively small, short studies on which results can be published quickly.

Overriding the entire problem, and implicit in these hearings, is the general conclusion that research in education has not been supported at a level commensurate with its importance. We have nothing comparable to the concerted efforts and massive investments which have, for many years, been behind nuclear physics, national defense, medicine and pharmacology. Some educational support has been "bootlegged" as in the case of the National Science Foundation which stretched its definition to include psychology and economics and anthropology but could not quite make it go as far as education. Similarly, the National Institutes of Health were broadened to include mental health, with some educational overtones, but not focused on education flying under its own flag and operating under its own name. Even NDEA had to be sponsored for the sake of National Defense rather than education.

The explanation is relatively simple: The old, long-standing bogey of federal control and the sensitivity of local school boards and college trustees. This sensitivity has caused massive delays in federal aid to education and as a concomitant has prevented substantial support for educational research. Now that we have overcome that barrier, there should be major efforts to apply modern technology to education, but we cannot expect miracles overnight. There is no backlog of educational development and there is a shortage of trained researchers, in part because there have been (until now) no federal training funds comparable to those in other disciplines.

It seems quite likely that we will be able to benefit from the fallout from other fields. The computer program to schedule a milk-delivery route can probably be adapted for school buses. The investment in training operators of an air-defense system can probably be adapted to train machinists, but it does not follow that this is also suitable for the teaching of citizenship.

To conclude: Yes, I think the potential of R&D in education is as great as it has been in other fields. We haven't really tried it, so there is no way of knowing for sure, but the first step is to take inventory of our human and other sources so that we can find out what we already know, what we have, and where we should go from here.

Mr. C. R. Carpenter's Replies to Questions

1. ADULT TRAINING AND LIBRARIES

Request leaders in continuing education and extension services to plan a nationwide program designed to make adult learning a major activity of communities. Include liberal adult educators and media administrators. Invite publishers and the producers of programed "kits" or "packages" of materials. Provide Federal funds only for materials that will be produced on a cooperative inter-institutional basis.

2. COOPERATION OF EDUCATIONAL INSTITUTIONS AND PRIVATE INDUSTRY

Promote, encourage and finance on matching bases centers for the production, testing and distribution of instructional materials. The centers should be parts of the developing Regional Education Laboratories. They should be open for schools, colleges, universities, publishers and other producers of instructional materials.

3. EDUCATIONAL EFFORTS AND PRODUCTIONS—HOW MEASURE

Establish in the Regional Laboratories "pilot plant" models that test educational technology applications and estimate effects and costs when applied on realistic scale.

4. QUALITY OF EDUCATIONAL PRODUCT

Encourage the development of at least six organizations like the Educational Test Service of Princeton, N.J. The Services should be located in major regions, e.g. South, Southwest, Midwest, etc. Emphasis would be put on educational assessments, standards, quantification of behavioral measurements, educational, cultural, social and economic analysis and interpretations.

5. PROSPECTS FOR REDUCING UNIT COSTS

Prospects are excellent in higher education when institutions cooperate in the areas of instruction and share facilities and programs, especially by using inter-institutional communications systems. Related is the need to encourage independent study on the part of students.

I believe that unit costs, on the average, could be reduced by at least 50%. There are many areas of instruction, however, where costs need to be increased rather than decreased.

6. WILL RESEARCH AND DEVELOPMENT PAY OFF?

Yes. The pay-off will come: 1. When better research is done. 2. When research results are accepted and translated into applications. 3. When combinations of results are demonstrated realistically to have significant educational and economic advantages. Research results need to be marketed.

Politics can be strong support for innovations and use of good research results.

7. WHAT ASPECTS NEED MORE DEVELOPMENT?

a. Individualization of instruction to adjust to individual differences. b. Development and application of the systems approach to defining educational strategies. c. Developing models for providing and testing instructional materials and programs. d. Provision for reinforcement and "feed-back" of right kind, right amount at right time to learners.

8. ARE THERE SUBSTANTIAL ECONOMIC BARRIERS?

Yes. a. The limited capital that private industries are willing to invest in educational ventures. b. Limited funds available for producing and distributing radio and television programs and for providing supporting materials.

An Objection—C. R. Carpenter

I wish to object to any statement that indicated that investments of Federal funds for educational and instructional television have failed. The Federal Government has made minimum investments in television—about $32,000,000.

The program is in mid-stream and cannot be evaluated on an overall basis. Federal funds have released other capital investments by states, communities and institutions. The providing of equipment and facilities throughout the Nation is progressing nicely, but the development of programs is lagging behind equipment availability. Funds are needed for this phase of the development. In this connection, the support by the Ford Foundation for cultural programs and *not* for educational-instructional programs is exceedingly unfortunate—if not a tragedy.

Federal investments have greatly stimulated state and community efforts. In central Pennsylvania and through the efforts of The Pennsylvania State University $100.00 of Federal funds stimulated the establishment of a television station that cost about $500,000. This station reaches 22 counties in a culturally deprived area of the mountainous part of the commonwealth. The station—on channel 3—would not have been built without Federal funds and matching State funds.

Chairman PATMAN. Mr. Widnall.

Representative WIDNALL. Thank you, Mr. Chairman.

Chairman PATMAN. Pardon me, for a moment.

May I suggest that the transcript will have in it the questions I have read, and you will have the benefit of them when you go to answer them.*

Representative WIDNALL. I do not have this question for any particular member of the panel. I would like volunteers to answer.

Is there a diminishing return for educational expenditures? In other words, could the quality of education suffer from an over-abundance of money and research?

Mr. CARPENTER. I have two thoughts on that, but I am not an expert in this field. One is that there is no limit to a possible return. That would be the answer that I would give to the first question.

The answer to the second question is that the danger is the rate at which funds are made available in relation to the possibility of appropriately investing them. This is the crucial problem.

Representative WIDNALL. In other words, to be sure that you have a person who is able to use the programs and knows exactly the goals and the ideas sought by the program; in other words, highly trained personnel for the use of the new technology?

Mr. CARPENTER. And programed, scaled in relation to the rate of the investment over the period of time.

The appropriation has to be made before you can get the highly trained personnel that you need to carry out the program.

I think any component is extremely important—the program. What are you going to do? How is this planned? How is it designed to accomplish certain specific goals?

Representative WIDNALL. I think, in your testimony, you disagreed with last Monday's testimony to the effect that schools and colleges, generally, make only limited and often inconsequential use of available technology, particularly in instructional television. There are, of course, successful, localized instances of intensive use. I would like to know what the other panelists think about that. Do you agree with that general assessment of last Monday's panel's testimony?

Mr. ARNSTEIN. Yes, I do, but at the same time I would like to point out that we lack some effective mechanism for sharing programs. We do not have the equivalent of an interconnected network as do the three commercial networks. Thus, if there is a good program, it

*Responses to Chairman Patman's questions had not been received from witnesses Folger and Glaser at time of publication.

is extremely difficult to reproduce it and to disseminate it and to make it available to other school systems.

We also have a tradition of local control over our schools which, in a way, mitigates against the acceptance of a program produced somewhere else. This tremendously increases the cost of production, except for the simpler types of programs which present one or two persons speaking in front of a microphone, except that it can be watched as well as heard.

Representative WIDNALL. Where is that road block? On the part of the teachers, the school administrator, or what?

Mr. ARNSTEIN. I am not making a judgment as to whether it is a roadblock, which implies that it is bad. I merely say that we have a tradition of local control, locally prepared materials with tremendous increases of costs.

Representative WIDNALL. Do you have any comment?

Mr. FOLGER. I would certainly agree that technology has not been introduced into education very rapidly. There is an exception, the introduction of technology for research in universities has been extremely rapid. Technology is intimately bound up with research processes, and as research moves forward, it has to do this by utilizing more and more sophisticated technology. You have a fairly sharp contrast here between the development and use of technology for research in the university and in the use of technology in the instructional process.

Representative WIDNALL. Mr. Glaser?

Mr. GLASER. I do not know whether I can say anything that is not too complicated. It is like someone from industry saying that we produce all of these products, but people are not using them fast enough. In one sense, I submit that maybe they are supplying educational products which are too close to what they have been turning out for many years. Perhaps, they are not innovative enough, so that they are sold primarily on the basis of sales potential rather than on merit or any actual demonstration of how good they are, so that people will readily accept them.

There is also the formidable necessity in education for making sizable and obvious demonstrations of things that work and things that do not work, but you have to invest a lot of money into showing an innovation which makes a significant improvement in education. It is almost like investing a sizable sum of money in trying to put a man on the moon, rather than disbursing efforts to some extent, and you may put a sizable amount of money into showing a major educational innovation which convinces educators around the country that this is the thing we must do—and too much concern with, you know, disbursing the funds and not showing what is really possible.

I think that if we can show what is possible, then people will be much quicker to pick it up.

Representative WIDNALL. Do you think that could be accomplished more easily by a concentrated demonstration in one area, rather than trying to have it all over the country?

Mr. GLASER. I think that we have been a little overly concerned with disbursing it widely, rather than making some hardheaded judgments about demonstrations which we want to show to the country. I think that might be a useful way of doing it.

Mr. FOLGER. I will disagree and say that I do not think it is primarily the nature of the product or the lack of adequacy of some of the demonstrations of the way in which technology can be used in instruction, but that it comes back to the point that Dr. Carpenter mentioned earlier, that we are dealing with a system where you have a self-sufficient and self-contained instructor and he regards himself as self-sufficient, whether he is or not, and the tradition of the institution is that this is the way he is treated. I think this is the principal impediment to rapid introduction of new ideas which require that he behave in very different ways—the notion of bringing in a technological system is one in which the individual has to cooperate with not only the equipment but other people in a whole new set of relationships, and this is why, in my judgment, technology has been slow to move into the instructional process.

Representative WIDNALL. Mr. Arnstein.

Mr. ARNSTEIN. Your question specifically dealt with educational television but it also was broader than that and dealt with the use of technology. In general I would like to suggest that schools and colleges have been fairly progressive in using data processing equipment for administrative purposes, particularly in those areas where it is demonstrably effective. It is being used to prepare pay checks which can be run off by the computers rather than by bookkeepers using quill pens.

Here schools and colleges have very good records. It is in the area of instruction that the picture is much more nebulous. I think it harks back in part to something that you mentioned last Monday when you raised the question of dehumanization, whether the computer is a threat. And here I disagree with what some of the panelists have said, because I do not think that the computer is fully accepted among colleges and universities or public schools, because there are some members of the faculty and many students, and many of their parents who see it as a threat and see precisely the kind of dehumanization that was implied in your question last Monday. I will be glad to elaborate on that.

While I do not share this particularly, it is a danger, but I do not think it is an overriding danger.

Representative WIDNALL. Why do you not add to your remarks in the transcript when you receive it? I was actually trying to get to this at this time, whether there are present deficiencies in the instrument, for example, whether teachers find that television is not particularly useful in the classroom.

(Supplemental information supplied by Mr. Arnstein:)

THE PROPOSED MANPOWER AND TALENT CLEARING HOUSE (MATCH) [1] BY GEORGE E. ARNSTEIN, ASSOCIATION FOR HIGHER EDUCATION, WASHINGTON, D.C.

The project which I am heading is the Manpower and Talent Clearing House which produces an acronym—MATCH (as long as you spell Clearing House as two words). In fact, MATCH does not exist as a functioning system for we are currently funded only for a feasibility study under a grant from the Esso Education Foundation to the Association for Higher Education. Can we design a system which will inventory vacancies—and their descriptors— and stockpile

[1] Summary of a presentation at the 46th Annual Convention, American Association of Junior Colleges, St. Louis, Missouri, March 3, 1966. Excerpted from "*Selected Papers*," Washington, Association of American Junior Colleges, 1966.

biographical data on professors and other professionals so that they can then be matched by computer?

The answer is yes. What is much less certain is the question of whether this kind of a system will be accepted in education, especially in higher education with its relevant and proper concern with human characteristics, with finding the right man (or woman) of the right job.

There is not enough time this morning to cover all of the difficulties nor all of the expected advantages. Somewhat immodestly I'm going to refer you to an article in the November 1965 *Phi Delta Kappan* entitled "MATCH: Square Pegs for Square Holes." (If you'll drop me a line I'll be glad to send you a reprint.)

I do want to take a few minutes to cover the question about the "human" factor, the problem of the computer as an inhuman beast and how it can possibly do a good job, or a better job, of finding the right candidates for the right jobs. I am firmly convinced that the inhuman beast, in fact, can do a better job than our traditional methods. Let me review very briefly how we now accumulate a list of candidates.

Most of you get letters or calls asking you to recommend somebody to fill a faculty position or a deanship or to head a project. I have done a bit of sampling and it seems that all of our memories work in a similar fashion: We think of our relatives (of whom few qualify, even remotely). Next we think of friends and colleagues, many of whom may come reasonably close. In fact, we probably got the inquiry in the first place because our friends and colleagues may be suitable. And then we search our memory for whatever else we can come up with.

Our list of nominees is likely to be short, in part because our memory is imperfect. I have had the embarrassing experience of reopening my list, of adding a name or two, just after I looked at the morning mail which contained a letter or an article by somebody whose name had escaped me but whose timely mailing jogged my nerve endings. Others, with whom I have discussed this matter, report similar memory joggers—an unexpected visit or telephone call from somebody they should have nominated on the basis of his qualifications or merits, or, an old friend who confided that he might be available. Availability, of course, is usually couched in careful jargon: It isn't that he is being fired but that he is looking for a new challenge; it isn't that he wants more money but that he is looking for an opening offering greater public service. Leaving aside the rhetoric, we do know of people who are "available" or "moveable".

That, then is one way of accumulating a list of candidates. The other way is to call the college placement officer (or several placement officers of professional body snatchers or snatchers of professional bodies). He too will use his memory; in addition he will ask one of his clerks to look through his file and in a very few cases he may press a button on his computerized information retrieval system. His memory, of course, is imperfect, just like yours and mine. His clerk may run out of patience and have her mind on the next coffee break. And his computer ought to be just right, except that it is a localized operation instead of a national network. After all, we are talking about higher education where the market is nationwide and where the search ought to be equally broad.

Anyway, by now you should be aware of the point I am getting at. A computer, with proper input, should be able to deliver an objective, meticulous, and thorough search. It can be programmed so that it will only search for candidates who are "available" or it may be encouraged to look for the best man regardless of his availability or lack thereof. The important thing to remember is that a computer has a longer and better memory than human beings, that its input is imperishable until it is instructed to purge itself.

It is just barely possible that you may have noted that I have not used the word "placement". This is deliberate because we do not propose to establish a placement service; we do not propose to make judgments about the quality of the candidates you—and others—may want to consider. This decision-making process we will leave to you or those you designate. No, we hope to establish a national, voluntary manpower inventory so that we will know, as a nation, what talent we have and so that we can identify and locate professionals with relevant qualifications. Beyond that, further action is up to you.

Employers will have to be educated to use this system, for one of the tricks will be to define the man and his talents as realistically as possible. I suspect, for example, that we tend to put down the Ph.D. requirement almost absent-mindedly. Do we really mean Ph.D. or do we accept equivalents such as Doctor of Education or Doctor of Science? For that matter, will we settle for an MA or MS?

That example is enough to give an idea of the ramifications which will grow out of a system we hope to design. I cannot, in all candor, tell you *if* we will actually launch it, or *when* we will start operations. I can't even tell for sure whether it will be sponsored by the Association for Higher Education, or, more likely, by a coalition of organizations or a new nonprofit service corporation. I do know that there are no electronic obstacles. IBM uses a system like that within the corporation and so does General Electric. The Federal Civil Service Commission is investigating the possibilities, and the report of the National Commission on Technology, Automation and Economic Progress[2] just last month (Feb. 1966) called for a computerized system of matching men with jobs. (The Commission also called for a 14-year education system, as John Mallan has reported to you in the AAJC federal legislative reporting service).

In higher education, on a very limited basis, the educational placement officers, through their Association, hope to launch a computer-based service which will expand their base and may eventually become nationwide, although it seems to be limited to active candidates.

I am happy to report that the reception we have met so far is basically favorable—not unanimously and not immediately, in part because it takes time to understand just what MATCH will be like. Ironically, I don't know all of the details because we keep changing them. We have been exposed to questions and suggestions and criticism and they have engendered several modifications of MATCH which offers, to my way of thinking, an exciting new alternative to an old problem. It should make it possible to use our human resources more effectively, to ease the tasks of employers and talent scouts, and it should provide greater fulfillment to the professionals who will have a better chance of finding the kind of job they really want. And all of this because computers are the witless beasts which will do what they are told and do it vigilantly and competently.

Mr. CARPENTER. May I reply to that since I have had quite a number of years of experience at testing just exactly what closed circuit television can do in a large university. Incidentally, if you wish to see a documentary film of about 30 minutes in length, we have produced one that is available through the U.S. Office of Education.

You run into all kinds of blocks and barriers, including costs, engineering, installation, et cetera. It is not the medium itself that is defective. Here I must agree with Dr. Glaser that it is what we do with it and how we use it. We have misused television in many instances. We have used a mass media, for example, for too limited use, which does not make sense, and we have used multichannel instruments and systems to put a professor's face on the screen, talking too much, because it is cheap. We operate on that kind of a level all too frequently. We do not have the production resources to produce the kinds of programs that I am sure that Dr. Glaser and I would propose.

Representative WIDNALL. You are saying that there is a lack of suitable material for presentation?

Mr. CARPENTER. Suitable programs, adequate quality appropriate to the requirements of education. If we had much better materials then we would have much greater acceptance of television in schools and colleges than that at present.

Representative WIDNALL. Are there institutional personnel problems in connection with this?

Mr. CARPENTER. There always are with anything that is new and which requires as much learning and change of role performance as television.

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[2] *Technology and the American Economy*, Vol. I. Washington: GPO, 1966. 75¢.

I would like to focus this question on the broad array or wide spectrum of technology, rather than on one single component like television.

Representative WIDNALL. I would like to ask all of you in the panel: Do you feel that there are substantial economic barriers to more extensive and effective use of a variable technology?

Mr. Arnstein. Yes.

Mr. GLASER. You are dealing with the problem as you are well aware, of making improvements in innovations which have to do with human affairs, and it is much tougher to make innovations and changes in "people technology" than it is with developing new radar and television sets. There are sizable barriers in school systems throughout the country because of the resistances to changing a school system, let us say. You introduce television, or you introduce teaching machines into a school system, and when you do this you probably are going to revise the traditional pattern of how a school is run. To produce a new pattern is a process whereby individuals have to be shown, their behavior changed, and you have to proceed along successful steps. How do you go from where you are now to where you want to get?

One of the things that is required, I suppose, is for leaders in government and industry to say, "Here are models of the things that we can do," and to show them to the people, and then the question will arise, "How do we get there?" But in the absence of such things, the resistances of overhauling the school system and doing away with classes and changing the role of the teacher is just tremendous.

Representative WIDNALL. Would any of the rest of you like to comment on that? I just have one more question.

What is currently being done to overcome any barriers, to bridge the gap at the present time? Has any major effort been made to meet the problem right now?

Mr CARPENTER. Well, I think that magnificent effort is being made by the U.S. Office of Education in its cooperative research program which has been greatly expanded, and the new research and development centers. I think these are operating in the right direction, the experimentation that is being done, and in the demonstration and the dissemination programs.

We still do not have anything comparable in scope or in effectiveness in education to compare with what is being done in agriculture, but I think that we are taking the first faltering step in this direction. In almost every institution, I think, you have certain projects going on, like computer-based instruction in a number of places, to illustrate and demonstrate possibilities.

These are ways of breaching the gap.

I think institutions are investing their own funds in new types of developments; they have to in order to get the job done.

Representative WIDNALL. Thank you very much.

Senator PROXMIRE (presiding). I would like to follow up on one of the questions asked by Mr. Widnall, because I think it is so interesting.

I would like to ask Mr. Carpenter to comment first. Mr. Mitchell hit this very hard. I want you to get the flavor of his language. He said this:

> Educational television has been the most expensive and disastrous failure in modern educational technology. Instructional television has unlimited possi-

bilities, yet it is a puny, minor instrument in practice. An investigation of this subject by a committee headed by Dr. Kilian found that it was "$80 million late."

Meaning that they have wasted $80 million, have poured $80 million into it and got nothing from it.

In general, your replies were related, especially from Dr. Folger, and I assume from the other gentleman, that it was related to the use of technology in general and not so much specifically to Mr. Mitchell's very, very strong criticism of television. He is an extremely able man, I am sure you will agree, a responsible man, a man deeply devoted to this particular subject.

What do you, Dr. Carpenter, suggest that we can do about this?

Mr. CARPENTER. Well, you have opened up a very wide range of problems here.

Senator PROXMIRE. I want to zero-in on that. It would seem to me off-hand that we could narrow it down a little bit. You have to begin with the instructor. You say that there is a lot of good material available. You have to have some way of showing what the material is—what is available—how we can best use it—some opportunity for him to become sufficiently familiar with it so that he recognizes this as a good technique whereby he can be a better teacher. It gives him that.

Mr. CARPENTER. I would love a debate with Mr. Mitchell on this issue which would take 3 hours, and I would lose, but I would love the debate anyway.

Senator PROXMIRE. I am not so sure you would lose.

Mr. CARPENTER. On your point, I think that you do not precisely start with the instructor. You start with the instructional requirement, the instructional functions. You start and look at your program across the university or across the school system. That is the place to start.

When you start with the instructor and begin to say to him, "Now, you change that. You use this." Without providing him with the backup resources and the people to help him, he is going to play the role that he is trained to play. This job is enormous. You have to change the habit system of your mature people, frequently. We find in introducing closed circuit television that the mature people are more willing to take the risk than the younger people. They can afford it. Our best instructors are the men in the fifties who have gained full professorships, et cetera.

My main point is, in order to be specific, that you do not start with a specific instructor. You start with defining the instructional requirement. And, incidentally, I, also, look at the other side. What are the requirements on the part of the student? And, perhaps, this is the more important consideration, because it is the learning operation that should be focused on rather than the teaching operation.

Senator PROXMIRE. I have assumed from what you have said that—that we had the materials—that we had defined the areas where educational television could be most useful. You say that we have not?

Mr. CARPENTER. We have not.

Senator PROXMIRE. Then you say that Mr. Mitchell, is, at least, to this extent, right—that the fault is with the inadequacy of it?

Mr. CARPENTER. Mr. Mitchell is wrong. The fault is partly with Mr. Mitchell's product. It is useful in certain areas. It is not useful in many other areas. And it is not good enough. I mean, Mr. Mitchell makes a proper product——

Senator PROXMIRE. It is not usable?

Mr. CARPENTER. He is doing a pretty good business—a pretty widespread business—a national business—one of the best in the country.

Senator PROXMIRE. My point is that he said that it is not being used—it is not getting into the classrooms. I do not know whether my children—I have five of them—have ever had any educational television anywhere.

Mr. CARPENTER. Mr. Mitchell's business is film production, not television.

Senator PROXMIRE. I am talking about whether it has been a failure where it has been used. Let me ask Dr. Glaser if he would like to comment on that particular phase.

Mr. GLASER There has been a lot of wasted money in educational television. To that extent, Mr. Mitchell has a point. But it has come about because someone said, "Let us use television for education."

A lot of people proceeded to use television the way they always used motion picture films—they proceeded to use television in the school system as it has always been constituted. There may have been one or two researchers around the country, mainly, Mr. Carpenter for one, who have had a long history of experience, who had tried to point out the way that television should be produced. What quickly happens is that a lot of money is invested in television.

A lot of people jumped into the use of television. Commercial organizations sell television. Quickly, they have introduced it into the system and have said, "Use it." And there is no system thinking, and there is no evaluation. This is a complicated answer. I did not mean to make it so complicated.

Senator PROXMIRE. You mentioned system thinking. What was the other term you used?

Mr. GLASER. Evaluation.

Senator PROXMIRE. And evaluation. How do you achieve those?

Mr. GLASER. You achieve those by trying to introduce some quality controls into the products produced by the people that sell television.

Senator PROXMIRE. Whose job is that—whose responsibility is it?

Mr. GLASER. Those are responsibilities of the educational associations and the educational research and development people and the competition of industry.

Senator PROXMIRE. People like Dr. Carpenter?

Mr. GLASER. Yes, people like Dr. Carpenter. And the funds that are available to assess the evaluational products. You say, the education of television is, how old?

Mr. CARPENTER. 1954 or 1955, really—beginning in 1952. It is a short period of time.

Mr. GLASER. It started even before the Government became concerned with its network of research and development centers, and regional laboratories that are concerned now with assessing and eval-

uating educational products. There really was no mechanism for putting the producers on their toes, to evaluate and assess.

Senator PROXMIRE. Is the Killian study going to help?

Mr. GLASER. I am not familiar with that.

Mr. CARPENTER. I would hope so.

Senator PROXMIRE. Do you think that is a good thing?

Mr. CARPENTER. I think that it is a necessary step with specific references to television. I think that we ought to broaden that kind of study and have studies that include more of the educational technology.

Senator PROXMIRE. Let me ask this, would it be your conclusion that the teachers have nothing, absolutely nothing, to fear from educational television in terms of being replaced, that it is supplemental enrichment, that it is that kind of an operation, that in view of a proper emphasis on individualization, as Dr. Glaser points out, in education that this is something that will make educational experience better and broader and deeper and of a higher quality?

And that we are not going to have television sets take the place of the teacher? You will never do that, in my judgment. Is that your judgment?

Mr. GLASER. I think that is a perfectly correct judgment. It should be frequently and often said. The business of replacing the instructor with automation is an incorrect notion, a misconception. The teacher has to become more increasingly a professional so that we do not say that anybody can teach. It is a technical job. It will become increasingly this way as educational technology develops. These people are going to get good just like physicians get good, because they are supplied with tools for their profession. This is what automation will do. This is what your remark actually implies. Automation is not a replacement. It is a tool that has to be part of a profession. And these people with these tools can be better than ever before.

Mr. ARNSTEIN. I think that we should be aware of the fact that there have been attempts to use television to replace the teacher. And they did not work, let me say parenthetically. If there is a feeling of discomfort about it because it has been tried and it did not work, it was because the video tapes did not teach as well as the live teachers did, for one thing.

I, also, want to add a comment as to this other proposition. I do not know where the figure of $80 million came from, the sum we allegedly have wasted in this field, but in the area of educational television as in most other areas of education, I think we ought to have experimentation. Experimentation, by definition, must have the right to fail. Otherwise, we will only play the safe way and that is hardly the way to innovate.

I do not think that $80 million has been spent on educational television experimentation. What may well have happened is that some commercial producers or manufacturers chose to sell the product before it was adequately tested; like the Edsel, it did not find acceptance by enough people and thus was "wasted." But it seems to me that is hardly the responsibility of the educational community. If that is waste, well, that is a different problem.

Senator PROXMIRE. Congress authorized $50 million for educational television. It was primarily to construct educational television

stations which, also, seems to be something of a failure inasmuch as they have not been able to capture much of the market.

Maybe this is built into our commercial television operation and the habits of Americans, the fact that "Batman," "Peyton Place," and these other programs seem to absorb people.

Mr. ARNSTEIN. The television facilities were not solely for the purposes of instruction but, also, for cultural enrichment programs, the kind of thing that I may watch on channel 26 to 9 o'clock in the evening in the Washington area, which is not what we have been talking about for the past few minutes.

The other is the money which went into the construction, but not into programing. It is in the area of programing that the results very often have been most disappointing, particularly for the young people.

Senator PROXMIRE. This is a question by Mr. Stark, who is advising this Committee. He says, one of the issues that worries educators is the quality of programing. We do not have the highly competent imaginative personnel who create good programs for the machine; that we are in danger of mediocrity. What do you do about this in a system in which we have high money rewards for commercial television and, obviously, the educational media, can never really compete with that.

Do you think there are ways of attracting very competent people to this medium, or do we have to settle for mediocre performances?

Mr. CARPENTER. I suggest that the national complement of production centers where educators and the industrial business people could develop the kind of program that we needed. This is my suggestion, a cooperative deal. There will be Government money as well as more private money in order to get these established. It is a new view of the textbook industry. It might be larger than the textbook industry.

Senator PROXMIRE. It can be a very remunerative one—they can make all kinds of money out of that. That is one of the reasons, I suppose, we have great companies in this business. And some people are shocked with the notion of making money out of text books. I do not know why they should be. If people can do well in the case of television, I suppose that this might be a way of doing it, too.

Mr. CARPENTER. I think the fallacy is that this is a one-man performance. It is more likely to be a group effort involving a great many specialists in order to produce the program.

Mr. GLASER. One implication behind the question is the challenge that is required for commercial television which is, primarily, entertainment. At the same time, that is not required for educational television which has a different function.

Senator PROXMIRE. In part, they are not the same. You are right, sir, about the fact that entertainment is different in the one. But, certainly the imaginative use of lighting and of cameras and of scenes that are dramatic and exciting, and so forth, that kind of capacity is in great demand, and I imagine it might be hard for an educational TV station to compete unless you can put it on some commercial basis to reward it.

You spoke about updating the skills for adult TV, that it is of great importance here, Dr. Glaser, in educational techniques. This is

obviously needed. But do we have the institutions to achieve this? These are the kinds of educational TV that we talked about where we can turn to channel 26.

Some cities are lucky enough to get it on their high frequencies instead of the ultra frequencies. But this is so enormously important because of the great improvement in education and the obsolescence of skills. Can you rely on the job training? Can these be used? Or are they being used? And are they being used more effectively as time goes on, as technology improves on-the-job training programs?

We have done very well in the progress that has been made with on-the-job training, the enormous investment that Congress is putting into this.

Mr. GLASER. If one examines, before one produces products, the ways in which adult education is going to be most effective, what sort of groups can be easily reached, how people will keep attending, what kind of material people will use. If one begins to investigate these kinds of questions, rather than saying, "Well, the way to handle the problem is to write books that they can read and to produce educational programs that they will watch," you may find that they may not watch these and may not read the books, but if one begins to ask themselves, "What kind of procedures will be most useful," then you are going to be forced to do things somewhat differently than you did before. For example, you will have talk-back television, which is not very expensive. Or you will have——

Senator PROXMIRE. You said, "talk-back television?"

Mr. GLASER. Television connected to a telephone line, so you can interrogate the lecturer. Or it can be by radio. You can have television that stops the film when one asks a question.

The biggest problem in training adults—not all adults—is that they have learned that education is the sort of thing that you go to school for and you get taught, rather than that you go out and do something so that you can teach yourself. In contrast it is easy to produce materials that may make it easy for you to teach yourself, if this is investigated.

Using what we know now, what we can sell fast, we can see what will help people go and eagerly learn by themselves. That is the answer. And it is going to come to such things as self-study kits that you can work with at home. I think that those will sell very well. Once these things have been tested and people who would use them know that they work. It is this extra process of testing and evaluation of your product in education which has been completely missing in the commercial production of educational material.

Senator PROXMIRE. I think that is very important. Dr. Seaborg, the Chairman of the Atomic Energy Commission, has, I understand, made the estimate that in the next 30 years we will discover more about mankind, about ourselves, about the world, and so forth, than we have discovered in all human history to date.

We will be using computers to classify and organize information. We will have techniques to enable people to learn more if they desire to do so, to give them motivation, to make it convenient, and so forth.

That is why it is so important that we pour as much effort into research as we can to find ways in which we can achieve this, because it just is a happy coincidence that at the time when we are developing

our extra knowledge and information, we do have a technology that is going to help us organize it and to use it more effectively.

I would like to ask a question along that line of Dr. Arnstein. Would you give us a little more specific notion on your BETA bank that you talked about? You implied that we already are working in the area of job vacancy statistics that affect teachers. Do you have that to a considerable extent?

Mr. ARNSTEIN. The National Education Association every year puts out a statistical report on "Teacher Supply and Demand" and the Association for Higher Education cooperates with NEA in the publication of a biennial report on supply and demand in the area of higher education.

Senator PROXMIRE. Say, a teacher teaching English literature wishes to work on the Pacific coast, is there any way that he or she can discover what jobs are available there?

Mr. ARNSTEIN. No, not yet. That is specifically what I am working on right now, to see whether we can design a system in higher education which will inventory the vacancies, on the one hand, and inventory the candidates and their special skills and qualifications on the other hand; and then proceed to match them by computer. As matters stand right now, we will probably launch an intermediate step which would be the periodical publication of a bulletin listing academic vacancies. This will enable the candidates for the first time to come up with a substantive and substantial list of vacancies so that they can decide where they want to apply or want to be considered.

The National Education Association has similar plans in the area of elementary and secondary education but they are not quite as far along. The main difficulty, of course, is that the computer based system along these lines will be tremendously expensive. The bulletin of academic vacancies is an intermediate step which will be much less expensive, which is one reason we are going in that direction.

Senator PROXMIRE. We had hearings on job vacancy statistics. We had very encouraging testimony—and very strong support for it by the administration people—and by independent people. Labor is a little reluctant about it.

Mr. ARNSTEIN. I carefully read the testimony of Dr. Clague, who was the Commissioner of the Bureau of Labor Statistics, approximately 3 years ago before the Joint Economic Committee, in which he pointed out that it was extremely difficult in the general field of labor supply and demand, merely to define a vacancy. And he was very reluctant.

Senator PROXMIRE. Three or four weeks ago, we had testimony from a number of people. You know there have been a series of pilot studies on this as to the practicalities which have been pretty well established, and the responsiveness of the employers, and the accuracy of the statistics.

There was a private foundation study made up in Rochester, N.Y. And then there were 16 labor market areas where the Bureau of Labor Statistics did quite a comprehensive job. And they tell us that these statistics are reliable.

This would be a fine supplement for the manpower training operation. Would that fit into education, too? Would you be able to dovetail with that? Would it be useful to you?

Mr. ARNSTEIN. As a matter of fact, I have had several conversations with Mr. Frank Cassell, who is the head of the U.S. Employment Service. I have an appointment this afternoon to pursue that further.

Senator PROXMIRE. Can you give us information on the costs of securing the data to which you refer and some notion of the two or three top priorities?

Mr. ARNSTEIN. I think that we have to break the question down. Are you talking about the computer-based system? If so, all of higher education? Or are you merely talking about our next immediate proposed step, which would be the bulletin of academic vacancies in the area of higher education?

Senator PROXMIRE. I am talking about it, overall.

Mr. ARNSTEIN. We do not have enough actual facts and we do not have any actual figures. But it would be my guess that it will be in excess of $2 million, because in order to make——

Senator PROXMIRE. $2 million, now, would be what?

Mr. ARNSTEIN. To operate a computer-based matching system in the field of higher education alone. The difficulty is——

Senator PROXMIRE. This is the matching for the jobs?

Mr. ARNSTEIN. Yes.

I want to make it clear that it is not a placement service, because we do not want to go into the whole area of evaluation. We merely want to bring suitable candidates and suitable employers together, who then have to check out each other on their claimed statements and, I guess, references.

Senator PROXMIRE. This will be privately financed?

Mr. ARNSTEIN. Well, this is one of the difficulties. It is so expensive that there really are only two possible sources. One is foundation support. The other one is Federal support. And, eventually, the system might become self-supporting through charging a system of dues or registration fees. But, the minute that you do that, the market becomes constricted because some employers may no longer wish to pay the fees. The system will be most effective if it is as comprehensive as possible.

Of course, this might point toward a long-term subsidized operation or a federally supported operation. We have great reluctance about it being a federally operated one, precisely because of the traditional reluctance toward that.

Senator PROXMIRE. It would seem to me that the product of this $2 million would be of enormous value to the colleges and that it would be a relatively modest amount if they would be able to match all of the masters and all of the doctoral candidates who are looking for jobs with the jobs, and would be able to get the information quickly and easily, that it would be well worth the kind of investment you mention. It would be a few thousand dollars for each of our great universities, far less for smaller institutions.

Mr. ARNSTEIN. Not only that, there are no mechanical obstacles; it can be done.

Senator PROXMIRE. Would it be practicable to do it without Federal or foundation support by asking the universities to do it? After all, they are the beneficiaries.

Mr. ARNSTEIN. Yes. They are the beneficiaries. They might well participate but there are some universities that might find it too

cumbersome. For example, one of our consultants, David G. Brown, who has done an extensive study of the academic labor market (under Federal funds from the Department of Labor, the National Science Foundation, and the Office of Education), points out if we charge a modest fee for an academic vacancy to be listed, the amount of paperwork necessary for a university to file that kind of a requisition might become too cumbersome because in a typical university there is no central place where all of the vacancies are inventoried. Each chairman makes his own inventory when he is ready and when the budget permits him to list a vacancy or make his need known.

Thus, if you have 50 departments, you have 50 chairmen who have to post 50 separate requisitions. Particularly in some of our State-operated institutions this might become very cumbersome.

Also, the minute that you invoke a charge the listing will be less than complete. It will be less comprehensive than if the listing becomes free. But above that, it will take a tremendous effort to launch the whole system, because there are some analogous systems now operating, and most of them, at least the ones I know of, are in trouble. They do not have enough candidates to attract enough vacancies, to attract enough candidates. So there is a kind of spiral effect.

Thus, a major effort will have to be made to induce large numbers of candidates or large numbers of universities to list their vacancies, and these have to be publicized, so that the system can be, so to speak, stocked or, at least, induce a heavy volume of transactions.

Senator PROXMIRE. Do you have the same kind of problem in trying to work up organized information on, say, Ph. D. dissertations, so that if a student, a professor wanted to find out what work had been done in a particular field, in a particular year—wanted to find all of the dissertations pertaining to manpower training studies, for example, that kind of thing, that he would be able to secure them quickly and easily?

Mr. ARNSTEIN. There is much improvement in this area. There is now an annual compilation of dissertations and dissertation abstracts and University Microfilms is a supplier of complete copies. So here is an example of technology having brought about a significant improvement. But an annual compilation of dissertations, I am afraid, is not quite fast enough to meet the needs today where often the dissertation may deal with a temporary or an experimental program which may well be obsolete by the time the annual compilation comes out and the researcher finally writes for the microfilm.

Senator PROXMIRE. In some areas it would be of clear commercial values, these studies which you might put on a quarterly or monthly basis, such as in chemistry and the natural sciences.

Mr. ARNSTEIN. University Microfilm is part of Xerox Corp. There is, also, the tendency for some dissertations to be undertaken under a Federal research grant and that may well include at least minimal sums for the publication of, say, 250 copies in mimeographed form, so that copies can be put into circulation either by the Federal sponsoring agency or the author himself. So there is improvement there. What your question points to is computer-based compilations which would either be accessible by immediate inquiry by telephone or teletype or would result in a monthly or bimonthly publication of the material.

The dissertation bibliography that is now put out is not very well indexed and, therefore, not the most useful tool in existence.

Senator PROXMIRE. One final question. And I would like to read this question because I think it is a general one which is a good one. And I would like to ask each of you gentlemen to answer it if you will.

All of the witnesses last Monday emphasized the importance of defining objectives and goals for the educational processor. They indicated that contributions of technology will be limited and disorganized unless it can be directed toward the establishment of specified goals.

In effect, the witnesses for industry appeared to be asking that educational policymakers should specify particular purposes to be served by technology within an expressed philosophy of education. In your opinion, do we have in this country the necessary institutional organs and leadership to formulate a program of educational goals and objectives which would be both specific enough to be useful and broad enough to be generally acceptable in the educational community?

If so, by whom and in what manner is the function being performed? Or if not, what needs to be done to fill this basic gap?

Mr. CARPENTER. I think that your statement about a few years ago is a good starting point. I would like to see goals and objectives given a policy framework or a frame of reference, rather than just dealing with specific goals and objectives in order to get generalities.

At the same time, within that context, stating objectives and goals, to get something that you can get your teeth in and get action.

My feeling is you will need a diversity of these. There is no homogeneous or monolithic statement of goals and educational policies. And in this sense they should be diverse. Therefore, if you are looking for a highly unified statement, it is, probably, unrealistic and not very desirable.

There are people who can do this. I mean, you have, for example, as Secretary of the Health, Education, and Welfare Department, one of the great educational statesmen in the country. And there are other people somewhat in this category.

Senator PROXMIRE. You speak of Secretary Gardner. You have some of the presidents of the leading universities in that, too? And who else?

Mr. CARPENTER. Kilian, for example. You have mentioned him in this hearing. This gets very delicate.

Senator PROXMIRE. At any rate, you think that it should be diverse—that it should be stated by outstanding competent people?

Mr. CARPENTER. And these people exist.

Senator PROXMIRE. Yes.

Mr. CARPENTER. Dr. Kerr, for example.

Senator PROXMIRE. You would be very much opposed to have any statement from the Congress? That is, to imply that this would be the legal objectives?

Mr. CARPENTER. Congress can do an enormous amount to give it visibility once the statements and policies are prepared. I suggested in my paper that they supplement the national goal statement by more specific consideration of what is required now to implement it.

Senator PROXMIRE. I am talking about a very specific area—I am talking about the application of technology to education. The in-

dustry people say that we need goals and that we need definitely defined specific areas. Tell us what they should be, so that we can move ahead.

Mr. CARPENTER. I would mention another man: And, incidentally, he is of a type of educator-engineer who is, also, a first-rate person in this field of educational technology. He is Eric Walker of Penn State. People like President Walker are well acquainted with the technology on one side and educational problems on the other. And if we could select six people in his category of competence they might come up with an exceedingly well-thought-out document in this area of educational technology.

Senator PROXMIRE. Mr. Glaser.

Mr. GLASER. I think that insistence on the definition of educational goals, specific educational goals, in terms of what adults and children should know, and the kind of standards and knowledge, and the way they are to use their knowledge, is extremely advisable. I think that the publishers have learned to ask for this in some of their research and development programs from their people who have consistently said to them, "What, exactly, are the materials that you are turning out supposed to do?"

And this has been a constant question. We can only evaluate what you turn out if you tell us what they are supposed to accomplish and to teach, and so forth. That is a fundamental question.

We can establish national goals on a broad basis, but I think that when we get down to specific objectives of education, knowledge to be learned and the way the individuals are supposed to think and use their knowledge, I must agree with Mr. Carpenter, that what we really want is diversity.

We want, say, major mathematics professors in the country to say that, "Here are things that I think students ought to know about elementary mathematics." We want people to talk to them and to say, "Here is the way that it ought to be taught." But other people are going to say, "Well, maybe, from the aspect of the new mathematics, that is sort of silly. Let us try another approach to teaching people to think, to have people think in terms of numbers."

There are different objectives that will accomplish different things, and different ideas as to how a body of knowledge should be organized. We will teach English this way and physics this way, but we should be really blessed with a diversity of objectives, and then the technologists will come along—and it is their job to say, "How can these objectives be best taught?"

It is up to the commercial publishers to say, "We will produce the best series to teach for these objectives." That is, if this is what the school people want and they say have to be done. But they should be prepared for diversity of objectives and constant improvement in these objectives.

The technologists can also help answer the question, "Really, how do you determine what our objectives should be, and how should they be stated?"

Senator PROXMIRE. Diversity, of course, makes the production cost much higher for these industry people who sell and who represent very big firms—and one of the problems is that the small firm is at a big disadvantage in this area—the big firms want a national market—

they want unity. If they can have a specifically defined limited objective, they can be more efficient. If you are too diversified, the technology becomes so expensive that you cannot use it. You have to have some way of reconciling it so that you can make this material available on an efficient and economic basis.

As you know, it is one of the toughest things in the country and it will continue to be.

Mr. GLASER. I think for the educational industry at this point to attempt to impose standards and standardization on the educational market in terms of now what is to be taught at the sixth grade and what people should learn in college is just a publisher's target. We do not really know how far our students can go with improved education. We do not know why we should not teach calculus in early high school.

Senator PROXMIRE. Could you work it out so you would have information for a reasonable period of time as to a national standard defined on how you should teach mathematics, how you should teach sixth-grade mathematics, with as much diversity on all sides as you want for the gifted people in private institutions, for those who want to try experimental approaches; but, at least, with one standard established, that would be common to most of them.

Mr. GLASER. Again, not because we are really in such a fortunate position as you indicated before of getting a real educational upheaval—they have to live a double life, I believe. They have to have a product which is fairly standard and fits the average, and they can market it well, and a lot of people will buy it. But, also, together with that, or on top of that, they have to keep publishing experimental things which is difficult for them to do, which they say they do not make enough profit on to get into this expensive research and development thing, and so forth.

I believe this is true. They will have to lead this double life. They will hit the mass market as much as they can, but they will have to be sensitive to these pressures for doing these educational things which are going to change their base product. That is the only way they have to live.

Senator PROXMIRE. Mr. Folger.

Mr. FOLGER. I would say that standardizing the process of education would be the wrong thing to try to achieve. And let me give, first, an analogy that in research, which is an extremely diverse process, a very substantial market for technology has developed. And diversity of research activity, which is absoutely essential, has not kept the market for technology from developing. And, indeed, this has, probably, stimulated technology.

Senator PROXMIRE. Specifically, what are you talking about?

Mr. FOLGER. Specifically, all sorts of counting and measuring equipment, very highly sophisticated, which is entirely essential for research today, has been marketed at a profit, even though the research in which it is used has a wide variety of procedures. And there is no effort to standardize research goals. I think that in instruction we would like effective learning, that is the goal we are interested in achieving, but we are less likely, I think, to achieve it by trying to introduce a limited number of standardized teaching processes than by putting emphasis on the common goal of how you get more effective learning.

Senator PROXMIRE. Is it not true that the first tools are likely to be standardized to a considerable extent—tools that are used for accounting and so forth are likely to be standardized? Of course, the individual researcher demand will be his individual judgment and purpose; and, therefore, may be used in a variety of ways.

The same way a teacher can take a standardized text book which has been used in a thousand other classrooms, and give it a wholly fresh, different kind of interpretation and approach, and insight. Somehow this technology, the mass technology in our system, is going to have to have a very high degree of standardization, I am afraid.

Mr. FOLGER. The standards for counting equipment change every year.

Senator PROXMIRE. So it does for automobiles.

Mr. FOLGER. And it still seems to be that there is sufficient profit to keep large numbers of firms competing in this field. I think that any pressure from equipment manufacturers to standardize the educational process would be detrimental to the achievement of a better educational system in this country, and would inhibit its development. I think that there will be enough standardization, enough opportunities to market standardized products in the diversities that exist. And it is not really the lack of similarity about the way people carry on instructional tasks that inhibit the introduction of technology.

Senator PROXMIRE. You object to the argument that it will be limited and disorganized unless they can be direct, you say?

Mr. FOLGER. I am all for having clear educational goals, but not for standardizing educational processes, so that you have a uniform national way of teaching sixth grade mathematics. Maybe you have five or six national ways of doing it, but I say that given what we know about how people learn, that is not the way to improve education in this country.

It may be just a case of words between us.

Mr. GLASER. You are very correct in forcing the educators to state exactly what they would teach in certain grades. That is a perfectly justifiable, and a highly desirable thing to do But just what will our students be capable of doing? We need much more information on that. We need to look into it, so that we can find out whether it is possible to teach things much earlier or to teach things at a lower level, we just do not want to limit human capabilities yet. To look into it for that purpose is quite another thing.

Senator PROXMIRE. I think it is a terrible thing not to permit change. Just as we change the models of automobiles.

Mr. ARNSTEIN. As I point out in my paper, I am in favor of agreement on a standard, but the kind of standard I have in mind is a technical standard, such as, for example, the number of lines on a television screen which the industry has reconciled some time ago, and a definition of a school today, and a teacher, and things like that, which is being done in part by the handbook series of the U.S. Office of Education. But as far as the goals are concerned, I think that we can agree upon major goals such as the national goals mentioned by Mr. Carpenter, or even a specific goal which goes back to 1642 and to the Old Deluder Act of 1647, which stated the goal of literacy in Massachusetts. But we have fallen far short of that one.

Maybe I am reading more into the question than is there. I almost get the feeling that we have confusion of ends and means. The question implies that we should have standardized education in order to make it suitable to the standardized product and the standardized machines that industry will then prepare. We should decide what we want to educate. We, as a nation, should do this. Or if this is something to be entrusted to educators, then we will decide, then industry may or may not be able to come up with a suitable product. But if the market is not large enough, then maybe we should not be using technology.

Senator PROXMIRE. What I am asking is this. Nobody can dispute the argument that the educators should decide, precisely, their goals.

What I am asking is whether or not you can compromise without any essential loss of educational quality or diversity, that is, an essential loss, by reasonable adjustments, After all, we have had standard textbooks for years in this country.

There have been some complaints. But, by and large, they have been accepted. There has been an acceptable compromise, for instance, even in economics. We have a textbook by Paul Samuelson. A million people have bought it—or more. We think that is very advantageous. And not only to Mr Samuelson, but to the students.

Mr. ARNSTEIN. You are quite right. We probably are too set in our ways in terms of local control. There may be acceptable compromises, but interestingly enough the example that you have used, the textbooks which have to have large distribution, have been quite controversial, particularly in the area of social studies and race relations. Textbooks in social studies have been guilty of dilution, so as to be able to be sold both North and South. They refer to the Civil War as the War Between the States, and things like that.

The textbook is your example and I like it because it illustrates precisely what happens when you try to homogenize the product to make it universally, reasonably acceptable.

Senator PROXMIRE. On that note, I think that we can close.

I want to thank you gentlemen for another very interesting and helpful, and informative, and useful day.

We will recess, to reconvene on Monday morning at 10 o'clock in this room, to hear further witnesses.

(Whereupon, at 12:30 p.m., the above committee adjourned, to reconvene at 10 a.m., Monday, June 13, 1966.)

TECHNOLOGY IN EDUCATION

MONDAY, JUNE 13, 1966

CONGRESS OF THE UNITED STATES,
SUBCOMMITTEE ON ECONOMIC PROGRESS OF THE
JOINT ECONOMIC COMMITTEE,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room S–407, the Capitol, Hon. William Proxmire presiding in the absence of Chairman Patman.

Present: Senator Proxmire.

Also present: James W. Knowles, executive director; John R. Stark, deputy director; and Hamilton D. Gewehr, administrative clerk.

Senator PROXMIRE (presiding). The Subcommittee on Economic Progress of the Joint Economic Committee will come to order.

We have had the privilege during the past week to hear two highly expert and articulate panels on the subject of educational technology. One was made up of industry representatives, who are pioneering in the development of technology and systems to help meet our vast educational needs. A second panel, made up of four outstanding experts on education, discussed the prospective effects of new technology on education.

The subcommittee has been made aware of a very extensive move in our economy to bring our tremendous technological knowledge into our school systems. Our panelists have been candid. They made it quite clear that this new development does not offer any easy road to quick success. Rather, they warn that we must coordinate our efforts far more than at present and avoid mediocrity in programing new equipment. Clearly, our public officials, our educators, and our equipment makers face some serious problems of better organization and mutual efforts.

It is fitting that we round out our present inquiry now with a panel of Government officials. The three witnesses with us today represent three levels of government: Federal, State, and local. They are all very able, devoted men, deeply familiar with the problems of education and the promise of new systems and technology.

Gentlemen, we are delighted to have you with us today.

We will hear first from Dr. R. Louis Bright, Associate Commissioner for Research, U.S. Office of Education.

He will be followed by Dr. Norman D. Kurland, director of the Center on Innovation in Education, New York State Department of Education, in Albany, N.Y.; and by Mr. John R. Martin, superintendent of schools in Mt. Vernon, N.Y.

This appears to be New York day.

Mr. Bright, you are not a resident of New York, are you? Is it Wisconsin?

Mr. BRIGHT. No; Pennsylvania.

Senator PROXMIRE. That is closer to the Middle West than New York.

Please proceed.

STATEMENT OF RICHARD LOUIS BRIGHT, ASSOCIATE COMMISSIONER, BUREAU OF RESEARCH, OFFICE OF EDUCATION, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, WASHINGTON, D.C.

Mr. BRIGHT. Mr. Chairman and members of the subcommittee, I am Richard Louis Bright, Associate Commissioner for the Bureau of Research which has the responsibility for administering the research programs for the Office of Education.

Commissioner Howe asked me to extend his appreciation to you for your courtesy in allowing me to appear in his place. At the time of your invitation to him he had already made a commitment to be out of town on this date.

I would add, however, that in addition to substituting for Commissioner Howe, I am happy to have the opportunity to appear before your committee this morning to discuss educational technology since this is an area of particular interest to me.

Educational technology covers a broad subject area ranging from behavioral psychology to computer programing. Its purpose is to design an educational system that will result in the most effective and efficient learning.

The major thrust in educational research today is toward the goal of truly individualized education. This would result in a system in which the material is organized and presented individually to each student, such that the subsequent material which he receives is selected on the basis of his previous performance and in a manner that will permit each student to progress at his own speed independently of any other student in the class. Such a system has great benefit for the fast student, for the slow learner, and for students with special education problems, such as the handicapped.

One branch of educational technology specifically directed toward this goal is called programed instruction. Programed instruction is based upon two principles. The first is that curriculum objectives should be carefully spelled out in terms of the specific change in the behavior of the students. To put it another way, how would you expect a student who has taken the course to behave differently from one who has not? The second fundamental principle is that, if the student doesn't learn—that is, if he does not exhibit this change of behavior—then it is the fault of the system and not of the student. This latter principle is a very interesting one and has several consequences. The first is related to the techniques of developing programed instructional material. Basically the material is organized in a logical fashion with frequent questions which test in depth the student's understanding of the concept just covered. If, in testing the material on an initial group of students, it is found that a significant number of students miss a particular concept, then that section of the course is rewritten. The revised course is then tested on another group of students. If a significant number of students still miss that section,

that section is again revised. This procedure is continued until essentially all of the students get any particular question correct. In fact, a standard evaluation procedure of programed instructional material is to continue this revision sequence until 90 percent of the students taking the course score 90 percent on the final examination. Such a statement is almost equivalent to saying that any student can learn anything. It simply takes some longer than others.

Perhaps of particular interest to this committee may be the analogy between this revision sequence and much automatic control equipment. Both of them, basically, are controlled by feedback and correction.

Experience has shown that the brightest students in a course using programed instruction will cover the material in perhaps one-fifth of the time normally taken. On the other hand, the poorer students in the class may take two or three times as long as normal to cover the material but they will score 90 percent on the final examination when they do finally complete it.

Programed texts are published in a variety of forms. The two most common are linear and branching texts. With the linear text, the student goes straight through the material answering each question, turning the page to see the correct answer, proceeding to read the following material and so on in a linear fashion.

In a branching text, after answering the question the student turns the page to find the correct answer. If the student gave an incorrect answer, the text would direct him to turn to some other page in the book to read a different presentation of the same material. The student would then be retested.

There is an abundance of programed material on the market today—some good—most of it poor. The good material has been carefully prepared and put through a revision sequence until the objective of 90 percent of the students answering 90 percent of the questions correctly has been attained. It is well established by now that if a student does work through one of the better programed texts, he does indeed learn the material and learn it very well.

In 1961 and 1962, there appeared on the market a great variety of teaching machines whose purpose was to provide individualized instruction. Most of these machines were simply mechanical gadgets that contained a programed text either on a paper scroll, microfilm, or some other such media. Careful analysis showed that a majority of these machines served only as devices to cover the answer until a button had been pressed, whereupon the answer would become visible to the student or as automatic page turners to carry out the branching function. Thus, in effect, these machines really perform no educational function that the programed text itself does not. Most users are convinced that such machines do indeed have no significant advantage over a programed text itself.

Another more recent innovation is the computerized classroom. This also might quite correctly be described as simply another gadget to present programed instructional material. While such a statement is partially true, the computer can perform several functions which the text cannot. For example, it is much more flexible in its branching criterion, or in other words, it can be much more adaptable to the needs of a particular student and has a general characteristic that it does not bore the good student nor does it ever advance the slow

student until he has truly demonstrated confidence in the concept being presented.

A central computer also can keep all of the student records which are necessary for school administration: report cards, parental reports, guidance diagnoses, et cetera. Incidentally, if one visualizes a school of perhaps 4,000 students each progressing at his own speed, it takes a computer to keep track of them—of what is going on.

Another advantage of the computer is that it can automatically alert the teacher whenever a particular student is having an excessive amount of difficulty in a particular section. Computer systems also have the advantage over a text in that they can present audio output—a characteristic particularly valuable when dealing with young children or poor readers.

To digress a moment, I have several times heard people say that they refuse to believe that a computer can teach. Yet I have never heard anyone say that he does not believe a motion picture projector can teach. Of course, neither a computer nor a motion picture projector can teach. In both cases, it is a program that teaches—a program which originally must be written by a teacher. As stated before, carefully prepared materials do teach and do teach very well. This does not mean that computers will replace teachers, but it does mean that the role of the teacher will change.

Although a computer can present conventional subject matter very effectively there are things that it cannot do. It cannot, for example, develop the capability of the student to communicate effectively with other people. It cannot train the pupil to originate ideas, or to talk confidently before a group. I believe that the fundamental consequence of educational technology is that a teacher should never stand in front of the class presenting material. Rather he should be the leader of a discussion group in which his objective is to get the students to talk and express their ideas. Such an educational system will result in a great deal more interaction between the students and between any individual student and the teacher than is now provided by the conventional classroom in which, to be realistic, only the top 5 percent and the bottom 5 percent really have much personal attention. Thus, one is led to the apparent contradiction that a computerized school will probably result in a much more personalized experience and much more human interaction with others than a student now experiences.

The educational system which I have been describing is a very exciting one. I wish I could tell you that it exists, but I must emphasize that it does not. Technology does indeed have this potential, but it is not ready for application on an operational basis in your neighborhood school. There are three areas in which a great deal of work remains to be done. The first is equipment development, the second is course material development, and the third is teacher training.

To be useful in a neighborhood school, equipment must be very simple to operate, extremely reliable, and economically feasible. There are many exciting experiments that have been performed in the last few years on all types of equipment. This equipment has ranged from small simple computers completely self-contained at each student's desk to very large expensive systems involving central computers and elaborate equipment at each student's console. The

results of these experiments give us insight into what a system might eventually accomplish educationally. However, none of this equipment would satisfy the criteria of simplicity, reliability, and ecnomy. In order to receive widespread application, the amortized cost of this equipment probably should not be greater than about 25 cents per student-hour for use in elementary schools or perhaps 50 cents per hour for special education. These student-hour costs could be converted into initial capital costs of somewhere between $2,000 and $4,000 per student console. Although that price range is not applicable to any system having the capability of the computerized system which I have briefly described here, I believe that in about 3 years this price objective will indeed be reached with equipment that is simple and reliable.

The major hurdle in the development of the computerized classroom is the preparation and availability of course material. The preparation of such material is an expensive process. The best figures that I have been able to assemble indicate that, after specific curriculum objectives are established, it probably will cost in the neighborhood of $4,000 to prepare the amount of material that an average student will go through in 1 hour. This is, of course, not a repetitive cost in that once the material has been prepared any number of students could use it. The Office of Education is supporting development of such course materials and the demonstration of their use. For example, there will be a computerized classroom in the Brentwood School District in California starting this fall in which the first, second, and third grade arithmetic and reading will be taught entirely by the computer system on an individualized basis. I believe that with concentrated development activities in this field it would be possible for a school to consider regular operational use of such a system which would be competitive with traditional techniques, perhaps in the fall of 1969 and most certainly in the fall of 1970.

Again, I wish to thank you very much for the privilege of appearing before this committee and I will be glad to attempt to answer any questions which you may have.

Senator PROXMIRE. Thank you very much, Mr. Bright.

We will next hear from Mr. Kurland.

STATEMENT OF NORMAN D. KURLAND, DIRECTOR, CENTER ON INNOVATION IN EDUCATION, NEW YORK STATE EDUCATION DEPARTMENT

Mr. KURLAND. Mr. Chairman and members of the committee, my name is Norman D. Kurland. I am director of the Center on Innovation in Education in the New York State Education Department. I am here today to represent that department and Commissioner James E. Allen, Jr., who very much regretted that he could not be here himself to discuss this very important subject. It is one to which the department has given a great deal of attention. In fact, one of the functions of the center on innovation, which was established 2 years ago, is to explore the impact of automation and technology on education.

Surveyor I is sending back thousands of pictures of the Moon, but its most important message is about life here on Earth. It reminds

us that it has been less than 9 short years since Sputnik I. Children who were in kindergarten then will just be entering high school this fall. How much the world has changed while they have been in school. How much more will it change during the next 9 years which will still see many of those same youngsters in school and college? And how much more change will there be in the 50 years beyond that which will be the life expectancy of these youngsters—years for which present schooling is supposed to be preparing them?

To pose the question in this way is to suggest a major dimension of the problem the schools face, and why it is appropriate for a committee of Congress to ask how technology—the same technology that placed Surveyor I on the Moon—can help increase the effectiveness of our schools. For I would hope that the question is asked not because our schools have been ineffective—the men responsible for Surveyor are, after all, a product of those schools—but because of the recognition that the schools need help to remain as effective in the future as they have been in the past.

Rapid technological change and the explosion of knowledge are only parts of the pressures to which the schools must respond. The civil rights revolution has posed a challenge to the schools to be as effective for all as they have been for some, and a growing prosperity and rising aspirations have extended the number of years of schooling expected by all. In face the of these pressures, were the schools to proceed along even the best of paths laid out in the past, a decline in effectiveness would be inevitable. Given the fact that the best was far from universal, it is easy to see why there is a concern for effectiveness now and for the future.

How, then, can technology, which is part of the problem, contribute to the solution? Here exciting possibilities open before us, exciting as the possibilities that lie beyond Surveyor. Let me try to suggest some of these by describing some of the innovations that I have seen as I have gone around the country.

I have seen computers that present lessons to students in such a way that each student receives a lesson uniquely tailored to his needs. He controls the speed at which he moves through the lesson and his performance determines what the lesson will be. Where he has difficulty he gets help immediately; where he shows mastery he is moved ahead to more challenging materials. The presentation can be in written form, it can be by voice, it can be by pictures, moving or still, or any combination of these. The student makes his responses on a typewriter keyboard, by pressing buttons, or by pointing a light pen at a tube.

The computer can provide the student with a printed record of his own progress in each lesson, or over any span of lessons. The teacher can get a similar record of progress or a record on an entire class or any group within the class. She can get an analysis of the lesson itself to find out which parts are causing difficulty to which students. Changes can be made where difficulties are identified, and, as readily, new materials can be added when called for.

I have seen other computers on which children go through exercises that simulate real situations—running a government, doing a chemical analysis or choosing a career. Development of problem-solving and decisionmaking abilities are the special aims of such programs.

I have seen a student dial into a central learning recourses center and call up the lesson of his choice—a lecture on tape, a film, language instruction, music—anything indeed that can be stored photographically or electronically and transmitted electronically.

I have seen "talking typewriters" that help teach children and adults to read by creating a situation for learning to read that approximates that which makes learning to speak such a seemingly effortless experience for most children.

I have seen beautifully prepared instructional materials—books, slides, transparencies, produced so inexpensively that there is no excuse for not supplying them to every classroom and child who needs them.

I have seen copying machines used in ways such as to provide virtually instant textbooks—today's Congressional Record can be tomorrow's classroom text for a class of ten or a thousand.

I have seen classes taught by television, and children discussing the latest exploits in space seen live on television in class or at home. I have seen students and student-teachers complete an activity and immediately see and analyze themselves on video tape. I have seen exhibits under a microscope or too small for a class to see enlarged via television so that every student can see what the instructor is describing.

I have seen students select film cartridges, insert them in individual projectors and watch a frog embryo develop, see a reenactment of a Civil War battle, or learn about a career.

I have seen classes talk via amplified telephone with an expert in the field of their current interest, debate an issue with their Congressman in Washington, or exchange experiences with children in another land.

I have seen a student engage in a dialog with a computer to select his courses for the next year, and guidance counselors call up in an instant the full record of the student as well as relevant data comparing him with others of similar interests, abilities, and experience.

I have seen the administrative and recordkeeping chores of schools taken over by data processing equipment, thus freeing administration and teachers for more important tasks.

I have seen libraries automating their processes to provide more effective service and to keep pace with the explosion of knowledge.

I have seen school buildings using the latest materials and construction techniques to provide an exciting environment for learning at a cost that any community can afford.

THE SCHOOL FOR THE FUTURE

Now, imagine, if you will, all of these pieces put together into a single system. We can then look forward to a time of universal, individualized education when every person will be educated and no two will be educated alike. Teachers deeply committed to the art of teaching and thoroughly versed in the science of learning will have at their disposal a full panoply of learning materials to which they will direct each individual student in accordance with his needs, abilities, and interests.

There will be no lockstep and indeed no common schedule. Each student will proceed at his own pace through a curriculum uniquely

adjusted to his needs. He will have, through many media, access to the best teaching and the best information on each subject along his way. Intrinsic motivation will largely replace extrinsic as the student early discovers the power of knowledge and the joy of learning and has opportunity to grow in directions which attract him. He will move smoothly and early from directed, highly structured learning situations to self-directed, unprestructured activities where the learner plays an active role in learning.

If one seeks a current model of this school in the future it is best seen in the public library. To the library each user comes with his own demands, and each is more or less successfully accommodated, though no two persons are served quite alike. There are almost no age or grade divisions—adult and child may work side by side and even at times use the same materials. Each proceeds at his own pace toward his own goals. Moreover, the library never presumes that it must supply all the users' needs for information. It does what it can do best and leaves the other agencies in the community portions of the task appropriate to them.

I should remind you that what I have projected is based largely on electronic, computer, and communications technologies in combination with new understandings derived from the behavioral sciences. Present activity in biology in the studies of the brain and its functioning and in genetics may have even more profound implications for education.

The central thrust of this application of technology to education is, as I see it, twofold: On the one hand, to achieve for the first time truly individualized conditions of learning for each student and, on the other, to effect the efficiencies of instruction that can be achieved by mass education. With the new technology what is done well once can be multiplied a thousandfold. The economies so realized can release resources to do for every child what once could be done only for a few. Thus education can become more effective even as it becomes more available. We can have both quantity and quality, though the latter will be much harder to achieve than the former. To the public school official this prospect of holding the costs of education to a reasonable rate of growth even as quality and quantity increase is extremely attractive. For each year we see school budgets rise and we now know that by traditional methods we shall never keep pace with the demand. For example, in New York State expenditures for public elementary and secondary schools rose nearly threefold from 1955 to 1965 to a level of $2.5 billion and are expected to rise another billion by 1970, an increase of 40 percent. During the same 1955–65 decade public school enrollments went up 30 percent and are likely to go up another 10 percent by 1970 to a total of nearly 3½ million students. In higher education, enrollments are expected to go from 560,000 in 1965 to 775,000 in 1970, an increase of nearly 40 percent while costs may nearly double.

We also know that effective education is a key factor in economic growth. If educational expenditures are an investment, as many economists now argue, how much more so are the funds expended on the improvement of education.

One word of caution is in order at this point. I will yield to no one in my enthusiasm for the potentialities of the new educational tech-

nology. At the same time I recognize that it will not perform miracles. Yet because of the success of technology in other fields and the exciting vistas it does open up in education, there will be a tendency to turn to it for solutions to the tough problems that confront us in education. The task of leadership in the years ahead will be to restrain those who would seek all answers in technology while ignoring those who believe no answers are to be found there.

Let me stress that the above is but one limited vision of the possibilities inherent in our present technology.

I would like to enter another vision, entitled "The Forward Looking School," into the record.

Senator PROXMIRE. That will be made a part of the record. We will include it in the appendix. (See p. 240.)

Mr. KURLAND. Others may have other visions more or less rosy. But to go from present reality to anyone's vision will require major effort, much wisdom, careful planning, and not a little luck. For the potential for evil in any technology is equal to that for good—as witness nuclear energy or the internal combustion engine. It is men who determine whether anything produced by man shall enrich or debase humanity.

Everything I have described is being done today at least experimentally. The hardware necessary for large-scale adoption is available or can be readily developed once the need is identified. Even the cost factors are such as to make this a relatively minor consideration in the decision to move to such a system. What is lacking are two essential ingredients—the software and the system to transform our present schools into those of the future.

By "software" I mean all of the program content, all the concepts of learning and instruction, all of the decisions about what should be taught to whom and when, without which the machines are useless. These elements have always been the heart and soul of education and nothing about the new educational technology changes this one iota.

And these are the costliest, most difficult portions of the system to produce. I don't know what the ratio of software to hardware costs will be in education, but it is certainly high. Yet it is often so much easier to get funds for the hardware than the software, just as in the past it was easier to get funds for buildings than for teachers' salaries. I should like to urge that in any funding of the new technology by Congress, full recognition be given to this point.

Secondly, if the potentialities of electronic and related communication technologies are to be realized, they must be matched in ingenuity and creativeness by a new educational systems technology that matches machine and communications capabilities to human goals, needs, and capacities. To accomplish this task well will require the best minds of our society and the combined resources of the schools and private industry.

Private industry has the technical capability, it has great flexibility to move in new ways on new problems, and it has the profit motive to make it seek the most efficient use of resources. I suspect that there will be a great temptation for some of the new education-oriented industries to feel that they can do the school's job so much better that they will grow impatient with the schools.

But aside from the claims of tradition, a not significant claim, the schools have a vital role to play. They bring to education other

values besides efficiency. For one thing they, particularly the public schools, are responsible for all children, not just those that can be most readily reached. They are concerned with basic goals of education that are not amenable to efficiency measures or susceptible to realization through technologically mediated means. And it is primarily through the schools and other public agencies that the public funds will be channeled in the field for education.

But before the new partnership between the schools and industry can become fully effective, problems such as the following will have to be faced and answered:

1. Because the investment required in the new educational technology will be very great, initially most of the funds will have to come from the public sector. How can an effective mix of public funds and private enterprise be achieved in education? Can public education agencies enter into working partnerships with private businesses without being subject to the charge of favoring one company over another? Can a company work openly with a public agency without jeopardizing its competitive advantage? Are changes in law needed to facilitate effective working arrangements between public and private agencies?

2. As the complexity of new educational systems increases, it will become increasingly difficult even for a knowledgeable administrator or teacher to evaluate them. How can the schools and the public be assured that the new educational systems are sound? Should the States or the Federal Government provide some system for assessment of the products of the educational technology? If there is assessment, how can the values of diversity and freedom be protected?

3. Are existing copyright laws and rules regarding use of materials produced with public funds adequate both to protect the interests of the public and the producers and to provide incentives to private enterprise to undertake the risks of development?

4. There is likely to be a tendency for private industry to look to the Federal Government as the primary partner in this new activity, both because it has greater funds and because it is easier to deal with one jurisdiction no matter how complex than with 50 to 25,000. What will this do to the traditional role of the States and localities? How can they be brought into viable involvement in the partnership? I would particularly urge the importance of the role of the States as the level of government primarily responsible for education and, in many cases, in the best position to provide the direction and coordination needed if the new is to blend smoothly with the old.

These are questions deserving of careful study by this committee or some other agency. The answers can greatly influence the speed of developments and the nature of the outcome.

There are also the larger questions raised by the new educational technology to which all who are concerned with the quality of human life must address themselves. Will the new technology transform man into a mere extension of the machine—mindful of the things necessary to keep the social machine operating, mindless of the things that make men human? Or will it enable each to become all that he is capable of and desires to become?

These questions need answers because our choice is not whether we shall apply technology to education, but only how, by whom, and under what conditions.

Senator PROXMIRE. Thank you very much, Mr. Kurland.
Our last witness is Mr. John Henry Martin.

STATEMENT OF JOHN HENRY MARTIN, SUPERINTENDENT OF SCHOOLS, MOUNT VERNON, N.Y.

Mr. MARTIN. Thank you, Senator Proxmire.

Public education is the last great stronghold of the manual trades. The impact of the industrial revolution has scarcely begun. All of these major electronic and publishing companies are in the process of major arrangements and mergers. This is a new phenomenon in the history of education. Big business has decided that the knowledge industry will be profitable. The center of gravity for educational change is moving from the old seats of power, the teachers' colleges, and the superintendent's office to the executive suite. General Mills, General Motors, and General Dynamics will soon be operating nursing school laboratories to test theories and products. It is my prayer that their offspring will be legitimate.

One reason to push the development of technology for educational purposes lies in the sad discovery that many of the social and economic ills which plague our society share poor reading ability or nonreaders as one root cause among their many other causes.

Criminologists point to the high incidence of illiteracy in our penal institutions. Students of juvenile delinquency find an extraordinary correlation between the youthful offender and his inability to read. Students of the dropout phenomena—the school rejects or the school rejecting—find inability to read a heavy factor. The economists concerned with the impact of automation and technology on the industrially displaced, are increasingly disturbed that a lack of reading capacity makes those whose skills are, or are about to become, obsolete, untrainable, or difficult to train.

Among students of the problems of poverty, there is a growing awareness that poverty is as transmittable by parents as their physical characteristics are hereditary from their genes. Dullness is an acquired trait, a side effect of poverty. Imbedded in this turgid pool, modern sociology finds again functional illiteracy a part of our depressed urban centers. The frustration, bitterness, and racial hostilities of our slums are related cousins to each other as well as being related to incompetence in reading.

Paradoxically, it is important to say that the American experiment in mass public education has succeeded numerically to a greater extent than in any other civilization in the history of mankind. It is important to know that, in doing so, the American public school has used instructional procedures, methodologies and pedagogies as old as mankind. Other than the invention of the textbook readers, we have made little fundamental change in the methods we use to teach children to read from that employed by the ancient scribes using a finger in the sand, chalk on slate, to the present pencil on paper.

I am deliberately omitting the field of audiovisual equipment, the 8 millimeter, 16 millimeter, and the variety of minor audiovisual devices.

This process of teacher-directed learning has had its shortcomings hidden by its massive success. Our public schools took the polyglot

peoples from an essentially European culture, used a middle class set of values, and succeeded because the immigrant family was eager for the success of its children. The public schools homogenzied a diversity of children because the children of the immigrants were sent to school submissive to the superior culture. We exploited successfully a dynamic to learn that originally came from a Protestant mandate to read the Bible and later immigrant drive to become American and rich. "Don't talk like a greenhorn, Papa," provided us with millions of children who learned because they were driven almost prenatally to want to. Secondly, our apathy toward the nature of poverty and the consequences of racial distinctions kept us blind to the fact that the Indian culture, the back eddies of our mountain culture called Appalachia, and the Negro in the rural and urban slum were not being taught to read.

The slum and poverty-ridden child is physically handicapped, is mentally suppressed, is intellectually unfertilized to a damaging degree by the time he enters the public school. This has been said often by those who would both apoligize and give penance for their previous indifference. But the reason, academic tragedy, begins when the schools take him in. The facts are now clear. Study after study in the cities of the United States reveal that whatever the slum child, taken in large numbers, is at age 6, he is worse by age 12. His IQ has significantly declined. His relative position to nonslum children declines even more precipitously with the passage of the years in school. Children at age 5 or 6 are doomed by the continuing pressures of a nonliterate community environment as well as by the debilitating consequences of an education unfitted to their needs. For this "educational program" succeeds but poorly in teaching children what it seeks to teach, but ironically, succeeds too well in convincing a child of the slum that he is stupid and cannot learn and is unteachable. Out of this morbid milieu comes a hostility to the windows of public buildings; the fixtures in public toilets; and—when mixed with race—the white man's power structure; "Mr. Charlie," the policeman; and "Whitey." That despite all this, significant numbers of the ill-taught learn and survive, illustrates once again, that nothing happens to man that cannot be used to prove that it cannot. No process is so good that hell does not receive some of its products, and nothing is so bad that it produces only imperfections. The point of our discussion is that the schools are now not good enough.

The most widely heralded single answer to improving the education of the children of our socially and economically handicapped families has been the inauguration of nursery schools and kindergartens. Reportedly, half our school systems have yet to adopt kindergartens and, with rare exceptions, almost none had nursery school programs before 1965.

The nursery schools and kindergartens have developed many practices and materials including blocks, crayons, puzzles, songs, dances, paper and toys, and playground equipment. Some of this, it is assumed, is directly related to the mental growth of the children; much of it is related to their physical and social development, and some we hope is related to language improvement and prereading readiness. Two limitations obtain: first, in all these materials and activities,

there is little precision in our understanding of what contribution is made by which material or which activity, if any is made at all; secondly, there is an adult directiveness or teacher dominance which, to this observer, intrudes negatively between a learner and most of the activities and equipment used.

Nevertheless, to children whose home environment has given them little in the way of play toys and learning materials and who have not had adults read to them, et cetera, the whole program of our conventional nursery schools and kindergartens must be an important contribution. We live in that faith called "Headstart." Repeated observations of these schools will reveal children busily involved in activities that by and large interest them and that engage their happy and vigorous attention. These are old and subjective measures, and while they are comforting, they are no longer good enough. We need disciplined research.

It is necessary to point out that some of the happy assumptions regarding the effects upon children of kindergartens and nursery schools are hopes rather than fact. There is no definitive study of the less than 50 percent American children who have had the advantage of kindergarten education in the past generation to show that these fortunates are conspicuously fewer in numbers amongst the categories of delinquent, dropout, reading disabilities, and unteachables or contrariwise are greater in number amongst high school and college graduates.

Large-scale studies are not available even in crude, gross form. There is no sophisticated study of the consequences of early childhood education taking into account race, region, or parent income. Some fragmentary and longitudinally brief studies are available. They ask, "Did children from the nursery do better in the first grade?" Or more usually, "Did they accommodate to the middle-class nature of our regular school programs?" And they answer modestly, "Yes." Our nursery schools have been in large measure prompted by benignly intended mental health orientated people as an upper middle class, "good thing to do for children." Again, for all the thousands of children so exposed, there is no hard and rigorous examination of long-term consequences from amongst the many middle class or poor who had this advantage as well as the many more who did not. There is some evidence that these experiences have been helpful in producing the kind of intellectual docility needed in a mass educational system.

And this for myself who has founded and served on the boards of a series of private nursing schools. I am thoroughly persuaded that they are valuable. I am simply documenting that there is no basic documentation as to their validity.

What is needed is a new scientific pedagogy. Our society, our culture is showing in the midst of its troubles some of the happy signs of stress. Inventions, contrivances are percolating by the hour. Panaceas, patent medicines, old errors in new bottles are being peddled not only in the professional journals but daily in the popular press. They are fed to a hungry public aware that somehow there is a promise for their children in education.

Out of all the current babbling of new and old ideas, there are some of promise. "ITA," a new linguistic analysis, a less mechanical phonemic study, the use of color and graph techniques for the initial

study of letters and "words in color" are all currently under demonstration in our schools. This popular pressure upon our schools is a healthy push toward efforts at reform of reading instruction. However, most of the projects are without research design and many of the techniques while good are based upon partial truths. None currently are assisted by technological developments of any sophistication.

I suspect that the Russians approximately 30 years ago discovered an explosive truth about the nature of infancy and its potentials for the nature of a new society. Some pieces of their research have dribbled to us during this period of time. I suspect, without knowing, that in very recent years they have clamped security controls on the release of some of their insights on early childhood education with the same oriental secretiveness they apply to their military hardware. There is more than suspicion behind this. The literature has dropped off considerably the last few years. Israel, faced with a problem of the education of the non-European Jew, on the surface at least, descriptively identical with our slum disadvantaged, has been at work on a very pragmatic research level looking for answers. Very little from either of these sources, Russia or Israel, has affected our practice. In this country, some crystal-bright prismatic gleams have been discovered by Mundt, Bloom, Bruner, and Deutsch. Incidentally, I learned that Skinner has moved from pigeons to the cradle.

There are now more than these glimmering insights that justify as an extraordinary hypothesis in education that the years from birth through age 4 are a potential for the creation of an intellectual quality of man on a mass scale never before dreamed of. For example, just as we are now convinced that environmental intellectual impoverishment is immediately debilitating and may be permanent in its consequences, we now have some reason to believe that an environment that is positively fertilized to induce an earlier child manipulation of the symbols of communication called words and language can have equally positive and permanent consequences on his intellectual growth.

We are pathologically minded as a society. We find it easy to talk about what is needed to be done to correct something that is ill. We forget, just as in algebra, from the negative positive to the level of zero is only one-half of the algebraic formula. The positive number begins past zero. And so, correspondingly, we have become agitated at a deficiency correction and fail to recognize that if mankind can be damaged by early environmental impoverishment, there is considerable and logical evidence that a percolation of that infancy can produce a new order of intellect. More than this, and somewhat way out, is an awareness that teaching must shift its emphasis from being something that adults do to a learner to an internal examination of what happens to children when a contrived environment surrounds the learner and invites him to manipulate it.

There is reason to believe that this internalization of a child's awareness of his power to learn is an energizing force that is the human equivalent to nuclear fission. To speak in a literary metaphor: To be seized by love is to be enveloped and filled with a force that energizes every gland, every muscle, every thought of the organism. There are no dull moments. There may be pinnacles of enthusiasm and vigor. There may be oceanic depths of chagrin but the seizure is whole and volcanic. There is reason now to believe too that

compared to the dull, the routine, the fraction of a self that our current pedagogy invites a learner to use, that we can now partially accomplish a mobilized organism, burning glass intense, in the act of learning.

Accordingly, the potentials for the able infant may be even greater than for those heretofore discussed as being needed for the suppressed. Our expectations may be very low and equivalent to a farmer of 30 years ago planting corn. Hybrid yields per acre of today would have been beyond his capacity to fantasy. How much is genius a biological sport, and how much can it be environmentally cultivated?

My thesis is that we have not started to examine that proposition. There are clues in those brief instances in history when a small cultural group exploded and produced an inexplicable number of creative individuals. The city of Florence for 100 years was not a rational biological phenomena. A complete denial of the importance of biological hereditary. Before and since the progeny of Da Vinci, and the others, there was such an outpouring of creative genius in one place with no biological base to forecast it and no biological permanency of the consequences afterwards. Nor was the number of political geniuses who happened in the last 25 years of the 18th century here and in Europe. It has been said by students of greater understanding than mine that the men assembled in the Convention in Philadelphia in 1787 put together in one room more geniuses of a high order of political understanding than have ever been assembled before or since on earth, and I suspect that that is not a chauvinistic judgment. We do not know what dynamic cultural forces are at work in shaping or in cultivating talents. But we can, with some positiveness, insist that these forces and factors are susceptible of discovery. We have not begun that task.

These overstatements are deliberate. They are my efforts to describe a bursting of the bombs of our current circumscribed expectations of what education is all about. A great society is going to need a great people. And I see in technology a very real force in bringing us to some of these great potentials in the education of the very young.

I discuss in my rapidly prepared paper here some technological developments about which you have heard before. I will only briefly say that they are in agreement with everybody else, with some odd points that need to be said, I think.

On the current scene, there are developing two broad categories of learning instruments properly called machines. The first are relatively simple desk or tabletop devices. The second category contains electronic equipment of some complexity, size, and cost with computer-operating capacity. Many of the simpler devices were spawned by the impact of Skinner's programed learning. These were metal boxes, with or without electric motor drives, designed to permit a learner to see a small piece of information, respond to it, check his response with a model previously concealed by the instrument and go on to the next bit or frame if correct. If a response was incorrect, the machine caused the learner to sidestep or branch until it was assumed that the item had been learner. After 5 years of heavy expenditures along these lines, Skinner programed learning has moved away from mechanical devices toward rather strangely fashioned paper manuals.

Skinner's theory of learning is sound but extraordinarily narrow. That is, it is true that learning will be facilitated if complex tasks are

reduced to tiny simple bits whose instant learning is instantly rewarding to the student. But the past 5 years have revealed the limitation. of this piece of learning theory and the equipment developed from its

That oldest of adages about six blind men encountering an elephant is true of the learning theory. The beast of learning theorists have grabbed hold of the tail, the trunk, or a side, a slab of the beef, and so powerful is any piece of learning theory that our literature is full of extraordinary consequences from the one-faceted analysis of one piece of human behavior that was germane as to how human beings learned, but the complex of human behaviors involved in a systematic analysis of a whole series of similar acts or concurrent acts or sequential acts, this synthesis of learning theory has got to come before us, and this is the root cause of the confusion in the development of technology. Skinner has make a magnificent and powerful contribution. If we remain under the assumption that the software must of necessity be a product of the bit by bit kind of a pabulumizing of education, then we will operate as one more blind person with one hand on the tail of an elephant. Our technology deserves more than this.

I discuss now the current level of the inadequacy in the whole computer field. This is a semitechnical analysis, and I would like to comment on this.

The second family of learning instruments are those based upon the computer as a digital or analog "brain center" as distinct from the simpler desktop devices.

There are three technical areas requiring additional development before computer-assisted or directed-learning systems can be considered ready for large-scale use. The first of these problems stems from the fact that present computers have difficulty in responding to several interrogators simultaneously. The microsecond speed of computer response makes possible almost simultaneous use by several students. When the number increases from 12 or 16 to 24, intermediate filter equipment is necessary to split-second hold or sidetrack inquiries addressed to the computer until it is free to respond. This is called timesharing. Unless such multiple-simultaneous use by a minimum of 24 to 30 students is possible, computer time costs will remain enormous and not suitable to public education and mass use. The present stage of development of such intermediary equipment is described by laboratory personnel as being 1 year or somewhat less away from performing laboratory models.

The second factor delaying application, also in the development stage, is the need for audio channels to talk to the learner. Computer don't talk in audible speech. Prerecorded speech used to address, direct, or correct a student or to vocalize information contained in typewritten form or cathod-ray-tube presentations to the learner can be directly controlled by the computer. But speech must come from an instrument which stores recordings which upon computer direction searches for the precise words needed and transmits them to the learner coordinated with the other material in the learning program. Philco has one piece of equipment sufficiently tested to be deemed adequate. IBM and Westinghouse have others currently being developed. Neither has a working model, and both estimate something less than a year for completion.

A third characteristic of computerized teaching needing more time is the need for equipment with which to confront the learner and to

permit him to register his responses with the computer. The equipment and instruments in the individual learning stations are not well thought through. It is important to note here the potential luxury of what American ingenuity could produce. Unfortunately, as of the summer of 1965, what has been produced is considerably below our realistic expectations. A typewriter which uses a cathode ray tube for paper, the teletypewriter, and a light pencil which moved over and pressed upon reverse screen images produced by optical system filmstrips are the several instruments now conceived and reasonably usable and computer controlled.

The last need for the fuller exploitation of computer technology in learning is perhaps the first and root cause for much of the present confusion in the field. Because a cohesive theory of the human behaviors involved in learning is not now being applied to this whole field, the material, called "the program," that is, the content material to be learned, is meandering and frequently, internally contradictory. We have long known that involving several of the senses of the learner will increase the rapidity of his acquisition of information. We have also known in recent years that the active interaction by the learner through his several senses with the instrument is essential. Looking at television may be the new "opiate of the masses." To use these two pieces of learning theory well requires that a body of information be presented in a scientifically tested series of pictures, or drawings, with audible speech, printed or typewritten material, with a planned orchestration of these simultaneous sensory effects. The learner would then respond appropriately in writing or in speech. This is to "program" learning. It has scarcely been done. More importantly, the need for instrumentation to make both multisensory presentation and response possible has been made, with one notable exception, only crudely defined to the hardware researchers. To quote the director of a major computer research team after 2 years of close collaboration with a universally staffed project on computer learning, "If you fellows would only tell us what you want."

This lack of a disciplined description of learning for translation into technology is at the root of our present groping. The technical abilities and capabilities are abundantly present. The goals have been fuzzed over.

The costs involved in this effort are large, larger than the present local tax base of public education can finance. But awe-inspiring results are a potential. We used Federal resources to subsidize the building of railroads and the design and prototypes of our commercial airplanes. The introduction of computer technology to the schools is likely to be delayed by years if similar Federal effort is not used.

I ask now: What can be done? I insist, repetitiously, that a comprehensive theory of learning is mandatory. Learning must be seen as a series of behaviors which can be produced when a child is confronted with an instrument designed to evoke these behaviors in him. Much more is involved in learning theories than in the following generalization.

For private enterprise, more particularly for educational publishing for the school and family market, this analysis and summary of educational technology has little thus far to contribute. But it is now possible to develop a whole series or family of learning machines

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whose prices may range from the toy price of the mass-produced doll to the electric train sets.

The first requirement is a comprehensive theory of learning. Learning must be seen as a series of behaviors which can be produced when a child is confronted with an instrument designed to evoke these behaviors in planned order.

Much more is involved in learning theories than the following generalization: Learning is a sequence of behaviors using the several senses concurrently. This is not much broader than Skinner's theory previously criticized, but for our purposes it is not necessary at this time to go into a fuller exposition of other factors involved in a broad and comprehensive theory of learning. From this limited generalization, a series of criteria that will serve as the genesis for inventing, creating, and designing technological instruments to assist learning that will range from simple mechanical devices to major electronic installations can be derived:

The criteria for such a learning instrument are—

(1) It should attract.
(2) It should contain the elements of sameness and novelty.
(3) It should be capable of being made to move its parts.
(4) It should isolate the element or sequence of elements to be learned and mastered.
(5) It should control and limit the possibility of error.
(6) It should be self-corrective.
(7) It should produce in the learner an internal sensing of success. He must know he knows.
(8) It will invite repetitious use to the learner's own sense of redundancy.
(9) It should then invite a new level of explorative use.
(10) It should involve tactile and kinesthetic senses along with sight and hearing.
(11) It should call for the use of these senses in an active interaction with the instrument.

The second major requirement for producing learning machines is an expert analysis of the material to be learned. Bruner has helped our thinking about learning by pointing out that a body of knowledge has an internal, concept structure which must be taken into account in organizing information to be learned. The new technology I have called for above leans heavily upon the idea that instrumentation should be based upon models of the concepts to be learned as well as employing the several senses of the learner. Thus learning to read through an instrument should proceed from moving models of what we think the subject of reading contains as a series of concepts or ideas. For example, how symbols stand for sounds; how a series of symbols become a series of sounds that can be heard as a word. These phrases seen as functions to be performed by an instrument manipulated by a learner are the genesis of the design and performance characteristics of a learning machine.

Several other partial illustrations follow:

Bruner used wooden forms and a wooden balance rod to have children almost self-learn mathematical concepts. These wooden pieces were manually manipulated by the children in the presence of a teacher or tutor. Application of the sensory criteria to these

wooden pieces could produce a learning machine which would meet the requirements of self-teaching. The child's toy kaleidoscope is an example of an unexploited manual device which could be instrumented to become a learning machine for understanding color and form. The combination of the three elements—a broad theory of learning, concept analysis of material to be learned, with the engineering creativity of modern technology—will produce new automated instruments for learning that will lift educational goals to new heights.

This is not a plea for electronic complexity; rather it is the result of a strong feeling that the true synthesis of these insights with the brainpower of our computer thinkers and electronic engineers will lead to families of instruments in the very immediate future.

It is important to conclude with some indication of what machines are not likely to do or may never do, although there is real danger that our control love for the machine may bind us to the limitations. Machines will not teach values or virtues. Children need to learn to cherish freedom for their neighbors, love for others, and to enjoy, create, and have experience from planned learning in school studies as carefully programed as the human brainpower can produce. Our capacity to produce a citizen recommitted to these virtues is more vital to our survival than training programs and material productivity. The production of educational technology promises great strides in an increase in learning skills, insights, and the like. The need to move simultaneously with the learning of attitude values and commitments to the concepts of freedom are, unfortunately, but dimly seen.

The need for rapid development of educational technology is great. The social ills of our society need improved mass education. Poverty is nourished by ignorance. The present educational programs of our schools then act as a limitation upon children born in poverty, and the present institutional structure of public education is archaic and needs to be destroyed. Educational technology promises to bring this kind of learning into being and broad Federal support, as for everything else, is necessary at this time.

Psychological and neurological theory hints strongly that a new order of intellect can be produced for the able as well as the disadvantaged.

Senator PROXMIRE. Thank you very much.

I would like to interrogate you, and I will direct questions to each of you in turn, but I want you all to feel free to join in and give me your opinion and do not hesitate to do so, because it will help the discussion a great deal. It will enlighten me and through the record the other members of the committee and the Members of Congress.

First, Mr. Bright, the programed instruction that you were talking about. Primarily it sounded to me like a device to do two things: in the first place, to improve the memory, or at least to work in the area where memorization is the principal requirement; and, in the second place, to enable the less-competent student to improve.

Both of these are very highly desirable goals, I am sure, but I want to be sure that I do not misjudge and misinterpret your remarks. That was the impression that I got from what you said. I am not saying that I do not appreciate the value of this, but I want to know whether my conclusion was fair.

Mr. BRIGHT. I do not believe so. It does not have this inherent limitation. It can do these things, but concepts can be well taught.

Senator PROXMIRE. Let me interrupt there. If you have every student within a given period of time, you say that the bright student can do it five times faster than the poorer student who will take two or three times longer than normal?

Mr. BRIGHT. Yes.

Senator PROXMIRE. But within some period of time, you will have all of the students able to do satisfactory work. The benefit here, obviously, if you stop right at that point, is for the poorer student.

Mr. BRIGHT. That is correct. Well, for both.

Senator PROXMIRE. Yes, but unless you say that the better student has to go on, do something with this, with the additional time that he will have——

Mr. BRIGHT. That is right. Presumably, you would have to have additional materials available so that the better students would not simply stop and wait for the slower students to catch up, but, indeed, would be proceeding to additional materials.

Senator PROXMIRE. Is that the way it is operated in most cases?

Mr. BRIGHT. It is difficult to answer that question, because there really are not any schools in operation this way as yet. Let me say that the nearest approximation to it that exists so far—yes, this is the way it is working.

Mr. KURLAND. I have a comment on that. There is a delightful experience that one researcher, Prof. Richard Carlson, found in the application of programed instruction which illustrates beautifully the problem of the introduction of a new approach. In a school using programed materials the teachers let the slow students take the materials home and made the quicker students use them in the classroom in order to keep the students together. So, the teachers were using the programed materials in just the reverse of the way they were intended to be used: not for individualization but just as another kind of textbook.

Mr. MARTIN. May I point out that the introduction of any major change into an institution must change the institution. Henry Ford did more to change the nature of family life in America than all of the sociologists and family counselers have been able to effect since.

The precise answer to your question: In terms of its institutional consequences, as Mr. Kurland has indicated, the structure of the school is a Procrustean bed. If they fit, they live; if they are too long, they get cut off, and if they are too short, they, presumably, are supposed to be stretched by ropes, but the inherent nature of the grade organization is archaic and antagonistic to the nature of children and the nature of learning. It presumes that they can be packaged in bundles, whether homogenized or not, by age range, or by intellectual ability.

Senator PROXMIRE. What you are saying is that unless you change the approach in the school—if you simply impose the program and instrumental material on the present institutional setup, then what you are going to do is to do this shrinking and stretching and you are not going to enable them to move ahead in an enriched program.

Mr. MARTIN. That is right.

Mr. BRIGHT. I can state some examples from an operating school which is not using hardware, but which is using individualized instruction in a text form. Here there are fourth graders that are working in fourth-grade reading and second-grade arithmetic, second graders doing second-grade reading and fourth-grade arithmetic, and I think one sixth grader is studying calculus. So that there is a tremendous spread. It is not consistent among the various students. Some are better in one respect, and some in others.

Senator PROXMIRE. You say that there is a second grader in calculus?

Mr. BRIGHT. It is a sixth grader.

Mr. MARTIN. May I point out that, with the one-room rural school in America which we destroyed, we had that in America; we had it before we had the programed instruction. We changed the nature of the institution for mass educational purposes and set up a bureaucratic system to package children into grades.

A one-room rural school teacher, of whom I was one, was confronted with 45 or 55 children ranging in age from 7 to 14 or 15 years. When the weather was good, very few of them came, because they were needed on the farms, and when the weather was bad, I had most of them.

It would have been insane to the understanding of the children and myself to have called for the fourth graders to recite in arithmetic. The absurdity of that was apparently apparent to every child in the room. Instead, I called for those prepared to recite in the fourth form in arithmetic, and children stepped forward of a variety of ages. When I asked for the fourth form in another subject, some of them sat down and others took their places. Some of them remained. This was not programed instruction. It was particularly American-made good sense.

Senator PROXMIRE. What you are saying is what it really takes——

Mr. MARTIN. A change in the institutional structure of public education in America.

Senator PROXMIRE. And, then, in another area here, too, I would like to have this question answered: You also said, as I recall, Mr. Bright, that the teachers should not be involved in the simple presentation of the material of the kind that the computer can do just as well. Instead, he or she would be a discussion leader. This suggests that we may have to do an enormous amount of teacher training that we have not done in the past, because, as I understand it, the discussion leader in education in addition to being a higher quality teacher in terms of educational achievement, must learn a kind of psychological willingness to permit people to work their own thoughts out and to make mistakes, to discuss things in a way which are different than the usual approach to the subject, not the far simpler pedagogy of putting out and then getting it back as close to verbatim as possible.

Mr. BRIGHT. That is exactly correct. As I mentioned, there are three areas of concern: the equipment, the required material, and the application of known techniques. In other words, it is primarily a development procedure involving excellent people, but with adequate funds, I think that we can, indeed, do this.

The last point is an interesting one. To the best of my knowledge there has been no work yet done in the country on a consideration of

what the teacher's role is in a school, using educational technology to its maximum feasibility.

Senator PROXMIRE. Is that now a part of the job of your agency to do that?

Mr. BRIGHT. Yes; we are going to do so.

Senator PROXMIRE. Do you expect to get moving fairly soon?

Mr. BRIGHT. We are going to try.

Senator PROXMIRE. I thought that Mr. Martin's indictment of the lack of this was devastating. And it indicates to me that this is perhaps a No. 1 project that should take priority, to enable us to move ahead, on the basis of some kind of effective scientific basis.

Let me just ask one other thing along the lines that you were talking about. You said, 25 cents or 50 cents per student-hour. Would that assume a particular-sized school?

Mr. BRIGHT. I am saying that in order——

Senator PROXMIRE. And you went on to say that in order to make it practical, you would have to do this, but you would have to make assumptions as to what size of school you were working with to make a computer practical?

Mr. BRIGHT. I think so. It appears—and opinion may differ on this—my own estimate upon analyzing this, is that it is possible to use these costs if you have approximately 100 student consoles within one institution.

Senator PROXMIRE. You have 100—what?

Mr. BRIGHT. Student consoles within one institution. This means that if a student spends an hour to an hour and a half a day at such a console, consoles could be kept fully loaded in a school with, perhaps, 500 students. So, I believe that for a school that size—or larger, of course—an installation of this type could be economical.

Senator PROXMIRE. Did you have a comment on that, Mr. Martin?

Mr. MARTIN. No. I would agree essentially with what Mr. Bright is saying. We will not quibble about numbers, but they are only indicator numbers, so that there is no point to that.

Senator PROXMIRE. How about the application here to college education?

Mr. BRIGHT. This is an area that has very many interesting applications. I think that from one point of view one of the major problems in adult illiteracy education, particularly, is the fact that it is extremely difficult to get adults to sit in a classroom and publicly expose their ignorance. They simply will not do it. This is one of the greatest difficulties in adult teaching. The techniques that we are seeking here can be completely private systems in which none of the other people in the room are aware of the performance of any particular individual. So, we believe that this has the potential of being much more successful with adults. In fact, the adult is not even conscious of the fact that the instructor is aware in detail of what he is doing. So that, for this reason alone, we believe it will be extremely successful in adult education.

Mr. KURLAND. If I may: I have a paper here called "Stay-at-Home Classrooms for Space-Age Adults," which develops the potential of this technology for adults to provide this kind of instruction in the home.

Senator PROXMIRE. You say you have a paper on that?

Mr. KURLAND. I have a paper on it; yes.

Senator PROXMIRE. I would very much like to have that in the record. It will be very enlightening.

Mr. KURLAND. I will furnish it for the record.

(The document follows:)

STAY-AT-HOME CLASSROOMS FOR SPACE-AGE ADULTS [1]

(Norman D. Kurland)

Men now "walk" in space and soon they will walk on the moon. What would happen to education if the imagination, daring, and resources that are going into our adventure in space were marshalled for an adventure in learning? This chapter is an attempt to explore some of the possibilities.

For too long, education has sought to cope with its problems merely by extending traditional procedures to handle larger numbers and by the slow and piecemeal introduction of new ideas and methods. But the problems confronting education, created by the twin explosions of knowledge and population, are too great to be handled by traditional procedures. A breakthrough is called for of the dimensions appropriate to a generation that is going to see men visit the planets, communicate with intelligent life elsewhere in the universe, change at will the hereditary characteristics of genes, create living tissue from inorganic materials, transmit information and power by light beams, and achieve the myriad of other potentialities—not miracles—of existing science and technology. Whether our social and political institutions will be able to adjust to the impact of these changes will depend very largely upon the success with which we change our educational system so that it fits—and keeps fit—our citizens for the new world that is upon us.

What follows will seem fantastic, even mad, to those who view educational change from traditional perspectives. Indeed, the great likelihood is that traditional modes of operation and sheer inertia will continue to prevent the large-scale, ordered, and imaginative adoption of new ideas in education. Instead, they will be introduced piecemeal here and there—never enough to realize their full potential, never enough really to meet the needs of the times. Education probably is doomed to lag behind needs and possibilities. With this acknowledgment to the realities, let us consider what might be if we had the wits, the will, the imagination, and the courage to use the knowledge and technology which now are available to us.

COMPUTER-ASSISTED PROGRAMMED INSTRUCTION

Programmed instruction, with or without machines, undoubtedly will have an increasing, albeit limited, role in education. Ordered sequencing of materials, active response, immediate feedback, and self-pacing presentation have obvious educational merit. As more is learned about this method and better programs are produced, it will find an increasing place in our classrooms.

It is the addition of a computer which transforms a useful additional teaching tool into something which, next to the human teacher, may prove to be the most effective teaching instrument yet devised. The computer is far more than a complicated device for presenting programmed material. It can be employed to direct the learner at each stage of his development to the appropriate learning resource, whether it be a programmed lesson, a television or audiotape, a book, or even the teacher himself. It adjusts to the actual learning experience of each student so that no two "programs" are ever alike. The slow learner will be taken through strategies designed to overcome his particular learning difficulties; the fast learner will be moved ahead to materials of appropriate levels of difficulty. Progress will be fully analyzed and recorded, providing counselor and educational researcher with information of a kind never before available: the counselor will have a detailed record of students' past performances and, if the necessary evaluation procedures are built into the program, a secure basis for placement; the researcher will have detailed information on the specific behavior of the learner under controlled conditions at every stage of the learning process. The effects of large and minute changes in the learning situation can be studied exhaustively and hypotheses about learning at last can be analyzed under near-laboratory conditions.

[1] Reprinted from "Automation, Education, and Human Values," School & Society Books, New York, 1966.

At this point, it is hard to estimate whether the research or teaching effects will have the greatest educational significance.

Important as these two effects are, they almost can be considered bonuses beside two others: the equalizing of educational opportunity, and the release of teachers to do those tasks which only the human teacher can do. Under present teaching arrangements, the equalizing of educational opportunity never can be much more than a dream. In most school situations, classes will not be homogeneous or small enough or teachers able enough to adjust adequately to individual differences. Every learner will be handicapped in some way—the fast, by being held down to the pace of the slower, with the attendant boredom, frustration, and loss of powers not sufficiently exercised; the slow, by never quite mastering a subject before being forced to move along to the next topic; and the average—but there is no one average in everything! With computers we can come closer to insuring that the fast learner moves ahead at a pace adjusted to his capacity and that the slow learns thoroughly each lesson before he is allowed to move ahead, thus eliminating the perpetual frustration which must be a major obstacle to his educational achievement. Moreover, once programs are developed for learners of different capacities, it should become possible to understand the obstacles to learning and to develop more effective strategies for helping learners at all levels to learn more and better. It is even conceivable that the difficulty of some slow learners may derive from an inherent incapacity for manipulation of verbal symbols. Machines permit the presentation of non-verbal stimuli—pictures, diagrams, or even things—and thus may make educable individuals who now appear to be uneducable.

Programmed instruction automatically would take into account individual differences in maturation rates. Slow maturers now may be handicapped permanently by being tagged in their early school years as "dumb" and by failing to master fundamentals before they are moved along to more advanced materials. Programmed instruction would adjust to changing capacity for learning throughout the learner's educational career and thus try to assure that each one would achieve to the maximum of his capacity.

Another instructional role for the computer will be in providing simulated experiences as a means of approximating the conditions under which knowledge is applied. Suggestive work is going on in adapting the technique of the business and military game to education. In a "game," the student is exposed to a complex situation in which he has to apply previously acquired skills and knowledge to the solution of a problem. The computer provides both immediate feedback on the results of his "decision" and new information that must be taken into account. Through the mediation of the computer there also can be interaction among several players. In time, complex computer-mediated games may be a widely utilized form of community education and recreation.

There is some fear that machines will replace teachers, but a little consideration will make it evident that the only teachers who will be replaced, if any are, will be the poorest ones. In a programmed instructional system, teachers will have two basic roles—one new, and one old but usually inadequately realized. The new role will be to prepare materials for the machines—programs, televised lessons, filmed demonstrations, audio and visual illustrative materials, demonstrations, and evaluation instruments. Such work will require vastly increased understanding of both the learning process and the subjects to be learned. Intelligence and imagination will be demanded as never before. When these qualities are present, they will be available not just to the handful of students with whom even the best teachers now can work, but to as many as the system cares to have these qualities reach.

The other role of the teacher will be to do what the machine never can do—motivate, counsel, and lead students to those higher-order functions which are the primary goals of education—to question, imagine, invent, appreciate, and act. The teacher need no longer be the purveyor of information or even the developer of basic skills and understanding. When he meets students in formal classes, they will be prepared together to move into the most intricate and challenging aspects of a subject. And the numbers of such formal meetings which will be required will be greatly reduced. There will be time for his own research *and* for the more intimate, informal contacts which all good students find to be the most rewarding part of collegiate life. Under such conditions the teacher can be what, at his best, he always has been—a model, a stimulator, guide, planner, and fellow searcher after truth, meaning, and value. In this way we may yet preserve that vital personal relationship between student and teacher which is so gravely

threatened by the onrush of students and the attendent depersonalization of our institutions.

A final benefit of the large-scale introduction of technology into teaching is that it will provide a basis both for raising teachers' salaries to professional levels and for differentiating among teachers of differing abilities. The obvious increased "productivity" and level of professional competence of the teacher who directs a learning "system" and participates in the creation of effective learning materials will justify a reward more nearly commensurate with the training and ability required for the task. The effectiveness, too, of teachers with lesser abilities, working in a team with able leaders and using well-designed programmed materials, will be greatly enhanced.

Lest there be any illusions about technology increasing the teacher-student ratio, let me state that I do not see this as a likely long-run result. The effect of well applied technology will be to improve instruction and alter the functions of teachers and their relations to pupils and each other. But the effect of improved instruction is almost always to put greater demands on the creative teacher. What we can hope for from the introduction of technology, then, is not a saving of manpower, but of "mindpower" and a level of educational achievement more nearly up to the needs of our culture.

LEARNING RESOURCE CENTERS AND THE NEW EDUCATIONAL ENVIRONMENTS

Educational practice, up to now, has been dominated by the classroom in which learners are brought together in small or large groups with one instructor. Even when students are sent off to study on their own, they usually are provided with large reading rooms in which hundreds are expected somehow to concentrate in a hotel lobby atmosphere. In the world of work, when we expect a person to perform important intellectual tasks, we give him a room to himself, and when we really want high performance we provide him with all the aids he may need for his work. As one of the most important and demanding intellectual tasks, learning deserves conditions no less conducive to high-level performance. In recognition of this fact, increasing numbers of schools and colleges are providing individual student study spaces.

Into such spaces can be brought, by wire from a central learning resources facility programmed material, live and taped television lectures, audio-tapes, language lessons, and broadcast television and radio—all selected at will by the student or available to him on predetermined schedule. Devices are even being developed to give ready access to printed materials at remote locations. From the space, the student's responses can be fed in a variety of forms—audio-visual, electronic, punched card—to the central facility for analysis, evaluation, and recording or to a teacher for response.

Such individual spaces, combined with a limited number of seminar-size rooms and large auditoriums, can provide a learning environment far more adaptable to individual learning needs than anything now available. In such an arrangement, scheduling problems virtually disappear, and learning and instruction both can be organized for more effective realization of individual and institutional goals.

CONTINUING EDUCATION

Five things can be said, with a high degree of confidence, about continuing education in the remainder of this century:

1. Nearly as many adults will be working for college degrees on a part-time basis as will undergraduates enrolled full-time in all of our higher institutions.
2. The demands for advanced education on a systematic, continuous, easily accessible basis by adults will increase, spurred both by the decreasing need for unskilled workers and by the explosion of knowledge. There will be fewer jobs for the under-educated, and anyone quickly will become under-educated who does not continue learning at a high level throughout his adult life.
3. The success with which those needs are met at a high intellectual level will determine in large measure the quality—if not the survival—of American society in the last part of this century.
4. Universities, as presently organized, are not prepared to meet these needs and, being preoccupied with the flood of undergraduates and their increasing research responsibilities, are not likely to organize to meet them.
5. Educational television, by itself, is not likely to meet these needs.

Given these conditions and reflecting on the developments described in the first two sections of this chapter, a solution to the needs for continuing education

suggests itself which is so staggering in its potential effects as to border on the fantastic. Yet, given the need and the resources which are potentially available, what follows may be a highly realistic suggestion.

There is every reason to believe that the kind of individual study spaces described above could be designed for installation in conveniently located community centers, such as libraries, and in homes. Were this done, a central learning resource facility, equipped with a large high-speed computer and extensive library of programmed, televised, recorded, and printed materials, could service whole cities, states, or even regions. If manufactured on a large scale, suitable study facilities, perhaps each equipped with its own small-scale computer, could be made available for a cost that would not much exceed that of a good television receiver ($400-$500). Such a system would provide access to well-conceived learning aids, available when needed, self-paced, and with feedback and built-in self-evaluation procedures. It could be expected to increase the significant educational activity in any community so serviced—a gain not merely in quantity, but, far more important, in quality of the educational experience. Here—not in open-circuit television—is the real mass education medium of the future.

To insure that such a system does not become an instrument for indoctrination of one viewpoint on a scale never before possible, all points of view and approaches must be represented in the resource materials library. This could be achieved not only by the determination of the staff to stock the facility with a full range of materials, but also by an open supply policy. This would permit any individual or group to place in the library any material technically compatible with the system. The storage and catalogue listing of such material would be a small item and a very small price for the freedom it would help protect.

What results might be anticipated from such a system which would justify such a large undertaking?

1. An extension of educational opportunities to every segment of the population of a variety and even quality never before possible and at a cost per student hour of instruction at least comparable with, if not greatly below, present costs.
2. An upgrading of the real educational achievement level of the population commensurate with the needs of an increasingly complex culture.
3. An increase in the general level of political and economic sophistication—a gain essential to the survival and vitality of democratic society.
4. An increase in the demand for cultural resources of high quality so that theater, music, literature, and the plastic arts would flourish as never before.
5. A vast gain in the vocational adaptability of the population. As a rapidly changing technology accelerates the rate of vocational obsolescence, effective means must be found for continuous up-dating of the training of large proportions of the working force. The proposed system will be the most expeditious means for achieving this objective.
6. An effective adjustment to the greatly increasing amount of non-work time available to everyone. Whether this time becomes "leisure" time, in the richest connotation of that term, or merely is filled with increasingly desperate efforts to escape boredom will depend largely on the accessibility and quality of the education for leisure available. Again, the proposed system will make a major contribution to this need.

COSTS

What would such a system cost? Until detailed feasibility studies are conducted, any estimate is only a guess.

1. For preliminary research and development—$1,000,000. (Some of the necessary work has been done. Research and development should be a permanent part of the operation as it now is in any advanced industrial or commercial enterprise.)
2. To establish and stock a central learning resource facility for a single region, including installation of high-speed computers and development of programs—$50–$100,000,000. Although the initial "hardware" will require large expenditure and, of course, will be essential, the effectiveness of the system will depend primarily upon the quality of the educational materials transmitted via the hardware. Their development will be a major charge. Yet, even here, perspective is called for. If high-quality offerings can be developed for an average of $20,000, then $10,000,000 will "buy" 500 offerings. Even at an average of $100,000 per offering, the costs would be well within justifiable range. This assumes that some items can be incorporated at minimal cost, while others—the video-taping or programming of complex courses—may run into the hundreds of thousands of dollars.

3. For transmission lines, regular telephone lines may be used for part of the service. The estimate of the cost has not been determined.

4. To provide 100,000 individual study spaces in public centers—$50,000,000. This would be done to give the program an initial impetus and to provide for persons unable or unwilling to purchase their own units. The production and sale of home units would be left to private enterprise, which could be expected to launch the development, production, and sales effort comparable to that which put a television receiver in nearly every home. The estimated total cost of introducing the system in a state such as New York would thus be $100–$200,000,000.

TIMETABLE

Without the full, systematic, large-scale development envisioned above, the system is still likely to be in existence in many localities by the end of this century. Given the decision to implement the above proposal with the needed resources, the system could be in limited operation within five years. Within 10 years it could be expected to reach a majority of homes in the participating areas, and in 15 years have a full-range of learning materials available.

If this seems optimistic for such a large undertaking, remember that it was less than five years from decision to man in orbit and about 10 years from the beginning of commercial television to nearly nation-wide reception. While the pace of educational change traditionally has been far slower than this, and the number of persons involved in implementation is far larger than the space program, with sufficient determination the indicated timetable is feasible, as far as establishment of the system is concerned. Full acceptance and utilization will be slower, of course, but the educational needs by the end of the present decade are likely to accelerate acceptance far more rapidly than anything our past experience would suggest.

What is called for, then, is a "Manhattan project" in education to put the new technology at the service of the highest function of man before it destroys him.

STRATEGIC CONSIDERATIONS

The proposed system could be developed for formal education from the kindergarten through graduate school. Two considerations argue against this approach:

1. An effort to introduce the system on the scale proposed would run into all the entrenched interests, habits, and values of established institutions. The resistance certainly would slow down the program, and the compromises required to make even a little headway probably would vitiate the best effects of the system. In concentrating on advanced adult education, the system would be entering a field now serviced by a wide variety of institutions, none strong enough to resist the program; and, in any case, few are doing anything in the areas in which the system would be most important.

2. Educational considerations argue for beginning as proposed. Assuming that the proposal is not implemented, the educational needs of youth will be met, more or less, and new technology will be introduced, although at a slow rate. There is little prospect, however, that the needs for advanced, continuing education will be met on anything near the scale and quality required. Thus, the proposal will meet a large unfilled need in an area in which resistance to its introduction will be minimal. Success in this area, of course, will have profound effects on the schools, bringing about changes far more rapidly than would direct introduction of the system.

There are those who will feel that this proposal puts excessive emphasis on "hardware" and ignores the central importance of teachers and ideas. Without going into a detailed argument on the point, the following considerations will suggest the lines along which discussion might proceed:

1. There is, certainly, no substitute for a good teacher, and such a teacher can teach under any conditions. In mass education, however, it is unrealistic, unfortunately, to think in terms of good teachers for every student under any foreseeable or existing arrangement. Given a vast majority of average to inferior teachers, the question is how can we help them to do a better job and at the same time extend, without destroying, the effectiveness of the really good teachers? This is one objective of the proposed system.

2. The environment in which teaching occurs and the tools teachers work with profoundly affect the character of education. The printed book certainly changed education, and the kind of buildings we now have is, many believe, an obstacle to

improved education. But most important, the right changes in "hardware" may do more to stimulate fundamental thinking about the nature of the educational process than the most well-conceived efforts at curricular reform.

3. The emergence of this system undoubtedly would generate great demand for direct contact with teachers. Once people get a taste for education through independent study, they generally want the experience of sharing ideas with others. Increased opportunities for such experience would be an inevitable result of the proposed system. Whether in privately arranged group meetings or in specially organized formal seminars or workshops, individuals would find ways to satisfy the need to exchange ideas with fellow human beings.

There is more at stake than whether the role of the teacher will be kept, modified, or abolished. The central question is the impact on the individual. Will such a system transform him into a mere extension of a machine—mindful of the things needed to keep the social machine operating smoothly, mindless about the things that make men human? Whether man is mechanized and enslaved by his machines or freed by them depends on how he uses them. Every external extension of the human hand or brain has put some aspect of human functioning outside of the individual. Is man lessened thereby or freed? Though this debate will go on as long as man survives, the issue of how our vast technological capabilities and material resources are to be put to use in education is before us.

And the issue is *how* and not *whether*. The need for change is here and cannot be denied. Already other agencies whose concerns in the past have not been primarily with education—business, industry, government—are considering how they may meet the need. If educators leave to others the determination of how new needs are met and new resources used, they will have little to complain about if the results are not to their liking. They must lead and not follow in adjusting their practices to meet changing needs and in exploiting new resources to help in meeting the needs. They should welcome the contributions of technology for what they can do for education. The hope for the future lies not in denying powers that history has put in our hands, but in using those powers for the enrichment of life.

Mr. KURLAND. My conclusion is that very definitely these systems have tremendous potential for adults. In many respects, I think the possibility of introducing some of these systems into adult education is even greater than at the elementary and secondary levels, because we do not have the educational rigidity that we do have in the elementary and secondary levels.

Senator PROXMIRE. At the same time you do not have the institutional rigidity—and you do not have the institutional availability either—you have all of the school aids and the like in the schools in the elementary and secondary levels. Few adults, relatively few adults, are volunteering for additional work, but the educational setup is discouraging. Many adults work an 8-hour day and come home to family responsibilities. I am wondering if there is any way that this could be used either via home television or in job training, or something of that kind, that would enable a much higher proportion of the adults to take advantage of it?

Mr. KURLAND. Very much so. I think this is what the great potential in this system is, to give the adult access to learning opportunities at a time appropriate to his schedule, at the best time for him. It may be 8 o'clock in the evening when he wants to get a lecture or a programed course in biology; it ought to be possible to do so.

I suggest that the library is a good model. Technology is putting us in such a position that we ought to be able to make learning opportunities nearly as accessible as the books in a library.

Mr. MARTIN. May I speak to a point peculiar to the technology subject and its consequences in these respects? The machine is benign; it is neutral; it can be prostituted to use the same language of the particular didactic teacher, and, as such, it will destroy itself;

but the machine responds to only what the learner does for it. He owns it. He controls it. He activates it. And for the first time the machine makes possible a concentration on the satisfactions of learning for the sake of learning itself—a thing that has almost been destroyed in our educational cultural pattern.

We reward extraneously. We intrude between a child and the thing learned an extraneous factor called "the praise of the adult." That praise carries within itself the implied threat of the withdrawal of such a praise or punishment. We know enought now about the learning theory to know that this is devastating in its consequences. The individual sustains himself despite this, but in 12 to 15 years of formal schooling, we prostitute the act of learning to external consequences having no intrinsical importance to the quality of the learning.

Let me give you an illustration. I discovered an 18-year-old illiterate. I discovered him, because I insisted in a public high school that children of limited intellectual capacity be given opportunity to leave school early and, under school supervision, work. The resistance of the school staff to this imposition upon their time was such that they told me off, with justification, for the stupidity of my insistence that such a boy had been placed in a warehouse job and had to be taken from the job because he could not match labels on the truck of materials he was pushing around to the bins in the warehouse in which these orders on the truck were to be disbursed. They said: "See, you just cannot get these kinds of people a job."

Because I was engaged then in the talking-typewriter work with kindergarten children, teaching them to read, and the down time on these machines began at 3 o'clock, I removed this boy from the warehouse job and put him into a suborderly job which required no literacy—there being no symbols on bedpans that required reading—and at 3 o'clock, I had him chauffeured by an assistant superintendent back to the elementary school and put him in a booth with this typewriter that he manipulated. It talked to him, and he talked to it. In 3 months' time, this juvenile version of Sonny Liston, hostile, with black hatred of the white race, produced in himself a metamorphosis of self-pride and self-visual picture of himself, and he became, in effect, the shepherd to the little children in the day, and took such a pride in the accomplishment of the little ones which he was paralleling in his illiteracy. By the way, we showed him the New York State manual for learning how to drive, with a vocabulary level that Lucy Jane would never have approved of. In 3 months' time this boy had a vocabulary in excess of 200 words.

The important thing was that he had been exposed to reading clinics, reading experts, remedial attention in all of the conventional and some of the nonconventional best procedures, including the "Metropolitan University Summer Program for Culturally Deprived," and all of this had succeeded only in adding one more layer in an increment of self-hate, and hatred for society. When we got the adults out of the way with their carrot in their hand and their promise of reward, and let him work at an instrument which he controlled and devoted himself to the intrinsic act of learning for the sake of learning itself, this was a revolution internally in the metamorphosis of the human being. That is adult education, too.

Senator PROXMIRE. What do one of these talking typewriters cost?

Mr. MARTIN. Currently, the press says $30,000, and the sellers are talking $35,000. You will have to ask them, but that is what I understand it is.

Senator PROXMIRE. What did the one that you have in your school cost?

Mr. MARTIN. I have four of the instruments at work in a preschool program for the 4-year-olds in a city center with over 100 children, operating with about 85 percent Negro and 15 percent white, with medium IQ, just above mental retardation for the children on individual tests out of Dr. Kurland's division in Albany, who are doing the testing for us. The rental there runs about $1,000 a machine per month.

Senator PROXMIRE. They are on a rental basis?

Mr. MARTIN. Yes. And I am waiting for Dr. Bright's division to give me a Federal fund to expand the program.

Senator PROXMIRE. Is this a kind of instrument which, if it were developed on a mass basis, the cost would be greatly reduced?

Mr. MARTIN. I understand that it would rapidly come down, probably to one-third to one-half of its present cost. You see, we have not had in education the need for the thinking that is so common to industry. Industry would not think of the purchase of a piece of capital goods without a cost analysis of the productivity factors. We have no productivity measurement in education, because we have had, essentially, no capital investment beyond the bond issues for bricks.

Technology will compel us to do the kind of thinking that Dr. Bright was talking about a little while ago in talking about the cost per hour per student, but the cost per hour per student must be equated with the productivity of consequence. And if we are talking about a productivity that matches or exceeds slightly the present productivity output of the handicraft industry called teaching, then it seems to me that we are talking very, very inadequately.

Senator PROXMIRE. The only difficulty, of course, is that you have the school boards to sell. You have property taxes that have to be raised.

Mr. MARTIN. You tell me about those, will you? [Laughter.]

Senator PROXMIRE. I know a little bit about them, because we have that problem in our State, and I learned about it when running for Governor and losing all of the time. I was in the State legislature. So, I am somewhat familiar, but much less familiar then you are. Nevertheless, I know that this is a problem. If you're going to get this on a substantial basis, the question of cost is going to be asked, and the productivity will run into it.

Mr. MARTIN. The present cost of these machines is a byproduct of the fact that the total cost of their development is privately sponsored without Federal subsidy. As a consequence, therefore, the initial sale of such products must in a very short time recapture the investment cost, but this was not true with the American railroads; it was not true with the fantastic subsidies given to the American automobile industry by the Federal building of roads, and it is not true of the current aircraft industry.

Senator PROXMIRE. How many of these talking typewriters are there?

Mr. MARTIN. In current use?
Senator PROXMIRE. Yes, in current use.
Mr. MARTIN. Oh, less than a dozen.
Senator PROXMIRE. Is that true?
Mr. MARTIN. That is true.
Senator PROXMIRE. That is in the entire country?
Mr. MARTIN. I have the largest installation in the country.
Senator PROXMIRE. Where are these sets?
Mr. MARTIN. The four that I have are in Mount Vernon, N.Y.; two are in the hospital.
Senator PROXMIRE. Four are in Mount Vernon, N.Y.?
Mr. MARTIN. Yes, sir. This is a fortunate place. We have a number of compensating ills for that. [Laughter.]
Mr. MARTIN. There are two up at the Imogene Bassett Hospital, used for therapeutic purposes. It is paralleled, by the way, with the same work that we are doing in the later hours in the day. We have three children, age 5, who spoke to no one 4 months ago. They were the autistic situations, with an immobile posture. And we do not know and neither do the doctors—Drs. Campbell, husband and wife, working at Imogene Bassett Hospital—as to why this consequence occurs. I suspect, in terms of my telling you about what happened to this 18–19-year-old Negro boy, that the same kind of thing happens with these autistic children. They had been well badgered by the nature of the adult world, and they had withdrawn from it. It was reported to me last week that all three of these age 5 children are now talking to the machine and coming out and talking to the attending physician for the first time in their life.
Senator PROXMIRE. Do you find this machine is of equal value with children who, apparently, have no particularly problem, you know, from normal family surroundings, et cetera?
Mr. MARTIN. The research sample that I worked on originally was in the village of Shreveport, Long Island, a couple of years ago. We had 22 children, 4 of them with 135–140 IQ and above, very bright. The results there were simple and clean. They moved extraordinarily. In 5 months' time they were all second-grade readers.
Senator PROXMIRE. All right. Mr. Kurland, you said you would have a word of caution of too much reliance on technology. Specifically, what do you think are the limits?
Mr. KURLAND. Well, I think that some of them are the kind of things that Dr. Martin himself suggested. Technology cannot teach values or determine what the values are that are to be taught in the school. It cannot improve the relationships between and among children and between the children and the adults in the community. Technology cannot by itself determine what the goals of education ought to be. It cannot assess its own effectiveness. These are matters that require human judgments, to be made in terms of the values of society and the values of the school. I am not sure how much help technology will be in the development of esthetic sensitivity, except for one thing, and that is that if technology is able to achieve the efficiences of learning that many of us think it will, then it will save the students' and the teachers' time and leave them free to do many of the things that the schools have been doing inadequately in the areas of values, culture, and cultivation of the senses.

Senator PROXMIRE. Will you continue a little farther along that line? You also said something about software not being changed by technology. It would seem to me that if technology makes it easier to learn certain things that have not been learned, it might well be possible that hardware—that is, technology—does not change software, that is, the programs and material. I had 9 years of French in school and 6 years of Latin. I cannot understand a word of French. I can read it, but I cannot understand it. People talk to me in French, and they might just as well be talking Chinese. I think this is very common in my generation. It has been improved partly because of technology. Why is it not conceivable that this interaction might change that?

Mr. KURLAND. I am sure that it will, that the software will be much affected by the machine, but not automatically. People are developing new equipment, and in doing so they have to pay attention to the software. But if they do not pay enough attention we will have something like the experience we had with the language laboratories where they were introduced very widely across the country and yet today there are reports that many are sitting unused because good materials were not developed and because teachers were not trained to use them. After the initial enthusiasm wore off, they were set aside because they were not internalized within the educational structure. That is where the software considerations come in.

It is also important to note that as it becomes easier to teach many complex things, it will be even more critical than ever in the past to ask what ought to be taught. Just because you can teach calculus to a sixth grader does not mean that a sixth grader ought to learn calculus. Somebody has to decide what it is that youngsters ought to be given an opportunity to learn. At the same time, if we make the system more open, if we get the youngsters active in the process of learning, we may have to give them more freedom to follow along paths that interest them. Suppose that a youngster in the sixth grade is tremendously interested in calculus, should we let him pursue it and not study English or languages or some of the other "required" subjects? This is a question that technology can not answer, a question which educators have to come to an understanding about and find answers for. The considerations which have prevailed in the past will continue to prevail, and it will not be easy to get good answers, but we will have to find answers. It will be imperative to find answers, because as more things become possible, as more alternatives are available, choices become more difficult. But this is what makes the future in education so challenging and exciting.

Senator PROXMIRE. In your capacity in the State of New York, in the governmental area of the State responsibility for education, what role do you conceive for the State government in helping local educational agencies and institutions of higher education to select useful innovations in technology? Is this where it ought to be done, at the State level? Is this where it can most usefully be done?

Mr. KURLAND. Yes, I think for the most part it can. I think we have to explore and determine at what levels various kinds of decisions and activities can most effectively and profitably take place. The State knows a great deal more about the need of the various localities and the State as a whole than does a Federal agency. On the other

hand, a Federal agency can bring to bear the experience of all the States and not just the experience available in a single State.

Senator PROXMIRE. In States the size of New York and California, you have great resources, and an opportunity to have a variety of experiences.

Mr. KURLAND. Right. I think that we have a full range within New York State. Our people are out in the field constantly. They know the State. They know the needs of the communities. They work closely with the local school authorities. We try to identify the available innovations, the new approaches, and bring them to the attention of our people.

We also are entering into a program to try and help in the evaluation of material. With the vast output of instructional films, programed texts, and other new media and materials, it becomes an impossible burden on any local school to determine which of these are really worth while and for what purpose. So, we are beginning to establish an evaluation system that will help the teacher determine which of all of the films in biology for the fourth grade are the ones likely to be of the greatest use to meet her particular need. We will have to provide teachers with a great deal more help of this kind, because, as the availability of materials increases and the quality generally goes up, as I hope it will, the problem of selection becomes a very severe one.

One of the major roles of the teachers is going to have to be to determine which of all of the materials available are the ones to be used. And in this, she ought to have the best available expert advice she can get and the time to make her decisions. This is another thing that technology can do. It can free the teacher from having to spend so much of her time in direct supervision of student learning.

Senator PROXMIRE. Are you in State government—because you are away from the widespread convictions that the Federal Government should not dictate or dominate curriculum—in a much better position to exercise leadership in this field of suggesting ways in which to proceed to teach the people more efficiently?

Mr. KURLAND. Yes.

Senator PROXMIRE. And more effectively than the Federal Government possibly can?

Mr. KURLAND. There certainly ought not to be dictation from the Federal Government. We have now before us the question of the role of the State. New York State, as you may know, has played a large role in giving guidance and direction to local schools. Now that the local districts have become more sophisticated and capable, and as better alternatives become open to them, it may be that the State role might even shift away from being prescriptive about what should be taught to a role of assessing the overall performance of the schools, saying to the schools, in effect: "There are many ways to teach each subject and many ways to structure the sequence of school experiences." What the State wants to know is that every youngster is getting those experiences which are identified as being important to him so that he can attain a level that is appropriate to his capabilities, needs, and interests. The Federal Government should back up the States in this effort; it should work to strengthen State education agencies, not displace them.

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Senator PROXMIRE. You set forth in your statement that there will be an immense increase in education as there has been in the past—you say 40-percent increase by 1970. Do you think that educational technology is something that will get more for your educational dollar, or is there possibly a way of somewhat reducing the rate at which the spending in this case might otherwise increase?

Mr. KURLAND. I think both of those. We ought to be able to get more for our educational dollar. There are many things that we now do that are terribly costly in terms of the efficiencies of operation, both at the administrative level in education and in teaching. We ask teachers to do many things in the classroom that could more efficiently be done by a machine or by an aid with lesser training. Of course, what we have done, in effect, is to hide these costs by keeping these teachers' salaries low. We pay them in accordance with the lowest level of the tasks they perform.

Senator PROXMIRE. They have been increasing pretty rapidly in the past few years.

Mr. KURLAND. That is right. That is why we can no longer afford to have teachers do things that the machines or aids can do more efficiently. If we pay teachers truly professional salaries, we ought to expect them to do professional tasks.

Senator PROXMIRE. We had testimony last Friday that teacher training had increased so greatly that the shortage of teachers would diminish and might conceivably, within a few years, at least in some disciplines, mean that there would be more people available to teach than there were opportunities, unless you had some change in the situation.

There is a view on the part of some of the teachers that technology represents a threat to this profession; that is, if you have a television program, you can have the best qualified expert to present a lecture in history or political science or whatnot, that one teacher might replace many other teachers. There was testimony Friday, however, that if technology is properly used to supplement an enriched curriculum, that it would not be a threat to any teacher.

Mr. KURLAND. It is a question of what you define as the demand here.

Senator PROXMIRE. That is one thing that enters into it.

The happy aspect of it is the flexibility. There are many married women who come into teaching; it is one of the most convenient things they can do. They often have good qualifications.

Mr. KURLAND. It is also a question of what you do with the teachers when they are in the schools. If you expect the teachers to spend all of their time in front of the class, then that creates one situation in the school, but I suspect that we will not get major improvements in the quality of instruction until we begin to let the teachers spend more of their time during the regular schoolday in preparing the lessons to be taught and in improving their own capabilities, in their own professional development, until, in other words, we get at the school level to the kind of teaching loads that we have at the college level. This means that we need many more teachers in relationship to the number of students. But they will be doing different kinds of things, and some of the things that are now done by the teachers will be done by machines or persons with lesser training.

At the same time, the school will be called upon to do many more things than it now does; for example, to provide enriched cultural experience. These are the kinds of things that take a lot of adult attention. They take a lot of preparation. If we are able to free teachers from some of the more routine tasks of instruction and free students' time from having just to learn "basics," we will be able to use both the students' and teachers' time in some of these areas that have been considerably neglected in our past mass educational system.

In other words, in answer to your earlier question, we will get more education for each dollar, but we will be spending more dollars because we will expect education to do more things for more people through a greater part of their lives.

Mr. MARTIN. May I say that we do not really need to speculate on the answer to your question. I think that we have parallels in industry over the last 50 years. As the capital cost of capital goods for productive workers rises, his productivity increases and the lower order skills, short of the master craftsman, are forcing industry in direct relationship to availability of technology to partially displace him. Hospitals are instances involved. Hospital costs have risen and have risen and have risen. Under the pressure of that rising cost the semiprofessionals and professional services have been chopped down into pariprofessionals or what the medical professional calls anciliary services. So, from the doctor, the nurse, and the orderly, a whole hierarchy of subordinate lower paid personnel have moved into the hospitals to provide and relieve the high cost per unit of the operation of the professional. This has not even begun in education.

Senator PROXMIRE. Do you think that it will be?

Mr. MARTIN. Yes, I think so.

Senator PROXMIRE. That we will have teaching assistants?

Mr. MARTIN. That is right. This is what Dr. Kurland has been talking about in part. So, I see the same paradox that exists in industry and in other institutions.

Senator PROXMIRE. What element of the teaching assistant would be mechanical? Would it be the use of television or the use of other instruments of various kinds?

Mr. MARTIN. Yes. So, I see this paradox. The productivity of the unit cost of output, using completely industrial language, will decline if the productivity is the measure, but the operational costs will rise and some lower order paid skilled people will move into the educational scene, but the gross operating costs will still skyrocket.

Senator PROXMIRE. Of course, productivity is so hard to measure, because the product is so hard to evaluate. Mr. Kurland has indicated that we would have to do this to maintain the efficacy of our educational system. My own experience, which is very limited compared to yours, although I have spoken at many, many high schools, and I have made it a practice to do as much of that as I can in my State—from that, I am convinced that the quality has enormously increased in the last, 10, or 15, or 20 years, that is, the quality of the faculty, the quality of the students, their capacity to grasp and understand ideas, their interest in what is going on in the world, and so forth, has greatly improved. How do you measure this?

Somebody might disagree with me on this and make a strong case. Productivity is something that will be largely subjective, rather than something that you can measure precisely as you can in industry.

Mr. MARTIN. I agree with the limitations, but I am also pointing out that with the high cost of capital investment, the imperative test of productivity will move out of a vague subjective observational role into a greater precision of cost understanding.

Senator PROXMIRE. Your argument is that we are moving in such a complicated world and the explosion of knowledge is so great that unless we do greatly increase our educational quality, we will not be able to handle the kind of world we are moving into. Then, Mr. Martin's very brief allusion to Russia, where we obviously have a situation—unless we keep pace, we will fall behind in the terrible area of military terminology as well as in other areas, too.

Mr. KURLAND. We have been exploring the possibilities of actually beginning to get some performance measures. It would appear that there are some very good prospects here, to get better indicators than we have had in the past. Here the computers are a tremendously powerful tool.

Senator PROXMIRE. For evaluation?

Mr. KURLAND. For evaluation. In the State we routinely collect vast amounts of data about the schools that we have never been able to put together before, and now with the computers and sophisticated analytical techniques we can begin to develop measures of educational performance that fully take into account the complexity of education.

As the result of title I of the Elementary and Secondary Education Act we tested last fall in New York the first, third, sixth, and ninth graders in all public and private schools in the basic skills of reading and arithmetic. The data have been entered into a computer. The results already produced are terribly revealing as to what has happened in these two areas. We must now learn how to use these data and combine them with other data on the schools that we have or can get in order to give us a better picture of what the schools are doing and are not doing.

It would be nice, for example, if we could use census data. But we found in trying to work out the distribution of title I funds how difficult this is to do because census tracts and school districts do not have the same boundaries. It would be of great help in 1970 the Census Bureau punched in one additional item for each household—namely its school district code.

Mr. MARTIN. I would like to add a point to this, if I may. In my own experience, working with computerized instruction and the like, one can quote rather amazing achievements in this subject. The thing that impresses me was the fantastic personal change that accompanied working primarily with disadvantaged students, that in approximately 6 weeks, you would see a complete change of personality. So, I think that this is heard by all of us here, and I think that still some of the most important consequences of this are things which are extremely difficult to measure but which are extremely obvious to the people engaged in them.

Senator PROXMIRE. Mr. Martin, you said that no significant research has been done as to which materials or methods have been successful, and so forth.

Would you document that a little more. And I would like for Mr. Bright and Mr. Kurland, the people who are responsible for this kind of work to some extent, to give us their evaluation, too.

Mr. MARTIN. What I meant by that sweeping statement was that in a typical nursery-kindergarten life of the children there are 76 to 114 kinds of activities that are built into the nature of what children do and what is done to children. There has been a little analysis of the factors, the specific contribution of any one of these elements in a longitudinal study over the life of the child on a controlled research basis. We do not know whether building blocks do or do not add or subtract anything. We do not know whether the play period, the rest hour, speaking, reading, listening to a record, whether these do or do not contribute. What we have is a host of activities drawn from Pestalozzi, Montessori, and Froebel of 50 years ago, child development contests, playthings, toy activities, for which no rigorous analysis of contribution has been had.

Senator PROXMIRE. This is really amazing.

Mr. MARTIN. It is like Topsy. It just growed.

Senator PROXMIRE. That there is an utter lack of knowledge as to this. I cannot understand what these people have been doing, who have been studying how we can improve education, if they are not working on this kind of thing.

Mr. MARTIN. There are hundreds of studies.

Senator PROXMIRE. I mean studies done in a rigorous disciplined way, which can be examined and criticized and then some kind of consensus arrived at. What you are saying is that we do not know in the training in the kindergarten field, at least, which of these many methods that are used are of value, the extent to which they are of value. I think that is really a serious indictment.

Mr. MARTIN. Let me put it in an historical way. American industry did not fall in love with research until possibly World War I, and only a very few corporations moved into it then. Its popularization as an adjunct to industry is a World War II phenomena. You now research or you do not live. That most active of institutions called the poverty-stricken thing of public education in America is just awakening up to this. So, we have lived by advocacy, argumentation, and persuasion. This seems like a good thing to try, so we have been trying things since Noah's time as to what seems to work with children. And traditionally, incrementally, a whole host of practices have come in on this. What we have called research has sometimes been observational studies, many times efforts to demonstrate that what started as a good idea obviously must work. So, the conclusion having been determined—and you know some of our foundations have not quite relieved us of this—some of this has been most conspicuous in announcing the results of an intended experiment at the time they made the grant—witness television in the classroom. So, what sounds like an indictment of an institution is simply a reflection of our total cultural pattern. We have been just a little more impoverished in the area of research than industry, so that we come in about one-half a generation later.

Senator PROXMIRE. Do you agree, Mr. Bright, that education has been in that position?

Mr. MARTIN. We have never had this role up until about 2 years ago.

Senator PROXMIRE. I know that.

Mr. BRIGHT. I agree, in some respects. I think, just to clarify what Mr. Martin means: Actually, there has been a great deal of

experimentation done to see whether blocks are better than this technique or something else at the kindergarten level, where the performance is judged at the end of the kindergarten period. There has been a lot of experimentation here.

I think what Mr. Martin means is that there has been very little study, if any, done on the students in the third or sixth grades to see if there is any effect on their performance at that grade level, depending upon the early education that they received in kindergarten and in the nursery. In that respect, I agree that there has been practically none. We are getting some results from some of our surveys. It is a little difficult for the Federal Government to engage in surveys of this kind, because we have considerable opposition, but we are attempting to do so, and we are getting some preliminary results which are interesting. Primarily they tend to show that it does not make much difference what you do, which is somewhat discouraging.

I would like to make a comment on another point in a moment.

Mr. KURLAND. I would say that one way of looking at it is that if research is really so essential to improvement, we are doing very well considering the small amount of research funds that we are given for doing this work in education.

Senator PROXMIRE. Would you agree with the statement, with Mr. Martin, or at least the impression that he gave me, that this is probably more important than the introduction of technology?

Mr. KURLAND. Is more important?

Senator PROXMIRE. More important. In other words, knowing what you are doing, knowing what methods are working, what are effective and what are not, that if you are going to make an investment, that this is where you ought to make it?

Mr. KURLAND. Right. One of the things that I detected in my work with innovation was a tendency for educators to say: "How can we introduce team teaching or programed instruction?" rather than analyzing their needs and problems and saying: "What are the available solutions? Can programed instruction or computer-assisted instruction, help us with our educational problems?" We need much more attention to the analysis of needs and problems.

Senator PROXMIRE. You are in one of the most progressive States in the Union, one with great resources, more than any other State has, a big State, so that you have a variety of experiences. How much research have you been able to do in this area or do you plan to do or will you do?

Mr. KURLAND. Our research funds have been very limited. We have had very great difficulty in getting the legislature to commit funds for educational research and development. In the last few years, we have gone to the legislature each year for funds, but when cuts have to be made that is one of the things that gets cut. We were aiming at 1 percent of the State's assistance to public schools which is a little over $1 billion. We thought $10 million for research activities would be a reasonable start, but the Governor cut this to $1 million, and then the legislature the first year cut it out entirely. We now have $500,000 of State funds for experimental and innovation programs. In a State spending close to $3 billion on education, $500,000 is not a very sizable amount of money. Even if we put together all of the funds being spent in the State on anything that

could reasonably be called educational research and development, we would not come up to 1 percent of expenditures. When you consider that progressive industries spend 10 to 15 percent, it is clear why we have not had more progress in this field.

There is a study of the research on reading, a basic subject, which showed that the average research project was funded at less than $1,000, which is hardly enough to pay the typists to type the report. This is why we have not gotten better results.

Senator PROXMIRE. This is a very valuable message to the Congress.

Mr. MARTIN. I would like to very heartily endorse that. Essentially, what has happened is that the research primarily has been done in small and nonrelated pieces. One thing that has been missing completely in the educational area has been what you might call the development phase—how do you take the results of the research, the knowledge that has been gained through research and apply it in a practical way to a practical problem? That is, systems analysis, if you will, where, essentially, you consider the entire educational problem to be performed by a school and then determine what techniques, what technologies, you can use to perform this and actually implement the development programs to achieve it.

I think if you will look into DOD or any other activity in which research and development has played a large part, you will find that the development expenses are generally similar to 5 to 10 times the research expenditures, that is, the funds necessary actually to implement the first demonstration system, utilizing research results after the analysis.

Senator PROXMIRE. In order to acquire this, it would be relatively a modest amount for research?

Mr. BRIGHT. Yes, but the amount required for development is not. It is extremely large. It simply has not been available anywhere.

Senator PROXMIRE. You would agree then that a new scientific pedagogy, as Mr. Martin was discussing, requires research.

Mr. BRIGHT. My point is that this is not the whole story—only a small part of what is necessary.

Senator PROXMIRE. After you move into the development.

Mr. MARTIN. May I reinforce Mr. Bright's very important point?

Research investment is small. The big translation step is the cost of the demonstration on a larger scale from the laboratory to the pilot operation. The cities of America, by and large, are bankrupt. I represent a small one. We are close to the State of New York's constitutional tax limitation. Mayor Lindsay steals the show from us, because he needs more, but he is in the same predicament that we are.

Senator PROXMIRE. And you have two-thirds of all of the talking typewriters in the country.

Mr. MARTIN. We husbanded our poverty very judiciously. [Laughter.]

May I point out the very recent phenomena of the establishment of directors of research as a part of the hierarchy of personnel in the school systems which is an overnight phenomenon in this country—a reflection of Federal intervention.

May I point out the paradox?

Congress voted the ESEA law in 1965, the great revolution in Federal aid; title I of that represents $1 billion of the total amount of $1 billion several hundred million. Implicit in the act and in all of of the instruction materials from the Office of Education is a repetitious use of the word "evaluation," "evaluation," "evaluation," yet as of last week, in the flood of that literature, manuals of precision and how to undertake this evaluation of consequence are not available from either the States, who will not do it and cannot do it, or the Federal Government who has mandated that it be done. And the necessary skills for doing this within the local community are remarkably absent.

So, here is a Federal appropriation of $1 billion in 1 fiscal year calling for: "What results are you getting?" "What difference has this made?" And we will hear magnificently sentimental stories about how the children now look happier.

Senator PROXMIRE. I am not surprised.

Mr. BRIGHT. This is an extremely valid point. There have simply not been the needed evaluation instruments. Under the research program, we are directing activities in this direction. Quite recently, I must admit. We have just recently established, through a research and development center at UCLA, the specific assignment to them to develop evaluation techniques and instruments for such a program. We will also be expecting to support some additional programs.

I would like to comment on a point Mr. Martin made.

Senator PROXMIRE. It seems to me that we have passed the act. That was in 1965. That is all over.

Mr. MARTIN. Yes.

Senator PROXMIRE. We passed that more than a year ago.

Mr. BRIGHT. Yes.

Senator PROXMIRE. This seems to be a long time to see just the beginning of it being established in an agency in California to do the work.

Mr. MARTIN. May I speak in this respect?

Senator PROXMIRE. Would it be possible to be more precise as to what you mean by "evaluation"?

Mr. MARTIN. Coming from the State of New York, it is appropriate to refer to what Al Smith would say:

> It just so happens that I have here a locally produced effort called Project Evaluation—title I, ESEA, which we developed in the city.

It starts with such as:

> How many children were involved in the project?
> What proportion of these were educationally disadvantaged?
> What proportion of non-public school children?
> What criteria were used to select or admit children to the project?
> What children's needs were served by the project?
> What procedures or methods were used to provide for these needs (summary)?

May I speak to some of the things that normally are not spoken of in public? This is as to evaluation of program outcomes. There are five basic steps in evaluation of an educational program:

STATEMENT OF OBJECTIVES

Description of methods designed to achieve these objectives.

Specification of methods, techniques, instruments, for estimating degree of achievement of objectives under prescribed conditions.

Statement of criteria, standards, norms, to be used in judging significance of results. Consideration of general design, control groups, et cetera.

Analysis of data, and formulation of conclusions and recommendations based on the findings.

In each of these five steps I proceed to an analysis of each of them in some detail. May I just hop-skip in an item?

The most important aspect of stating objectives, and in some cases the most difficult, is formulating them in the clearest and least ambiguous terms possible.

The rule to follow is that general objectives should be translated into behavioral terms, and should be capable of measurement or estimation in some way, however tenuous. This does not mean that those objectives which can be most easily or reliably measured are the most important or that they should take precedent over less easily measurable goals. It is frequently true that the most important goals of a project are the most difficult to measure accurately. These objectives should and must be stated as clearly and behaviorally as possible. As the general statement of goals is translated into behavioral terms, the probability increases that measuring devices will be developed to measure them.

Example 1.—A frequent objective of many educational programs is the improvement of the ability to think critically.

As to the specifics, to describe these in behavioral terms:

The pupil will—

Draw logical conclusions from stated premises;

Detect inconsistencies in statements or data;

Ask or raise questions for purposes of clarity;

Offer alternate explanations or interpretations;

Attempt to predict consequences of alternate decisions;

Seek causal relationships.

We go on a third-step analysis to a higher degree of specificity and then from these derive the terms of measures or the instrumentations for accomplishing measurements quantitatively and qualitatively. This is the kind of guidance that local school systems need, and typically do not have the resources for.

I should like to submit this for the record.

Senator PROXMIRE. It will be made a part of the record at this point.

(The document entitled "Project Evaluation—Title I—ESEA" follows:)

MOUNT VERNON PUBLIC SCHOOLS,
Mount Vernon, N.Y.

PROJECT EVALUATION—TITLE I, ESEA

Project No. ——.
Name of project: ————.
Project period: ————.
Date: ————.

PART I. DESCRIPTIVE INFORMATION

A. How many children were involved in the project? ____
B. What proportion of these were educationally disadvantaged? ——
C. —— proportion of non public school children? ____
D. In what way were these children educationally disadvantaged?

E. What criteria were used to select or admit children to the project?

F. What children's needs were served by the project?

G. What procedures or methods were used to provide for these needs (summary)?

E. Estimate number of children in district requiring project services, who were not included in project—for any reason. ____
I. Number and kind of personnel used in the project. (Ex. psychologist, 2; clerk, ½)

J. How much total time did the average child spend in the project; for the project period? ____
K. What procedures, methods, techniques, approaches, were found to be of particular value?

L. Which procedures, methods, techniques, approaches, were found to be in need of revision, or may be abandoned. Why?

M. General recommendations for the improvement of this kind of a project.

PART II. EVALUATION OF PROGRAM OUTCOMES

There are five basic steps in the evaluation of educational programs:

A. Statement of Objectives.
B. Description of methods designed to achieve these objectives.
C. Specification of methods, techniques, instruments, for estimating degree of achievement of objectives under prescribed conditions.
D. Statement of criteria, standards, norms, to be used in judging significance of results. Consideration of general design, control groups, etc.
E. Analysis of data, and formulation of conclusions and recommendations based on the findings.

A. Statement of Objectives

1. Generality to Specificity.

The most important aspect of stating objectives, and in some cases the most difficult, is formulating them in the *clearest* and *least ambiguous* terms possible.

The rule to follow is that *general* objectives should be translated into *behavioral* terms, and should be *capable* of measurment of estimation in some way, however tenuous. This does *not* mean that those objectives which can be most easily or reliably measured are the most important, or that they should take precedence over less easily measurable goals. It is frequently true that the *most* important goals of a project are the most difficult to measure accurately. These objectives should and must be stated as clearly and behaviorally as possible. As the general statement of goals is translated into behavioral terms, the probability increases that measuring devices will be developed to measure them.

Example 1.—A frequent objective of many educational programs is the improvement of the ability to think critically.

GENERAL OBJECTIVE	SPECIFIC
To improve Critical Thinking.	Pupil will— 1. Draw logical conclusions from stated premises. 2. Detect inconsistencies in statements or data. 3. Ask or raise questions for purposes of clarity. 4. Offer alternate explanations or interpretations. 5. Attempt to predict consequences of alternate decisions. 6. Seek causal relationships.

In the above example a general objective is stated in six specific ways, each capable of *behavioral expression*, and therefore objectively identifiable. Achievement of specific objectives 1 and 2 above may be measured by suitable tests, whereas observation counts may be used to gauge the achievement of objectives 3–6.

Example 2—

GENERAL	SPECIFIC
To Improve "Attitudes" Toward School or To Improve School Adjustment.	Pupil will— 1. improve school attendance. 2. respond more to teacher direction. 3. require less disciplinary action. 4. finish more papers (though work quality may not improve). 5. volunteer to help on various tasks and assignments. 6. work and play more cooperatively. 7. be selected more as a partner in group activities. 8. show improved sociogram position. 9. reveal improved attitudes through projective test techniques.

Again a somewhat vague general objective is translated into specific goals capable of behavioral expression, and therefore objectively identifiable.

However, in this case, even the "specific" objectives can be reduced to a more sharply defined behavioral form, as in the following examples:

SPECIFIC OBJECTIVE	"POSSIBLE" BEHAVIORAL OBJECTIVE
1. Improve school attendance.	There will be a minimum of a 20% reduction in days absent.
2. Respond more to teacher direction.	There will be a minimum increase of 25% in response to *first* teacher directive (oral).
3. Require less disciplinary action.	Appearance in principal's (or disciplinarian's) office will be reduced at least 20%.
6. Work and play more cooperatively.	The total length of time engaged in group activity in relation to number of complaints of uncooperative behavior—will be increased by 20%.

Secondary Effects.—In the process of evaluating program outcomes, it is not uncommon for "secondary" effects to become apparent. These "secondary" or side effects may or may not have been anticipated in the statement of objectives, and so results of a program should be combed to discover these effects, which may be of considerable interest and value.

Example.—New York City recently announced the results of its Higher Horizons program which offered a broad range of enrichment experiences and educational services to disadvantaged secondary school pupils. One of the major aims of the program was the raising of the scholastic skill level of the pupils involved. Although the results indicated that the primary objective was not decisively attained,

pupil and parent "satisfaction" with the program was reported high. This secondary outcome is clearly of great importance because of its bearing on school-community relationships and possible effect on future pupil attitude and performance.

2. Table of specifications

In the more "subject matter" type educational program it is often helpful to construct a "table of specifications". This is helpful in the formulation of specific objectives, as well as in the determination of emphases to be given to various parts of the program, and in the selection of appropriate measuring instruments.

The table of specifications is a two-dimensional table with the major objectives grouped along the horizontal dimension, and subject, content, or level categories along the vertical. Each cell, therefore, would represent a category for which a set of specific behavioral objectives could be formulated, at least theoretically.

Example.—*Table of Specifications for a Remedial Reading Program* (for illustration purposes only).

3. Partial list of general educational program objectives

Pupil Effects:
- Knowledge and Concepts.
- Applications (problem solving).
- Critical and Evaluative Thinking (draw conclusions, inferences, detect inconsistencies and inadequacies).
- Subject Skills (Word Attack, Multiplication, Comprehension, etc.).
- Performance Skills (Laboratory Skills, Chart construction, etc.).
- Communication Skills (clear oral or written reports, etc.).
- Study Skills and Work Habits (location of information, planfulness, etc.).
- Creative Thinking and Productivity (original solutions, proposals, productions).
- Attitudes and Adjustments (toward school, self, others).
- Appreciations (cultural and scientific contributions).
- Values and Goals (level and quality of aspiration).
- Physical and Mental Health.
- Attitude toward Integration.

Parent Effects:
- Parent aspirations for pupil.
- Parent aspirations for self.
- Parent view of school.
- Parent participation in school-community projects.
- Parent relationships to others.
- Parent relationship to pupil.

Teacher and School Effects:
- Teacher Self Concept and Confidence.
- Staff and Pupil Morale.
- Teaching and Learning Conditions.
- Organizational structure.
- Staff changes.
- Program changes.

School-Community Relations:
- Effects on—
  - School status in community.
  - Community willingness to support school financially.
  - School relations with community socio-cultural groups.
  - Intra-community group frictions.
  - School integration program.
  - General community social stability.

B. Description of methods designed to achieve stated objectives

Although this step is primarily instructional, there are implications for evaluation, nevertheless, in the effect of the choice of method on the interpretation of the results of the program. For example, suppose in a summer educational camp program one objective specified is, "to improve physical health, as indicated by a 25% reduction in the number of underweight children." Suppose further that the method applied in this case is the overall summer program which called for a morning of scholastic skill work, nature studies, arts and crafts, followed by a nourishing and enriched lunch, followed by exercise, fresh air, sun and swimming. Whatever results are obtained at the end of the program, will tie together this specific methodology (program), including the sequence of program events, to the specific objective stated at the beginning. Should results be positive,

a positive association will have been demonstrated between the specific program and the specific objective. Should the criterion not be reached, no or little relationship between *specific* method and objective will have been demonstrated. In the latter example, one could say that there was no relationship between the program (scholastic skill work—lunch—exercise) and the objective (reduction in the number of underweight children), whereas a slight change in method (exercise, lunch, scholastic skill work) might have produced more positive results. The first method may produce more significant results than the second in terms of, say, better sleep habits, but this was not the specific health objective aimed for.

Thus it is most important to shape and formulate a method which is maximally consistent with the objectives and most likely to yield a significant "payoff" in terms of the specific objectives established.

C. Specification of methods, techniques, instruments, etc. for estimating degree of achievement of objectives, under prescribed conditions.

It is strongly recommended that when describing the techniques or instruments to be used in testing or evaluation, the conditions of testing be delineated as carefully as possible. It is readily seen that the conditions of testing many have an important bearing on the outcome of the testing and the conclusions which would be drawn.

Example:

Objective: A statistically significant increase in I.Q. scores, at a specified level of confidence.

Program Method: A detailed program of compensatory and enrichment experiences.

Testing Method: Children will be given the 1960 Stanford-Binet test, (form L–M) prior to the program and again at the end of the program.

The procedure described under "Testing Method" above is incomplete and if allowed to stand unchallenged would yield data which actually could be of little or no value because the *conditions* of testing are not specified.

In specifying the conditions of testing, it would be most important to provide information answering questions such as the following, for both pre and post testing situations:

Will white or non-white examiners be used?

Will examiners be male or female?

What will be the experience background of the examiners?

Will the children tested be acquainted with the examiners and if not, how much "rapport" time will be allowed?

Where will the testing be done?

Will the standard or "anxiety reducing" method of administration be used?

What kind of experiences might be expected to precede the test administration?

Will testing be done in the morning or afternoon?

Will the standard or "short form" be used?

It is clear from the above that the specification of the conditions under which measurements or observations for evaluation will be made is of crucial importance, and in many cases consultation with personnel knowledgeable in the area of educational and psychological testing and evaluation may be necessary.

Illustrative List of Evaluation Techniques.—Here are some suggestions, with a few brief illustrations, for techniques of evaluation, organized according to type of learning outcome.[1]

1. Subject-matter and skill achievement
    1. appropriate standardized tests
    2. teacher-made objective tests
    3. teacher-made performance tests
2. Changes in attitude
    1. observation (particularly by outside observers)
    2. questionnaires, to be answered by pupils or parents
    3. rating scales
    4. dropout counts (changes, comparisons)
    5. records of parent involvement in school sponsored projects
    6. case studies
    7. anecdotal records
    8. attendance records
    9. records of participation in an activity

[1] From *Nations Schools*, April. 1966

3. Interest
    1. questionnaire
    2. attendance records
    3. case studies
    4. anecdotal records
    5. dropout counts
    6. records of parent involvement
    7. tabulations (such as average number of books read per pupil)
    8. rating scales
    9. check lists
4. Ideals
    1. anecdotal records
    2. observation
    3. pupils' writings
5. Ways of thinking
    1. appropriate standardized tests (rare)
    2. teacher-made tests
    3. rating scales
    4. pupils' writings
6. Work habits
    1. observation
    2. anecdotal records
    3. rating scales
    4. check lists
7. Personal and social adaptability
    1. dropout information
    2. attendance records
    3. anecdotal records
    4. rating scales
    5. pupils' writings
    6. sociograms
    7. case studies

D. Standards, norms, and evaluational designs

After measurements and observations are made, the results must be compared to *standards* or norms in order to determine the degree of attainment of goals and objectives.

Standards are usually discrete levels or categories, and individual or group performances are described as either having attained or not having attained the standard. Standards may be set at any level ranging from *minimum standards*, the lowest levels of accepable performance, to high standards, representing a relatively high degree of proficiency.

Example 1.—The New York State Achievement tests include a Minimum Competence Reading Test for twelfth grade pupils. Sixty five percent (correct responses) is considered the *minimum* standard for passing the test. That this is the *minimum* standard is indicated by the fact that 97% of twelfth grade pupils statewide attain or exceed this standard.

Example 2.—A summer remedial program may establish as an objective, the standard of *grade level achievement*, for all participants. For children in a summer remedial program, the achievement of this standard would be a real accomplishment. Few children would be expected to reach this *relatively high standard.*

Other *kinds* of standards in education are (for pupils) attendance, grade level scholastic achievement, specific performance levels in physical education, laboratory work, shop. Standards for schools may include levels of achievement, dropout rates, percent of graduates going on to college.

In contrast to standards, *norms* provide a *distribution* of evaluational measurements or observations, *for specified reference groups.* Indivudal or group measurements are then compared to the distributions for these reference groups, to see how an individual or group compares to reference group performance. Reference groups may be national or local in scope or be differentiated on the basis of sex, geographical area, socio-economic status, age, national or racial background, kind and severity of disability; in short on almost any basis for classifying pupils.

In setting standards and formulating objectives, it is frequently necessary to specify the norm (reference groups) which will be used to evaluate performance.

Example 1.—

Program Objective: To increase the percentage of 3rd graders who will perform at or above the 50th percentile on a standardized test, at the conclusion of a special program.

Norms: End of year, northeast regional, norms will be used.

Example 2.—

Program Objective: To reduce the percentage of arithmetic "under-achievers", defined as one year or more below expected achievement score.

Norms: End of year, northeast regional norms—separate norms for boys and girls, and for those in a modern or conventional math program.

Units.—All scoring units for evaluational instrument need *not* be in terms of test scores or performance scores. Simple *counts* of events tied to specific objectives may also be used as scoring units.

Examples:

OBJECTIVE	SCORING UNIT
To improve general school "adjustment"	Attendance count
To develop interest in reading	number of books borrowed from library
To encourage oral expression	minutes of classroom recitation
To improve social relationships among Negro and White children	number of positive social contacts

Evaluation Design—Principles.—Following the collection of data, after utilizing appropriate measurement techniques and units, scores, standards, norms, the question must be raised:

How do we know whether or not the project has been effective? Did it in fact—make a difference?

(1) *Pre and Post testing.*—In order to be able to state unambiguously the amount of gain, or change, in a performance during the program period, measurements, etc. should be made both *prior* to, or at the beginning of a program, and then again at the end of the program.

(2) *Need for Control groups.*—Even if it is shown that there is an impressive change in performance or in the degree of achievement of an objective—for the project group, one is not certain whether or not these gains would have been made in the absence of the project. Therefore, the performance of the project group must be compared to the performance of a "control" group, that is, a group, just like the project group, but not exposed to the program of the project. Gains of the project group can then be compared to gains of the control group. (At this point a brief statistical analysis may be required to determine whether the achieved difference in gains represents a "significant" or "real "difference.) The absolute necessity of a control group, is seen in many studies of the results of remedial reading programs where "before" and "after" test scores show substantial gains. Control group testing would show that much of these gains is due to a phenomenon known as "regression" and does not represent "true" gains. Control groups can be organized by matching (on the basis of criterion related variables) or by randomization.

(3) *Randomization.*—If pupils can be assigned to project and control groups *randomly* (by lot or random numbers), *pre-testing is not essential.* The assumption is that random assignment of pupils to project and control groups assures that the distributions of qualities are identical, or differ only by chance, at the beginning of the project. Hence, end of project measurements will reflect differences in changes between project and control groups.

(4) *Prior Performance—Comparison Group.*—It is frequently impractical, or too late, to provide for a true control group, but one must still answer the question, "Did the project achieve the objectives to a greater degree than the conventional program?"

Although the following procedures *will not lead to unambiguous interpretations,* they may be used to salvage data which otherwise would need to be discarded because of their collection under poor design conditions.

(*a*) From past experience of similar groups a projection might be made as to what level of performance would have been expected without the project intervention. Actual and "projected" levels could then be compared.

(*b*) The average performance level, or change in performance of a similar group over the preceding five year period, could be used as a standard for comparing actual project group performance. Inherent differences in criterion related qualities between project group and other groups would need to be examined for possible influence on performance.

(*c*) If measurements are available prior to the commencement of a project, on a criterion related variable or quality, then statistical adjustments can be made

(covariance analysis) which would tend to make two non identical groups more alike with regard to the criterion related variable (and hence with regard to criterion variable also)—at the beginning of the project. Some of the original differences between groups, therefore, may be taken out of the end of project scores.

Example. A new programmed instruction text in arithmetic is introduced on an experimental basis to class A. At the end of the year standardized arithmetic test scores are procured for class A and another class in the same grade and school, class B. No pre test is given, and pupils have not been assigned randomly. However, the year before both classes received in I.Q. test. Final grades (prior yr) in arithmetic are also available for both classes. These prior data on criterion (standardized arithmetic test) related variables (I.Q., arithmetic grades) can be used in statistically equalizing the two classes, so that a difference between classes on the standardized arithmetic score can be more meaningful.

Of course if it is important to know only the degree to which a project group achieves a designated objective or standard, and not necessarily the contribution of the *project* to this achievement, then control groups, and even pre-testing are not essential.

However, if one is interested in the effectiveness of a project, and whether it has been instrumental in the achievement of project goals and objectives, the more refined designs outlined above should be used.

Senator PROXMIRE. Do you think it is too onerous a burden for them to have to respond to this specifically? Would this be one of the reasons for their reluctance on this?

Mr. BRIGHT. The schools are not staffed to do this job, except for the large city systems of schools. In America, we do not have the hierarchy of personnel that industry would not think of operating without.

We have no foremen in American education.

Senator PROXMIRE. I think that the Congress and the Office of Education would be remiss in proposing reporting requirements that would be inordinately difficult to meet. I think that you are right in indicating that at least some of these schools are well equipped to meet them; certainly, the larger school systems are, and to the extent that they are, it would be immensely valuable if they would respond.

Would it be possible, Mr. Bright, to work this out on some kind of a basis so that we will have a substantial school system that has resources to do this, to make these reports?

Mr. BRIGHT. Very definitely. This requirement is in the title. We recognize that responsibility by different school districts will be very difficult.

The office is attempting to adopt a realistic policy in regard to this, expecting the various school districts to do what is reasonably possible.

Senator PROXMIRE. But unless you have a pretty specific and definite standard method, you will not be able to have anything that you can very well evaluate and compare. It would seem to me that if they are all talking different languages that some would come in with quite different reports than would others, and the value of having this done, which the Congress required, will be pretty small.

Mr. BRIGHT. That is correct. And I guess that, historically—to relate some of these things leading to this—I might say that under title I there is no provision for Federal funds to develop such instruments. The only discretionary funds of the Office of Education are under title IV which is in the research program. Here there have been major changes in philosophy and in policy. Up until approximately December, the entire program of research in the Office of Education was in response to unsolicited proposals from universities and

such other agencies interested in performing research. One of my major assignments was to change the situation so that at least a significant amount of research would be done in response to specific problems outlined by the Office of Education, so that the Office might identify major problems and get work done in these areas. This entire policy of approach in that direction is very new. The concept of requesting research proposals for the solution of problems related to other titles and other needs in the Office of Education was unheard of up until a couple of months ago. We are just now beginning to implement such procedures.

Senator PROXMIRE. Did you want to comment?

Mr. KURLAND New York is a State that has done a great deal with the evaluation of school performance. Last year was the 100th anniversary of our regents examinations. This system provides some assistance to the schools. The problem is not simply the unavailability of instruments or even our lack of knowledge of how to evaluate, it is more the attitude toward evaluation of the schools which has to be changed if we are going to have an evaluation. The schools have resisted any outside evaluation. They have argued the point about the intangibility of educational outcomes, and the fact that you cannot really measure the effectiveness of the total educational program. Schools are very defensive when the State even begins to suggest that it might compare one school district with another school district as to how it is doing or even suggests that schools use the data to evaluate themselves.

Senator PROXMIRE. You can overcome that with the regents?

Mr. KURLAND. The regent examinations are not used for this purpose generally. Occasionally, the newspapers pick up information and publish it, comparing one school system with another, but our department has been very cautious about using the results in this way, even internally. We do not use them as instruments, generally, for assessing individual schools, but I think that our attitude, and I think the attitude of many school systems is beginning to change, partially under the impetus of ESEA title I. The climate is changing toward acceptance of the idea, so that we can begin to say something about performance of the schools. The attention to educational deprivation and disadvantage has produced a realization that we no longer can take the schools' and the professional educators' evaluation of how well the schools are doing. The fact that some children are not learning can no longer be explained away on the theory of hereditary inadequacies or social or cultural disadvantages. Educational failure is the responsibility of the school and the State has the responsibility to see which schools are performing well and which ones are not, and to take appropriate action. I think that we will need a lot of help from the U.S. Office of Education, both funds to help us move forward and in developing more effective and more sensitive measuring instruments.

Senator PROXMIRE. What you are really talking about is something different than what Mr. Martin started talking about. You are talking about evaluating schools. We are talking about evaluating the methods and the systems, and so forth; and the evaluation of the schools can be invaluable. I think that there will be all kinds of unhappiness and competitive fallout that might be unfortunate for

some people, but I think that altogether it might be quite healthy; that is, to find out that their school system is poorer than others. "I would like for you to do something about it," they will say. There would be concern enough so that they will work with the school boards to get their school boards more aggressive, to pay higher teacher salaries or to invest in various areas that will improve the system. This, in the long run, overall, can be very good for the children themselves.

Mr. KURLAND. This is all a part of the effort.

Senator PROXMIRE. Mr. Martin was talking about, as I understand it, something different; evaluation of the schools or a comparison of the schools and of the systems, so that we can have a better or the best possible method of teaching children.

Mr. KURLAND. Of course, one of our problems in research is that we have tended to focus on one element at a time: "Do blocks make any difference, for example?" The answer depends on the teacher, the classroom environment, and the youngsters who are in the class. These are all interrelated. You cannot separate them.

Senator PROXMIRE. That is true, but unless we get it in sufficient numbers, it will wash out. You cannot tell whether it is working or not, but I think that you would agree that if you have a sufficiently comprehensive project, you can tell whether it is blocks or whether it is another effective method.

Mr. KURLAND. In a system that is as large as the whole of New York State it may be possible to get numbers large enough so that we can begin to tell which of all of these factors makes a difference. It takes a lot of instances to show up something that makes a very small difference. As Prof. Harold Clark of Columbia has said, it would be worth a large investment to produce something that would reduce by 1 day in 12 years the amount of time needed in school by every child in America.

I think that we are at the point where we could, if we wanted to, begin studies on this scale. In fact, title I is an experiment on a statewide basis, using $100 million of Federal money in New York alone. This money ought to make some difference, and we ought to have instrumentalities so that we can tell whether it is making any difference.

Senator PROXMIRE. Of course, what Mr. Martin said earlier today is that the vital years are from birth to 4, from the time the child is born until he is 4 years old. And work at this age can be compared with atomic energy in its great potential. That suggests to me that what we need is a great deal more education of mothers and fathers, because after all it will probably be some time before we send their children to school before they are 4 years old. And even when they go there, the main influence will still be that of the mother with whom they spend most of their time. So, are you not suggesting that somehow, some way, we have to reach the parents, really, if we are going to do the job that will be comparable with what you just implied very dramatically, that Russia may be making great inroads and may be breeding a group of not supermen or superwomen, but people who might have a little higher intelligence capability than we have?

Mr. MARTIN. Let me give you one of my inferential pieces of evidence. We know, for example, that as early as 1925 the Russians adopted Dewey and Masse and moved into factory-based nursery

schools, et cetera. By 1935, they became disenchanted with "progressive education," yet the institutionalization of early childhood infancy nursery school concepts remained on a wider degree than any mass education ever adopted before with the possible exception of the Scandinavians. Yet, Khrushchev, before his ouster, issued a public release that was completely contrary to that history and made no surface sense.

He announced the establishment of four new pedagogical institutes devoted to early childhood education. In the substance of that press release, printed in full in the New York Times, the description of these institutions was precisely identical with the 40-year-old previous history of such institutions in Russia.

A year ago, a couple years after his ouster, an American reporter was taken to one of these in the Urals. This is a new and radical departure in total top labeling. The material he was permitted to see and the handout—and we are all aware of that kind of handout that contains its own aroma, whether it is printed in Russia or here—once more respoke old and archaic truisms of nursery education. Obvious conclusion, the four new institutions depart very little from the previous 40 years, and what is going on in those we can only speculate by the fragmentary reports by men like Dizkosji and Uriah, who are refugees from Russia and who have been reporting on some of these phenomena plus the work of Blum at Chicago and Hunt and others in this country, who are moving in this area gropingly.

And I suspect a great deal is going on there that we do not know about.

Mr BRIGHT. I would make one comment relative to your question and this is relative to the discussion made here earlier that our educational system has absorbed millions of immigrants from Europe who were themselves illiterate and were poverty stricken. If you look at all of the statistics on these people, they are very similar to many of the disadvantaged groups in the United States that we are now trying to help, where the schools have not been successful. Primarily, it seems to show that where there is parental interest, where there is an interest in having these children educated, that the school system has worked and worked very well; where there is not parental interest, the school system has been a miserable failure.

And this is, I think a much more significant variable than any of the variables in the school system itself to date. Where there is parental interest now the students are successful. Where there is not, they are not successful. And it is not likely that you will, by any simple educational system, get this interest to any extent.

Senator PROXMIRE. There are various ways that you could do that. You have an evaluation of the school. You will have parents, who have any pride at all, who are very likely to be concerned, if their child is going to the school.

Mr. KURLAND. You are talking of the middle-class parents now? The ones for which the school is successful now?

Senator PROXMIRE. Middle class? I do not know. I think that may be true of people in all classes. However, you may classify them.

Mr. KURLAND. There have been situations that show that when the parents in low-income families are properly approached, that they,

too, become very much concerned, but it takes a different approach than the schools have been willing to make.

I also want to make a comment on this matter of early education. What has been learned recently about the influences of early childhood years on future intellectual development is of tremendous importance. But there is a very grave danger that in seeking a solution to our problems by emphasis on prekindergarten education we are following a strategy of change without changing. We are adding to the system, not changing the system. The effects of good preschool education can be washed out in the next 6 or 12 years of education, unless there are basic major changes in the total school system. We need to watch out that we do not avoid basic changes by introducing something at the beginning of the system that leaves all the rest unchanged.

Mr. MARTIN. May I speak to what I think is partially hidden as a real revolution in civil rights and in Negro America? Both are a local phenomenon, to which I can testify. And I suspect on a more rational scale than we have been made aware of.

The Negro mother of today has become more determinedly insistent on the quality of the consequences for her children than ever before in the history of the Negro race in this country. And while it is camouflaged in terms of white man's interpretation of it as an insistence on desegregation of the schools, the real basis of the motivation is the true conviction that the all-Negro school in the American city is an educational curse and crime that needs to be removed. The fact that the Negroes are seeing this, and people in my position have been blind to it, blinds all of us to the fact that the real determination is a maternal hunger for consequences in education for their children of the American slums. And this is a new factor, and a more powerful dynamic factor then anything that the schools are doing internally with the children when they get them.

Senator PROXMIRE. I have detained you gentlemen too long. You have been very interesting and exciting to me. I apologize for having held you here. I have just one more area of questioning.

Mr. Martin, you said something about needing a greater period of learning. I am wondering in a system of government in which we pride ourselves on our Constitution. But education is not mentioned in the Constitution and we have the 10th amendment that makes it clear that this nonenumerated responsibility is the responsibility of the States. So we have a free and pluralistic society, in which we try not to impose any theory of learning, particularly. I wonder if we can reach this in some voluntary way.

What did you have in mind about the theory of learning which can be accepted?

Mr. MARTIN. I am glad that you gave me the opportunity to correct a misinterpretation of what I was saying. I was not talking about any agreed system of learning or theory of learning. I was talking about the need for a much more sophisticated behavioral analysis of pieces of learning that, together, constitute a totality of the learning act. I suspect that we are not a generation away from a law of learning. We are at the groping edge now of a series of fragments whose validity as pieces of things—whichever they happen to learn—constitutes an improvement in the way he learns.

For example, a very difficult one. Thirty years ago we wasted a great deal of time on what I called a moralistic effort to determine

what was efficacious and efficient in learning. This was called "praise or punishment," "reward and punishment." This is, essentially, a moralistic interpretation of whether or not it is better to abuse a child for an error than to reward him for a proper act. Recent studies indicate, for example, that there is strengthening consequence and a resistance level comparable to the individual who, having had a disease, now has a resistant capacity to further diseases, not only of the one itself.

A rigorous analysis looks at the act of learning, internal consequences that are rewarded and that are denied. Now, a consequence that is immunized from an emotional relationship to an adult in a situation is a different kind of learning act than the praise or blame of the adult involved for the teacher. We have not begun this kind of analysis.

So what I am saying is that we are gropingly at the beginning of increasing the more sophisticated understanding. All of us have seen the constructs of the atomic structure of a synthetic molecule. I pose as a hypothesis that the act of learning is a whole series of interconnecting behaviors that may, eventually, be diagramed three-dimensionally, multisensorially in a sequence of time, with, at least, a complexity with which we are now able to take an internal look at the construction of an organic molecule. And it is out of such learning series that the design of instrumentation to have a consensus on that series of behaviors will come.

Technology in education has thus far been severely circumscribed by an excessive reliance on Skinner's Little Fragmentary Truth. There are many more complexities to human behavior involved in learning. When these are more properly understood, instrumentation to evoke this behavior from a learning standpoint will become a reality.

Mr. BRADFORD. May I draw a distinction. In your reference to your constitutional violation, a distinct difference—the difference between a theory of learning and a theory of instruction.

The theory of learning seeks to identify how an individual learns. And this has nothing to do with an educational system. Certainly, it is not a violation of Federal control.

A theory of instruction might be, if indeed it were imposed uniformly throughout the country, but again, basically, what many people are trying to do is to determine the theory of learning, as to how individuals learn different types of things, skills, knowledge, and so on. They then try to develop, starting from the theory of learning, they try to develop a theory of instruction to determine how, then, best to teach these particular things. And it turns out that to date such results, although so in their infancy, have not really been very successful as yet.

The most successful instruction techniques have been developed pragmatically by testing them and changing them and finding ways that they work.

I think that this is one of the stages that shows that educational research is, indeed, in its infancy, and I expect to see in the next decade a significant contribution to the design of more efficient instructional systems as the result of what we are learning in our establishments of theory of learning.

Senator PROXMIRE. We thank you very much. I am going to ask, not presently, but for the record, when you have a chance to go over

your statements, that you will answer a question—Dr. Bright, that was raised from what Mr. Arnstein of the National Education Association testified about. The question will be printed in the record, and at that time you will have a chance to answer it in writing.

(The question above referred to, follows:)

At our hearing on Friday, Dr. Arnstein, who testified for the NEA, suggested establishment of a bureau for educational technology and administration. He described it as an educational clearinghouse or data bank or service bureau. It would provide a registry for educational research, a cross-reference file of computer programs and other software, a referral center to which requests could be addressed for new computer programs as needs arise, a file of educational consultants, and various other services. He thought this should be a nonprofit private organization, not a Government bureau, though he mentioned that it might need financial support from the Federal Government.

Does the Office of Education currently perform—or does it plan to perform—any of the types of services suggested for a bureau of educational technology and administration? Is the Office equipped or could it be equipped and staffed to render such services? Do you think the Office should provide these services? Or do you agree with Dr. Arnstein that a data bank for education should be outside the Government if it is to be established at all?

(The material requested of Dr. Bright and later supplied for the record follows:)

EDUCATIONAL RESEARCH INFORMATION CENTER

RESEARCH INFORMATION NEEDS IN EDUCATION

Educational research is a basic part of President Johnson's "* * * first work of these times." Beginning with the Cooperative Research Program, in 1956 the Office of Education has administered increasingly broadened research programs enacted by Congress. Answers to questions which have perplexed educators for years have already been emerging and soon will increase at a rapid rate.

Information about educational organization, curriculum, methods, and materials has little value, however, unless it is made known to persons who can use it—teachers, administrators, and researchers. Recognizing that the research on educational problems is only half the job, the Office of Education also has assumed responsibility for transmitting new information to educators and administrators. For this purpose, the Office of Education has, since 1964, been developing the Educational Research Information Center—ERIC.

WHAT IS ERIC?

ERIC is two things. First, it is a unit in the Division of Research Training and Dissemination, Bureau of Research, Office of Education. Staff members are responsible for the development and operation of one part of an education research documentation and information system. Second, ERIC represents a decentralized, nationwide network of information clearinghouses or research documentation centers, coordinated in the Office of Education. Some of these centers are located at research and development centers; others will be located at planned regional educational laboratories; and still others are or will be affiliated with colleges and universities, State departments of education, or professional and other appropriate organizations. Some are partially supported by Office of Education research funds; others affiliate with ERIC on the basis of cooperative agreements for the exchange of information, without receiving financial support.

HOW DOES ERIC OPERATE?

Through leadership and coordination provided by the central staff and with the efforts of persons at affiliated clearinghouses or centers, ERIC is committed to acquiring, abstracting, indexing, storing, retrieving, and disseminating nationally the most significant educational research and research-related documents. Development of a decentralized system, using specialized documentation processing centers, rests upon the conviction that persons knowledgeable in a given substantive area of educational research should decide what documents are of such

sufficient value that they should be distributed nationally. Thus, acquisition and selection of documents is carried out at various centers, each of which has responsibility for a given substantive field of research.

Once the professional staff at a center decides that a document has enough quality and significance to be made available to others, the document is abstracted and indexed according to classification principles developed under the direction of the central ERIC staff. The center records the abstract, index terms, and document citations on an ERIC resumé form, which becomes the principal vehicle for storage, retrieval, and dissemination of documents.

The key to indexing documents for storage and retrieval is a well-developed vocabulary. ERIC therefore has organized a Panel of Educational Terminology to develop a thesaurus of educational terms. In the meantime, centers are cooperating in developing interim appropriate indexing systems.

It is important to combine at least part of the input of the various centers into one large storage facility capable of answering certain kinds of general inquiries. Each center, therefore, sends to the central ERIC unit resumés and full texts of documents having the greatest national significance. Plans presently call for an indexed announcement of all new acquisitions supplied by centers. ERIC will inform educator and research specialists of the availability of this publication

DEVELOPMENT OF ERIC CENTERS

Although it is not possible to predict how many information centers will be ultimately affiliated with ERIC, a number will be operating by the end of 1966. Consultants, professional organizations, and staff in the Office of Education are assisting the central ERIC staff in identifying the substantive fields of knowledge of highest priority for which educational research clearinghouses should be established. As decisions are made for the order in which clearinghouses should be established in various fields, the Office of Education will ask for proposals for developing a clearinghouse or ERIC center in each identified field. Specifications will be provided for developing proposals. In cases where organizations may wish to affiliate with ERIC on a cooperative basis to exchange documents, for instance, but without financial assistance, interest may be expressed at any time to the Director of ERIC.

USES OF ERIC

The basic objective of ERIC is to provide reliable, current educational research and related information promptly and inexpensively to a wide variety of audiences: teachers, administrators, other education specialists, researchers, public officials, business and industry groups, and the public. The ultimate value of the service will be measured by the degree to which users anywhere in the country can count on ERIC to inform them of the most important developments in any area of specialization in education, regardless of the place where the new developments first occurred.

When announced as available, copies of documents may be otbained at nominal cost, either on microfilm or hardcopy, through the ERIC Document Reproduction Service.[1] Presently the Service can provide 1,700 documents as support material for planning programs for the educationally disadvantaged. Additional educational research documents will be available through the ERIC Document Reproduction Service within the coming year as new ERIC information centers are established. Orders for material generally will be filled within five days after requests are received.

ERIC, of course, is not, nor will it be, the only source of information about educational research. It will, however, provide services that do not now exist. By doing its job well, ERIC also will contribute directly to the development and strengthening of additional dissemination programs that begin where ERIC leaves off. For instance, State or city school systems, colleges and universities, or professional organizations may use ERIC to sharpen or expand their own dissemination programs. By relying on ERIC to inform them of research developments in education, organizations can develop the necessary means—through publications, video tape, and live demonstrations, for example—to carry the results of resarch to the classrooms, campuses, and laboratories of America. Also, by providing a systematic and comprehensive link between

[1] The ERIC Document Reproduction Service is operated under an Office of Education contract by Micro Photo Division, Bell & Howell Company, 1700 Shaw Avenue, Cleveland, Ohio 44112. Orders for documents by ERIC document number should be addressed to Bell & Howell Company. Announcement of the availability of ducoments will be undertaken on a periodic basis by ERIC, beginning with the documents related to programs for the educationally disadvantaged.

researchers and the many potential users of research findings, particularly teachers and administrators, ERIC can effectively contribute to speedy and widespread implementation of promising research leads.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE OFFICE OF EDUCATION, JUNE 17, 1966

The Bureau of Research is fully aware that advances in educational technology bring with them a need for largescale, systematic, and coordinated services to schools and colleges in putting these advances to work in improving education. Let me give you some background information on what is already being done, after which we shall be in a better position to look at what needs to be done and who should do it.

Historically, much of the Office of Education's support for educational technology has been in the area of new media, under Title VII of NDEA. Here are some examples: (1) Work in feasibility studies for interchange of instructional television materials has already resulted in our contracting for one national and two regional libraries of instructional television materials. (2) A series of studies has led to development of an educational media index. This first comprehensive across-media listing of non-book materials includes about 30,000 items of instructional material. (3) Under contract, we continuously provide support for development of a variety of monographs, summaries of research, and film reports on effective teaching practices using the newer media.

Title IV of the Elementary and Secondary Education Act gives an explicit mandate for research dissemination. This is being implemented through a number of contracts for analysis, interpretation, and reporting of effects of various dissemination strategies in bringing about desirable changes in the schools. Support is also being given to research about information needs in relation to the process of innovation in education. Project research in the area of curriculum development has the potential for increasing the quantity and quality of instructional software. It is also anticipated that activities carried on through the regional educational laboratories will contribute to the systematic application of the newer educational technology. The laboratories are engaged in work that is quite close to the consumer as well as the researcher and provide excellent communication between the two. Their development should provide part of the prescription needed for more effective coordination and dissemination on a regional basis.

The generation of all kinds of materials—instructional materials, how-to-do-it materials, evaluative materials—naturally increases the need for educational clearinghouse activities or other appropriate dissemination and services related to the products of research. Some progress already has been made to this end.

Feasibility studies originally conducted under Title VII provided the basic work leading to the development of the Educational Research Information Center (ERIC), a brochure on which I am appending to this report. This national information system is dedicated to the progress of education through the dissemination of educational research results and research-related materials. It will consist of a central clearinghouse at the Office of Education and a number of separate decentralized clearinghouse centers in specialized areas of educational interest. Steps have already been taken to establish centers in 12 different fields, and centers in other areas are to be added as funds and appropriate operating agencies become available. For example, in fiscal 1967, we expect to establish one or more clearinghouses in the areas of programed instruction, computer-assisted instruction, and educational media in general. Proposals for development of an ERIC information retrieval indexing and searching system for Central ERIC and the clearinghouse network are currently being evaluated.

Each of the specialized clearinghouse centers is operated outside the Office by whatever agency or organization seems most competent to handle the particular field. Central ERIC provides coordination for these centers and the usual services which are appropriate to a centralized clearinghouse, but the bulk of specific inquiries will be directed to the centers best equipped to handle them. While we do not at present have a clearinghouse center for educational technology, as such, we do have the framework for establishment of such a center. We have also taken steps in recent months to establish a network of instructional materials centers for use with the handicapped. Thus, you can see that the concept of clearinghouses or materials centers is not strange to the Office of Education.

But there are some important questions which must be answered about what the schools of the future will need to be doing before any kind of systematic coordination can be provided for the technology which will enable education to carry out its mission. In other words, the real problem is bigger than clearinghouse-type services in technology. It affects all of education. The application of educational technology requires techniques of systems engineering, which have been used in our military and industrial efforts. This means that, although an important consideration is information about what is available, an even more important consideration is the process of determining the components or blends of the technology which serve the most useful social purpose. It is the Office's view, for example, that computer usage by education is destined to be more than a storage and retrieval operation and an administrative instrument. It has teaching, remedial, and research functions. Above all, it must be regarded as a man-machine system that must display high sensitivity to human characteristics and needs. Similarly, educational technology must serve the cause of education, not control it. The educational enterprise is now on the threshold of having to make important decisions about how technology can best serve its emerging purpose, and what those decisions are will affect the whole direction and momentum of education's application of technology—including what kinds of clearinghouse information and services should be provided.

Senator PROXMIRE. I want to thank you for a most stimulating and provocative morning. I am going to call the attention of my colleagues to the testimony, because I think it is most helpful in every sense. We have statements from Blue A. Carstenson, Chairman of Legislative Committee, Adult Education Association, the National Farmers Union; Dr. John W. Sullivan, dean, College of Business Administration, Florida Atlantic University, and president of the Association for Educational Data Systems; and P. Kenneth Komoski, of Colombia University which will, also, without objection, be made a part of the record at this point.

(The statements above referred to follow:)

PREPARED STATEMENT OF BLUE A. CARSTENSON, CHAIRMAN OF LEGISLATIVE COMMITTEE, ADULT EDUCATION ASSOCIATION, NATIONAL FARMERS UNION

Mr. Chairman, it gives me a great pleasure to testify before your committee concerning the automation of technology in education.

I hold a doctorate degree in adult education, formerly was associated with the Department of Health, Education, and Welfare and the Office of Education.

We have a timelag of 15 years in adoption of new educational innovations. Nationally there is a 10-year timelag.

When you travel to the rural areas, the timelag is often as much as 20 and 30 years. Recently a friend went to a school in a rural community in Pennsylvania and found the school's only encyclopedia to contain a record about the airplane being newly invented but no practical value had been found for this invention. While much of the legislation was passed during the last 3 years which we have supported, it will do much to bring innovation in education. We call for several major new efforts which are needed to update our educational methods. The quickest way to present new educational methods and devices will be through the use of educational TV, but money and leadership must be available which will develop programs that will compete with private TV evening shows, such as "The Man From UNCLE" and the "Patty Duke Show" and expose adults, both as learners and as parents, as voting citizens, teachers of adults and

children and children to new creative educational techniques in program learning. If educational TV remains a second rate show in competing with private TV, and if they fail to use program learning and new technology we would have lost the greatest chance we have for upgrading education.

OUR FARMERS UNION CONVENTION STATEMENT

We support legislation and policies by the Federal Cummunications Commission which would result in more television channels being reserved for educational purposes. We oppose any degradation of the existing high standards which make possible the television reception now enjoyed by farmers and other rural residents.

We urge the development of television programming reflecting increased time devoted to informational and cultural programs designed to broaden the understanding of the citizens.

Secondly, regarding the idea presented by the National Communication Laboratory of program learning being made available in teen centers, community centers, and other gathering points for adults and children, so that these people can, at their leisure, learn in a creative manner, I would suggest very strongly that some means be found to establish these program-learning facilities and the so-called teaching machines in more libraries and perhaps in laundrymats; and that VISTA and the Teaching Corps be asked to supply some list of volunteers to man these programs. It may be very possible that the senior citizen volunteers of VISTA of the proposed National Senior Citizen Service Corp might be the very best persons to serve for this kind of program when supervised by trained educators.

I regret to say that our vocational and adult education programs, while doing an effective job, have not been as aggressive in adopting the educational technology as the vocational and adult education programs in the industry or the Armed Forces. By and at large, this has been because of a lack of money. With money provided by the Ford Foundation in the early 1950's, adult educational technology moved rapidly. Without funds innovation remains stagnant.

FARMERS UNION CONVENTION STATEMENT

Federal aid should be provided for the construction of all public educational facilities where local or state funds are not available to insure this opportunity. All adults should have an opportunity to participate throughout life in meaningful educational programs, with educational centers provided for this and other educational needs of rural America.

Urban, city and rural people alike have need for a broad-based educational and cultural program which the Extension Service should develop in cooperation with all departments of land-grant colleges and universities. Transformation of the Extension Service in some areas to serve these needs should be extended to other areas. As progress is made toward the goal, the feasibility of merging, at national and state levels, general and extension service programs should be thoroughly explored as the means to better coordination of adult educational programs.

We commend those state and Federal officials who have taken action to prevent state agricultural extension services from engaging in any activity which discriminates against any private farm organization. We urge any state, where this policy has not been fully implemented, to adopt it.

We favor "cabinet status" for education. In the current reorganization of various branches of education and looking toward autonomy in the Executive Branch for education, we oppose any effort to lower the status of vocational agriculture.

With knowledge changing so rapidly, we cannot attempt to educate only in childhood for a lifetime, but must make education available

throughout life. Certainly the senior citizen, if he is to remain an intelligent voter and worthwhile citizen, must receive continuing education. We know that it will be helpful for health as well as making a better citizen.

Senior citizen centers exist in many areas of the country and could serve as an open-experimental laboratory for new educational technology. This can be done with existing funds under the Administration on Aging. Program learning will be great to help senior citizens learn to paint or do pottery, because they know that the educational experiences and patterns which they learned many years ago are out of date and they need and can accept new educational techniques.

Finally, I would like to focus the attention of the committee to a critical cost in rural America, the social cost of operation. Senator Metcalf and I agree that this is one of the most significant papers concerning rural education and other social programs and the economic cost of change and development of programs in rural areas. I ask that this paper be a part of my testimony because of its great significance.

Unless educational TV is improved in quality and begin to use the new technologies more widely, commercial TV will edge educational TV out in from 5 to 10 years. Educational TV is the only way we will reach many of our rural areas.

We can't wait for the kids to be educated and grow up. We must, for economic, political, and world survival, mass educate the entire adult population. This includes the senior citizens which constitutes 20 to 25 percent of the actual voters. Programed learning must be freely available to all Americans. Unless the parents are using programed learning, school systems will be slow in adopting it for the kids.

We strongly urge adoption of title VII on adult education in the elementary and secondary education bill of 1966 as reported by the Subcommittee of the House Education and Labor Committee, or as submitted by the Adult Education Association before the Senate Education Subcommittee. This includes a research and experimental program.

PREPARED STATEMENT OF JOHN W. SULLIVAN, DEAN, COLLEGE OF BUSINESS ADMINISTRATION, FLORIDA ATLANTIC UNIVERSITY, AND PRESIDENT, ASSOCIATION FOR EDUCATIONAL DATA SYSTEMS

The program which has been carried on throughout the United States in the development of modern technology, with particular emphasis on its use for and by educators, is one of concern, interest, challenge, and anticipation to all of education and in a broader sense, to the entire public. Several national organizations now devote their entire energies to the effort of utilizing effectively the technology which has become increasingly available in recent years for the improvement, extension, expansion, and intensification of educational effort on behalf of the total economy of our Nation.

Among, specifically, these national associations has been one of recent creation having approximately a 4-year history at the present time, known as the Association for Educational Data Systems. With a national center located in Washington, D.C., AEDS has membership

throughout the United States, Canada, and other foreign countries, with more than 25 local chapters serving smaller geographic areas. A significant aspect of such an association is not the nearly 2,000 individuals who now constitute its membership, but those persons whom they in turn represent in local, State, and university systems of education; private and public research centers and special programs throughout the United States. Information concerning the effective use of educational technology in combination with the developing field of the informational sciences is, then, directly represented and involved within the membership of the Association for Educational Data Systems.

Therefore, when I direct to your attention my concern as president of the Association for Educational Data Systems, I am in fact referring to some 50,000 people throughout these United States who day by day are directly involved in the applications that relate to technology in its utilization as an improvement, extension, and expansion of the educational community and the total educational establishment. From this vantage point and in line with the attached materials, which I make available to you, of the efforts already undertaken by this association and the plans which it has, I would respectfully direct to your attention that this is a single association. There are several associations with similar interests in exactly this area that should be available to you for consultative services at such times when you, as a group, review and consider efforts in the area of educational utilization of modern technology pointed at the total economic growth and development of our Nation.

I do, on behalf of the association, respectfully request that, at such time as additional hearings are held concerning educational technology and the effective utilization of various types of new and modern educational devices, with particular references to computerized educational systems, the Association for Educational Data Systems be included as a regular witness. Also, that information concerning this and other hearings under negotiation and development before this subcommittee and the full committee be directed to the attention of our national office. It is requested that this be done on a regular basis so that the membership of the association and the people they represent may be consciously aware of the efforts which are being made by you, gentlemen, on behalf of our Nation in active consideration of this most important area to our total economy.

Secondly, I would call to your attention the fact that there are a number of actual efforts underway by various groups of considerable stature, directly related to the extension and/or change of existing educational legislation with regard to this particular field. There are proposals which will be made to this session of Congress supporting a variety of changes, modifications, and limitations which logistically will make it possible for the full impact of modern technology to be brought to bear on the economics of our total society as applied to the development of new and most important programs.

To be specific, there is at the present time, through the Committee on Educational Data Systems of the Council of Chief State School Officers, a direct effort being made to amend title X of the National Defense Education Act. These amendments will make it possible for all of the States to take full advantage of the effort which has

been so effectively utilized by some States in the development and improvement of their total computerized systems serving education and educational technology. Recognition of the informational needs required by the multiplicity of new programs which are being developed, extended and expanded by the Congress and the systems, rather than the application approach, could and should make it possible for this committee and others, to have access on an ongoing basis, to necessary educational information. They could then determine, not merely the administrative but the economic, educational, and other informational analysis necessary to actively consider a variety of legislative and congressional endeavors by the States of the Federal Government in accomplishing a tremendously improved program with its subsequent increase of economic utilization.

It would be my opinion that it is essential at this time that a review, by this committee, of proposed legislation now pending before various committees of the House and Senate, be an immediate staff responsibility. You are aware that one or more of these enactments would measurably effect the potential educational utilization of technology in many of its various aspects throughout our Nation. If such review could be made, it might be most appropriate for this committee to review the chart of certain legislation already affecting computer and educational data systems. One portion of this total educational technology which is already enacted, operational and based upon these programs, considers the coordination and cooperation between State, local, and national governments for the exchange of information. When applied to public and private education, the effective utilization of this new technology for the economic welfare of our Nation, becomes, in fact, a possible and a necessary reality which can and must be accomplished.

I am charged by my association with presenting to you, in addition to these particular concerns, a request for continued contact with this committee as it considers this area. The proposal that we, as an association, by virtue of our current established national center and available resources, suggest, is to join with groups of the Congress and/or other special organizations with similar ability, in the holding of national seminars, workshops, and clinics. One of these might basically review the testimony presented at these hearings and present to this committee, as a body of staff work, information required to enable education to take full advantage of the economic ability of our Nation and so be best served by the full development and utilization of modern technology within the educational establishment.

If it be the desire of this committee to have AEDS serve you and the Nation in this way, I would respectfully request that such a desire be directed to the national center and our executive secretary, I can assure you of the immediate attention of myself and the board of directors in the activation of what I feel would be a significant review of the materials presented at this particular hearing. In addition, any subsequent outlined areas of information which this committee may wish to have before it prior to the development and establishment of a proposed piece of legislation relative to this area could be prepared.

Assessing the New Educational Technology [1]

(By P. Kenneth Komoski, associate director, Institute of Educational Technology, Teachers College, Columbia University)

In a world so technologically sophisticated that machines not only produce other machines but in which our most advanced machines may be soon able to reproduce themselves, it may seem somewhat old fashioned to preface these comments about educational technology with the remark that technology is the purposeful use of skills as well as tools.

I feel impelled to make this remark because a few years ago the phrase "educational technology" was little more than space age educationese for a familiar array of audiovisual devices that had recently been augmented by language laboratories and instructional television; a set of tools perhaps, but hardly tools that were known for being used with either skill or purposefulness. However, in 1958, three unfamiliar devices that carried within them the seeds of a technological approach to the skill of teaching were added to that array, and a radical redefinition of "educational technology" was begun.

These three devices were (1) the simple teaching machines of the types developed by B. F. Skinner and Norman Crowder, (2) the even simpler programed textbooks developed by Lloyd Homme and Robert Glaser and, (3) the more complex teaching machine that was born when a computer was first programed as an instructional device by Gustave Rath and others.

The "radical" aspect of these devices was not grounded in any feats of mechanical or electronic engineering, but rather in the process of instructional programing which is the skill that makes it possible for a teaching machine to teach. The development of this process redefined educational technology by injecting into this once tool-tied technology a much-needed set of skills that might lead to the more effective use of all types of educational hardware. It was the emergence of the process of instructional programing that has opened the way to the development of a balanced technology within education, and that is helping us to lay to rest the idea that educational technology is simply the array of existing technological devices that can easily be applied to education. In short, instructional programing promises to supply education with skills that will make it possible to turn a rather mixed bag of tools into an effective technology. However, despite the fact that this long overdue balance of tools and skills promises to produce desirable, well-balanced results, it may be important to assess this new technology as best we can in terms of its most obvious strengths and weaknesses in an attempt to throw some light on the results that are likely to occur as it develops within our educational enterprise.

The particular strengths and weaknesses to which I wish to direct your attention stem from three sources: the first source of both great strength and embarrassing weakness is the research base from which instructional programing has emerged. This base is a source of strength because it gives confidence that instructional programing is

[1] Excerpts from a lecture presented to the faculty of the School of Education of the University of Illinois May 16, 1966, edited for inclusion in the report of the hearings on automation in education conducted by the Joint Economic Committee.

more than simply a bag of teaching tricks, and because it holds out the promise that with continued research, the skill of instructional programing will one day be transformed from an empirically derived set of teaching rules into a technology based on a reliable set of scientific principles. Thus, this research base is potentially a great source of future strength even if it does not, as yet, offer solace to the working programer during the wee hours of the morning. But the present inability of research to supply answers to many of the practical problems that plague instructional programers is not the weakness I have in mind. This more mundane weakness has to do with the fact that because programers are involved in a "science-based" technology their most trivial results are often greeted with respect by laymen and educators alike. This is clearly an unfortunate state of affairs, and one that invited the rampant overselling of the first teaching machines and programed textbooks a few years ago when door-to-door salesmen were giving gullible parents the impression that the entire psychological community had joined together to produce a "scientific" device that could make Johnny read or do anything else, just as soon as the home office arranged to have it programed.

As a result of the pressure to "get it programed" there was a rapid horizontal spread of the first few useful skills generated by education's new "science-based" technology; a spread that was so rapid and so horizontal that it resulted in a discouragingly low level of competence among those who ended up with the responsibility for producing the programs that were to carry the new technology into the classroom. All the weaknesses that one might expect to find in the use of an underdeveloped technology by inexperienced practitioners were clearly apparent as early as 1961 when a parade of unimaginative, redundant, instructional programing began to enter the schools. These programs are still very much with us today, and we may see them or programs for which they will serve as ready models as we enter the large-scale utilization of educational technology that is just around the corner.

I simply take this large-scale utilization for granted as the inevitable outcome of a commitment on the part of the Federal Government to supply American schools with the financial resources necessary to increase the quality of instruction, and the equally strong commitment on the part of American industry to convince schools that this quality can be achieved by utilizing a technology that puts "scientific" skills to work by means of various "systems of devices," led by the most versatile device of them all, the computer. The list of companies that will soon be following this approach to the school market reads like a"Who's Who of American Industry": IBM, General Electric, Westinghouse, RCA, CBS, Xerox, ITT, Raytheon, and Litton Industries; these represent only some of the major corporations that are planning to play a central role in the development of what could conceivably become the largest industry in the United States before the end of the century.

These corporations, and the new industry they comprise, represent the second source of strength and weakness within the new educational technology. First and foremost, this emerging industry has within its power the ability to compound either the strengths or the weaknesses that are associated with the newly acquired research base of a redefined, but hardly refined, educational technology. On the

plus side, therefore, it seems almost patently obvious that this new industry will, in fact, strengthen the future research base of the new technology. This is true because many of the companies in the industry have, or are building, research capabilities that are comparable to, if not far better than, the university laboratories that established the technology's present research base. Granting that much of the research done at these industrial research facilities will be redundant, and/or strictly proprietary, it will inevitably build a broader base of new research faster than could be built by university activity alone.

There are obviously many aspects of the learning and instructional processes that need to be researched, some of which are more fundamental than others. And considering that the members of the "old educational technology industry" (that is, the producers of audio-visual equipment and films along with the entire textbook industry) would never have invested in "basic" research even if they could have afforded it, it would seem almost mandatory to say a hortatory word here about the need for more and more research into such basic problems as motivation and learning. But if there is one thing that the major companies in American industry do not have to be told it is that the mother lode lies in important basic discoveries; the kind of discoveries that don't merely create new products but point the way to whole new technologies. Therefore, it may come as something of a surprise to call for anything that might possibly draw attention away from such important research. But the new industry is in a position to fill an important gap in the technology by addressing a large part of its initial research to the solution of a pressing, practical problem that was largely ignored by the scientists who built the present research base. Those early researchers were primarily interested in the control of learning. Their initial research employed devices and tangible rewards which were used to control the learning of lower organisms.

The first teaching machines, were, in fact, comparable devices designed to control human learning and, instructional programing was, at least at first, a literal byproduct of those early teaching machines. That is to say, the early and still dominant form of programing was an attempt to control learning by means of words. As a result of this desire to learn as much as possible about the problem of controlling learning, researchers most frequently took an easily stated set of instructional objectives and concerned themselves with the task of controlling the learning of these objectives by creating an instructional program that would lead to their ready acquisition by the learner. An understandable axiom of such research was "an objective that can't be clearly specified should be avoided." What this has meant in terms of developing an educational technology that has relevance for our schools is that our present research base tells us practically nothing about the process of how to program most of our educational objectives—or even how to state these objectives so that they may be programed. I realize that to the layman this may seem like an easily accomplished task, and one that is being done all the time but, on the contrary, it is one of the most difficult, most frequently neglected, and critically important aspects of the new educational technology. The research needed in this area is, of course, not basic in the usual sense, rather it is research that would be devoted

to discovering techniques that would enable educators and producers of educational materials to state instructional objectives in a way that would increase the possibility that the new technology can help learners achieve these objectives.

The skill of dealing with objectives in this way is the truly underdeveloped area in the new technology, and it is the research area that contains the greatest immediate payoff for industry and education alike. On the other hand, there are some indications that this problem of stating and preparing instructional objectives may become a major weakness within industry's position. This may, indeed, occur if industry maintains the position that the responsibility for solving this problem rests with the educators. The all too common reply of instructional technologists to those who have criticized what and how they have programed has been to say: "If the educators would only state what they want in behavioral terms, we'd be able to program it." Such a position is frequently only a cover for the fact that the technologist is not willing or competent enough to come to grips with any but the simplest of objectives, that is, factual and procedural learning. Industry can ill afford such an attitude. The attitude that it must take is that the whole area of stating and preparing objectives has been left underdeveloped by educators and the producers of educational materials alike, and that major efforts to make up for years of stating objectives in terms of vague generalizations must be undertaken by both parties. However, I suspect that industry will have to make the first move. After all, it is industry that is doing the selling.

This brings me to another potential weakness within the new educational technology which paradoxically arises out of two of American industry's great strengths. The first of these is industry's confidence that it can solve any technological problem, given a large enough market to justify the financial investment needed to solve it. The second is industry's ability to see how to deal with problems technologically that seem to defy technological solutions. These undisputed strengths have, indeed, helped to make American industry what it is, and, in the process, make America what it is. On the other hand, American education (pretechnological and primitive though it may have been) has also played a major role in shaping this country—a role that has been sometimes complementary to and sometimes in conflict with, and critical of, the objectives of industry. Today, as these two molders of our national character meet in the common cause of making better education more readily available to an increasing number of learners, it would be a mistake to attempt to view all of the educational process as a technological enterprise. Ours is more than just an industrial society.

We must avoid any possibility of industry and education becoming two sided of a single mold. Given the potential size and educational power inherent in the burgeoning new education industry, it could conceivably become an unprecedented force in American education by contracting directly with local school boards to supply educational services more cheaply and with less bother for the local citizenry than the existing system. Such an arrangement might have seemed fanciful a few years ago, but not only has this been proposed by one educational critic, but the grapevine is rife with

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rumors of school boards that are exploring arrangements of this type with industry.

Obviously, the implications of this type of reconfiguration within local education are too complex and too far reaching to adequately discuss here, but the very possibility of such a reconfiguration raises the question of the extent to which our existing system of local education and the existing community of professional educators who maintain it bring any unique strength or weakness to the new educational technology. Barring a major revolution in educational policy-making throughout all of the 50 States, members of the existing educational community will continue to be the purchasers, the users, and the people with whom the ultimate responsibility for making this new technology work will rest. Yet, these superintendents, directors of instruction, and teachers have not been, nor are they being made, active participants in the design and use of the technology.

The weakness inherent in this situation is as serious as it is obvious. The fact of the matter is that educators are about to be handed the tremendous responsibility of making wise, discriminating use of a new technology that is as confusing and threatening to them as the advent of the automobile was to the owner of a livery stable—for, like the automobile, the new educational technology represents the advent of a totally new, more complex, and faster paced vehicle of education that just might conceivably pass one right by. Given this threatening state of affairs, is it possible that the new educational technology can be strengthened by the existing educational community? Unlikely as it may seem, I believe that the answer to this question is "Yes." It is "Yes" because it is only within the educational community—within the schools themselves—that the new educational technology can be shaped and reshaped to meet our educational needs and objectives. But this potential within the present educational community for shaping the new educational technology is, at present, only a latent potential.

One way of transforming this potential into an active, positive force would be through the establishment of a nationwide network of schools that would contribute product-performance information to a central data source that could be used to assess the pattern of performance of specific products of the new education industry. The system I am proposing would have to constantly gather information that would result in the maintenance of a continuously updated performance profile for each product and class of products. These performance profiles could in turn be matched to profiles of instructional needs that would be supplied by schools interested in introducing new instruction systems. The proposed product information system would then supply the inquiring school with a list of the available instructional systems that meet his specifications as to instructional objectives, cost, type of teaching pattern with which the system to be purchased must be compatible, et cetera.

In order to increase the chances that both the would-be system and the products it was helping to assess were being used productively, the system would also need to include a program of inservice teacher-training that would offer basic courses in various aspects of the new educational technology. Such basic training would, of course, employ the skills and tools of the new technology. This bootstrap approach

could have great payoff by giving teachers and educational administrators firsthand experience with new approaches to teaching and learning.

This type of information and training system would not only help educators become discriminating users of the new technology, but it would build an efficient corrective feedback mechanism into a new technology being developed largely by a new industry that is dealing with what in many ways is a totally new market. Put another way, such a system would supply the basis for an operation dialog between producer and consumer that could go a long way toward educating both parties on how to achieve the common objective of using all of our educational tools and skills as purposefully as possible.

Senator PROXMIRE. And, without objection, the staff will be authorized to include in the appendix of the record various articles and statements on the subject of educational technology that have been brought to our attention, including certain tables which were contained in the 1965 edition of a publication of the Department of Health, Education, and Welfare entitled "Projection of Educational Statistics to 1974–75."

Thank you very much, gentlemen. The subcommittee will stand adjourned.

(Whereupon, at 12:30 p.m., the above subcommittee was adjourned.)

APPENDIX

The following tables have been compiled by the staff of the Department of Health, Education, and Welfare:

TABLE 1.—*Expenditures for education, by level of instruction and by control: United States, 1954–55 to 1974–75* [1]

[In billions of 1963–64 dollars]

Year and control	Total (all levels)	Elementary and secondary day schools [2] (nonpublic school expenditures are estimated on the basis of expenditures per teacher in public schools)				Institutions of higher education [3]		
		Total	Current Expenditures [1]	Capital outlay [2]	Interest [3]	Total	Current expenditures [4]	Capital outlay [5]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1954–55:								
Total	18.4	13.8	10.1	3.5	0.2	4.6	3.6	1.0
Public	14.8	12.2	8.9	3.1	.2	2.6	2.0	.6
Nonpublic	3.6	1.6	1.2	.4	(6)	2.0	1.6	.4
1955–56:								
Total	19.6	14.7	10.8	3.7	.2	4.9	3.8	1.1
Public	15.9	13.1	9.6	3.3	.2	2.8	2.1	.7
Nonpublic	3.7	1.6	1.2	.4	(6)	2.1	1.7	.4
1956–57:								
Total	21.8	16.1	11.7	4.1	.3	5.7	4.4	1.3
Public	17.6	14.3	10.4	3.6	.3	3.3	2.5	.8
Nonpublic	4.2	1.8	1.3	.5	(6)	2.4	1.9	.5
1957–58:								
Total	23.2	17.2	12.7	4.1	.4	6.0	4.7	1.3
Public	18.7	15.2	11.2	3.6	.4	3.5	2.7	.8
Nonpublic	4.5	2.0	1.5	.5	(6)	2.5	2.0	.5
1958–59:								
Total	24.1	17.4	13.7	3.3	.4	6.7	5.2	1.5
Public	19.2	15.4	12.1	2.9	.4	3.8	2.9	.9
Nonpublic	4.9	2.0	1.6	.4	(6)	2.9	2.3	.6
1959–60:								
Total	26.0	18.8	14.8	3.5	.5	7.2	5.7	1.5
Public	20.8	16.7	13.1	3.1	.5	4.1	3.2	.9
Nonpublic	5.2	2.1	1.7	.4	(6)	3.1	2.5	.6
1960–61:								
Total	28.5	20.1	16.0	3.5	.6	8.4	6.2	2.2
Public	22.6	17.8	14.1	3.1	.6	4.8	3.4	1.4
Nonpublic	5.9	2.3	1.9	0.4	(6)	3.6	2.8	.8
1961–62:								
Total	30.8	21.6	17.4	3.6	.6	9.2	7.0	2.2
Public	24.3	19.1	15.3	3.2	.6	5.2	3.8	1.4
Nonpublic	6.5	2.5	2.1	.4	(6)	4.0	3.2	.8

See footnotes at end of table, p. 211.

TABLE 1.—*Expenditures for education, by level of instruction and by control: United States, 1954–55 to 1974–75* [1]

[In billions of 1963–64 dollars]

Year and control	Total (all levels)	Elementary and secondary day schools [2] (nonpublic school expenditures are estimated on the basis of expenditures per teacher in public schools)				Institutions of higher education [3]		
		Total	Current Expenditures [1]	Capital outlay [2]	Interest [3]	Total	Current expenditures [4]	Capital outlay [5]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1962–63:								
Total	32.7	22.6	18.7	3.3	0.6	10.1	7.9	2.2
Public	25.6	19.9	16.4	2.9	.6	5.7	4.3	1.4
Nonpublic	7.1	2.7	2.3	.4	(6)	4.4	3.6	.8
1963–64:								
Total	35.6	24.5	20.2	3.6	.7	11.1	8.9	2.2
Public	27.9	21.6	17.7	3.2	.7	6.3	4.9	1.4
Nonpublic	7.7	2.9	2.5	.4	(6)	4.8	4.0	.8
1964–65:								
Total	38.0	26.1	21.5	3.9	.7	11.9	9.7	2.2
Public	29.8	23.0	18.9	3.4	.7	6.8	5.4	1.4
Nonpublic	8.2	3.1	2.6	.5	(6)	5.1	4.3	.8
Projected:								
1965–66:								
Total	40.6	27.1	22.8	3.5	.8	13.5	10.7	2.8
Public	31.6	23.9	20.0	3.1	.8	7.7	6.0	1.7
Nonpublic	9.0	3.2	2.8	.4	(6)	5.8	4.7	1.1
1966–67:								
Total	43.1	28.4	24.0	3.5	.9	14.7	11.9	2.8
Public	33.6	25.2	21.2	3.1	.9	8.4	6.7	1.7
Nonpublic	9.5	3.2	2.8	.4	(6)	6.3	5.2	1.1
1967–68:								
Total	45.6	29.8	25.4	3.5	.9	15.8	13.0	2.8
Public	35.3	26.3	22.3	3.1	.9	9.0	7.3	1.7
Nonpublic	10.3	3.5	3.1	.4	(6)	6.8	5.7	1.1
1968–69:								
Total	48.1	31.2	26.7	3.5	1.0	16.9	14.1	2.8
Public	37.2	27.6	23.5	3.1	1.0	9.6	7.9	1.7
Nonpublic	10.9	3.6	3.2	.4	(6)	7.3	6.2	1.1

See footnotes at end of table, p. 211.

TABLE 1.—*Expenditures for education, by level of instruction and by control: United States, 1954–55 to 1974–75* [1]

[In billions of 1963–64 dollars]

Year and control	Total (all levels)	Elementary and secondary day schools [2] (nonpublic school expenditures are estimated on the basis of expenditures per teacher in public schools)				Institutions of higher education [3]		
		Total	Current Expenditures [4]	Capital outlay [2]	Interest [3]	Total	Current expenditures [4]	Capital outlay [5]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1969–70:								
Total	50.1	32.5	28.0	3.5	1.0	17.6	14.8	2.8
Public	38.8	28.8	24.7	3.1	1.0	10.0	8.3	1.7
Nonpublic	11.3	3.7	3.3	.4	(6)	7.6	6.5	1.1
1970–71:								
Total	51.9	33.7	29.1	3.5	1.1	18.2	15.8	2.4
Public	40.1	29.8	25.6	3.1	1.1	10.3	8.8	1.5
Nonpublic	11.8	3.9	3.5	.4	(6)	7.9	7.0	.9
1971–72:								
Total	54.0	34.7	30.1	3.5	1.1	19.3	16.9	2.4
Public	41.6	30.7	26.5	3.1	1.1	10.9	9.4	1.5
Nonpublic	12.4	4.0	3.6	.4	(6)	8.4	7.5	.9
1972–73:								
Total	56.3	36.0	31.4	3.4	1.2	20.3	17.9	2.4
Public	43.3	31.8	27.6	3.0	1.2	11.5	10.0	1.5
Nonpublic	13.0	4.2	3.8	.4	(6)	8.8	7.9	.9
1973–74:								
Total	58.6	37.2	32.6	3.4	1.2	21.4	19.0	2.4
Public	44.9	32.8	28.6	3.0	1.2	12.1	10.6	1.5
Nonpublic	13.7	4.4	4.0	.4	(6)	9.3	8.4	.9
1974–75:								
Total	60.9	38.4	33.7	3.4	1.3	22.5	20.1	2.4
Public	46.6	33.9	29.6	3.0	1.3	12.7	11.2	1.5
Nonpublic	14.3	4.5	4.1	.4	(6)	9.8	8.9	.9

[1] Includes current expenditures of public elementary and secondary school systems for community services, summer schools, community colleges, and adult education. Interest is included in the estimated current expenditures of nonpublic schools.

[2] Includes capital outlay of State and local school building authorities. Annual capital outlay figures were derived from the 5-year figures shown in table 31.

[3] Interest from nonpublic schools is included with current expenditures.

[4] Includes expenditures for interest from current funds. Excludes expenditures from current funds for capital outlay.

[5] Annual capital outlay figures for 1960–61 through 1974–75 were derived from the 5-year figures shown in table 35.

[6] Interest for nonpublic elementary and secondary schools is included with current expenditures.

Source: For sources of data and assumptions on which projections of expenditures were based, see Projection of Educational Statistics to 1974–75, 1965 edition, Department of Health, Education, and Welfare.

TABLE 2.—*Current expenditures of public school systems: United States, 1954–55 to 1974–75* [1] [2]

Year	Average daily attendance [2] (in thousands)	Allocated to pupil costs [3]				All programs [4]	
		Per pupil		Total (in billions)		Total (in billions)	
		Current dollars	1963–64 dollars	Current dollars	1964–64 dollars	Current dollars	1963–64 dollars
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1954–55 [5]	26,978	$278.54	$320.85	$7.5	$8.7	$7.7	$8.9
1955–56	27,880	294.22	337.74	8.2	9.4	8.4	9.6
1956–57 [5]	28,801	314.62	350.90	9.1	10.1	9.3	10.4
1957–58	29,875	341.14	368.33	10.2	11.0	10.4	11.2
1958–59	31,184	357.71	380.96	11.2	11.9	11.4	12.1
1959–60	32,477	375.14	393.97	12.2	12.8	12.5	13.1
1960–61 [5]	33,524	396.50	411.05	13.3	13.8	13.6	14.1
1961–62	34,682	418.50	429.51	14.5	14.9	14.9	15.3
1962–63 [5]	35,882	439.00	445.00	15.8	16.0	16.2	16.4
1963–64 [5]	37,241	462.00	462.00	17.2	17.2	17.7	17.7
1964–65 [6]	38,500	484.00	478.00	18.6	18.4	19.1	18.9
Projected:							
(*a*) Excludes the effects of the Elementary and Secondary Education Act of 1965:							
1965–66	38,800	----------	492.00	----------	19.1	----------	19.6
1966–67	39,600	----------	507.00	----------	20.1	----------	20.6
1967–68	40,200	----------	523.00	----------	21.0	----------	21.5
1968–69	40,700	----------	539.00	----------	21.9	----------	22.5
1969–70	41,400	----------	554.00	----------	22.9	----------	23.5
1970–71	41,800	----------	570.00	----------	23.8	----------	24.4
1971–72	42,300	----------	585.00	----------	24.7	----------	25.3
1972–73	42,800	----------	601.00	----------	25.7	----------	26.4
1973–74	43,200	----------	617.00	----------	26.7	----------	27.4
1974–75	43,800	----------	632.00	----------	27.7	----------	28.4
(*b*) Includes the effects of the Elementary and Secondary Education Act of 1965:							
1965–66	38,800	----------	503.00	----------	19.5	----------	20.0
1966–67	39,600	----------	523.00	----------	20.7	----------	21.2
1967–68	40,200	----------	542.00	----------	21.8	----------	22.3
1968–69	40,700	----------	563.00	----------	22.9	----------	23.5
1969–70	41,400	----------	582.00	----------	24.1	----------	24.7
1970–71	41,800	----------	598.00	----------	25.0	----------	25.6
1971–72	42,300	----------	612.00	----------	25.9	----------	26.5
1972–73	42,800	----------	629.00	----------	26.9	----------	27.6
1973–74	43,200	----------	646.00	----------	27.9	----------	28.6
1974–75	43,800	----------	660.00	----------	28.9	----------	29.6

[1] Sources and method: Data are based on statistics shown in U.S. Department of Health, Education, and Welfare, Office of Education publications: (1) Statistics of State School Systems, Biennial Survey of Education in the United States, ch. 2 (1953–54 through 1957–58); (2) Statistics of State School Systems circulars (1959–60 and 1961–62); and (3) Statistics of Public Schools, fall 1964. Current expenditures were converted to 1963–64 dollars on the basis of the Consumer Price Index published by the Bureau of Labor Statistics, U.S. Department of Labor. For method of converting, see appendix table 1.

The projections of current expenditures of public school systems are based on the assumptions: (1) the ratio of average daily attendance to fall enrollment in grades K to 12 (table 2) will remain constant at the 1964–65 level of 93 percent; (2) current expenditures allocated to pupil costs per pupil in average daily attendance will follow the 1954–55 to 1964–65 trend; and (3) the ratio of current expenditures for all programs to current expenditures allocated to pupil costs will remain constant at the 1964–65 level of 1.026.

For methodology details see appendix table D and discussion in text.

Projection B assumes additional increase in current expenditures allocated to pupil costs and to current expenditures for all programs of the public school systems as follows: 1965–66, $0.4 billion; 1966–67, $0.6 billion; 1967–68, $0.8 billion; 1968–69, $1.0 billion; and 1969–70 to 1974–75, $1.2 billion per year.

[2] The expenditures shown on this table include current expenditures for administration for State boards of education, State departments of education, and intermediate administrative units. Therefore, they are higher than those that exclude such expenditures.

[3] Includes only the current expenditures for public day schools allocated to pupil costs, and excludes the expenditures shown in footnote 4.

[4] Includes current expenditures for summer schools, adult education, and community colleges operated by school districts, in addition to expenditures allocable to pupil costs.

[5] Estimated on the basis of actual enrollment and interpolated expenditures per pupil.

[6] Derived from estimates furnished by States.

NOTE.—Data are for 50 States and the District of Columbia for all years.

TABLE 3.—*Fall enrollment in educational institutions: United States, 1954–74* [1]

[In thousands]

Fall	Total enrollment [2]			Institutions of higher education—Degree-credit		Regular elementary and secondary day schools			
						Grades K to 8		Grades 9 to 12	
	Total	Public	Nonpublic	Public	Nonpublic	Public	Nonpublic	Public	Nonpublic
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1954	36,401	30,908	5,493	1,359	1,093	23,106	3,600	6,443	800
1955	37,941	32,164	5,777	1,484	1,177	23,917	3,800	6,763	800
1956	39,547	33,385	6,162	1,666	1,262	24,541	4,000	7,178	900
1957	41,099	34,714	6,385	1,763	1,285	25,230	4,200	7,721	900
1958	42,718	35,975	6,743	1,894	1,343	26,004	4,400	8,077	1,000
1959	44,159	37,166	6,993	1,984	1,393	26,911	4,600	8,271	1,000
1960	45,764	38,397	7,367	2,116	1,467	27,398	4,800	8,883	1,100
1961	47,325	39,793	7,532	2,329	1,532	27,969	4,900	9,495	1,100
1962	49,224	41,323	7,901	2,574	1,601	28,637	5,100	10,112	1,200
1963	51,181	43,035	8,146	2,848	1,646	29,304	5,200	10,883	1,300
1964	53,067	44,596	8,471	3,180	1,771	30,025	5,300	11,391	1,400
Projected:									
1965	53,935	45,219	8,716	3,519	1,916	30,300	5,400	11,400	1,400
1966	55,324	46,460	8,864	3,860	2,064	30,900	5,400	11,700	1,400
1967	56,610	47,401	9,209	4,201	2,209	31,100	5,500	12,100	1,500
1968	57,720	48,299	9,421	4,499	2,321	31,300	5,500	12,500	1,600
1969	58,566	49,119	9,447	4,619	2,347	31,500	5,500	13,000	1,600
1970	59,425	49,715	9,710	4,815	2,410	31,500	5,600	13,400	1,700
1971	60,374	50,576	9,798	5,076	2,498	31,700	5,600	13,800	1,700
1972	61,263	51,365	9,898	5,365	2,598	31,900	5,600	14,100	1,700
1973	62,259	52,056	10,203	5,656	2,703	32,100	5,700	14,300	1,800
1974	63,289	53,006	10,283	5,906	2,783	32,500	5,700	14,600	1,800

[1] Sources and method: For sources and method of making projections, see another set of school enrollment projections, showing somewhat lower totals, as set forth in "Current Population Reports," Population Estimate Series, p. 25, No. 338, May 31, 1966, Projection of School and College Enrollment in United States Until 1985.

[2] Excludes nondegree-credit enrollment in institutions of higher education and enrollment in the following nonregular or special schools: Residential schools for exceptional children, subcollegiate departments of institutions of higher education, Federal schools for Indians, and schools on Federal installations. Nondegree-credit enrollment in institutions of higher education was reported in fall 1964 as 288,181 in public and 41,666 in nonpublic institutions. Enrollment in nonregular or special elementary and secondary schools in fall 1964 is estimated as 228,000 in public and 72,000 in nonpublic schools.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 4.—*Fall enrollment in grades K to 8 and 9 to 12 of regular day schools, by control: United States, 1954–74* [1] [2]

[In thousands]

Fall	Total public and nonpublic			Public			Nonpublic		
	K to 12	K to 8	9 to 12	K to 12	K to 8	9 to 12	K to 12	K to 8	9 to 12
					Estimated [3]		Estimated		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1954	33,949	26,706	7,243	29,549	23,106	6,443	4,400	3,600	800
1955	35,280	27,717	7,563	30,680	23,917	6,763	4,600	3,800	800
1956	36,619	28,541	8,078	31,719	24,541	7,178	4,900	4,000	900
1957	38,051	29,430	8,621	32,951	25,230	7,721	5,100	4,200	900
1958	39,481	30,404	9,077	34,081	26,004	8,077	5,400	4,400	1,000
1959	40,782	31,511	9,271	35,182	26,911	8,271	5,600	4,600	1,000
1960	42,181	32,198	9,983	36,281	27,398	8,883	5,900	4,800	1,100
1961	43,464	32,869	10,595	37,464	27,969	9,495	6,000	4,900	1,100
1962	45,049	33,737	11,312	38,749	28,637	10,112	6,300	5,100	1,200
1963	46,687	34,504	12,183	40,187	29,304	10,883	6,500	5,200	1,300
1964	48,116	35,325	12,791	41,416	30,025	11,391	6,700	5,300	1,400
Projected:									
1965	48,500	35,700	12,800	41,700	30,300	11,400	6,800	5,400	1,400
1966	49,400	36,300	13,100	42,600	30,900	11,700	6,800	5,400	1,400
1967	50,200	36,600	13,600	43,200	31,100	12,100	7,000	5,500	1,500
1968	50,900	36,800	14,100	43,800	31,300	12,500	7,100	5,500	1,600
1969	51,600	37,000	14,600	44,500	31,500	13,000	7,100	5,500	1,600
1970	52,200	37,100	15,100	44,900	31,500	13,400	7,300	5,600	1,700
1971	52,800	37,300	15,500	45,500	31,700	13,800	7,300	5,600	1,700
1972	53,300	37,500	15,800	46,000	31,900	14,100	7,300	5,600	1,700
1973	53,900	37,800	16,100	46,400	32,100	14,300	7,500	5,700	1,800
1974	54,600	38,200	16,400	47,100	32,500	14,600	7,500	5,700	1,800

[1] Sources and method: Enrollment data and estimates are based on U.S. Department of Health, Education, and Welfare, Office of Education publications: (1) Fall 1964 Statistics of Public Schools; (2) Enrollment, Teachers, and Schoolhousing circulars (1954 through 1963); (3) Statistics of State School Systems; Biennial Survey of Education in the United States, ch. 2 (1952–54 through 1957–58); (4) Statistics of State School Systems circulars (1959–60 and 1961–62); and (5) Nonpublic School Enrollments in Grades 9–12, Fall 1964, and Graduates, 1963–64. Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports; Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projection of total regular fall enrollment in day schools is based on the assumptions: (1) Enrollment rates of the 5–13-year-old population in grades kindergarten through 8 will reman constant to 1974 at the average 1962–64 rate; (2) enrollment rates of the 14–17-year-old population in grades 9 through 12 will follow 1954–64 trends; (3) the proportion of total fall enrollment in nonpublic schools will remain constant at the the 1964 rate through 1974. For methodology details, see appendix table A.

[2] Does not include residential schools for exceptional children, subcollegiate departments of institutions of higher education, Federal schools for Indians, and schools on Federal installations.

[3] Fall enrollment not reported by grade prior to 1962; grade breakdown for years 1954 through 1961 estimated from school year enrollment.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 5.—*Fall enrollment, by organizational level of school and by control: United States, 1954–74* [1] [2]

[In thousands]

Fall	Total public and nonpublic			Public			Nonpublic		
	K to 12	Elementary	Secondary	K to 12	Elementary	Secondary	K to 12	Elementary	Secondary
							Estimated		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1954	33,949	24,922	9,027	29,549	21,322	8,227	4,400	3,600	800
1955	35,280	25,959	9,321	30,680	22,159	8,521	4,600	3,800	800
1956	36,619	26,216	10,403	31,719	22,216	9,503	4,900	4,000	900
1957	38,051	27,061	10,990	32,951	22,861	10,090	5,100	4,200	900
1958	39,481	27,815	11,666	34,081	23,415	10,666	5,400	4,400	1,000
1959	40,782	28,506	12,276	35,182	23,906	11,276	5,600	4,600	1,000
1960	42,181	29,150	13,031	36,281	24,350	11,931	5,900	4,800	1,100
1961	43,464	29,503	13,961	37,464	24,603	12,861	6,000	4,900	1,100
1962	45,049	30,364	14,685	38,749	25,264	13,485	6,300	5,100	1,200
1963	46,687	30,975	15,712	40,187	25,775	14,412	6,500	5,200	1,300
1964	48,116	31,521	16,595	41,416	26,221	15,195	6,700	5,300	1,400
Projected:									
1965	48,500	31,779	16,721	41,700	26,379	15,321	6,800	5,400	1,400
1966	49,400	32,171	17,229	42,600	26,771	15,829	6,800	5,400	1,400
1967	50,200	32,296	17,904	43,200	26,796	16,404	7,000	5,500	1,500
1968	50,900	32,328	18,572	43,800	26,828	16,972	7,100	5,500	1,600
1969	51,600	32,300	19,300	44,500	26,800	17,700	7,100	5,500	1,600
1970	52,200	32,400	19,800	44,900	26,800	18,100	7,300	5,600	1,700
1971	52,800	32,416	20,384	45,500	26,816	18,684	7,300	5,600	1,700
1972	53,300	32,501	20,799	46,000	26,901	19,099	7,300	5,600	1,700
1973	53,900	32,630	21,270	46,400	26,930	19,470	7,500	5,700	1,800
1974	54,600	32,936	21,664	47,100	27,236	19,864	7,500	5,700	1,800

[1] Sources and method: Enrollment data and estimates are based on U.S. Department of Health, Education, and Welfare, Office of Education publications: (1) Enrollment, Teachers, and Schoolhousing circulars (1954 through 1963); (2) Statistics of State School Systems, Biennial Survey of Education in the United States, ch. 2 (1952–54 through 1957–58); (3) Statistics of State School Systems circulars (1959–60 and 1961–62); (4) Fall 1964 Statistics of Public Schools; and (5) Nonpublic School Enrollments in Grades 9–12, Fall 1964, and Graduates, 1963–64.

The projection of total regular fall enrollment in public schools by organizational level of school is based on the assumption that the percentage of enrollment in grades 7 and 8 that will be organized as elementary and as secondary enrollment will follow the 1954–64 trend. The projection of regular fall enrollment in nonpublic schools by organizational level is based on the assumption that all nonpublic enrollment in grades 7 and 8 will continue as elementary enrollment. For methodology details, see appendix table A.

[2] Does not include residential schools for exceptional children, subcollegiate departments of institutions of higher education, Federal schools for Indians, and schools on Federal installations.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 6.—*Total and 1st-time opening fall degree-credit enrollment in all institutions of higher education, by sex: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Men	Women	Total	Men	Women
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	2,452,466	1,566,737	885,729	626,403	383,720	242,683
1955	2,660,429	1,737,469	922,960	670,013	415,604	254,409
1956	2,927,367	1,916,802	1,010,565	717,504	442,903	274,601
1957	3,047,373	1,991,411	1,055,962	723,879	441,969	281,910
1958	3,236,414	2,098,164	1,138,250	775,308	465,422	309,886
1959	3,377,273	2,160,886	1,216,387	821,520	487,890	333,630
1960	3,582,726	2,256,877	1,325,849	923,069	539,512	383,557
1961	3,860,643	2,408,601	1,452,042	1,018,361	591,913	426,448
1962	4,174,936	2,587,291	1,587,645	1,030,554	598,099	432,455
1963	4,494,626	2,772,562	1,722,064	1,046,417	604,282	442,135
1964	4,950,173	3,032,992	1,917,181	1,224,840	701,524	523,316
Projected:						
1965	5,435,000	3,328,000	2,107,000	1,445,000	823,000	622,000
1966	5,924,000	3,616,000	2,308,000	1,430,000	809,000	621,000
1967	6,410,000	3,911,000	2,499,000	1,440,000	810,000	630,000
1968	6,820,000	4,159,000	2,661,000	1,470,000	823,000	647,000
1969	6,966,000	4,234,000	2,732,000	1,528,000	857,000	671,000
1970	7,225,000	4,382,000	2,843,000	1,614,000	902,000	712,000
1971	7,574,000	4,589,000	2,985,000	1,699,000	945,000	754,000
1972	7,963,000	4,805,000	3,158,000	1,776,000	984,000	792,000
1973	8,359,000	5,036,000	3,323,000	1,842,000	1,018,000	824,000
1974	8,689,000	5,219,000	3,470,000	1,911,000	1,052,000	859,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projections of total and of 1st-time opening fall degree-credit enrollment in all institutions of higher education are based on the assumptions: (1) attendance rates of men and of women aged 18–21 years in all institutions will follow the 1954–64 trends; (2) entrance rates of 18-year-old men and of 18-year-old women into all institutions will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 7.—*Total and 1st-time opening fall degree-credit enrollment in all institutions of higher education, by control: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Public	Private	Total	Public	Private
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	2,452,466	1,359,304	1,093,162	626,403	373,199	253,204
1955	2,660,429	1,483,677	1,176,752	670,013	400,372	269,641
1956	2,927,367	1,665,557	1,261,810	717,504	430,149	287,355
1957	3,047,373	1,762,726	1,284,674	723,879	434,066	289,813
1958	3,236,414	1,893,843	1,342,571	775,308	474,621	300,687
1959	3,377,273	1,984,022	1,393,251	821,520	501,543	319,977
1960	3,582,726	2,115,893	1,466,833	923,069	577,744	345,325
1961	3,860,643	2,328,912	1,531,731	1,018,361	648,236	370,125
1962	4,174,936	2,573,720	1,601,216	1,030,554	669,728	360,826
1963	4,494,626	2,848,454	1,646,172	1,046,417	686,861	359,556
1964	4,950,173	3,179,527	1,770,646	1,224,840	814,664	410,176
Projected:						
1965	5,435,000	3,519,000	1,916,000	1,445,000	967,000	478,000
1966	5,924,000	3,860,000	2,064,000	1,430,000	964,000	466,000
1967	6,410,000	4,201,000	2,209,000	1,440,000	976,000	464,000
1968	6,820,000	4,499,000	2,321,000	1,470,000	999,000	471,000
1969	6,966,000	4,619,000	2,347,000	1,528,000	1,045,000	483,000
1970	7,225,000	4,815,000	2,410,000	1,614,000	1,111,000	503,000
1971	7,574,000	5,076,000	2,498,000	1,699,000	1,173,000	526,000
1972	7,963,000	5,365,000	2,598,000	1,776,000	1,231,000	545,000
1973	8,359,000	5,656,000	2,703,000	1,842,000	1,282,000	560,000
1974	8,689,000	5,906,000	2,783,000	1,911,000	1,335,000	576,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current population Reports: Projections of the Population of the United States by Age and Sex to 1985, Series P–25, No. 279.

The projections of total and of 1st-time opening fall degree-credit enrollment in all institutions of higher education by control of institution are based on the assumptions: (1) attendance rates of the population aged 18–21 years in all public institutions and in all private institutions will follow the 1954–64 trends; (2) entrance rates of the 18-year-old population into all public institutions and into all private institutions will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TOTAL 8.—*Total and 1st-time opening fall degree-credit enrollment in 4-year institutions of higher education, by sex: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Men	Women	Total	Men	Women
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	2,170,033	1,394,985	775,048	497,054	307,203	189,851
1955	2,352,018	1,540,798	811,220	530,044	329,428	200,616
1956	2,580,022	1,691,167	888,855	554,694	341,293	213,401
1957	2,678,211	1,753,732	924,479	556,239	337,932	218,307
1958	2,850,805	1,850,124	1,000,681	600,359	357,678	242,681
1959	2,967,558	1,901,132	1,066,426	639,841	376,633	263,208
1960	3,131,393	1,974,722	1,156,671	709,093	410,942	298,151
1961	3,342,718	2,088,445	1,254,273	774,584	446,248	328,336
1962	3,585,407	2,221,667	1,363,740	770,114	441,936	328,178
1963	3,869,837	2,385,902	1,483,935	774,744	441,220	333,524
1964	4,239,305	2,593,483	1,645,822	902,599	508,117	394,482
Projected:						
1965	4,644,000	2,836,000	1,808,000	1,061,000	593,000	468,000
1966	5,058,000	3,081,000	1,977,000	1,047,000	580,000	467,000
1967	5,466,000	3,324,000	2,142,000	1,052,000	578,000	474,000
1968	5,804,000	3,528,000	2,276,000	1,070,000	584,000	486,000
1969	5,918,000	3,583,000	2,335,000	1,109,000	606,000	503,000
1970	6,139,000	3,707,000	2,432,000	1,166,000	633,000	533,000
1971	6,424,000	3,875,000	2,549,000	1,225,000	661,000	564,000
1972	6,743,000	4,049,000	2,694,000	1,278,000	685,000	593,000
1973	7,068,000	4,237,000	2,831,000	1,323,000	706,000	617,000
1974	7,339,000	4,387,000	2,952,000	1,369,000	727,000	642,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projections of total and of 1st-time opening fall degree-credit enrollment in 4-year institutions of higher education are based on the assumptions: (1) Attendance rates of men and of women aged 18 to 21 years in 4-year institutions will follow the 1954–64 trends; (2) entrance rates of 18-year-old men and of 18-year-old women into 4-year institutions will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 9.—*Total and 1st-time opening fall degree-credit enrollment in 4-year institutions of higher education by control: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Public	Private	Total	Public	Private
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	2,170,033	1,118,159	1,051,874	497,054	264,661	232,393
1955	2,352,018	1,218,351	1,133,667	530,044	283,084	246,960
1956	2,580,022	1,367,936	1,212,086	554,694	292,743	261,951
1957	2,678,211	1,446,736	1,231,475	556,239	293,544	262,695
1958	2,850,805	1,562,962	1,287,843	600,359	328,242	272,117
1959	2,967,558	1,628,055	1,339,503	639,841	348,150	291,691
1960	3,131,393	1,723,583	1,407,810	709,093	395,884	313,209
1961	3,342,718	1,872,531	1,470,187	774,584	438,135	336,449
1962	3,585,407	2,054,463	1,530,944	770,114	445,191	324,923
1963	3,869,837	2,297,146	1,572,691	774,744	452,104	322,640
1964	4,239,305	2,558,668	1,680,637	902,599	539,251	363,348
Projected:						
1965	4,644,000	2,825,000	1,819,000	1,061,000	638,000	432,000
1966	5,058,000	3,098,000	1,960,000	1,047,000	634,000	413,000
1967	5,466,000	3,368,000	2,098,000	1,052,000	641,000	411,000
1968	5,804,000	3,600,000	2,204,000	1,070,000	653,000	417,000
1969	5,918,000	3,689,000	2,229,000	1,109,000	681,000	428,000
1970	6,139,000	3,850,000	2,289,000	1,166,000	721,000	445,000
1971	6,424,000	4,051,000	2,373,000	1,225,000	759,000	466,000
1972	6,743,000	4,275,000	2,468,000	1,278,000	795,000	483,000
1973	7,068,000	4,499,000	2,569,000	1,323,000	827,000	496,000
1974	7,339,000	4,694,000	2,645,000	1,369,000	859,000	510,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projections of total and of 1st-time opening fall degree-credit enrollment in 4-year institutions of higher education by control of institution are based on the assumptions: (1) attendance rates of the population aged 18–21 years in public 4-year institutions and in private 4-year institutions will follow the 1954–64 trends; (2) entrance rates of the 18-year-old population into public 4-year institutions and into private 4-year institutions will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 10.—*Total and 1st-time opening fall degree-credit enrollment in junior colleges, by sex: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Men	Women	Total	Men	Women
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	282,433	171,752	110,681	129,349	76,517	52,832
1955	308,411	196,671	111,740	139,969	86,176	53,793
1956	347,345	225,635	121,710	162,810	101,610	61,200
1957	369,162	237,679	131,483	167,640	104,037	63,603
1958	385,609	248,040	137,569	174,949	107,744	67,205
1959	409,715	259,754	149,961	181,679	111,257	70,422
1960	451,333	282,155	169,178	213,976	128,570	85,406
1961	517,925	320,156	197,769	243,777	145,665	98,112
1962	589,529	365,624	223,905	260,440	156,163	104,277
1963	624,789	386,660	238,129	271,673	163,062	108,611
1964	710,868	439,509	271,359	322,241	193,407	128,834
Projected:						
1965	791,000	492,000	299,000	384,000	230,000	154,000
1966	866,000	535,000	331,000	383,000	229,000	154,000
1967	944,000	587,000	357,000	388,000	232,000	156,000
1968	1,016,000	631,000	385,000	400,000	239,000	161,000
1969	1,048,000	651,000	397,000	419,000	251,000	168,000
1970	1,086,000	675,000	411,000	448,000	269,000	179,000
1971	1,150,000	714,000	436,000	474,000	284,000	190,000
1972	1,220,000	756,000	464,000	498,000	299,000	199,000
1973	1,291,000	799,000	492,000	519,000	312,000	207,000
1974	1,350,000	832,000	518,000	542,000	325,000	217,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projections of total and of 1st-time opening degree-credit enrollment in junior colleges are based on the assumptions: (1) attendance rates of men and of women aged 18–21 years in junior colleges will follow the 1954–64 trends; (2) entrance rates of 18-year-old men and of 18-year-old women into junior colleges will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 11.—*Total and 1st-time opening fall degree-credit enrollment in junior colleges, by control: United States, 1954–74* [1]

Fall	Total fall enrollment			1st-time fall enrollment		
	Total	Public	Private	Total	Public	Private
(1)	(2)	(3)	(3)	(5)	(6)	(7)
1954	282,433	241,145	41,288	129,349	108,538	20,811
1955	208,411	265,326	43,085	139,969	117,288	22,681
1956	347,345	297,621	49,724	162,810	137,406	25,404
1957	369,162	315,990	53,172	167,640	140,522	27,118
1958	385,609	330,881	54,728	174,949	146,379	28,570
1959	409,715	355,967	53,748	181,679	153,393	28,286
1960	451,333	392,310	59,023	213,976	181,860	32,116
1961	517,925	456,381	61,544	243,777	210,101	33,676
1962	589,529	519,257	70,272	260,440	224,537	35,903
1963	624,789	551,308	73,481	271,673	234,757	36,916
1964	710,868	620,859	90,009	322,241	275,413	46,828
Projected:						
1965	791,000	694,000	97,000	384,000	329,000	55,000
1966	866,000	762,000	104,000	383,000	330,000	53,000
1967	944,000	833,000	111,000	388,000	335,000	53,000
1968	1,016,000	899,000	117,000	400,000	346,000	54,000
1969	1,048,000	930,000	118,000	419,000	364,000	55,000
1970	1,086,000	965,000	121,000	448,000	390,000	58,000
1971	1,150,000	1,025,000	125,000	474,000	414,000	60,000
1972	1,220,000	1,090,000	130,000	498,000	436,000	62,000
1973	1,291,000	1,157,000	134,000	519,000	455,000	64,000
1974	1,350,000	1,212,000	138,000	542,000	476,000	66,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25, No. 279.

The projections of total and of 1st-time opening fall degree-credit enrollment in junior colleges by control of institution are based on the assumptions: (1) attendance rates of the population aged 18–21 years in public junior colleges and in private junior colleges will follow the 1954–64 trends; (2) entrance rates of the 18-year-old population into public junior colleges and into private junior colleges will follow the 1954–64 trends.

For methodology details, see appendix table A.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 12.—*Estimated total opening fall degree-credit enrollment in institutions of higher education, by level: United States, 1954–74* [1] [2]

Fall	Total	Undergraduate and 1st professional	Graduate
(1)	(2)	(3)	(4)
1954	2,452,000	2,235,000	218,000
1955	2,660,000	2,418,000	242,000
1956	2,927,000	2,656,000	271,000
1957	3,047,000	2,760,000	288,000
1958	3,236,000	2,924,000	312,000
1959	3,377,000	3,046,000	331,000
1960	3,583,000	3,227,000	356,000
1961	3,861,000	3,474,000	387,000
1962	4,175,000	3,753,000	422,000
1963	4,495,000	4,031,000	464,000
1964	4,950,000	4,433,000	517,000
Projected:			
1965	5,435,000	4,857,000	577,000
1966	5,924,000	5,284,000	640,000
1967	6,410,000	5,706,000	705,000
1968	6,820,000	6,058,000	762,000
1969	6,966,000	6,175,000	790,000
1970	7,225,000	6,391,000	834,000
1971	7,574,000	6,686,000	888,000
1972	7,963,000	7,015,000	948,000
1973	8,359,000	7,349,000	1,010,000
1974	8,689,000	7,623,000	1,066,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education publications: (1) Opening (Fall) Enrollment in Higher Education (1954 through 1964); and (2) Comprehensive Survey of Education (1954, 1955, 1957, 1959, 1961).

The projection of total fall degree-credit enrollment by level is based on the assumption that the proportion of total enrollment at the graduate level will continue the 1954–61 trend to 1974.

For methodology details, see appendix table A.

[2] Total opening fall degree-credit enrollment by level is estimated from enrollment by level reported in the Comprehensive Report on Enrollment (annually 1953–55, biennially 1957–61) and in the Migration of College Student Survey (1963). Estimates of undergraduate and 1st-professional level include students studying for degrees such as M.D., D.D.S., D.V.M., LL.B., B.D., and other degrees classified as 1st-professional. Graduate enrollment is about 8 percent higher than enrollment for advanced degrees (478,011 in 1964) because graduate enrollment includes students takng work at the graduate level but not enrolled for advanced degrees.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 13.—*Estimated total opening fall degree-credit enrollment in institutions of higher education, by level and by attendance status: United States, 1954–74* [1] [2]

Fall	Total		Undergraduate and 1st professional		Graduate	
	Full time	Part time	Full time	Part time	Full time	Part time
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	1,721,000	731,000	1,637,000	598,000	84,000	134,000
1955	1,857,000	803,000	1,763,000	655,000	94,000	148,000
1956	2,020,000	908,000	1,913,000	743,000	106,000	165,000
1957	2,077,000	970,000	1,964,000	796,000	113,000	174,000
1958	2,215,000	1,022,000	2,091,000	833,000	124,000	189,000
1959	2,314,000	1,063,000	2,183,000	863,000	131,000	200,000
1960	2,466,000	1,117,000	2,323,000	904,000	143,000	213,000
1961	2,714,000	1,147,000	2,551,000	923,000	163,000	224,000
1962	2,902,000	1,273,000	2,725,000	1,028,000	177,000	245,000
1963	3,068,000	1,426,000	2,881,000	1,151,000	188,000	276,000
1964	3,418,000	1,532,000	3,204,000	1,229,000	214,000	303,000
Projected:						
1965	3,747,000	1,688,000	3,508,000	1,350,000	239,000	338,000
1966	4,079,000	1,844,000	3,814,000	1,470,000	266,000	375,000
1967	4,410,000	2,001,000	4,117,000	1,589,000	293,000	412,000
1968	4,685,000	2,135,000	4,367,000	1,691,000	317,000	444,000
1969	4,778,000	2,187,000	4,448,000	1,727,000	330,000	461,000
1970	4,952,000	2,273,000	4,603,000	1,788,000	349,000	486,000
1971	5,184,000	2,390,000	4,812,000	1,874,000	372,000	516,000
1972	5,443,000	2,520,000	5,046,000	1,970,000	397,000	550,000
1973	5,706,000	2,653,000	5,282,000	2,067,000	424,000	586,000
1974	5,924,000	2,765,000	5,476,000	2,147,000	448,000	617,000

[1] Sources and method: Enrollment data and estimates are based on U.S. Department of Health, Education, and Welfare, Office of Education publications: (1) Opening (Fall) Enrollment in Higher Education (1954 through 1964); and (2) Comprehensive Survey of Education (1954, 1955, 1957, 1959, 1961).

The projection of degree-credit enrollment by level and attendance status is based on the assumption that in each enrollment category the 1964 ratio of full-time enrollment to total enrollment will remain constant to 1974.

For methodology details, see appendix table A.

[2] Total opening fall degree-credit enrollment by level and attendance status was estimated from 1st-term enrollment by level and attendance status reported in the Comprehensive Report on Enrollment (annually 1953–55, biennially 1957–61). The estimates were adjusted to agree with enrollment by attendance status reported in Opening Fall Enrollment Surveys 1962–64.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 14.—*Estimated undergraduate and 1st-professional opening fall degree-credit enrollment in institutions of higher education, by type of institution and by attendance status: United States, 1954–74* [1] [2]

Fall	Undergraduate and 1st-professional fall degree-credit enrollment					
	2-year institutions			4-year institutions		
	Total	Full time	Part time	Total	Full time	Part time
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1954	282,000	153,000	128,000	1,952,000	1,483,000	469,000
1955	308,000	171,000	136,000	2,109,000	1,591,000	518,000
1956	347,000	193,000	153,000	2,308,000	1,719,000	589,000
1957	369,000	206,000	162,000	2,390,000	1,757,000	632,000
1958	385,000	214,000	170,000	2,538,000	1,876,000	662,000
1959	409,000	225,000	184,000	2,636,000	1,957,000	678,000
1960	451,000	246,000	204,000	2,775,000	2,076,000	698,000
1961	517,000	282,000	236,000	2,956,000	2,239,000	717,000
1962	589,000	317,000	272,000	3,163,000	2,408,000	755,000
1963	624,000	327,000	297,000	3,406,000	2,553,000	852,000
1964	710,000	396,000	314,000	3,722,000	2,807,000	914,000
Projected:						
1965	791,000	441,000	351,000	4,066,000	3,067,000	999,000
1966	866,000	481,000	385,000	4,418,000	3,333,000	1,085,000
1967	944,000	524,000	420,000	4,762,000	3,592,000	1,170,000
1968	1,016,000	563,000	453,000	5,042,000	3,804,000	1,238,000
1969	1,048,000	580,000	468,000	5,127,000	3,868,000	1,259,000
1970	1,086,000	601,000	485,000	5,305,000	4,002,000	1,303,000
1971	1,150,000	635,000	514,000	5,536,000	4,176,000	1,359,000
1972	1,220,000	674,000	547,000	5,795,000	4,372,000	1,423,000
1973	1,291,000	712,000	580,000	6,058,000	4,570,000	1,488,000
1974	1,350,000	744,000	607,000	6,273,000	4,733,000	1,541,000

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare, Office of Education circulars: Opening (Fall) Enrollment in Higher Education (1954 through 1964). Population data used are consistent with series B projection in U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Projections of the Population of the United States by Age and Sex to 1985, series P–25 No. 279.

The projection of total undergraduate and 1st-professional degree-credit enrollment by type of institution and by attendance status is based on the assumption that in each enrollment category the 1964 ratio of full time enrollment to total enrollment will remain constant to 1974.

For methodology details, see appendix table A.

[2] Undergraduate and 1st-professional opening fall degree-credit enrollment by level and attendance status was estimated from 1st-term enrollment by level and attendance status reported in the Comprehensive Report on Enrollment (annually 1953–55, biennially 1957–61). The estimates were adjusted to agree with enrollment by attendance status reported in Opening Fall Enrollment Surveys, 1962–64.

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

TABLE 15.—*Estimated full-time 1st-term enrollment in institutions of higher education, by degree-credit status of student and by control of institution: United States, 1954–55 to 1974–75* [1] [2]

[In thousands]

Year	Total			Degree-credit full-time equivalent enrollment [3]			Non-degree-credit full-time equivalent enrollment [4]		
	Total	Public	Private	Total	Public	Private	Total	Public	Private
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1954–55	2,353	1,359	994	2,285	1,306	979	68	53	15
1955–56	2,573	1,492	1,081	2,496	1,432	1,064	77	60	17
1956–57	2,811	1,657	1,154	2,694	1,567	1,127	117	90	27
1957–58	2,904	1,735	1,169	2,748	1,616	1,132	156	119	37
1958–59	3,070	1,851	1,219	2,904	1,723	1,181	166	128	38
1959–60	3,187	1,925	1,262	3,015	1,791	1,224	172	134	38
1960–61	3,376	2,049	1,327	3,210	1,922	1,288	166	127	39
1961–62	3,636	2,251	1,385	3,473	2,128	1,345	163	123	40
1962–63	3,900	2,459	1,441	3,681	2,290	1,391	219	169	50
1963–64	4,180	2,702	1,478	3,933	2,509	1,424	247	193	54
1964–65	4,580	2,995	1,585	4,298	2,774	1,524	282	221	61
Projected:									
1965–66	5,002	3,292	1,710	4,682	3,041	1,641	320	251	69
1966–67	5,424	3,586	1,838	5,065	3,304	1,761	359	282	77
1967–68	5,836	3,875	1,961	5,435	3,560	1,875	401	315	86
1968–69	6,175	4,120	2,055	5,736	3,775	1,961	439	345	94
1969–70	6,272	4,200	2,072	5,810	3,837	1,973	462	363	99
1970–71	6,469	4,347	2,122	5,976	3,960	2,016	493	387	106
1971–72	6,743	4,549	2,194	6,212	4,132	2,080	531	417	114
1972–73	7,048	4,773	2,275	6,476	4,323	2,153	572	450	122
1973–74	7,355	4,994	2,361	6,738	4,509	2,229	617	485	132
1974–75	7,600	5,176	2,424	6,943	4,659	2,284	657	517	140

[1] Sources and method: Enrollment data from U.S. Department of Health, Education, and Welfare Office of Education circulars: (1) *Total enrollment in Institutions of Higher Education First-Term*, 1954–55, 1955–56, 1957–58, 1959–60, 1961–62; and (2) *Opening (Fall) Enrollment in Higher Education* (1954 through 1964).

The projection of 1st-term degree-credit full-time equivalent enrollment is based on the assumption that the ratio of 1st-term degree-credit full-time equivalent enrollment to opening fall degree-credit enrollment will follow the 1954–64 trend. Nondegree-credit full-time equivalent enrollment was projected similarly.

Separate projections were made for each control group. For methodology details, see appendix table A.

[2] The formulas for calculating 1st-term full-time equivalent enrollment and the enrollment categories included in each credit status group are as follows: For degree-credit, 100 percent of full-time resident graduate and undergraduate, 40 percent of part-time resident graduate and undergraduate, 50 percent of extension; for nondegree-credit, 60 percent of resident and extension terminal occupational, 20 percent of resident and extension adult education.

[3] First-term (October to January) enrollment in degree-credit courses differs from opening fall (October) enrollment mainly in the period of time covered.

[4] First-term enrollment in nondegree-credit course includes enrollment in terminal-occupational courses and in adult education classes of regular length. Opening fall enrollment in nondegree-credit courses, on the other hand, includes enrollment in terminal-occupational or general studies programs but excludes enrollment in adult education courses. Opening fall enrollment in nondegree-credit courses is available only for the years 1963 and 1964. Opening fall full-time equivalent nondegree-credit enrollment for these years was:

Control of institution:	*1963*	*1964*
Public	131,000	173,000
Private	32,000	26,000

NOTE.—Data include 50 States and the District of Columbia for all years. Because of rounding, detail may not add to totals.

FROM RESEARCH TO DEVELOPMENT TO USE

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The title of this paper emphasizes the traditional assumption that there is a fairly smooth sequence from research through a developmental phase to the utilization of research results. More and more evidence is being accumulated to show that this sequence is very seldom followed in actual practice and that special efforts must be made to assure that the results of research or new developments are, indeed, carried through to application in a school setting or, for that matter, in most other applied situations. There is widespread recognition that a problem exists in making the translation process effective. This is recognized by many actions at the national level. For example, the last Congress passed the State Technical Services Act of 1965, which will provide federal assistance to the states, in helping them acquire the necessary documentation and information to assist their local industry in applying the results of federally-sponsored research and development.

The problems associated with utilizing research findings have been receiving increasing investigation throughout the departments of the Federal Government, particularly in the Department of Defense. As is well known, each year the Department of Defense spends around 6 billion dollars on research, test, development, and evaluation. For several years now there has been concern that the new knowledge gained through many research and exploratory development projects is not being adequately translated into useful weapon systems. Because of this concern the Department of Defense has been sponsoring a series of studies on the way in which new knowledge and reports are used by engineers and scientists in laboratories and industrial organizations. In addition to the Department of Defense, other federal departments supporting research and development have been looking at the problem of how change is introduced as a result of new knowledge and techniques.

In education this is not a new topic by any means, but it is one that is receiving increased emphasis. This emphasis is evidenced by symposia such as the one in which we are participating, as well as the publication of books and newsletters on the problem of education innovation. A good example of the latter is the recently-instituted newsletter of the Conference of Strategies for Educational Change being produced at Ohio State University (4). Professional educators in the universities and in the public schools are trying to solve this particularly difficult problem.

This paper will relate some of the studies and investigations that have been alluded to above. Three separate studies from quite different settings will be described to illustrate some of the findings and problems associated with the generation of new knowledge and its impact on the institutions which receive the knowledge. Finally, an attempt will be made to relate these studies to the mission of the regional laboratories.

A Study of Factors Affecting Military Research and Development

Although this symposium is largely concerned with problems in education, it seems desirable to examine some of the studies that have been done in other fields in an attempt both to understand the generality of the problem we are discussing and to gain specific insights which can be derived from other studies. First, a review of an extensive study recently completed for the Department of Defense by Arthur D. Little (5) will be presented.

The Department of Defense procures very advanced new weapon systems, some of which turn out to be quite successful while others fail to meet their design goals. The question can be asked regarding the management and development factors that led to the development of successful weapon systems in some cases and unsuccessful ones in others. In order to obtain some answers to this question, it was decided to study six recently developed successful weapon systems.

The systems studied varied considerably in complexity and function and included the development of a new 105 mm. howitzer, an acoustic homing torpedo, the Hound Dog air-to-ground missile system, the Sergeant missile, the Polaris missile system, and the Minuteman ballistic missile system.

It was judged that the successful development of each of these systems required the application of new technology which had not priviously been incorporated into weapon systems. The Arthur D. Little team studied the technical reports and descriptions of these six systems and tried to identify all of the significant research and development events or units of new knowledge or technology that were instrumental in the successful completion of these particular systems. The team also visited the laboratories and private contractors responsible for the design and manufacture of these systems. The individuals who were involved in the early design phases of each of the systems were asked to identify the significant new developments which led to a successful system. Some 11 research events and 52 exploratory development events were selected for more detailed study. The following list will provide some notion of the kinds of events selected: the development of castable double-based propellants, the conception of canted rotatable nozzles for thrust vector control, the prediction of the ablative behavior in flight of quartz heat shields, the development of the high-temperature shock tube, the development of a disc memory for the digital navigation computer, etc. Once these various events had been identified, the team interviewed the management of the organization in which the event occurred, and the people who were personally involved in the development under consideration. From these interviews and detailed studies of the development of the weapon systems the study team drew a large number of conclusions, many of which appear applicable to some of the problems facing educational research and development. Listed below and briefly discussed are several of the conclusions reached by the study team.

1. Transition from Research and Development to Use Is Not a Straightforward Process.

Their observation of the development history of the various systems led to the conclusion that research and exploratory development are not phased in any orderly progression from basic research through exploratory development, advanced development, engineering development, system development, to production. Rather, the several phases go on somewhat simultaneously, and in many cases the logical order of some of the phases is reversed. Likewise, there is often a lack of understanding of what new knowledge and technology is needed. Even though such needs may have been stated in formal reports or requirement statements, the information did not seem to get communicated to the people who were actually working on the project. The report says, "In eight of the research and 46 of the developmental events, knowledge of the need was communicated informally to those who responded with the idea to satisfy it, rather than by a formal document or briefing." Thus we see the research and development process as quite informal, often not well organized, in which personal interactions take on greater significance than formal lines of authority or communication.

2. The Time Lag between Initial Discovery and Application Is Large.

It was found that for many of the development events which were critical to the success of a particular weapon system, knowledge regarding the solution of the technical problem had existed for quite some time. For example, the study says, "For half of the events the technological base had existed five or more years prior to event initiation: that is, except for the particular innovative idea which formed the kernel of the event, all the other science and technology involved had existed and been available five or more years. . . . This clearly suggests that more rapid technological events are possible if there could be a more rapid bringing together of needs, idea sources, and allocable resources in the right kind of environment."

3. Communication in Research and Development Tends to Be Informal and Largely on a Person-to-Person Basis.

For 33 of the various R&D events studied, papers, patents, and written reports, although available, had not been particularly important in bringing about the utilization of the particular knowledge; rather, informal communication among the personnel involved in the development seemed to be a matter of overriding importance. The report observes that "a great deal of significant information and technical stimulation is transmitted by personal contact and word of mouth. Documents are not remembered as sources of information or of stimulation, but rather as back-ups and references to be used after an initial basis of understanding has been established by personal contact." This finding is entirely

consistent with another study recently completed by the Auerbach Corporation (1) on the methods of information communication used by a very large sample of defense scientists and engineers. Here again, it was found that personal communication and personal files were much more important than formal documentation procedures.

4. Ideas Are Pushed through to Application at the Location at which the Ideas Originate.

In studying the various R&D events it was found over and over that the pushing through of an original idea from the research stage to the actual application involved the same people and the same management as were involved in the original idea or discovery. Very seldom were there instances where an idea or new finding had been developed in one laboratory and successfully transferred to application in another laboratory or manufacturer's establishment. It is particularly significant that in 55 of the 63 research and development events studies, the conceiver of the idea remained involved in the execution from the research and exploratory development phases up to the stage of manufacture.

5. Strong Leadership Is Essential.

In 58 of the 63 research and development events it was observed that strong personal enthusiasm and commitment to the achievement of the goal was essential and that this greatly contributed to the successful completion of the particular development event. Strength of leadership is not meant as a disciplinary sense but rather in the sense of enthusiasm, real belief and dedication to the idea being worked on.

6. Funding Is Not Neatly Controlled.

It seems particularly significant that initial funding of many of the research and development events was outside of the normal funding channels and often the item worked on was different from the normal designation of the category for which the particular funds were to be used. In 43 of the 63 events the funds which launched the event were discretionary expenditures rather than expenditures which had been allocated for that particular development. Often it was found that the funding for the development had been borrowed from other activities.

7. An Adaptive Rather than an Authoritarian Organizational Environment Was Important.

One of the most interesting findings of the study deals with the problem of management environment. It is often said that in military organizations, and particularly in organizations which are managed by engineers, there is a tendency toward an authoritarian management environment. It is unusually significant that in 62 of the 63 successful events the local environment was adaptive rather than authoritarian. By an adaptive environment the study team meant that authority was not based on position in the hierarchy but on expertise with regard to the task at hand. Critical decisions were not confined to the top but were diffused throughout the organization according to the ability of each person to contribute his knowledge or talent to the job toward which the organization was dedicated. Communication was not necessarily through established channels but rather was a function of who needed to know the information and how it would help achieve the desired goals which had been previously agreed upon. Likewise, in these organizations, values and motives were communicated throughout the organizations, in addition to technical information.

Before leaving this interesting study we should note several reservations. One is that the team undertaking the study consisted entirely of engineers and physical scientists. It was not until late in their study that they recognized the need for the participation of behavioral scientists. One of their recommendations is that in future studies of this nature the team should be a mixed team with a strong behavorial science contribution. It seems possible that the study team overreacted to the adaptive environment findings, and they do not seem to be particularly familiar with the rather extensive psychological literature in this area. Another reservation is that all of the events studied were taken from the development of *successful* weapon systems. Initially, it had been hoped to also study unsuccessful weapon systems to ascertain what events had led to their poor outcomes. With regard to this the report says, "However, the very thought of gathering together such a body of information and stigmatizing it as characteristic of 'other' or 'unsuccessful' research and exploratory development met so much resistance that all attempts were abandoned very early in the project. Informally, it was made very clear to us by a number of people that it would be

inexpedient to pursue this line at the present time." In spite of these reservations, this study is a very fine addition to the knowledge we have of the factors affecting research and exploratory development. It is particularly encouraging that the Department of Defense is taking a careful, objective look at the actual events which make for success in this area. Work similar to the study reported here is being continued as a part of Project Hindsight under the general direction of Dr. Chalmers Sherwin of the Department of Defense Research and Engineering.

A Case Study of a Successful Development Project but Unsuccessful Diffusion of the Techniques Developed

Edward Glaser's Human Interaction Research Institute is currently involved in an interesting study for the Vocational Rehabilitation Administration. In this study they are examining the factors which seem to have inhibited a number of vocational rehabilitation agencies from adopting the techniques and methods of a successful demonstration by the Tacoma Goodwill Industries of a project titled "The Development of an Occupational Evaluation and Training Center for the Mentally Retarded" (VRA 308). The objective of the Tacoma Project was to demonstrate the feasibility of rehabilitating severely retarded young adults to a level of sustained employment. The population consisted of young adults between 16 and 30 who had measured IQ's between 50 and 75. In addition to vocational training, the workshop emphasized training in work habits and in the various attitudinal and performance characteristics which would make these people acceptable to employers. A team consisting of a phychiatrist, a psychologist, a nurse, a social worker, and a vocational specialist worked with the individuals trying to impart the necessary skills. As a result of this effort, 63 percent of the subjects were placed in jobs, with each person remaining on the job for a minimum of 3 months. Some of the individuals were retained in sheltered workshops but many were placed in competitive employment in janitorial, domestic, factory, and farm settings. Although the original project was sponsored by federal funds, the Tacoma Goodwill organization has been able to continue this work under local auspices. This study was completed in June of 1963, and the results were communicated through formal reports to VRA and distributed to a number of rehabilitation agencies. However, despite the successful demonstration by the Tacoma Goodwill Industries, no other organization is known to have adopted the procedures.

Glaser and his associates (3) have been studying the efficiency of various methods of communicating the results of this study. As a first step, a questionnaire was sent to 40 widely separate VRA-sponsored occupational training centers for the mentally retarded inquiring whether or not they were aware of the study and its results. Since very few knew of the study, they were sent reports and a special brochure on the study. As another communication step, a representative of the Tacoma workshop visited a selected sample of the agencies in the California area to communicate the Tacoma results to them. As a third technique, a conference and demonstration for 33 representatives of workshops was held in the state of Washington. In addition to the representatives themselves, consultants from Human Interaction Research Institute, the VRA, Tacoma Goodwill, and University of Washington participated in a discussion of the Tacoma Goodwill project. The amount of innovation resulting has been evaluated by (a) an assessment by the participating institution themselves, (b) a specialist in worshop training centers, and (c) Glaser's staff. The results indicate the following: very little change resulted from the written reports; somewhat more innovation resulted from the personal visit; however, the largest, and statistically significant, change resulted from participation in the seminar and observation of the demonstration project.

Having studied the Tacoma project and a number of other projects which had been sponsored by the VRA, Dr. Glaser and his colleagues have formulated six factors which seem to be essential for the development of innovative programs in the rehabilitation field. Since these same factors seem to be relevant to other fields they are listed below.

1. The vocational rehabilitation agency must be a relatively thriving one so that there are adequate resources of personnel and money to be spared from the struggle for basic existence.
2. There should be a leading person with a vision of what might be accomplished, and the dedication, energy, and enthusiasm to inspire others to share this vision.

3. This agency leader needs freedom of action and encouragement from his executive board, and through them the implied consent of the community.
4. The agency director should be able to seek and select key staff members in sympathy with his aims and with the abilities required to carry them out.
5. It is highly desirable to have understanding and support from the state vocational rehabilitation agency and preferably from the regional office of the Vocational Rehabilitation Administration.
6. Some influential person in the agency needs to be interested in learning about innovations elsewhere that might be of interest or relevance to the agency.

The Traveling Seminar and Conference for the Implementation of Educational Innovation

It is a common observation that American agriculture has undergone a profound revolution in the last 60 years. It is often asserted that the great increase in productivity of our farms is largely due to the application of research and development in the agricultural area. The Extension Service of the Department of Agriculture has played a leading role in bringing new developments to the attention of farmers. It is often argued that in other areas productivity and results have at times lagged because there has not been an adequate communication and demonstration technique employed to bring the fruits of research and development to the attention of practitioners. This was one of the motivating factors underlying the recent passage of the State Technical Services Act, and a similar suggestion has been made with regard to education. Since the agricultural example appears so frequently it is worthwhile to describe it briefly. The mode of operation of the Agricultural Extension Service and the analogy to education have been well presented by Clark (2): "Education today may have roughly the same relationship to its practitioners that existed in the field of agriculture in the latter part of the nineteenth century. At that time the primary vehicle of communication to the practitioner was the printed word—from research to practitioner. The impact on agricultural practice was slight. Interposed now between the researcher and the practitioner are two levels of translation. The extension specialist can read the research and translate it into something the county agent can understand. The county agent, however, does not typically pass this information directly on to the practitioner. *Instead, he provides an opportunity for the farmer to visit another farm in his neighborhood where the new practice is being employed.* (The research has already been packaged for marketing.) The situation is a real one. The farmer using the new method is risking his own money on his own farm. The visiting farmer has a chance to see what is going on and talk to the experimental farmer about it. The same suspicion on the part of the practitioner in regard to new practices, noted as typical of the teacher, led the Department of Agriculture to adopt this technique."

It is noted that one of the important characteristics of the agricultural demonstration has been the assignment of personnel who have a full-time responsibility for helping individual farmers translate research and development into practical application. Further, the demonstration takes place in the "natural setting" of the farm. A particular farmer is persuaded to try a new technique in his real-world farm situation. His success is then demonstrated to other farmers who have agricultural problems very comparable to the situation of the demonstration farmer. The analogy in education is that new innovations need to be demonstrated in an everyday ongoing school situation rather than in special demonstration schools or university laboratories.

The System Development Corporation was interested in testing the feasibility of conducting traveling seminars and conferences as a technique for increasing education innovation. There was a near, but not exact, analogy between the way in which the traveling seminar was conducted and the agricultural model mentioned previously. Under Title VII of the National Defense Educational Act the U.S. Office of Education supported SDC in its traveling seminar program. This program has been described by Malcolm Richland under the title "Traveling Seminar and Conference for the Implementation of Educational Innovation" (6). While Mr. Richland authored the report, a large number of people at SDC were involved both in conducting the seminar and conference and in evaluating the results. The remainder of this section will be devoted to describing the way in which the seminars were conducted and some of the conclusions which can be drawn regarding their effectiveness. Much of the material in this section has

been quoted or paraphrased from the report. The project had four major objectives, as follows:

1. To conduct a survey of, and visitations to, school sites with outstanding innovations.
2. To implement and conduct a traveling seminar of some 120 educators to selected innovating school districts in four regions of the United States.
3. To conduct a conference on the problems of implementing tested innovations.
4. To perform research related to the testing of the field extension service concept in education.

"Principal activities of the project included a traveling seminar in which four groups of approximately 30 educators each, representing four regions of the United States, visited selected schools where significant innovations had been introduced and in operation for at least one year. Immediately following the seminar, a conference of tour participants was conducted at SDC on the dynamics of educational change; approximately one year later, on-site visitations to the participants' own schools were implemented.

"The school visitation sites were analogous to the demonstration centers inherent in the field extension concept of the Department of Agriculture. Each tour was led by a well-known and respected educator ('outside change agent'), who was accepted by his professional colleagues as being especially qualified to interpret the experimental foundations upon which a particular innovation was based, if such foundations were, in fact, offered by the innovator."

These four tour leaders were responsible for conducting the tour, were involved in the selection of the sites to be visited by the traveling seminar, and made all the arrangements for the visits to the schools, including advance briefings to the officials of the schools involved.

The schools selected for visitations were ones that showed evidence of successful implementation of various educational innovations. The emphasis was on new educational media, major changes in curriculum, innovative teaching methods, and new school organizational patterns involving the use of teachers' time and classroom space. The schools selected also represented different sizes and urban-rural characteristics in the geographic region. Each of the schools visited had at least one year's experience with the particular educational innovation involved. To give a feeling for the kinds of innovations observed, the eastern tour, visiting one school in Massachusetts and two in New York, was exposed to the following:

Continuous Progress Plan
Lay-Personnel on Teaching Staff
New Vocational Training Plan for Culturally Disadvantaged Students
Educational Media Center
Closed-Circuit Educational Television
New Curriculum Materials
Auto-Instructional Devices for Individual Study
Flexible Scheduling

The tour participants formed a somewhat heterogeneous group. A number of studies have shown the importance of the school superintendent and the need for positive and effective leadership at this level. In addition, the representatives of the various formal echelons of education are important and their concurrence is often needed in effecting innovations. Therefore, the final composition of each tour group included 15 local administrators, 8 state education department officials, and 7 respresentatives from teacher training institutions. The tour itself lasted one week. Each group met on Monday of the week of May 11, 1964, were briefed by the tour leader, and then began the site visits. At the site they observed a particular innovation and discussed its advantages and problems with the teaching and administrative personnel. The team often met among themselves to discuss further the particular activity observed and then moved to the next site. The complete tour involved visiting at least three different schools in separate geographic locations.

Following the tour, the tour members came to Santa Monica for a conference on May 16 through 19, 1964. This conference was attended by the tour leaders, the tour participants, and selected consultants and specialists from SDC. At the conference each of the tour directors gave a fairly extensive description of the innovations observed by each team, as well as a summarizing report of the problems associated with the innovations observed. In addition, there were various addresses by leaders in the field of education and people who had studied prob-

lems associated with the introduction of change within various organizations. The following statement of general conclusions is quoted from the report.

"Using the reports of the four regional tours and the results of the work sessions at the conference as a departure point, certain conclusions are suggested upon which further investigation can be based and from which guidance may be obtained in planning new programs. The conclusions most consistently expressed by the traveling seminar and conference participants were as follows:

"a. Innovations are in practice in many schools throughout the country. Although more prevalent in districts with above-average financial support, innovations are found in some districts with limited resources.

"b. There is a patent lack of research upon which to evaluate existing innovational practices.

"c. Innovations tend toward accommodating the spread in pupil abilities and achievement by individualizing instruction. This is displayed by greater instructional flexibility in the use of space, time, methods, and group size.

"d. Wherever innovations have been implemented, there is evidence of strong, positive, and dynamic leadership. This conclusion tends to support Brickell's conclusion that the superintendent is the primary agent.

"e. Innovations often result from those crisis conditions that present problems needing new and dramatic solutions. Typical of such circumstances are radical population growth; major changes in the composition, structure, or economy of the community; and the onslaught of well-organized pressure groups.

"f. Implementation is often facilitated by the acquisition of federal funds or foundation grants. These funds provide seed or risk money and incline to have a pump-priming effect.

"g. There exists no structured program of planned change. No agency or institution is charged with the specific responsibility of aiding the implementation of innovations, nor is such responsibility designated in the formal line structure of school districts.

"h. Laboratory schools and demonstration centers are thought to be miscast in the role of dissemination. They do not build conviction because they are not credible.

"i. Although useful, the literature, conferences, workshops, and individual visitations are considered inadequate to the task of dissemination.

"j. It is generally agreed that implementation comes after research and development, or design. The 25- or 50-year lag or gap between research and implementation is attributed to a failure to take effectively the next step(s) of demonstration, dissemination, implementation and evaluation.

"k. The consensus among the conferees was that demonstration centers (not a part of a local school district) and laboratory schools are not the dynamic needed to build conviction (because they lack credibility) or to facilitate action programs."

Although the participants in the seminar expressed great enthusiasm for the traveling seminar as a technique for observing innovations and for stimulating participants to try such innovations in their own school setting, a more careful evaluation of the results seemed desirable. This evaluation consisted of two parts. One was assessment of a large amount of anecdotal material, letters, discussions, etc. The easiest way to summarize this material, which is discussed at considerable length in the report, is to say that the participants seemed to be extremely pleased with the program, and expressed plans to attempt many innovations in their own school settings.

The second effort was to undertake a formal evaluation of the effects of the program. In this evaluation, 46 of the 60 participating school districts were used as the experimental group and 57 comparable districts formed a control group. Prior to the initiation of the tours the superintendents for schools in both the experimental and control groups had filled out a detailed questionnaire concerning the nature of educational innovations in their districts. Approximately a year later each superintendent was visited, and participated in a structured interview regarding the school district and its innovations. Following the interview, the questionnaire and interview material were assessed by SDC staff personnel, and degree of innovation was scaled on a 0 to 4 scale. Table 1 shows the innovation index for the participants and the nonparticipants. As can be seen, the participating districts have a higher innovation score than do the nonparticipating districts. This change score has been analyzed by analysis of covariance with the results being significant at past the 0.1 level of confidence.

TABLE 1.—*Mean innovational index for participants and nonparticipants by geographic location and year*

	Number of cases	1964	1965	Change
Participants:				
East	14	34.7	39.5	4.8
South	12	23.2	29.5	6.3
Midwest	12	25.2	31.9	6.7
West	8	19.6	29.4	9.8
Mean gain				6.6
Nonparticipants:				
East	15	27.0	31.7	4.7
South	14	17.9	21.7	3.8
Midwest	14	23.9	28.5	4.6
West	14	26.3	29.5	3.2
Mean gain				4.1

In addition to the demonstration of the influence of the traveling seminar on innovation, we were interested in determining the various factors within a school district which seemed to be associated with the introduction of change. From questionnaires and interview material some 72 different variables were extracted and correlated against the change scale. The highest predictors of educational innovation are shown in Table 2.

TABLE 2.—*Predictors selected for multiple regression and their correlations with the 1965 innovational index*

Variable	*Validity coefficient*
Highest teacher salary	0.53
Superintendent's ambition	.51
Superintendent's autonomy	.50
High school density	.44
Population density	.42
Effect of innovations on finances	.40
Social class of district	.36
Effect of innovations on the organization	.34
Percentage of Jews in district	.32
Percentage going to college	.32
Influence of the board of education on the implementation	.30
Community support for innovations	.30
Percentage completing high school	.27
Urbanity	−.42

A multiple correlation of .78 is obtained from the variable shown in the table but a correlation of .66 can be obtained from using only the two variables "Highest Teacher Salary" and "Superintendent's Ambition." Using completely factual variables, such as "Highest Teacher Salary," "High School Density," "Degree of Urbanity," etc., one can obtain a multiple r of .63.

These results indicate that the traveling seminar and conference was viewed by the participants as a highly successful endeavor. The formal evaluation of the results of having participated in the seminar shows that those having had such experiences do, indeed, initiate more innovations in their school districts than one finds in districts which have not had the opportunity to participate in the seminar. In addition, some insight into the conditions which seemed to allow for educational innovation can be obtained from a study of the factors associated with the introduction of innovation.

As a result of the study of the effectiveness of the traveling seminar, the following recommendations can be made.

"1. The traveling seminar and conference technique should be expanded and actively supported by adequate financial resources as an effective dissemination activity for spreading innovation by the U.S. Office of Education, state departments of education, and local school districts.

"2. The traveling seminar and conference technique should be considered for incorporation in the dissemination programs of the planned U.S. Office of Educa-

tion regional laboratories for research and development, under Title IV of the Elementary and Secondary Education Act of 1965."

Implication for Regional Laboratories

The studies previously cited deal with a wide variety of research and development situations and the transition from development into the application of the new knowledge or techniques. It appears that all of the studies point in a similar direction; an attempt will be made to relate this impression to the regional development laboratories being established throughout the country.

First, a few words with regard to the situations in which research will be applied. One of the impressive results from the studies just cited, as well as from other observations, concerns the importance of the innovator and leader in research and development activities. It appears that frequently there is an individual who has a unique idea and who sees the possibility of developing it into a useful activity. This individual may will start out in the family pure research aspects of the area. If he is successful in these activities he may, with great determination, carry on into the advanced development and application phases. One can speculate that there may be many very successful research people who develop ideas and demonstrate their feasibility, but then do not carry forward to the application phase. In these instances the fruitfulness and utility of the idea become lost until some later person picks it up in connection with some other project (and, to judge by the Arthur D. Little study, this seldom happens). The importance of forceful leadership, dedication to an idea, and the carry-through from research into actual application is extremely important.

In large organizations there are frequently procedural and organizational considerations relative to the transition from research to development and to application. Often these activities are assigned to different major divisions of an organization on the theory that ideas developed in research will be picked up by a different group of people who will transform these ideas into an advanced development which is ready for application in some other part of the organization. The evidence seems to indicate that this is not a fruitful way in which to promote new developments. It would appear that considerable management and organizational flexibility is required, along with much crossing of organizational lines and management hierarchy, to carry forth successful developments.

Similarly, with respect to funding, large organizations, and particularly the Government, are constrained to develop budgets and administer funds under fairly rigorous financial procedures. However, this tends to inhibit the needed flexibility for development of new research. As was evidenced, particularly in the weapon development study, the funds used for various developmental research activities often do not come from the particular budgetary category which one would logically expect them to come from. Rather, the leaders of the new developments tend to find their funds wherever they can and to have little regard for the formal funding organization. While this is disruptive of both management responsibility and neat accounting activity, it may well be one of the prices to be paid for effective development activities.

Another area which is critical to the application of new knowledge has to do with the problems of communication. Traditionally, the researcher has taken the position that if he publishes his results in the formal scientific literature he has discharged his responsibility. From the evidence cited it would appear that the formal publication of new findings does not by any means assure that the results will be expeditiously translated into a useful development. Rather, the findings of the studies cited, as well as other material, tend to indicate that informal communication is by all odds the most important method or technique for transmitting ideas from one environment into a different one, and that engineers and technical people concerned with the application in new areas tend not to be as familiar with or dependent on the formal technical literature as the research scientist would like to think. This observation tends to emphasize the responsibility of the research scientist to make his results broadly known and communicate in a form which is readily accepted by practitioners.

With regard to traveling seminars, the SDC study has demonstrated that these seminars have the potential of being a very effective technique to stimulate the wide adoption of new innovations. However, a number of conditions are necessary before the traveling seminar will be useful as a powerful force toward innovation. Obviously, there must be large support on an extensive geographical basis, just as the Agricultural Extension Service is very widely supported. Perhaps

more important, however, is the requirement that the various innovations to be demonstrated must be credible—credible in the sense that they are demonstrations of innovation in the ordinary school setting, carried out by regular personnel and not be specialists who come into the school situation and then leave. This, of course, emphasizes that the environment in the demonstration school district must be appropriate for the reception and continuation of a particular innovation. The factors making such an environment appropriate have been spelled out in the traveling seminar research. They particularly emphasize the importance of a strong leader who is dedicated toward the introduction and maintenance of new innovations in his particular school.

Finally, some comments directly appropriate to the regional laboratories. The assumption is made that the primary purpose of the regional laboratory is not to undertake research *per se* but rather to facilitate the introduction and demonstration of new techniques in the various real school situations. There are already many sources of research sponsorship, and it would be unfortunate if these centers become simply another alternative way of administering research funds. Secondly, the regional laboratories will provide a great service if they are able to arrange for credible demonstrations of new techniques. The regional laboratory can stimulate local school personnel to try out new ideas and innovations to determine if they are applicable in the actual school situation and then use these demonstrations as examples for application in other school settings.

Implicit in this mission of sponsoring demonstrations is the problem of evaluating the effectiveness of new innovations. Before introducing innovations, it is important that the regional laboratories evaluate them, so that the demonstrations shown to other practitioners are demonstrations which have a proven usefulness in a school setting. Too often new techniques are introduced into the schools and are adopted widely without any sound evaluation to demonstrate that they, indeed, increase the effectiveness of instruction or school administration. It is extremely difficult to do good evaluation work in the field, and the regional laboratories will demand high quality personnel and sophisticated techniques if they are to be successful in this mission.

If the regional laboratories take as one of their missions the fostering of the transition from research to development to application, they would be well advised to adopt several policies which will be somewhat contrary to well-regulated organizational concepts. Among these are that the regional laboratories should promote the movement of personnel between various organizations. It would be valuable if they could assist university personnel to become members of the laboratory, to become members of regular school systems, and to go back into the research or university setting. The transition of new ideas depends very much on the transition of people from one setting to another. Often our institutional barriers make it difficult for an individual to leave one organization and move to another even though the efficient promotion of new knowledge requires it. If the regional laboratories can work out techniques which will allow people to move easily from one setting to another, they would be doing a great service. Second, it would be hoped that the regional laboratories will have considerable discretion in the way in which they can spend their funds, that is, that their funds not be earmarked for limited specific purposes but rather that the director and trustees of the different regional laboratories be given flexibility regarding the kinds of projects they will support and the nature of support given in the various projects. Finally, care should be taken that the regional laboratories maintain a high degree of objectivity and independence. It is clear that if the laboratories are to engage in promoting new innovations, and particularly in promoting innovations which are truly useful in the practical school setting, they must be independent of the many different special interests in education. This is not to say that the special interests should not have a concern. Clearly, the researcher is concerned, the school board is concerned, the parents are concerned, but if the new innovations are to be given an adequate trial and a fair evaluation, it is important that the innovator and evaluator be given as much freedom and independence as possible; otherwise, his objectivity may suffer, and he may unduly limit the perspective and scope of the various innovations he will feel free to sponsor.

One final comment—it appears that the regional laboratories may well be one of the important educational innovations of our time. The clear facing of the problem of introducing new ideas into the ongoing school situation is extremely important. If the laboratories achieve independence and strength, we may look forward to important gains in education; however, the regional laboratories

must be extremely careful to guard against the easy tendency to become simply another bureaucratic and report-generating organization. There is a challenge before the educational community, and this challenge is to make the regional laboratories really effective change-agents.

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CYBERNATION AND CHANGING GOALS IN EDUCATION

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I should like to share some speculations about the interactions between cybernation and changing goals in education, though in a half-hour I can barely touch on some important issues, much less explore them.

Obviously cybernation will have an impact on the social context, and hence on the goals, of education; by the same token, being "systems" people, we also realize that a changing social context will in turn affect the impact of cybernation. Thus persons concerned with the context surrounding education, like computer people, should be future-oriented; for both are engaged in a struggle to make the best use of what lead time there is to prepare for the use of computers on a wide front in education. Therefore my remarks will be devoted to reviewing some of the important aspects of the coming social context with which both educators and computer people must deal, and to mentioning some of the issues that merit attention in the application of computers to fulfillment of American educational goals—especially if these goals are changing. As I talk let's keep in mind we are referring to education in relation to both the young and to adults including older adults; for they present different problems, different opportunities, and perhaps different goals in education. Keep in mind, too, the fact that the educational environment will expand beyond the physical confines of the school, as a result of computer capability. In all this, of course, I am being tentative and speculative, in keeping with the spirit of this conference.

First, let me discuss population characteristics over the next decade or two, since today's school children will be adults during that time, and since today's adults will be trying to cope with many social transitions during that period, and in the process of coping will have to be educated and re-educated not only for work but also for new perspectives. We are told that by 1975, the population of this country will be about 235 million; and by 1980, it will be about 250 million. By 1975, those who are 25 or younger will represent about 50% of our population, and the percent who are over 65 will have increased very substantially—by about 20%.

This means, among other things, that we shall have a population not only of unprecedented size, making radically new demands on our technological abilities, but one also polarized in terms of age and hence in terms of values brought to the educational experience. Education will have to enhance or modify these values, which are not necessarily compatible between the young and the old, as they reflect social needs and aspirations.

The second contextual factor is that of the increasingly urbanized condition in which our population will live. You are familiar with the growth of the megalopolitan areas of the East Coast and the West Coast. There is one growing in the Middle West as well. The result will be a greatly magnified population living in an unprecedentedly interactive environment, where cities are no longer isolated

entities working out their problems separately, but instead must work together as parts of regions, or at least very large urban systems.

The third contextual factor has to do with the increasing role of government. To my mind, and to those of other observers to be sure, there seems to be no extant social invention, other than that of large scale government, to deal with the enormous scope and complexity of the issues that society faces and to do so in the kind of long-range systems-planning context that is required if we are going to take advantage of our opportunities and minimize our problems. The size of the population and the growth of megalopoli that ignore state boundaries seem to demand increasing federal involvement, a much larger federal contribution to the direction of the society. Certainly we shall have experiments with new forms of local governments: city governments as we've known them will be less and less effective and will gradually die hard.

Another factor that is, I think, extraordinarily and radically important to the set of relationships we are discussing will be the increasing effectiveness and utilization of what we can call social engineering: the systemic application of knowledge in economics and behavioral sciences, and so on, to the design, planning and manipulation of the society and its parts in order to attain efficiency specified goals. The stimulus is there, especially with the development of such nation-wide programs as the poverty program and the extended education legislation, and—while we don't talk about it—the area of counterinsurgency. In all these cases we must be able to plan exceedingly complex programs far enough in advance to phase and implement them effectively. Here, the computer provides an unprecedentedly powerful tool for better understanding men and their institutions, and hence for planning and for implementing these plans. For the computer provides us with the capability of simulating very complex models of human and institutional behavior with adequate real-time data processing capabilities to test the models against society as it is today, not as it was five or ten years ago. In particular, the computer provides the technology for storing and processing the data required to do longitudinal studies. Such studies are crucially necessary for developing the needed understanding of social processes and social change. For the most part, such studies remain to be done.

The status of these research areas is gradually growing, and inevitably new knowledge will be increasingly applied by government, and others, to the needs of such a large population living in such a complicated society. We can see the beginnings of this increased rationalization of programs and planning, as practiced in the Defense Department, now being applied in the education and the poverty programs. Obviously, this increased rationalization of social processes and of the means for planning and implementing them depend on the existence of the computer—not only because the computer makes possible the simulation of alternative policies and programs but because it allows us for the first tir e to encompass significant aspects of the environment. I doubt, for example, that our exciting plans for nationwide revisions in education could possibly be im plemented if the computer did not provide us with the understanding of what is happening in time to take advantage of it as it happens. National planning—long lead-time planning—clearly requires the existence of the computer, and will grow from that very existence.

One way to summarize this societal context is to state that it is of unprecedented complexity, and that to deal with this complexity we will have available to us through cybernation and other technologies an unheard of capacity for doing enormous good to ourselves, or enormous evil. With this background in mind, let me turn to some specific issues which relate cybernation to the changing goals of education.

We are going to need more planners who are able to use these technologies and can grasp larger social issues and work with them in a broader context. There is a real question about how to provide the education for this kind of role. It is going to take more than knowledge of computer techniques and the behavioral sciences to do this job both efficiently and humanely. For increased rationalization also means there will be increased "guidance" or "manipulation" of various segments of society. If the technology for doing so exists, it will be used, given the persistence of power-seeking motives. But, what's more, we will need to use it, since the necessary social changes cannot come about if the affected people do not understand and desire them. Thus, the pressures, the good moral and ethical reasons, for using attitude-changing techniques will increase; the potency of the technology for doing so will also increase; and, of course, there will be a mounting danger to the democratic tradition and the Judeo-Christian tradition on which it

is founded—unless we learn how to educate to protect them. I will come back to this point later.

Another question, in addition to that of educating leaders, arises: How do we educate run-of-the-mill citizens for membership in a democratic society, given the enormous complexity of social issues and the increasing abstruseness of the techniques for dealing with them? What, indeed, are the appropriate political roles for citizens in such a society? How does one educate to make people comfortable with, sensitive to, and aware of complexities? I am delighted with Dwight Allen's division of goals; I think it is appropriate. But how do we teach people to understand their relationship to long-range planning? Our tradition has always been short-range or no-range planning. And how do we teach people to be comfortable with, indeed to embrace, change and the process of change? Should we educate for this? I suspect we have to. But now?

In speaking of education for embracing change, I'm not limiting the need to youngsters. I include the teachers of the youngsters as well. Education for tomorrow's world will involve more than programming students by a computer it will equally involve how we program teachers and administrators and parents to *respond* to the education their children and students get for this kind of world. To the extent to which we succeed with the youngsters but not with the parents, we have an interesting, and, I suspect, a very serious consequence: we will have an increasing separation of the young from their parents, a kind of parallel to the relationship of immigrants and their children in this country. Perhaps it will be a more drastic one; certainly it will have psychological repercussions probably producing in the children guilt and hostility (arising from their rejection of their parents' views and values) and the kind of vitality and drive that goes with these or, in the past, has gone with these in the United States. Those planning the curricula for the young, I think, should not overlook this problem of producing a psychological gap between the young and their parents.

Let me turn now to some implications of cybernation for work in this society and its consequent implications for changing educational goals. (Here I am talking about other than the implications of unemployment due to cybernation.) There are important education issues pertaining to those who will have jobs. For example, many of them will be changing what they do two or three times throughout their lives. The question is: who are they in relation to what they do? Given a career or a type of job that has defined my identity—when the job changes, what happens to the definition of who I am? Work in this society means more than income; it has provided psychological meaning for generations of people who have defined themselves and have been defined by their work; and it is the basis for the Protestant Ethic regarding the sinfulness of nonwork. This holds not only for young people, but for their teachers, particularly those lower-middle-class teachers who constitute the bulk of the teaching core in primary and secondary schools and who reflect the traditional values about work. To the extent to which work changes its meaning in the years ahead, there will be deep questions raised about the appropriate, the "right", education needed to provide a redefinition of the relation of self to work. This is already a problem for older people forced or "encouraged" to retire before they are ready to. It does not follow, of course, that the approach appropriate for giving theological, ethical, and psychological self-definition to the early retired will be applicable to the young.

Of great importance in connection with work is the fact that some of the most interesting jobs will increasingly be human-oriented jobs. I don't mean sales jobs, but rather the kind of sub-professional jobs that involve real—not pseudo—rapport between people, jobs that we either can't do by machine or don't want to do by machine such as teachers' aides, clergymen's aides, welfare aides, mothers' helpers, etc. How do we educate for the kind of roles that are appropriate for such jobs? How do we educate people to be non-exploitive and non-manipulative in their relations with other people? How do we educate for rapport and empathy? And what is the relationship between educating for those human-related aspects of the future work situation and the tendency increasingly to expose people at all ages—but particularly young people—to a machine-educative environment. Please don't misunderstand me. I'm a great believer in and defender of the computer and the programmed environment. But I am raising what I think is a real question. What will be the effective means—in a computer valuing environment—for teaching these other "human" characteristics that will be increasingly important? Part of the poignancy of this problem is that many, many teachers, I suspect, are deficient in these characteristics as well. Their past tradition has been to educate for intellectual skills, for work, not for education, for emotional

openness, tolerance for ambiguity and cultural differences, and other characteristics needed for social-aide roles.

Because cybernation will radically change the work force composition and the purpose of work, education not only faces a very large task in altering its goals and its techniques for dealing with work but it must develop a radically different capability to educate for leisure. To the extent to which cybernation provides more productivity, it provides the opportunity for more leisure. I am well aware that the world's work is never done; there's plenty to do to keep everybody busy 24 hours a day and keep the sort that are in this room busy more hours than that. But the point is that people have chosen to take some of increased productivity in increased leisure; and there is every evidence that they will choose to do so more and more as the productivity of the society grows—in significant part as the result of cybernation.

The question then comes up of how to invent—and I think "invent" is the right word—adequate life styles for increased leisure time and then to teach them. And please don't say, "Oh, my god. If I had leisure no one would have to invent a life style for me." You are not the people I'm talking about, since top-flight professionals will be scarce and overworked for a long time to come. We have to invent these roles, and then we have to invent educative means for inculcating them in the young and in the older people who comprise the rest of the working population. Personally, I see no evidence that masses of people can suddenly learn "leisure" at the age of fifty, or even in college. And I find no comfort in what are sometimes suggested as historical precedents. Investigation indicates no historical models adequate for a 200 million person, highly technologized society trying to spend its leisure time meaningfully. I don't mean necessarily productively or creatively, but self-fulfillingly. Here, I think, is an enormous challenge: how to inculcate the cultivation of self. Can we transcend or operate to this end within a school system which, for the most part, is still premised on education for work and administered with an eye on efficiency?

Let me summarize my feeling about what we're up against and what the opportunity is. It seems to me that the ultimate challenge for educators trying to establish and implement goals for living meaningfully and fully in a cybernated society is two-fold: 1) that we be able to produce more intellectually skilled people, and 2) that we be able to produce in numbers and in quality, as never before, *wise* people. Now, in some important sense, wisdom is a function of trained intelligence, but I think we would all agree that wisdom implies more than trained intelligence. We are going to need wise citizens if they are to have responsibility for the direction of tomorrow's world and if they are going to prepare themselves and their children for it. But in particular, cybernation puts enormous burdens on the leadership of the society, for the efficient and humane use of cybernation will require a level and frequency of wisdom notably lacking in the leadership of our society, and indeed of all previous societies.

The balance between the individual and the mass will be increasingly difficult for leaders to maintain as the society becomes larger and aggregate solutions become more sophisticated or more necessary. (And on the basis of what I've said before, I think this is true even for the process of trying to figure out how to "individualize" instruction. "Individualized" instruction for what ends?) The pressures arise partly because the computer provides special techniques for dealing with the mass. The pressure also exists because there will be political demands to deal with the mass, and it will be aggravated by our very ability to manipulate a large society—an ability provided by the computer in part directly through information on what is happening to the society, and in part through the knowledge it has previously produced about how the society behaves. Thirdly, there will be pressure on leadership to deal with the mass rather than the individual because there will be a tendency to value most highly those things the computer can define, measure, and otherwise deal with: for this society, science and technology are our faith, and, as all true believers, we will emphasize what our faith purports to answer even if it falters in doing so.

We need what the computer can do, but equally or more so, we need a broader perspective. We need people who understand the human predicament beyond that which can be encompassed by programmed instruction and computerized education. We certainly don't know what wisdom is or how to produce it. Certainly we don't know what the relation of live teachers—to say nothing of computer teachers—might be to the production of wisdom. But understanding this blessed state of mind, and cultivating it, and providing the context which allows it to operate will become an increasingly crucial task for educators. For,

among all these speculations, one thing is clear: new curricula, new administrative methods, and computer technology will give more men than ever before vastly greater power than ever before to create or to destroy themselves as bearers of the Judeo-Christian tradition and as practitioners of the democratic process.

THE FORWARD LOOKING SCHOOL: SOME GUIDING PRINCIPLES FOR EFFECTIVE SCHOOL ACTION [1]

I. Introduction

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The usual description of the "good" school is written in terms of such features as class size, level of teacher training, library facilities, and scope of curricular offerings as measured against fixed standards.

The present effort to describe the good or effective school is made from a different point of reference: schools must be responsive to the needs of the community and society they serve. Our present socioeconomic order is rapidly changing, being characterized by great growth in knowledge, by automation and complexity. In such a society, schools themselves must change to meet new challenges. They must utilize advances in knowledge and techniques. It follows that the description of the "good" school cannot be written in static terms; it must be in action terms.

In this study, excellence is seen as the rate at which the school adjusts to changes. Adaptable schools respond more quickly and in more ways. The discussion identifies the action principles that guide productive schools in program development. Three components of the total school program are discussed: instruction, teachers, and school-community relations.

II. Instruction

The test of an effective school is the quality of education it provides. But in a world of rapid, far-reaching changes, the kind of education to be offered is itself a problem. We can no longer rely on the comforting assumption that young people will live and work in conditions similar to those which influenced their parents. We are living in a period of human history for which this assumption does not hold true. Today, schools are confronted with the immensely difficult task of preparing youngsters, not only for the world around them, but for a different world 10 to 70 years in the future. The formula for quality education today must provide for the foreseeable conditions of tomorrow.

Never in the past was the challenge to education so severe. One of the most critical problems is the changing world of knowledge. Not only has the amount of factual knowledge increased at a tremendous pace, but many concepts, theories and interpretations of previously known facts differ radically from those accepted only a generation ago. Powerful experimental techniques and sophisticated instruments of investigation have rapidly brought into the area of the known that which formerly could not be measured or explored and, consequently, precisely understood. In each of the traditional disciplines, there are today completely new bodies of knowledge, such as nuclear science in physics. Because knowledge today is so vast and changes come so rapidly, to know how to acquire knowledge with insight and understanding is as important as the amount of information already possessed.

The fact that modern life and modern knowledge are propelled unceasingly toward change by widespread research is of particular importance to education. The scientific method of inquiry has proved to be extremely effective in producing new ideas and discoveries. It is opening new frontiers for further exploration and creating systemically new industrial and commercial products. It has also become an indispensable tool in the solution of practical problems in political, social, and economic life. Today, some experience with the method of scientific inquiry is a necessary element of educational training.

The school must recognize new developments and make appropriate changes in its program. Curriculum and subject matter content must be reexamined and updated to include new ideas and interpretations. In modernizing the

curriculum the aim should be to familiarize students with the main notions which lie at the heart of each subject area, whether in the field of humanities or in social and natural sciences. Pupils should not spend time on outdated facts, theories, and generalizations. Instructional materials based on knowledge accepted by contemporary thinkers should replace obsolete information and antiquated theories. As the necessity for adding new material develops, it is imperative that time be provided by dropping or compressing less important material.

The massive growth of knowledge requires, too, that emphasis be placed on concepts and generalizations as well as on specific factual information. In a world in which knowledge changes continuously, fundamental principles have a more lasting value than specific content. Every subject should be taught as a way of understanding, not merely as a sum of facts which can be memorized. Content should be selected with the aim of helping pupils to recognize the explanatory principles which make any subject intellectually important. In social studies, for example, the bare information about how people have acted is insufficient. What problem they tried to solve, the circumstances which led them to prefer a given solution and the consequences following are more important than memorized facts and dates. Throughout the curricular program every possible effort should be made to join together isolated bits of subject matter into a meaningful interpretation. Pupils should know the facts about the differences in the way of living between themselves and peoples of other lands. They should also know why these differences exist.

Efforts to teach contemporary knowledge should not obscure the possibility that much that is taught today in various subjects may become obsolete in the near future. A responsible school must instill in pupils the awareness that some of the principles and generalizations they learn, although representing what is the best of present thinking, may be revised and altered as further knowledge is developed. While stressing the well established, teaching must not reduce pupils' receptivity to change. It is essential that pupils gradually be introduced to the idea that scientific concepts and theories are not final answers but tentative explanations in man's persistent effort to explore the unknown.

Also, in a period when the scientific method of study exerts such a dominant influence on every aspect of contemporary life, education should not rely solely on teaching methods which permit pupils to acquire knowledge passively. Learning by discovery, by the process of inquiry, by problem-solving techniques should be incorporated in some form into the courses of study. There ought to be a place in the curriculum for learning how to ask questions, how to seek out relevant information, how to classify, analyze and interpret experiences and observations, how to test ideas and how to draw conclusions. Content in various subject areas should be chosen at least in part to encourage the practice of intellectual inquiry and to give pupils the taste of satisfaction and excitement connected with discovery.

Intelligent adjustment to the requirements of the modern world of knowledge is one measure of quality education in an effective school. Meeting the challenge of rapid changes in the world of work, in which today's pupils will actively participate, is another.

Technological changes have drastically altered the nature of work. With the penetration of automatic machinery and computers into every field of occupational activity, work is generally becoming less a question of skill and more one of thinking ability. Many occupations have acquired new characteristics. They demand more complex skills and a higher level of training. Some types of jobs are being made obsolete by technological innovations. In the years ahead, technological progress will create jobs which do not exist today in business and industry. Workers may be called upon to perform functions not yet conceived and use machines not yet designed.

There is little doubt that the advent of automation and modern technology makes successful work standards increasingly a matter of good education. The demand for those with little schooling is shrinking rapidly. The untrained and undereducated can expect only poor paid, deadend jobs. Modern economy has advanced to the point at which low levels of education and training reduce a person's occupational chances, increase his insecurity, and frequently result in permanent unemployment.

The facts summarily indicated above suggest the nature of responsibility a school must assume to meet the needs of our time. Positive steps must be taken by the school to advance the necessary skills and to raise the effectual intelligence of all children to the highest level attainable. The challenge can no longer be met

by simply making educational available to all and relying upon the ability, motivation, and persistence of pupils to take whatever advantage they can from the educational fare provided. The needs of different groups of children must be met by an education which is purposely structured to release and develop their potential. For pupils whose intellectual development has been hampered by unfavorable environment, the school should use new teaching methods and approaches to make up for the deficiencies of cultural and social deprivation. For those whose level of aspiration is unrealistically low, the school should provide learning conditions which would stimulate their will to learn and generate motivation for school achievement. For high ability pupils, it should provide challenging instruction and strong encouragement for their creative capacities and special talents.

In the second place, the school must realize that a sharp line can no longer be drawn between liberal education and what has been traditionally regarded as the sphere of "vocational" or "technical" education. In an age of automation, the two types of education cannot be kept completely apart. If vocational education needs the support of liberal education, the liberal studies are today incomplete without some understanding of what technology is, and the role it is going to play in the future. Today's children will use more machinery and scientific equipment of all kinds in their adult years. Consequently, they must acquire some notion of the significance of technological developments, the principles governing the intelligent use of machines, and the skills that are required in their operation. Modern society cannot tolerate lack of technological knowledge any more than it can permit illiteracy.

Finally, an effective school should convey to pupils in teaching and counseling an awareness that technological change makes the idea of terminal education unrealistic and unsuited to the demands of modern life. To meet the additional requirements of changing occupations, schooling cannot be limited to a set number of years of school attendance. Pupils must learn to view education as something to be continued and renewed through their working lives.

The demands for change placed on a school today require many modifications in the existing pattern of school operation. Above all, there is an urgent need for more flexibility in traditional scheduling arrangements of program, curricular sequence, and grade level organization. To accommodate the necessary innovations, a school must show its willingness to conduct experiments which promise constructive results. The rigidity of present educational forms must give way to new flexibility of program and purpose.

In the light of the preceding discussion it is possible to identify certain conditions which would indicate a high quality of education. These indicators are by no means complete or exhaustive. They simply suggest some of the ways in which a school can manifest its concern for quality education. In the numbered italicized paragraphs are listed the governing principles that distinguish the effective school. In the paragraphs following are listed practices exemplifying ways in which the principles are made operative. These practices are options, and other practices having the same purpose, would be as acceptable. Some of them have proved to be generally good; some, good under given conditions only. Others are still in the experimental stage. The point to be stressed is that forward looking schools are not waiting for trial and proof by others. They are themselves making changes and experimenting to find better ways of accomplishing their purposes.

1. An effective school makes a deliberate effort to upgrade the curriculum content in accordance with present-day knowledge, skills, and needs and stressing the understanding of principles side by side with the mastery of facts.

Two purposes underlie the widespread effort to improve curriculums. The first—mostly in the sciences, mathematics, social studies, and the vocational subjects—is to bring content abreast of present knowledge and of the needs of successful employment in a technological society. The second—in all of the subjects of the curriculum—is to take advantage of what has been learned about learning itself and to present material in a way suited to efficient learning.

Individual schools upgrade their curriculums by adopting materials prepared by competent agencies or by devising materials peculiarly suited to their own situations.

The State Education Department has been developing, and is continuing to develop, new curriculum materials, adding new and up-to-date materials, and discarding outmoded materials. At the same time, the materials are written in accordance with new theories of learning, breaking down artificial barriers between

related subjects, and stressing the understanding of principle. Examples of these newer curriculum materials, by title, are:

Mathematics K–6
Number and Numeration
Problem Solving
Science for Children K–3 and 4–6
Experimental Material: Reading Section, *English Syllabus 1, 2, and 3*
An Experimental Course in Mathematics 7–8–9
Science 7–8–9, and Experimental Syllabus
A Comprehensive Program in Home Economics Education
Secretarial Practice
Point to Point Numerical Control of a Machine Tool
Russian for Secondary Schools
Teaching About World Regions

Several national committees have prepared syllabus materials for the use of secondary schools. A partial list of these includes:

School Mathematics Study Group
University of Illinois Mathematics Project
Physical Science Study Committee
Chemical Bond Approach
Biological Science Curriculum Study

Many schools develop their own syllabus materials. Curriculum committees develop, in whole or in part, curriculums to meet special local need or take advantage of special local conditions. Many local schools prepare curriculum materials to meet the needs of groups for whom the usual materials are not suitable, as the mentally, physically, or culturally handicapped.

2. An effective school provides in its program appropriate opportunities of inquiry and discovery learning.

The goals of discovery learning are as much to promote interest in learning, encourage the spirit of inquiry, and develop creativity in the pupil as to master subject matter.

The essence of discovery learning is that (a) the pupil is given no directives as to how he shall handle the problem presented him, and/or (b) the end goal or generalization to which he arrives is not predetermined for him by the teacher.

A few courses have been built revolving strongly around the discovery method, notably the Illinois Mathematics Program and a physics course developed at the Massachusetts Institute of Technology.

The usual vehicle for discovery learning, however, is a shorter learning unit—a laboratory experiment, a project, etc. It can be provided in any subject field and at any level.

Discovery learning is not a method for continuous use, being time-consuming. Every pupil, however, should be exposed to it at intervals in his school career and in variety of subject matter settings.

3. An effective school designs a differentiated curriculum to serve the needs of students who differ from the average—the culturally deprived, the slow learners, the academically talented, the physically or emotionally handicapped, etc.

Syllabuses and commonly used courses of study are generally aimed at the average or usual student, with enough options and selective choices to cover a wide range of ability and interest.

The gifted. Gifted students are not fully challenged by the usual school offerings. Schools are making a variety of special provisions to meet their needs, including the following:

Talent search projects, to identify the gifted and give them guidance and encouragement to the full use of their talents.

Advancing subjects in the curriculum sequence, thus freeing the 12th year for advanced study.

Providing Advanced Placement Programs.

Providing courses nationally or locally prepared for high ability students.

Providing seminars or off-campus instruction, usually in cooperation with a nearby higher education facility.

Freeing high ability students from routine school activities to provide substantial blocks of time for independent study.

Children of low ability. Students who cannot master required learnings within the required time limits of the regular school program, meet with frustration and failure, and are likely dropouts with meager employment opportunities through-

out their adult lives. To meet their special needs, effective schools develop such programs as:

Special classes—smaller in number, with appropriately selected materials and adjusted to a slower pace.

Vocational education not highly specialized but preparing for clusters of low and medium skilled occupations.

School-work programs, combining work experience and an instructional program developed around employment needs.

STEP (School to Employment Program) for likely dropouts.

Culturally deprived children. Many students from economically deprived homes, even those of average or better ability, have school difficulties because they lack the background of experience needed to accomplish in school, and they lack motivation. To counteract these lacks, effective schools engage in such practices as the following:

Prekindergarten programs for children from restricted home environments to broaden their experience to prepare for entry into the regular program.

Home-school services to enlist the support of the home and aid in developing stronger motivational forces for education.

Remedial classes to bring slower students up to their potential level.

Special programs as Project Able and Higher Horizons to identify the talented among these students and urge them to higher levels of attainment.

Expanded guidance, psychological, and health services giving special attention to the needs of this group.

Expanded vocational programs to widen employment opportunities for this group.

Planned trips and visits to museums, art centers, and the like to broaden the students' background of experience.

College preparation classes for senior high students who show promise for further studies. Modern textbooks with absorbing and inspiring content, meaningfully related to the experiences of the deprived child.

The handicapped. The physically or emotionally handicapped child warrants some type of special school adjustment either within the regular classroom or in special classes. Schools may structure the school environment of these students in ways such as the following:

A combination of regular and special class activities to allow for activity restrictions and curriculum adjustments.

Remedial instruction during regular school class time or after school to improve basic skills.

Special placement programs—two or three handicapped children placed with a group with no apparent emotional problems and good peer relationships.

Small groups of children meeting in a specially equipped classroom with personnel trained to work with particular handicaps.

Conferences allowing parents and teachers of handicapped children to meet and discuss problems and approaches with a trained counselor or therapist.

Transportation of handicapped pupils to centers equipped to deal with their individual disabilities.

Transportation of a teacher from school to school to provide individual instruction for those with impaired vision, hearing, or speech.

4. An effective school experiment with new methods of organizing for instruction. The purposes sought in organizational experiments are greater flexibility in programming and more effective use of teachers' skills. Examples of experiments of this kind include:

Nongraded elementary organization to permit unforced and unhindered learning.

The use of teacher aides to free the teacher from routine, clerical, and custodial responsibilities.

The use of automatic data processing for scheduling students to classes, recording student grades, and reporting attendance to further reduce clerical duties of teachers.

Team teaching to promote more effective use of teacher skills.

Large group-small group instruction to conserve teacher time and permit more individualized instruction.

The extended school year to introduce greater flexibility and efficiency to the total program. The house plan to introduce the advantages of closer acquaintance, better knowledge of the pupil, etc., in the large school setting.

Dual progress programs for more effective organization of the total curriculum.

Theme readers to conserve the time of English teachers.

Voluntary weekend and summer seminars and classes for gifted pupils.

Shared services and/or teachers to make effective use of specialized teacher skills in small schools.

5. An effective school makes planned use of modern instructional aids to enrich and make more meaningful the educational experiences of pupils.

Instruction aids are used to make instruction generally more effective and also to individualize instruction. Irrespective of their effect on learning, technological devices should be a part of the educational experience because of their growing importance to adult life. Newer aids include:

Television—over-the-air programs broadcast by the television councils and closed-circuit programs developed by individual schools, or cooperatively by small groups of schools.

Programmed instruction—the use of learning machines, programmed tests or locally prepared materials to present materials in small steps with immediate feedback.

Computer—the use of computer-controlled teaching machines capable of providing individualized instruction to many pupils simultaneously by immediately evaluating the student's answer and determining what item he should advance to.

Language laboratories to extend opportunities for speaking and listening in foreign language teaching.

Taped materials for the greater individualization of instruction.

Augmented laboratory materials to make advanced instruction and free experiments possible in the sciences.

The school library as a materials center, equipped not only with books and periodicals, but with a wide variety of learning aids, and made the nerve center of the learning activity.

III. The Teacher

A competent faculty is the single most important requirement for quality education. Teachers, not details of the curriculum or the facilities, ultimately determine how well the school is able to carry out its educational responsibilities.

There is ample evidence today that the task of a competent teacher has become more complex than ever before. This is only natural. The forces of change which caused new formulations of educational purposes and new schemes for their accomplishment affect the teacher. Today, teaching is expected to be more than simply passing on selected aspects of knowledge to students. The goal is to release and to foster the individual's power to think, to understand, and to conceptualize. A competent teacher must strive to develop in the student the capacity to learn and the motivation to learn on his own initiative. He must try to encourage the student's creative thinking by activities which would stretch his imagination. He should seek to develop a problem-solving attitude by inviting the student to search for the right answer rather than by giving it to him. He must endeavor to awaken the student's curiosity and arouse his interest by focusing instruction on problems which are not immediately apparent to the student.

An important requirement of competent teaching today is an understanding of the cultural, psychological, and motivational factors which condition the attitudes of various groups of pupils toward learning. To be successful, the teacher must adapt his instruction not only to the abilities, needs, and interests of his pupils, but also to the peculiar handicaps and kinds of retardation from which some of them may suffer as a result of cultural and social deprivation. Under present conditions in the schools, the teacher must often know how to cope with values, behavior, and bases of motivation different from his own. He must deal with learning difficulties not yet fully explored, and to accept these as challenges to his teaching skill. A competent teacher today is expected to differentiate his methodology, emphasis, and pacing in accordance with the characteristics of special

groups of children—the slow learners, the potential dropouts, the culturally different, or the academically talented.

The role of the teacher has become more difficult, too, because of the necessity to keep abreast of the never-ending stream of new developments in the subject areas. The physics teacher must be prepared to introduce pupils into the mysteries of electronics, subatomic particles, atoms, and molecules; the mathematics teacher must help students grasp the idea of sets in the new experimental curriculum; the teacher of English and foreign languages must be able to apply teaching methods based on structural linguistics; and the teacher of social studies must sensitively guide pupils to an understanding on non-Western cultures.

In addition, rapid advances in the technology of education have added a new dimension to teaching. Today, a classroom teacher has available to him many techniques to broaden learning, to make specific adjustments to individual needs, and to make teaching more vivid and persuasive. By effectively managing all the new audiovisual tools of instruction—television, teaching machines, films and recordings—he can set up a supporting system of resources which will allow a significant variation of classroom experience and a better control over the learning situation. Conventional teaching must still remain a substantial part of instruction, but the understanding of the uses and limitations of new technological aids and devices permits the competent teacher to create a new organization of learning activities. All this tends to make the role of the teacher more flexible than before. It also presents a challenge to his ingenuity and adaptability.

It is clear from the foregoing description that the duties and responsibilities of the teacher have not remained static. Teaching today represents an occupation in which new patterns of activity are constantly being developed. Experimentation and innovation are likely to persist as the dominant feature for the foreseeable future.

Consequently, regardless of the quality and amount of education received by the teacher in his preservice years, college training can only provide the initial educational and practical foundations for the professional career. Even certification should not be interpreted as indicating more than minimum competency. As in other professions today, competence in teaching cannot be considered ever to be completely achieved. Both professional knowledge and skills must be renewed and brought up-to-date at regular intervals. The teacher still has to grow through practice after finishing his formal preparation, and must continue to acquire additional specialization through self-study, post-graduate work, and inservice education to prevent his knowledge and performance from becoming obsolete.

One of the most important responsibilities of the school is to acquire and maintain a competent teaching staff. To meet this objective, the system must provide a favorable teaching environment, reasonable teaching loads, and adequate salaries. It must also give particular attention to the planning of a continuous and dynamic inservice program for its teachers. The latter is the most vital contribution it can make to the effectiveness of the total school program.

In what follows, some of the ways by which a school can build up a strong teaching staff are examined. Again, the numbered italicized paragraphs list the principles to which effective schools adhere. The following paragraphs list practices, some proved in high degree, others highly experimental, by which schools are trying to improve the quality of their teaching personnel.

1. An effective school takes positive steps to insure the recruitment of a teaching staff with the professional qualifications and personal characteristics necessary for an effective implementation of its program.

In view of the fact now generally recognized—that preparatory institutions do not turn out "finished" teachers—the recruitment and selection process cannot be regarded as completed when a teacher agrees to come to the district. It continues over a period until such time as the school authorities can form a sound judgment as to the candidate's likelihood of success. Effective schools recognize the obligation to provide special guidance and help to the candidate through this period. Practices followed by effective schools include the following:

At least one person is given continuous responsibility for seeking out good candidates, so that recruitment is not a hurried, competitive activity of a few spring weeks.

Districts seek their candidates from several training institutions and from out of State to vary backgrounds, points of view, and philosophies.

Schools prepare brochures describing the community, schools, area educational, cultural, and recreational resources, etc. to attract candidates. Schools develop a screening technique based on scholastic records, test scores, performance in practice teaching, personal characteristics, etc.

Schools, especially those using team teaching techniques, definitely seek characteristics to bolster total staff strength.

In the first years of experience, schools provide augmented supervisory service, as a specially assigned helping teacher, and frequent evaluations with immediate followup.

Schools join with universities to establish an internship program.

2. An effective school makes special provisions to acquaint its new teachers with the community, the school objectives, and the characteristics of the pupil population.

The purposes of orientation programs are to help the new teacher establish relationships; make it clear what is expected of him, with goals operationally defined; acquaint him with the resources available to him; and make it unnecessary for him to feel his way, by trial and error, through what should be routine activities. Practices include:

Schools hold an orientation session, in part social, where teachers are introduced to administrators, supervisors, and older staff members.

Schools hold meetings with new teachers devoted to a discussion of school philosophy, disciplinary policies, and standards of evaluation of pupil achievement.

Schools provide teachers' handbooks defining the rules and regulations of the system, the rights and duties of staff, and procedures to be followed.

Schools provide each new teacher with all pertinent information about the pupils he is to teach.

Schools acquaint new teachers with community conditions both as they are a resource for teaching, and as they affect the classroom behavior of children.

Schools acquaint new teachers with all of the resources of the school and of related services, as the health and social services.

3. An effective school makes a continuous and concentrated effort to organize a sound and systematic program of inservice education for all teachers.

There is a growing awareness that irrelevant courses, taken to amass credits for advancement on the salary schedule, do not contribute to the effectiveness of the teacher. School practices to strengthen specific weaknesses in the school program and to insure the relevance of inservice and advanced training include the following:

Schools develop a mechanism for informing teachers of opportunities for participation in State-supported inservice programs:

(a) Collegiate based programs for training teachers of Russian, area studies, Advanced Placement subjects, English, science, computer mathematics, foreign languages.

(b) State-assisted locally originated programs in all of the academic fields of the elementary and secondary school.

(c) Regional programs designed to provide schools with qualified resource personnel to upgrade teachers of mathematics and science.

Schools give support for approved summer work. Schools give leaves of absence, with varying conditions of pay, for continued study or travel.

Schools analyze their own needs and organize local inservice courses under the leadership of a highly qualified teacher. Such courses frequently are quite specific and limited in their goals, as how to prepare effective visuals, how to teach for creativity, etc.

Schools organize workshops, built around lessons conducted by teachers of outstanding merit, designed to demonstrate specific techniques of strengthening motivation, activating emotional involvement, and raising pupil ability to manipulate knowledge.

Schools arrange teacher exchanges with private independent schools in order to adapt the best of private school work to the use of public schools.

4. An effective school provides adequate opportunities for its teachers to learn about and experiment with the total range of new audiovisual tools and devices.

Technological devices for teaching serve two purposes: to facilitate and increase learning and to give pupils a beginning acquaintance with the technological aspects of living. Effective schools conduct intensive training workshops for

teachers in the technical operation and educational use of modern audiovisua equipment and teaching devices. Some of the devices used include:

Learning machines for a wide variety of subjects.
Language laboratories for the teaching of foreign languages.
Closed-circuit television for teaching a wide variety of subjects.
Typewriters for beginning and remedial reading and for spelling.
The Edison Responsive Environment instrument for teaching reading.
A variety of recording, duplicating and calculating instruments for general as well as vocational education purposes.
Diagnostic instructional materials.
Individualized instructional materials; e.g., SRA materials.
Mobile instructional science materials.
Environment stimulating mode.
Special visual devices, as the bioscope, overhead projector, opaque projector, etc.

IV. The Community

A school needs the understanding and cooperation of the community to carry out its educational functions successfully. More than is the case with any other public institution, the confidence and support given by the community determine the effectiveness of the school. It cannot move forward toward new goals, nor can it modify its practices radically in an unreceptive or antagonistic community environment. If new types of programs are adopted in the face of active resistance the chances are high that counterpressures from the community will in time produce a return to popularly accepted educational practices. Only to the extent that school and community keep in step with each other can the school adjust adequately to the needs of changing times.

In spite of their natural interest in the school, parents and other citizens may not realize the influence of present conditions on the future of the school. Not so long ago, people in the community had a clearer picture of what was expected of their children by the school, what was required in each grade, and what schooling and school achievement meant. For generations, members of the community could feel secure in their belief that the school attended by their children would not differ to any substantial degree from that attended by themselves. But changes in educational philosophy, aims, and practices over the past few decades have been so extensive that the public is both surprised and confused by the contrast between the memories of their own school experiences and what is taking place in the classroom of a modern school today. The community has been left behind, while new scientific insights have brought about the modification of educational objectives and the introduction of expanded programs and new techniques of teaching. Thus attitudes, of indifference and apathy observed among some segments of the community appear to be at least in part due to a feeling by people that they cannot grasp the full significance of what schools are trying to do.

However, in a period of change and transition, increasing the community's comprehension of educational issues is undeniably a necessary condition for school improvement. The aspirations for more adequate education cannot be fulfilled unless local citizens are willing to support them. To this end the community must be made aware of the implications of social and economic changes for school education and children. They will then understand why the task of the school is more demanding and more involved than it used to be, and why school reform is the first order of the day throughout the nation. A program of interpretation, relating changes in the society and the world to the demands facing youth after completion of schooling, can help the community to understand the need for modifications in the school program and the necessity for experimentation with new educational practices.

All this emphasizes the compelling need for a more meaningful pattern of relations between the effective school and the community. The traditional posture of trying to "sell the school to the public" by presenting school accomplishments in the best possible light is simply inadequate. The situation demands a continuous and wide-ranging dialog between the school and community aimed at bringing about a harmony of understanding and genuine cooperation in planning and sharing in the decisions affecting the school.

Viewed in the perspective, the flow of communication into the community must be based on a systematic, comprehensive, and continuous program, not one that is spasmodic, intermittent, and perfunctory. Pertinent data and information should be brought to the attention of the community regularly, not only

when support for educational projects is sought or when increases in school taxes are contemplated. A school, instead of merely publicizing its successes, should involve the public in a continuous dicsussion of educational objectives It should invite public evaluation of school performance to pinpoint what the school failed to accomplish and suggest what it should do. The role of the public should not be that of giving the stamp of approval to decisions already made. All segments of the community should be drawn into this interchange of thoughts and opinions, including those persons who are apathetic, indifferent, or even hostile.

In a very real sense the pattern of desirable school-community relations depends on a sustained program of effective adult education. The community must be informed of the facts, issues, and forces which challenge today's education; it must be helped to clarify its own purposes; it must be encouraged to give considered thought to the ways and means by which it can achieve what it seeks for its children.

Recently, the growing public interest in more adequate educational provisions for children of the poor, the culturally deprived, and the segregated has given additional emphasis to the importance of close school-community cooperation. The major responsibility of the school for meeting the needs of these children is undeniable. But it is equally clear that problems of cultural deprivation are too complicated to be remedied by the school alone. Educational opportunities provided by the school must be supplemented and reinforced by a concerted and coordinated effort of parents, civic groups, and public agencies of the community. The school must try every avenue to advise parents how they can help their children to achieve better in school. It must try to enlist the services of lay citizens for such activities as tutoring, playground supervision, and others. And it must initiate and support the organized or informal actions of all groups in the community for the benefit of disadvantaged children. The broad dimensions of the problem of poverty and deprivation require the imaginative use of all resources of both the school and the community.

Following, in the numbered italicized paragraphs, are some of the principles that guide the effective school in its relations with the community. In the paragraphs following, as in the previous sections, are practices. Some are long-established and well-tried. Others are relatively new.

1. The effective school endeavors to implement consistently the idea of two-way communication in its relations with the community.

The school is an integral part of the community, responsible for the education of children in a manner acceptable to the community. Hence it must be aware of community wishes in this regard. Most schools have planned programs for communicating to the community. Forward looking schools take positive steps to insure that the communication extends both ways. Practices include:

Open school board meetings with opportunity, under prearranged conditions, for expression of lay opinion.

PTA meetings—regular and for special purposes.

Advisory committees to the board of education or the superintendent of schools.

Reports of student progress to parents by conference, opening the door to an explanation of school purposes and procedures.

Television programs, describing the content and method of teaching school subjects.

Newspaper articles describing school purposes, programs, and needs.

Talks to community groups by teachers and other staff members about school purposes and practices.

2. The effective school involves all segments of the community in a cooperative study of problems related to the educational program and its support.

Older professional texts advised new school superintendents: "seek out the community leaders, get their support, and you have the support of the community." In a simpler, monolithic society this was reasonable advice. In today's complex society, the leadership function is widely scattered, and there are diverse interests and cross currents that can make any proposition, entirely understandable by one group, beyond the understanding of another. To seek as far as possible the understanding and support of the entire community, effective schools:

Make positive efforts to see that all of the diverse elements are heard on critical questions.

Make positive efforts to draw into active PTA and committee membership, people from all elements of the community.

In the formation of special committees to study special problems, schools make sure that the committee has (a) a nucleus of skilled leadership and (b) a membership representative of all the community groups affected by the question under study.

3. The effective school takes the initiative and acts as a catalyst of the coordinated community effort in behalf of the economically and culturally underprivileged children.

Poverty and the social problems that accompany it have become the focus of national attention. In the attack on poverty, schools have the important responsibility of seeing that it is not self-perpetuating. To do this they must gear themselves to deal effectively with children who, because of restricted home backgrounds, have little motivation for education and, in the past, have formed the great body of school failures and dropouts. In this pressing area of concern, schools practice the following:

Participate with other community agencies in planning and carrying out the operations of community action centers.

Provide knowledge of the community, its services, and government, by outside trips and special classroom activities.

Arrange with nearby teacher training institutions for special training programs for teachers of the culturally handicapped.

Develop close home-school relations to establish mutual understanding and confidence.

Provide work-study programs enabling the more needy to contribute to their own support while attending school.

Extend opportunities of vocational training to both in-school and adult groups.

V. Conclusion

The challenge to education in a world of fluid change in inescapable. As everyone must realize, education cannot remain static to meet the demands of tomorrow. To the schools has been delegated the immensely important task of teaching the younger generation new ways of adjusting to a reality that is continually becoming something new and different. Only by a continuous examination of its goals, practices, and provisions can the forward looking school meet this responsibility. The preceding pages have shown what some schools are doing to meet changing need and to improve program quality in the areas of curriculum, teaching personnel, and school-community relations.

A board of education is in a key position to give this process the strength and direction it needs. It knows its community and its needs. Within the limits set by law and regulation, it has the power to determine program objectives and to allocate resources to accomplish its purposes. Through its control of funds, personnel, time, and space, it is at the core of any school improvement program.

Boards of education are finding, however, that the need for expansion and improvement is outgrowing the resources commonly provided for school purposes. Even our largest cities cannot meet the new and critical educational demands without resources beyond those provided through local tax and regular State aid formulas. There are many such helps available. Schools can obtain financial resource through expanding federal programs; through special State aid provided under given conditions for program improvement, for inservice teacher training, and for meeting the needs of special groups of children; or through private foundations.

Boards can extend their resources by cooperative effort, either through the established boards of cooperative services, by direct agreement with neighboring schools or other community agencies, or through the newly developing centers for educational service of one type or another. Boards, too, can obtain, usually at nominal cost, special services from a nearby higher institution for assaying needs, planning, and evaluation of new programs.

Thus, and finally, the effective or forward looking school is one in which the leadership, lay and professional, realizes that it cannot operate as a self-contained, isolated unit. It is alert to the resources that are available to it from outside its borders. It recognizes that both its opportunities and its responsibilities are without a tight geographical boundary.

(Supplemental information supplied for the record by Blue A. Carstenson.)

THE SOCIAL COST OF SPACE AS A CRITERION IN THE DISTRIBUTION OF FEDERAL GRANTS *

By Carl F. Kraenzel and Frances H. Macdonald, Montana State University †

Federal grants and aid programs have now been generally accepted as a way of equalizing certain basic services to people the nation over. They are so extensive that distortions in the formula are likely to produce burdensome inequities that were intended to be corrected. Specifically, grants based on population and per capita gross income, such as the Public Health grants, discriminate against the sparsely settled states, chiefly in the West. This paper is intended to report on the social cost of space in the less populated states for which adjustments must be made if the principle of equity is to be fully approximated. The social cost of space is so extensive and pervading that it must be included as the third criterion in the formula for distribution of aid.

The Economic Cost of Space

It is not difficult to demonstrate that there is an economic cost of space, borne and paid directly by the individual citizen. The average Montanan travels perhaps ten times farther than the average Iowan and perhaps fifty times farther than the average New Yorker for goods and services, as indicated in the following table.[1] Hence, the Montanan pays more in out-of-pocket expense daily and yearly just for travel.

State	Area (square miles)	Population (1960)	Density	Square miles per 1,000 persons
Montana	147,138	764,757	4.6	218
Iowa	56,290	2,757,537	49.0	20
New York	49,576	16,782,304	338.5	3

But even this figure favors the Iowan and the New Yorker. When faced with great distances and weather hazards, the risk of getting there and back is greater than when distances are shorter. It is, therefore, necessary to have private stand-by transportation—two or more motor vehicles rather than one, for example; with all the attendant investment, financing and insurance cost for the several vehicles. Sometimes this expresses itself as investment and upkeep costs for two homes, or offices, or schools rather than one. For example, for many farmers and ranchers this may mean one rural home and one town home near school, doctor and recreation services. At other times this may express itself as additional costs attendant on sending children to boarding places when in school.

It is clear, then that distance represents a greater outlay of expenditures per unit of service. But this is only one side of the coin—the expenditure side for individuals in terms of private and public outlay. People in remote places also tend to have less income—distance results in less income. The price of wheat or cattle tends to be that established in the central market places—Minneapolis, St. Paul, Buffalo, Chicago, Omaha and St. Louis, for example. Therefore, the farmers near these markets get more income per unit of product than the Montanans for their bushel of wheat or pound of beef.[2] The difference is the amount

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[1] This is based on the assumption that the residents of each area make about an equal number of trips for each type of service and for similar types of services.

[2] See Corley, Joseph R., *Changing Patterns of Grain Transportation in Montana*, Master's Degree Thesis, Montana State University, Bozeman, Montana, June, 1964, p. 16. Also see Trock, Warren L., *Cattle Feeding in the Northern Great Plains*, PhD. Thesis, Montana State University Library, Bozeman, Montana, March, 1963, p. 111 ff. In some instances for wheat and cattle, per mile rates are higher for longer than for shorter distances.

of the freight not only as a rate per mile (often lower when near the market) but also as a total bill. At the same time the farmers near Minneapolis pay less for their tractors, their fuel, their cars and trucks, their feed, and most of the other cost-of-living items that enter their operation and living cost budget. The oil field and mine workers, the forest workers and other laborers, and the businessmen and professional workers are similarly disadvantaged compared with their fellow earners in the densely populated areas.

Therefore, the economics of the nation discriminates against the residents who live in distant and remote places [3] on two counts at least: (1) they pay more to get the service; and (2) they have less net income to buy the services. They have only one temporary defense, economic and management wise: that is to enlarge their volume of business operations. By doing this they intensify the very difficulty they suffer from—they create more distance between themselves as neighbors, employers and employees, buyers and sellers, clients and professional men.

The Social Cost of Space

The above dilemma has resulted in one other way of coping with problems in the sparsely populated area—a solution not generally advertised and difficult to prove. People in the sparsely populated areas have received fewer services, have accepted poorer quality of services, or have had services only intermittently, or have had a combination of these deficits.[4]

It is difficult to measure quantity and quality differentials for services between areas and the statements above stand largely unsupported, except by inferences. The writers know of little research that has measured these differentials.[5] But a reference to information for Montana will be offered. The most recent report of the Facilities and Planning Division of the Montana State Board of Health has just been released. In recognition of the introduction of the medicare program this coming July, a stiffer set of standards of inspection for hospitals and nursing homes has been applied, compared to the standards employed as recently as two years ago. As a result of applying these stiffer and more uniform standards, the number of suitable or acceptable beds in hospitals has been decreased from 84.6 percent of the total in 1963 to 35.8 percent of the total in 1965. For nursing homes the number of suitable beds decreased from 85.6 percent of the total in 1963 to 77.9 percent of the total in 1965. This lower decrease for nursing homes is explained by an increase in new facilities almost entirely. It should be noted that the Montana bed-population ratios for both the hospitals and the nursing homes are reletively low by national standards, especially when considering acceptable beds. One might expect a higher bed ratio in a sparsely populated area because of higher occupancy ratios that attends distance and sparsity, a fact that is a measure of the social cost of space. The table on the following page gives specific information.

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[3] For an analysis of the economic aspect of the cost of space see Kelso, Maurice M., "Costs of Space in the West", in *Land and Water Use*, edited by Wayne Thorne, AAAS publication No. 73, Washington, D.C., 1963.

[4] For a more detailed statement of this social cost aspect see Kraenzel Carl F., "A Direct Measure of the Social Cost of Space", *Proceedings of the Montana Academy of Science*, 14:82–89, 1964; also "Pillars of Service for the Emerging Community of the Plains", *Journal of Health and Human Behavior*, Summer, Fall, 1964, Vol. 5., pp. 67–74.

[5] The U.S. Public Health Service itself has recognized the absence of full-time public health services in sparsely populated regions. To get at this problem the Service itself undertook a study to get at this problem. The results were reported in *The Health Study of Kit Carson County*, Colorado, U.S. Department of Health, Education and Welfare, Public Health Service, Division of Community Health Services, Publication No. 844, 1962.

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1963 and 1965 hospital and nursing home beds classified by total, acceptable and nonacceptable beds, and differences between 1963 and 1965, and population-bed ratios for Montana

[I—Acceptable beds; II—Nonacceptable beds; III—Total beds]

	Beds						Difference in beds						Percent of—			
	1963			1965			Number			Percentage			Acceptable		Nonacceptable	
	I	II	III	I	II	III	I	II	III	I	II	III	1963	1965	1963	1965
Hospital beds	2,830	517	3,347	1,165	2,088	3,253	−1,665	1,571	−94	−41.2	403.9	−9.7	84.6	35.8	15.4	64.2
Total population		701,000			739,000											
Ratio [1]	4.03	0.74	4.77	1.58	2.83	4.4										
Nursing home beds	1,661	280	1,941	2,045	580	2,625	384	3,000	684	123.1	207.1	135.2	85.6	77.9	14.4	22.1
Population 65 and over		63,511			67,018											
Ratio [1]	2.62	0.44	3.06	3.05	.87	3.92										

[1] Number of beds per 1,000 total population in the case of the hospitals and per 1,000 aged (65 and over) in the case of nursing homes.

There is no doubt that almost all, if not all, of this differential between 1963 and 1965 is to be explained by the tolerance of poor quality facilities as much as only two years ago—the poorer quality accepted as the result of the social cost of space. The differential is one important measure of the social cost of space.[6]

By doing without or by accepting lower quality services, including the postponing of services, many people have lowered their potential for retraining and job rehabilitation, their experience level, their health level, and their general adaptation level when faced with change. Prevention has been neglected; and cures or treatment are difficult to effect. These aspects necessarily are the true social costs that follow from the fact of space—deferred services, costs paid by the taxpayer rather than by the individual, costs resulting in the diminution of productivity and economic and social effectiveness, costs measured in human pain and suffering.

Often, for all these reasons, there has been out-migration of population, a factor contributing to an intensification of the problem of the social cost of space. Even aged adults who had planned to make the area their home for their last days resort to migration.

Some Partial Ways of Coping With the Social Cost of Space

In addition to out-migration and the lowering of the level of services or their number and type, there are some adjustments of a necessarily temporary nature that have come into being to cope with the social cost of space. These, however, have limits and may even penalize the principle of equal service eventually.

One example has to do with highways. The nation is building an extensive interstate highway system with 90 percent federal financing. The thirteen western states, including Hawaii and Alaska, are known as public domain states. Sparsely populated, it is an accidental fact that their portions of federal aid are increased beyond the 90 percent specification by an amount that represents the public domain involvement. For Montana the current cost ratio is reported to be 91.27 percent for the federal share and 8.79 percent for the state. For Alaska the ratios are reported as 94.91 percent and 5.09 percent; and for Nevada, 95.0 percent and 5.0 percent.[7] The formula for the ABC road system allows a greater federal matching, measured by the proximity and access to public domain.

Here then is an example of an accidental adjustment for sparsity by virtue of public domain. This, however, applies to construction only. For maintenance of the greater road mileage in the sparsely populated area, there is no such recognition of space costs.

The Bureau of Public Roads is, however, an "Angel of Good Tidings" in this respect compared with the ICC and the FAC. A look at the air trip costs shows how the small airlines in the Yonland areas [8] must charge first class fares to survive, while the lines closer to cities which also have inter-city traffic, with high volume, have "economy" runs. ICC has set a long history for a subsidy to the cities in this respect, based on such questionable historical rationalization as developed by Von Thünen and Alfred Weber.[9]

Progress in curtailing the burden of the social cost of space can come about in sparsely populated states by limiting settlement and consequently, community and social services, to certain areas only. In the arid western states this is easier to accomplish. Population, including rural, is confined to irrigated oases only. Man cannot survive in the non-irrigated areas. Rural and urban people live relatively close together. The social cost of space is limited, in part, fortunately by the fact of aridity. However, the oases may be small and may need to be knitted together into a service area of adequate size.

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[6] See *Montona State Plans for Hospital and Medical Facilities Construction* for 1964 (1963 data) and 1966 (1965 data) published by the Division of Hospital Facilities, Montana State Board of Health, Helena, Montana.

[7] Reported to the writers by way of telephone from the State Highway Office, Helena, Montana. The ABC system has reference to primary and secondary roads.

[8] By Yonland the writer has reference to the small towns and sparsely populated areas out away from the settled areas of the Plains. The Sutland areas are the more heavily settled, stringlike retail and wholesale areas in the Plains. These sometimes are the irrigated areas too and have ready access to communication facilities.

[9] These theories hold that for reason of geography, history, accident or other, populations begin to concentrate in what become cities. Land values, rents and prices go up and assist the development and offer advantages. From these centers transportation expands outward, and becomes more costly. Therefore, land values go down as distance increases, costs go up, net income goes down. These facts explain the location and growth of industry in limited areas. These are rationalizations perhaps as much as explanations at first, and later may be rationalizations chiefly.

But in the sparsely populated semi-arid Great Plains and other semi-arid islands of the nation, rural farm and ranch and village populations are scattered all over the land, in the fashion similar to that of humid America. Services have been similarly dispersed all over the land, with the consequences described by the social cost of space. There is gradually emerging a heavier concentration of this population in what is called Sutland areas. But because of lack of zoning, it will take a long time for the Sutland to acquire the degree of concentration typical of the oases in the arid regions. Nevertheless, this adjustment is being recognized as a necessary adaptation and is becoming more prevalent. As the level of living rises the pressure for this kind of adaptation will become greater.

There is a third kind of adaptation that is emerging. This is the possibility of coordination and integration of services among several cases and between Sutland and Yonland areas. By stressing flexibility and mobility of services and programs, rather than self-sufficiency, an entire area can be organized into a special service district and can have more effective services than is now the case. But this requires a higher and more sophisticated degree of cooperation than now prevails in the region. Costs would undoubtedly be higher than now, in many instances; but services would be more adequate. The task is to develop the special loyalties that must go with supporting this kind of program rather than destroying the community by shopping around. There are isolated examples of this kind of development. This represents a kind of consolidation not often practiced—one that encourages local survival of many services but back-stopping by specialists from larger places. It would mean the hand-in-glove cooperation of the generalist and the specialist.[10]

The Need for Including the Social Cost of Space in the Allocation Formula for Federal Aid

From the evidence above it would appear that (1) in additon to gross population, (2) adjusted for per capita income relative to the national average, a third criterion in the formula should be (3) an allowance for the social cost of space. It is suggested that H.R. 13197 and S. 3008 include this criterion in their formula for financing the public health services and programs envisioned.

The only aspect subject to debate is the specific amounts to be allowed in the formula for the social cost of space. In the absence of specific research data at this time, it is proposed that this be a 100 percent increase, without matching requirement for the most sparse states of the nation. Perhaps only years of experience will ferret out the specific details for the formula amounts. Adjustments will undoubtedly be required as time progresses, as improvements are made and as national policy goals require.

Therefore it is recommended that all of lines 18 through 22 of part B of page 12 in H.R. 13197 be deleted and the following be substituted:

"per capital income of the United States; except that an additional 100 per centum of the total thus computed shall be added to all states whose population density is less than five; an additional 80 per centum of the total thus computed shall be added to all states whose population density ranges from five to ten; an additional 60 per centum of the total thus computed shall be added to all states whose population density ranges from 10 to 37; and an additional 40 per centum of the total thus computed shall be added to all states whose population density ranges from 37 to 50.5 (the latter being the national average in 1960); and except that a like 100 per centum shall be added to the share for the Commonwealth of Puerto Rico, Guam, American Samoa, and the Virgin Islands; and except that none of this addition of 100 through 40 per centum shall require matching by the respective states, and only the original amounts governed by the per capita and income criteria shall require matching; and except that every state shall itself distribute these grant funds within its own state according to a formula that allows for the social cost of space, using its own density as the central criteria for a differential in a manner similar to the federal funds here allocated."

By way of explanation it should be stated that, using 1960 density data, this allowance for the social cost of space would do the following, namely increase the allowance:

(1) by 100 percent for Alaska, Nevada, Wyoming and Montana;

(2) by 80 percent for New Mexico, Idaho, South Dakota and North Dakota;

(3) by 60 percent for Utah, Arizona, Colorado, Nebraska, Oregon, Kansas, Oklahoma, Texas, Arkansas, and Maine;

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[10] The senior writer has emphasized this in "Pillars of Service for the Emerging Community of the Plains" *ibid.*

(4) by 40 percent for Washington, Minnesota, Vermont, Mississippi, and Iowa;

(5) by 100 percent for Puerto Rico, Guam, American Samoa and the Virgin Islands.

This same kind of social cost of space criterion should be instituted for federal grant programs in other areas such as elementary education, experiment station support in agriculture, adult education efforts, public welfare and social security programs generally, and for labor and small business programs.

There is usually an attempt to counter the argument of the social cost of space with one pointing up the social cost of density, and thus argue in favor of the status quo. The authors admit that there is a cost of density, but the latter argument can and should not be used to negate or destroy the former. It is only necessary to point out that people in a densely populated place represent a great volume, and a small payment by each person produces a considerable income. "Standing on the corner" in a city and watching the traffic enter a covered parking area, an airport, or almost any business demonstrates this fact. In the sparsely populated areas there is not the volume of business. Almost any charge is too high except for the bare essentials. Standing along a highway in Wyoming or Montana and attempting to hitch a ride is a measure of this fact.

It should be noted that the suggested formula imposes no penalty on density that is progressively greater than the national average by decreasing the federal aid below the original allocation for population and per capita income. It is concluded that there is nothing in the American tradition that should penalize sparsity. It would appear to be in the national interest to include the social cost of space as the third dimension in a formula for federal aid.

ARE BOOKS OBSOLETE?*

There was a time, not very long ago, when publishers and editors were able to sustain the illusion that their occupation was really more of a gentleman's pastime than an actual business. Publishing firms tended to be small personal or family enterprises. Usually they reflected the taste, the idiosyncrasies and the passions of the individual publishers (and their wives) and senior editors. Moreover, authors, editors and literary agents often created a social as well as a business community. What passed for business was conducted in the most casual and informal way. Salaries and profits were correspondingly modest—though for added compensation there were always the company of authors and the sense of belonging to the "literary community."

All of this has altered radically during the last fifteen years. The first changes had to do with the consumer. They bought the paperbacks—both quality books and ones for the mass market of the drug store—and the book clubs, promotions through the post and, with the entrance of Time Inc. into publishing, books produced and sold entirely on a subscription basis. The important man became the one who could juggle imaginatively with distribution, markets and sales; books were merely the commodity being sold. It is not surprising that soon publishing companies began to concoct instant books. These were geared to personalities or recent events, in the hope that the glamour or news interest would make the book a best seller even if only for short time. Today, most publishing houses have adopted this practice and their editors have either become fairly adroit businessmen or have been sacked.

The second marked change began a few years ago when a number of publishers of paperbacks began to print original books in both paperback editions and hard covers. Large sales are essential to the successful publishing of paperbacks. To lure well-known authors away from the traditional publishing companies the paperbacks houses offered big advances against publication. Mr. James Jones, for example, shifted from Scribners to Dell after he was guaranteed $1 million as an advance against three books, while Mr. Norman Mailer was enticed away from Putnams to the New American Library by a comparable sum.

This competition has forced the conventional publishers to increase advances and to offer better terms generally to writers. Even less well-known (though established) authors have been able to secure contracts guaranteeing $10,000 to $15,000 for publication. However, this year sales of paperbacks have dropped suddenly and the companies are beginning to feel the pinch caused by overproduc-

*Reprinted from "The Economist," June 25, 1966.

tion. Purchasing is being reduced and advances are dropping. The literary agents and the authors have not reconciled themselves to this setback and the next few months will probably see them shuttling from one firm to another seeking to maintain their new gains.

What they are counting on is that the overflow of capital from the third great change in publishing—which is yet to come—will carry them along too. This new development is the sudden interest that giant corporations are taking in the publishing industry. To some degree they have only just realised two things which the banks and the stock market scented early in the nineteen-sixties. One is that the great profits in publishing are connected with text books; (the rest account for only 7½ per cent of all sales). The other is that the increasing college population—the expectation is that by 1970 50 per cent of all high school students will enter a university—coupled with the availability of government funds for books and learning materials make publishing a major growth industry. Recently, the educationists themselves have begun to talk of a revolution that requires new types of teaching equipment. Since then one acquisition has followed another.

Behind these is the notion that the computer, and communications in general, can help to revolutionise the process of learning. The technologists hope to design teaching machines and to prepare educational material that will store and pass on information rapidly and with relative ease. No one has hit upon a precise formula, but the theories include using computers, programmed instructional machines and special films, both silent and with sound. At the moment the plans are confined to "research and development," for neither in the schools nor in the universities is there yet a clear idea of how to use such devices in the classroom. There has been some experimentation but the results have not been conclusive. Beyond this lie the problems of inducing teachers to accept the new materials and then of educating the teachers in their use.

Aside from the sudden influx of capital, which they welcome, where do the publishing companies fit into this scheme of things? Though no one says so publicly, text books seem to have only a limited place in the new philosophy. Media, materials, visual and audio forms—these are the new terms. In fact, if the research now underway proves successful, the communications and computer industries will really have supplanted the publishers. Why buy publishing companies, then? One answer is that the publishers have the salesmen, the networks for distribution, the solid reputations, the contacts with school superintendents, university professors and the federal Office of Education—all very conservative gentlemen where innovation is concerned. Besides, it is probably cheaper to buy the companies now than to put them out of business later.

Nevertheless, the faint chill of obsolescence has begun to creep into the marrow of a few editorial bones. At present the giant corporations have no interest in anything except text books. But what happens when they move into management and begin to glance at the profit and loss columns? Will they eliminate the "literary" works and, in the fashion of television, publish only entertainment for the mass market? Or, worse yet, will they turn even more inventive and design a storage or microfilm unit that will make books obsolete? These are spectres which only alarm the editors and publishers fleetingly; for the present the new money has meant higher salaries, may well permit the continuation of large advances for writers and gives publishers a sense that their industry has some access to power—sufficient compensations for the loss of their gentlemanly pastime.

KNOWLEDGE ON TAP*

FROM A SPECIAL CORRESPONDENT

In recent months two major—and seemingly incompatible—groups, the makers of computers and the communications industry, have been forming commercial alliances designed to hasten the long-promised revolution in collecting and disseminating the world's rapidly growing stock of knowledge. Linking some of the most impressive corporate names in America, this sudden rash of mergers is creating a new industry, described as "information display" or the "knowledge industry," and based on a bewildering array of machinery capable of storing and retrieving massive amounts of information with incredible speed.

Among the most notable ventures into this new area is that of the International Business Machines Corporation, the world's largest manufacturer of computers,

*Reprinted from "The Economist," May 21, 1966.

which has acquired Science Research Associates and has also entered into a licensing agreement with Dun & Bradstreet, Inc. Science Research produces electronic teaching devices, such as the so-called "reading laboratory," as well as publishing educational and testing material. Under the terms of its agreement with Dun & Bradstreet, IBM has combined its data processing capability with Dun & Bradstreet's economic intelligence gathering to meet the individual needs of subscribers who will pay a premium for exceedingly fast, accurate, up-to-the-minute commercial information. Last week IBM began to sell reports on market research.

Time, Inc. (*Time, Life, Fortune and Sports Illustrated* magazines) is not only installing $700,000 worth of IBM computers to make editing easier, but has also joined with another computer maker, the General Electric Company, to establish an educational publishing operation destined to market everything from conventional text books to electronic learning devices. The new firm has been christened the General Learning Corporation and Time announced recently that Mr. Francis Keppel, the Assistant Secretary of Health, Education and Welfare, had been invited to become its chairman and chief educational officer. Random House, Inc., a book publisher with best sellers which for months have topped both the fiction and non-fiction lists (Capote's "In Cold Blood" and Michener's "The Source"), is turning its general and educational divisions into an independently-run subsidiary of the Radio Corporation of America. The Xerox Corporation has purchased Wesleyan University Press. The Raytheon Company has acquired D.C. Heath, Inc., a long established text book publishing firm. Just this week the International Telephone and Telegraph Corporation announced an offer to buy Howard Sams and Company, a publisher which also operates technical reference services.

These new relationships represent an effort to cope with, and exploit profitably, what is commonly known as the information explosion—a modern phenomenon created by accelerated scientific discoveries and technological advances. More than 60 books, 500 general articles and 4,000 technical papers appear each day in America. It has been estimated that it would take a most scholarly scientist five sleepless centuries to read just the technical papers published last year. Another source estimates that the output of technical publications has increased 86 percent since 1960. Society seems in danger of being choked by its own unwieldly accumulation of knowledge. Most text books produced today are out of date before they even roll off the presses. And because information does not flow fast enough through orderly channels, there is a tremendous duplication of effort and waste of creative talent, both scientific and non-scientific.

Of necessity, the information explosion and the communications problems caused by it are fostering the evolution of a new science from the ancient art of catch-as-catch-can research. The existing methods of indexing libraries, along with grey-haired librarians and pretty young research workers, are giving way to automated and less fallible systems of storing and retrieving information. At Radcliffe College the women students in one hall of residence have a keyboard apparatus in the basement between the hairdryer and the washing machine. This gadget is linked to a computer in Valley Forge, Pennsylvania, which will give an instant answer to requests for information which would have taken up to twenty hours to gather in the library. Similar systems are being installed for Radcliffe's male counterparts at Harvard University and elsewhere. Some scientists now predict that the traditional devices of mass communications and learning—books, magazines and newspapers—may be replaced by a host of electronic monsters more capable than the printing press of disseminating "all the knowledge that's fit to know." This is just what some publishers fear. What will happen then to the copyright of books? Even though they are impressed by the technology of the electronics industry, a number of publishers remain doubtful about tying themselves to corporate alliances and want to remain free to enter into individual arrangements with electronic firms.

Most of the fast developing technology in this field revolves around the digital computer, which can perform prodigious feats of mathematics and serves as a storage bin for staggering amounts of information. One IBM model, about the size of a standard office desk, can hold nearly a million pages of debulked documents, any of which can be located in less than ten seconds. Documents of information, called input, are stored in these computers on microfilm strips in greatly reduced form. The cards used to retrieve information from these particular IBM systems carry unexposed film which can be activated by ultra-violet light.

Specialists called programmers (who themselves may be replaced by machines) perforate the cards so that when they are injected into the computer's storage bin they automatically locate the desired documents; the image of the document can then be transposed on to the card's film patch. Once the card has picked up the image, it is developed rapidly and ejected from the bin to be viewed or copied. The Central Intelligence Agency uses this particular IBM system to solve its esoteric problems of information.

This model, however, is just one of the countless computerised systems of retrieving information which are now in operation. In lieu of punch cards and microfilm, other systems employ magnetic tape and discs, typewriter-like keyboards and a plethora of scientific devices for communication between man and machine. Ranging in size from 60 to 180,000 pounds, these basic computers—with their attachments of accessories known as "peripheral equipment"—can be tailored to perform almost any specific task of information storage, retrieval and analysis. The Radio Corporation of America says that it has invented a computer that can talk.

Computers seem to be invading every aspect of life in which the retrieval, analysis and dissemination of information is important. Although the industry is just over twenty years old, sales of computers last year topped $5 billion in the United States and the number of computers in operation has grown from less than a hundred in 1951 to about 23,000 today. The federal government alone spends over $1 billion a year buying, leasing and maintaining these electronic devices, which seem to do everything from manning the nation's defense system to sorting the post. The electronic computer industry will undoubtedly continue to grow and to become more closely aligned with the mass media. A number of scientists are looking forward to the day when each home has a photocopier linked to a computer which will instantly produce reports and editorial material tailored to meet the needs and desires of each individual. This day may not be so far off. A team at the Massachusetts Institute of Technology is already attempting to design a nation-wide computer network which will make instantly available everything that mankind knows.

The implications of this situation for the publishing industry will be discussed in a later article.

ADAPTING NEW EDUCATIONAL MEDIA FOR EFFECTIVE LEARNING OF STUDENTS *

by C. R. Carpenter [1]

The so-called new media have been proposed, promoted, or projected for so many different reasons and for the hypothetical solution to so many educational problems that one can easily lose sight of the fact that they, like all teaching activities, are a means to one primary objective—instigating learning and appropriate changes of behavior in students.

Along with this primary objective, there are a number of general propositions which need to be firmly understood if the new media are to be effectively used in higher education.

First, all learning is *individual, private, and personal.* While learning, individuals may be members of groups of various sizes distributed in various ways. But no matter how the learner is situated, the changes in behavior which we call learning are painfully or pleasantly private and personal.

Second, even learning which is mediated by the new nonbook electronic media is individual, personal, and private. Although one may think of radio, television, or motion pictures as "mass" media because of the great number of persons they can reach simultaneously or successively, they are not, in a learning sense, mass media at all. The interaction that occurs between the perceptions of the listener or viewer and the listening or viewing stimulus surfaces is private and personal.

The third proposition argues that it is the content or the stimulus material (in psychological terms) and its very special value for the individual learner that is important and not the particular carrier of the information. Whether the content is transmitted by tape recordings, television films, or thermoplastic materials makes no *essential* difference to learning.

The fourth, and final proposition, holds that instruction made available by such means as language laboratories, closed-circuit television, magnetic tapes, pro-

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[1] This paper was presented at the annual meeting of the American Council on Education, October 7, 1965.

jectuals, or computer print-outs is no more mechanical, cold, remote, or impersonal than instruction transmitted through books. Today's books, like the new media, are the products of an extraordinary technical revolution which is concerned with preparing information in some form, reproducing or duplicating it, and distributing it or storing it for later availability. The modern distribution or warehousing operations, which are commonly sanctified by the term "library science," are enormously complicated for books as well as the so-called new media.

In brief, all learning is private and personal; this is as true for learning by the new electronic media as it is for learning that takes place by more conventional means of teaching; the content or stimulus material for learning is paramount, not the means by which it is transmitted; and the new media, including current textbooks, are the product of a useful technological revolution in information management.

The Central Problem

The central problem, as far as the new media are concerned, is that of determining how they can be best adapted to meet the requirements for effective academic learning. This cannot be done by using subjective judgments or *a priori* reasoning or even by committee decisions, however well qualified the members are. The effective adaptation of media and materials requires the use of empirical methods in the preparation of instructional materials and in the difficult work of improving curriculums.

A further requirement is the building of new kinds of facilities on campus. These may be thought of as laboratories for the developing and testing of instructional programs. Just such a laboratory was established at The Pennsylvania State University in 1961–62 and used temporarily for conducting research and development work in the use of the new media, including programed instruction.[2]

The task was to determine whether *programed* courses in contemporary algebra and in English grammar could be successfully adapted for presentation over closed-circuit television. The objective was to develop procedures and materials that would take advantage of both programed instruction and closed-circuit television. If these programed courses could be successfully adapted for closed-circuit presentation, then they could probably be presented successfully to much wider audiences over broadcast television.

While carrying out the developmental work, the researchers also decided to experiment with various methods of presenting the programed algebra and grammar courses to students. For comparison purposes they used a superior teacher, a book, filmstrips, and, of course, television instruction.

The students who participated in these experiments were all freshmen with roughly the same backgrounds and abilities in math and English. The rate of presenting the material, or frames, was determined by timing samples of students as they worked on the programed materials in book form. The researchers also experimented with four rates of "pacing" in order to determine the effects of varying the rates of presentation.

Results

Six results are worth noting. Briefly, they were:

1. It is feasible to use television and films, in combination with printed material, for *programed* instruction.
2. Even students with fairly similar abilities and experience have a fairly wide range of tolerances for pacing rates.
3. The effective presentation of *programed* materials on television requires highly active and persistent responses on printed forms from the students and immediate reinforcement of correct answers or extinguishing of incorrect responses over the video or audio channels of television.
4. "Paced" group study and individual study without external pacing yielded approximately the same results.
5. Pairing of students, i.e., having two students working on the same programed text and discussion and comparing answers, yielded scores similar to those made by individuals working alone, although interest and motivation seemed to be higher among the paired groups.
6. The programed materials developed for use on closed-circuit television were successful enough to lead to their being recommended for presentation over

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[2] *Comparative Research on Methods and Media for Presenting Programed Courses in Mathematics and English*, C. R. Carpenter and L. P. Greenhill, et al. 1963. The Pennsylvania State University.

broadcast television on a nationwide basis. However, this should be the next stage of research.

Media Use for Small Groups

The course development laboratory illustrated how different media, in combination, can be adapted to content, methods, and students' abilities. Another Penn State experiment in 1963—the Pyramid Program—dealt with the possibilities of adapting closed-circuit television instruction for use in small group discussions.

The Pyramid Program was also designed to show how specially trained undergraduate upperclassmen could serve as discussion leaders and models for freshmen and sophomores.

Each of the small discussion groups consisted theoretically of one senior, two juniors, four sophomores, and eight freshmen. All were majoring or intended to major in psychology. One idea was to keep the groups as free as possible from the presence or control of a faculty member.

A closed-circuit television system fed into fourteen classrooms with audio output back to the studio was used to coordinate and monitor the fourteen pyramid groups in the experiment.

The students selected the problem or issue to be discussed and I, as the faculty person responsible for the program during that fall term, would formulate the issue or problem for all the groups. Following these brief periods of drawing the issue, the "Telequest" sound system was used to monitor one at a time in any desired order the discussion and work of each pyramid group. Occasionally, a group that wanted to raise a question would signal me to ask for information, opinions or references.

In the beginning, the monitoring procedure was quite helpful to me in training the senior discussion leaders. After the first two weeks, the groups sharply reduced the frequency of their questions to me as they became more self-sufficient and involved in their own problems and issues. Throughout the term, the procedure served as means of studying and evaluating the discussions without interfering with the processes involved.

The above demonstration again illustrates the use of a complex closed-circuit television system as an instrument which can be adapted for facilitating the learning of students.

Some Near-Future Developments

Public Law 89–10, providing for a national complement of regional education laboratories, should significantly advance the adaptation of media for student learning. Even though the provisions for these potentially important regional laboratories are in the Elementary and Secondary Education Act, colleges and universities will be heavily responsible for carrying them out. Those interested in research, development, and innovation in higher education should read Titles III and IV.

Media for Teaching Large Classes

With increasing enrollments, colleges and universities must accept the requirement of teaching large numbers in large classes. This imposes many restraints and limitations on what are thought to be essential characteristics of good teaching. The demands of teaching classes in the 300–500 size range require new uses of space and configurations of equipment for teaching a wide range of subject-matter areas.

The instructional auditorium, a complex of architectural design and instrumentation, shows promise in dealing with the problem of large classes, but it needs further research and development. The fairly primitive models of such auditoriums at Miami and Wisconsin have paved the way for potentially more advanced models now being put into operation at the University of California, The Pennsylvania State University, Stephens College, and almost one hundred other schools and institutions.

The display systems of these auditoriums have the capabilities for using slides, films, and tapes as sources of projection. The equipment can be automated to some extent and will be preprogramed possibly by punched tape, in the not too distant future.

What has not yet been done satisfactorily is to provide for student responses, for the rapid computer processing of these responses, and for the presentation of the results back to students, individually or as a group, for reinforcement-extinction purposes.

When we in higher education do what we already know how to do theoretically and provide well-instrumented instructional auditoriums for large groups of students, we will be able to teach large numbers, to accommodate a wide variety of media to the needs of individual students, and to comply with the demands of learning and teaching theory. When these working auditoriums, with their potentially high efficiency, are equipped with on-site special purpose computers and tie-ins with computer centers, then we shall have created possibilities for contextual and realistic research on academic learning that we never before had available.

Instructional auditoriums of advanced design, will, of course, be expensive to construct and operate. And here again we will be dependent to a great extent on engineers and technicians. Like closed-circuit television, it will probably require up to five years of skillful diplomatic work to get faculties to accept and learn how to use these unusual facilities. Finally, as is the case with instructional and educational television, the *critical requirement* for success will be the availability of enough appropriate, high-quality, and proven instructional materials and programs.

REFLECTIONS ON RESEARCH ON HIGHER EDUCATION: STRATEGIES AND TACTICS*

By C. Ray Carpenter

The general theme of the 21st National Conference on Higher Education invites reflections about colleges and universities and their context. The addresses and discussion groups of the conference program, if the present can be predicted from the past, will reflect the informed viewpoints and mature wisdom of those educators who give content and substance to the program. The sessions will include scholarly essays, critical analyses of problems, rational expositions of issues, and considered judgements on the states of institutions of higher education and trends from the present into the near future. The main source of the content of programs will be the personal and professional experiences of educational leaders who attend this conference.

The character of the conference, the substance of its programs, and the sources of information and evidence reflect present-day methods of thinking about and describing higher education. There are reflected, also, the styles of work and of administration of colleges and universities.

Neither during this conference nor in the dialogues and activities of colleges and universities will the hard results of well-conducted research be often and importantly used. A weak trend may be observed during this conference of increasing references to the results of research and development on projects and programs.

The cold, hard fact is that most, but not all, of the major issues and problems of higher education have not been rigorously investigated, and, therefore, dependable and needed evidence does not exist for use in the analysis, exposition, discussion, and interpretation of and reflections on educational issues.

Institutional Research Dispersal

There are developments which should eventually change the attitudes toward research of those responsible men who make decisions about higher education. During the last 15 years, the organizations and activities of *institutional research* have survived and grown slowly. Apparently, the important functions of institutional research have been dispersed among different sectors and offices of institutions, rather than growing into large central services. Data or fact collection has been moved into or developed by those offices of the institution which are most responsible for specific functions. For example, the comptroller conducts research on costs and other concerns relating to finance and budgets. Student affairs has its own research unit. Academic affairs likewise conducts some research, and more often provides services for faculties. Plans and development and physical plant departments may have their own fact-finding units.

The notable development is, however, that the main fact-finding and record-keeping of institutional research have become permanently implanted in colleges and universities and will surely expand. As a consequence, more hard usable data of certain types exists now than formerly. A remaining problem is that of

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how to organize, store, and retrieve data of the right kind, at the right time and in a useful form.

The availability and usefulness of computers is rapidly solving these problems. Nevertheless, there remains much to learn about how to use effectively the increasing amounts of data in thought, actions, and decisions on higher education. There also constantly arises the question of what data should be made available. Collection of data on operations is the first and least difficult order of business in research on higher education.

Research and Development Activities

In a research and development-oriented society, the use of research methods directed to the study of educational problems and institutions might be predicted. Until now, however, the increase in the programs of research on higher education and related problems has been slow and limited in scope.

The needs and demands are increasing, however, for *high quality research* and *experimentation*. The size, complexity, and rate of growth of higher education argues not only for more but for better research. The requirements of funds, energies, and people, and the necessity to make rapid and refined decisions, additionally justify extended and improved research programs of both the analytical and the systematic types.

Support is rapidly increasing for the research, development, and dissemination of results on higher education. This is signaled by the rapid growth of the course content improvement program of the National Science Foundation and of the U.S. Office of Education. More importantly, the Higher Education Act of 1965 and the Elementary and Secondary Education Act of the same year provide authority and funds which call for relatively enormous increases for research and development on a very wide range of problems and programs.

These developments portend a new era and new direction for new kinds and dimensions of research.[1] The thrust will be toward the application of objective, systematic, and empirical research *on* the central functions of higher education, as these functions are defined. The objectives will be improving the understanding, increasing the core of hard information about all levels of the educational system, and using the results to improve the whole system.

Some Important Developments

The Cooperative Research Program of the U.S. Office of Education grew from a very small beginning in 1956 to a $16 million program in 1965 for a wide range of educational research. The Elementary and Secondary Education Act of 1965 authorizes an additional $70 million for educational research, with $45 million being available during 1966–1967 for construction and operating costs.

Although these provisions are made, especially in Title IV of the Elementary and Secondary Education Act, nevertheless, the carrying out of this Act will *need* the support and cooperation of colleges and universities. These provisions should have been cross-referenced in the Higher Education Act in order to emphasize the essential role of universities in the program.

Research and Development Centers

The Research and Development Centers Program has already led to the establishment of the following special purpose centers:

1. Center for Research and Development in Higher Education—University of California at Berkeley
2. Center for Research and Development in Teaching—Stanford University
3. Center for Research Development on Educational Differences—Harvard University
4. Research and Development Center in Educational Stimulation (ages 3–12)—University of Georgia
5. Research and Development Center for Teacher Education—University of Texas
6. Learning Research and Development Center—University of Pittsburgh
7. Center for the Advanced Study of Educational Administration—University of Oregon

[1] *Support for Research and Related Activities*, 1965. Bureau of Research, U.S. Office of Education, U.S. Department of Health, Education, and Welfare.

8. Center for Research and Development for Learning and Re-education—University of Wisconsin
9. Center for Urban Education—a consortium of seven New York City colleges and the State Department of Education

Regional Educational Laboratories

The regional educational laboratories which are now being planned and established throughout the nation will have very broad responsibility for identifying, investigating, and engineering needed educational improvements and innovations in a region and in the nation. These laboratories will be planned for continuing operations and refinanced periodically. Like the research and development centers, the laboratories will have funds appropriations for both construction and operation costs. Matching funds will not be required. The laboratories will be directed toward a number of major objectives, and they will conduct many kinds of research programs at different levels of the educational system. They will be interdisciplinary and interinstitutional. Thus, the maintenance of balanced programs will be difficult.

In the meantime, the other research programs of the U.S. Office of Education are expanding rapidly. The extensive and recent reorganization of the U.S. Office has put the programs into new organizational categories. There is now in the Bureau of Research a Division of Higher Education Research and a Division of Laboratories and Research Development.

Procedures for applying for funds and submitting proposals have changed. The new proposal screening office will receive, route, and process most research and development applications.

Strategies and Tactics of Research Programing

Research programs on educational problems are now well launched, and the possibilities of special research on higher education have been greatly increased by new legislation. All of these recent developments raise again and again the central question of *what should all of these research mechanisms, programs, centers, and laboratories do?* What kinds of research and development should be undertaken? What can be done by research which would *yield the most useful results* for education, both in the short and long-range of time? Who is responsible for deciding what programs shall be undertaken?

Existing Centers

As has been noted, the centers now in existence have planned research programs in such areas as individual differences, learning, teaching, and problems of maturation and development. The Carnegie Foundation Centers at Columbia University, The University of Michigan, and the University of California at Berkeley have attacked a very broad program of research information collection. In addition, these Carnegie Centers have contributed to the advanced training of men who join the staffs or faculties of institutions of higher education. Generally, each center or laboratory must select from many alternatives and decide on its own pattern of research, development, demonstration, and dissemination.

The National Feasibility Study and Suggested Research Problems

In 1962 the U.S. Office of Education contracted with the Pennsylvania State University to conduct a national feasibility study on the question of establishing research centers and laboratories of the regional, interdisciplinary, and cooperative types.

The author was requested to conduct the three-month study with the assistance of a small staff and an advisory-planning committee.[2] Planning seminars, small conferences, resource papers, and memoranda, as well as interviews, were used to collect information.

A main point of inquiry during the study was *what research should such centers undertake and conduct?* The following summaries are drawn from suggestions and proposals made by almost 150 selected and knowledgeable psychologists,

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[2] The Advisory Committee and Planning Staff consisted of the following: C. Ray Carpenter, *chairman*; L. P. Greenhill, Dale B. Harris, Otis E. Lancaster, and A. W. VanderMeer, all of The Pennsylvania State University; Wendell I. Smith of Bucknell University; and T. R. Robinson, Project Staff and New York University (Laboratory of Educational Materials).

educators, administrators, and educational investigators.[3] Most educational problems have been transformed into statements of problems that relate to meaningful human learning. Therefore, the following summaries emphasize the *conditions* and *processes* of academic learning.

On the basis of information collected 12 areas were defined, and a brief description of each may help create one perspective of needed educational research and development.

1. Conduct a systematic and critical analysis of the literature and existing information on meaningful human learning and teaching. Determine what summaries, generalizations, and applications can be soundly recommended. Develop rapid, effective ways of testing the *soundness* of possible recommendations, then distribute widely the tested general recommendations with instructions for application.

2. Improve and extend the *quantification* of information and evidence about learning and education, and develop research designs and conditions for using advanced designs for experiments in education and on complex human learning.

3. Investigate factors and conditions which determine the amount, kind, and rate of mastering areas of knowledge and of acquiring related complex intellectual skills. Measure the endurance or preservation of knowledge gains and accomplished levels of skilled performances, and their transfer or generalization to related areas of behavior. Study the full life history of complex patterns of concepts and performances, and chart both the positive and negative effects of environmental factors, including cultural and social factors, on learning, its preservation and generalization.

4. Investigate analytically, and in patterned combinations of individual learners and their interactions with conditions which affect learning and intellectual development. Relate results to such intellectual qualities as originality, problem-solving abilities, and other variabilities of learning reactions and responses. Also, relate analyses and other results to general and special abilities and to maturation rates and maturation levels. Study the conditions which produce in individuals such behavior as conformity, rebellion, stereotyping of thinking, affective-blocks, and conflicts with relatively rational, cognitive processes.

5. Investigate systematically the stimulus and perceptual requirements and conditions for learning different qualities and levels of information and skills from different media and modes of information and stimulus displays. Study the optimum ordering and sequencing of stimulus displays and their ordered contents for instigating the required intellectual performances. Explore the learning conditions which permit individuals to test the attainable limits of intellectual capacities and performances.

6. Study the approaches, sets, and attitudes of individuals about academic learning tasks and learning activities. Attack the problems of how to train and retrain young students and adults in favorable learning attitudes and interests, and in the *instrumental skills* for learning. Optimize conditions for increasing the abilities of individuals to interact with learning materials, and *to abstract and organize meaning* from print, pictures, oral language, speech, graphics, demonstration, and observed situations. Attack the broad problem of research and development on how best to use available modern technology to train and teach rapidly large numbers of people in the basic skills of learning behavior. Determine the life conditions which lead individuals to become autonomous self-directed learners.

7. Conduct research on the dynamics of motivation for learning. Factor analyze motivational patterns and measure positive and negative forces and conditions which affect learning. Assess the conditions affecting achievement motives. Develop and test models, both mathematical and practical, for significantly increasing motivation for academic achievements.

8. Develop both theoretical and practical models of principles, methods, and procedures for introducing and for sustaining the development of tested practices and new orders of instructional materials with schools, colleges, universities, and communities. Study how to increase the rates and degree of acceptance of tested developments for higher education.

9. Develop and apply computers and related advanced systems of instrumentation in research on learning, and to the solution of practical educational problems. Systems of instrumentation now available may be used to: (1) regulate learning with speed and precision, (2) store prepared and ordered information

[3] *A Research Report on Operational Plans for Developing Regional Educational-Media Research Centers.* The Division of Academic Research and Services, The Pennsylvania State University, University Park, Pennsylvania. Under contract with the U.S. Office of Education, Title VII, NDEA, April 1962.

and stimulus materials and make these available in predetermined patterns or in random access, (3) process data on the relevant characteristics of learners, (4) regulate the pacing and routing of students' responses, (5) through patterns and sequences of learning, provide for "reinforcement" and the knowledge of consequences of the efforts to learn, (6) measure the rates and levels of changes in the learners' performances, and (7) process many kinds of educational data. Computers may be used for research on and development of instructional materials, courses, and curricula.

10. Conduct experiments which would apply *systems analysis* and *operational research* to instructional and learning situations. Apply and test the application of these and other methods in the administration of educational institutions, and apply them in the conceptualizing, planning, and building of new educational institutions and programs.

11. With the cooperation of cognate disciplines, investigate the genetics of intellectual abilities and capacities, and study in detail effects on maturational intellectual abilities of the cultural, subcultural, institutional, and familial factors as they affect the development of individuals. Consider, by all appropriate means, the social and cultural consequences of applying advanced educational technologies and their effects on human populations.

12. Investigate the neurophysiological bases and correlates of learning behavior. Study intensively the biophysical and biochemical processes of the organism which relate to learning behavior.

The National Feasibility Study report not only suggested areas and programs of sustained research, development, and application of results, but also described how the centers may be established and what their general characteristics would be. They would vary in size and function, would be based in and would serve a region, would be coordinated, and would contribute to national educational information pools. The report recommended that the centers be based in and mainly operated by universities, in cooperation with school systems and state departments of public instruction. The centers or laboratories would have assured and sustained financial support, thus permitting the programatic approach to research on complex problems. Much of the research and development work would be done in the context where the results would be applied, thus increasing the appropriateness of research results to real practical problems. *The report of the National Feasibility Study recommended that a capital investment of $100 million be made in 11 centers or laboratories to be established during a four year period, and that the research programs be built up to the level of $25 million to $40 million of operating costs a year. Justifications for the recommendation were based on the estimated needs for research, development, demonstrations, disseminations, and applications, and on the desirability of balancing research on the science of learning and human development with support for other fields of research.*

The Study Section of Panel Approach to Research Planning

Another and very different approach to defining the areas for research was undertaken in 1964 by a Study Section of the U.S. Office of Education's Media Research Branch. (This research activity has been combined with the Research Bureau.) The Study Section consisted of six professional men who were experienced in research.[4] They considered many alternatives, combined many programs and projects, and finally briefly defined five target areas of research which, in their judgment, had the highest probabilities of yielding important and useful results when research was focused in them. May [5] reviewed the literature in each of the defined areas and made these reviews available to the Study Section.

The intent is to increase the productivity of research by inviting proposals for grants and contracts in defined areas, rather than to accept proposals for research on media which spread over the full range of interests represented by those who submit proposals to the U.S. Office of Education. Which is the better strategy remains to be determined.

The five areas tentatively outlined by the Study Section are the following: (1) meaningful verbal learning, (2) learner response and instructional media, (3) picture-word relationships in learning, (4) enhancement and simplification, and (5) sequencing and organizing subject content for instruction.

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[4] The members of the Study Section are: C. Ray Carpenter, John B. Carroll, Robert M. Gagne, Eric F. Gardner, Arthur A. Lumsdaine, Mark A. May, and Wilbur Schramm.

[5] May, Mark A., *Enhancement and Simplification of Motivational and Stimulus Variables in Audiovisual Instructional Materials (A Working Paper)*, 1965. U.S. Department of Health, Education, and Welfare, U.S. Office of Education Contract No. OE-5-16-006.

Search for Sites for a Center for the Study of Higher Education in the South

The 1961 report of the Commission on Goals for Higher Education in the South [6] entitled *Within Our Reach* [7] recommended that one or more centers for the study of higher education be established in that area. The Southern Regional Education Board which sponsored the Commission's work invited the author to work with James L. Miller and A. J. Brumbaugh of its staff in making site visits to self-selected institutions and institutional clusters to help determine where in the South centers for the study of higher education might be developed.

The Commission on Goals said:

"There is less fundamental research on the operation of colleges and universities than on almost any other social or economic institution . . . , higher education, which does research on everybody else's problems, does very little on its own" (p. 43).

The report called for:

". . . at least one center for long-range, fundamental studies dealing with problems common to all institutions. It was the opinion of the Commission . . . that funds invested in such a center would pay large dividends in future improvement of our colleges and universities" (p. 44).

Clearly, what the Commission recommended was research on the broad sweep of colleges and universities directed toward increasing the effectiveness with which these Southern institutions achieved their stated goals. This level and kind of research complements the recommendations of the National Feasibility Study, which focused mainly on the conditions and processes of complex human learning.

In 1963 the author visited seven locations in the South to explore the possibilities *for* as well as to stimulate thinking *about* the planning and building of one or more centers for the study of higher education.

An important part of the inquiry was that of learning *what kinds* of research faculty members and administrators would propose as they debated the desirability and feasibility of founding a proposed center.

The discussions were usually free-flowing and wide-ranging. A reflection of the kinds of research suggested during the studies is given by the following suggestions:

1. Evaluate the most important needs for research and determine what should be done differently in institutions.
2. Conduct continuing programs of studies on teaching and learning.
3. Improve curricula and course subject-matter content.
4. Collect, select, organize, and disseminate information of use to education.
5. Develop and test methods for assessing the products of education.
6. Investigate who and what determine educational standards.
7. Conduct research on the interactions of secondary schools and colleges.
8. Study junior (community) colleges and their interactions with other institutions of higher education.
9. Determine how educational "experiments" can be adequately and objectively evaluated.
10. Collect evidence for supporting new educational programs for the region.
11. Conduct continuing studies of the characteristics of students.
12. Study patterns of courses taken by students at the universities, and especially the courses taken by correspondence and otherwise from other institutions.
13. Study the "presses" and "pressures" of the college environment on students.
14. Analyze and evaluate the processes and impact of counseling.
15. Develop procedures for summarizing data collected from different sources.
16. Analyze, collate, interpret, and plot the significance and development trends studies from available data.
17. Explore basic issues and improve the definitions of educational problems.
18. Develop methods for measuring the effects of elements and parts of patterns of educational activities, e.g., the contribution of the laboratory in a lecture-demonstration course.
19. Test the usefulness of the case study method in large classes.
20. Develop institutional theory and apply it to colleges and universities.
21. Study how different educational programs affect the state and the university system.

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[6] Commission on Goals for Higher Education in the South: A. Boyd Campbell, Oliver C. Carmichael, Sr., LeRoy Collins, Colgate W. Darden, Jr., (*chairman*), H. H. Dewar, Marion B. Folsom, and Ralph McGill.

[7] *Within Our Reach*, 1961. Southern Regional Education Board, 130 Sixth St. N.W. Atlanta 13, Georgia.

22. Conduct research on a list of management problems such as purchasing arrangements, the flow pattern of faculty actions, theoretical and mathematical models for operating the physical plant, and the management of research contracts.
23. Conduct research and development work on the management of information in such areas as administrative communication networks, changes in patterns of communication with rapidly increasing size, improving organization of communication channels for the best results.
24. Conduct research and studies to provide the administration and faculty with the right evidence, in the right form and at the right time, for making decisions about the educational system.
25. Establish and operate in the Southern region several data pools on all aspects of higher education.
26. Plan research and development programs which will bring about adaptive changes in higher education.

This set of suggestions for research areas which might be attacked, given the resources of funds, buildings, equipment, and trained personnel, illustrates what was proposed generally by those with whom discussions were held. The variations of statements about areas of research were expected and found. There was, nevertheless, a strong consensus about needs for these kinds of research.

The question of what *focus* a center should have elicited the greatest differences from place to place, individual to individual, and group to group. The following are some possible focuses: teaching, its theoretical basis and practices; the development and application of a science of learning; the junior college and its role in the whole educational system; the administration and management of colleges and universities; studies of human development from infancy to adulthood; the problems of quantification and measurement of academic performance; student characteristics and institutional climates; and the building of data-information pools and shared uses of computers.

There were suggestions for empirical approaches to the establishment of centers. These approaches would determine the educational needs of a region and assess the requirements for meeting these defined needs. They would have the centers grow entirely out of the context of the region and the people, where they are to be established.

Everywhere there was interest and general approval for enlarging the scope and intensity of research efforts directed toward the understanding and management of institutions of higher education. Everywhere the assumption was accepted that research would help in this work. Usually the discussions dealt with fairly limited geographic areas and with a cluster of institutions. There were few proposals to build data pools and to extend research activities for the entire South. This is, in part, a result of the great diversity of the 16-state region. In many other respects the South is not homogeneous and cohesive. A number of centers should be established in the South, therefore, to cover its vast scope and diversity.

The 1965 federal legislation and present appropriations for research and development centers, service centers for schools, and regional educational laboratories create great opportunities for the centers for the study of higher education. Now it is apparent that many of these centers and laboratories as they are established can have strong divisions or sections which concentrate on the study of higher education. Even so, in each place the questions which have been raised in this article will be asked and *must* be answered: What kinds of research should be done? What areas and programs will be given the most emphasis and highest priority? How will the research patterns of efforts differ from center to center? How will the activities of the different centers be coordinated and the results shared and put to work?

Summary

These reflections on research on higher education have stressed the desirability of using evidence from research to supplement experience and personal wisdom in dealing with issues and problems of higher education. Research and development programs now being sponsored, especially by the U.S. Office of Education but also by other agencies, will probably provide the funds long needed for launching and sustaining large-scale and appropriate research and development programs. Deciding what problems to attack or what the research strategies will be and should become is of central importance. A report has been given of proposed problems, programs, and areas of research as developed in a 1962 National Feasibility Study, in a Study Section for the former Media Research

Branch of the U.S. Office of Education, and in a series of site visits conducted for the Southern Regional Education Board to encourage the establishment in the South of centers for the study of higher education.

In conclusion, with the great expansion of educational research the strategies and tactics of research become correspondingly and increasingly important. Not only should the sharpest possible instrument of investigation be used on higher education, but this research instrument should also be turned on research itself.

COMPUTER-TUTOR*

By James Ridgeway

A new industry in education has been taking shape this past year through a series of mergers, principally involving electronics companies and publishing houses. Along the way, the electronics companies picked up smaller concerns that make films, design tests and programmed instructional materials, produce educational toys and cheap scientific instruments.

The leaders are well enough known: IBM and its subsidiary, Science Research Associates; RCA and Random House; the joint ventures of General Electric and Time, Inc.; Raytheon and D. C. Heath; General Telephone & Electronics and *Reader's Digest;* Litton Industries; and the nest of education firms acquired by Xerox. (David Dempsey discussed the impact of this new business on book publishing in the May 14 issue of *The New Republic.*)

The government is shepherding the new industry along, providing it with funds from the poverty program and the Office of Education, so that ideas and products can be tested. The philosophy that governs its overall development comes from the Defense Department and in particular from the systems analysts around Secretary McNamara, who have worked hard to persuade both industry and the rest of the Administration that the systems approach is the best way to tackle the problems of the Great Society. Consequently the education businessmen don't look at their job from the standpoint of just selling one product, but rather with an eye to designing and carrying through several functions; that is, they want to design a school system, provide it with innovative materials and equipment, train the teachers how to use the equipment, and then test the finished product—in this case, the student as he comes out of one system and goes into another. The long-range thrust is toward making the computer into an effective teaching machine. If this can be done, the present school structure will radically change. It is conceivable that the school as we now know it will go out of existence altogether.

This business is very fluid at the moment. But here are a few examples of the sorts of things that are beginning to happen. The Office of Economic Opportunity recently gave the Chicago welfare department $600,000 for an education scheme that involves purchase of several "talking typewriters." These are small computers that have been successful in teaching three-year-olds how to read and write, and they have been particularly helpful in teaching backward children. New York City hopes to get $1 million from OEO for a similar project.

Next fall IBM will install the first of its new 1500 series instructional computer systems at a school in East Palo Alto, Calif. They will teach first graders. Computers already are used in some Boston schools to teach math. Philadelphia soon wants to award a contract for computer-assisted instruction. Litton Industries is helping Tulare County, Calif., design a model school system, and will help to train people to run it. The government is spending more than $1 million over two years in California in 10 school districts which have joined to set up a central data processing system which can schedule students, score test results, keep records and guidance information and print report cards.

However, programming instructional material into a computer and welding the whole into a useful educational tool may turn out to be a very long haul, a longer haul than many of these companies thought when they jumped into the education business.

Programs and teaching machines were developed in the mid-1920s but did not stir much interest until Dr. B. F. Skinner did his famous studies with animals in 1954. Dr. Skinner set out to shape the behavior of pigeons by giving them a bit of corn when they made the right movement. By this sort of encouragement

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he got them to playing ping-pong. His theories on shaping behavior were then applied to humans and led to programmed instructional materials.

A program breaks down a given subject into small steps or frames, which are presented one after another in logical sequence either in the pages of a book or on film or paper that can be viewed through the window of a machine. Each frame contains an item of information and the student is asked to put the information to work immediately by filling in a blank or answering multiple choice questions. In some programs repeated failure to answer correctly will result in the student's being shunted off onto a remedial track. For example, a program in basic chemistry works like this: In the first frame there is a picture of piles of pebbles, sand and powder. The program says: "This is a pile of pebbles. The pebbles are large, so it is easy to see them. If you make them smaller you have sand. If you make them still ——— you have powder." On turning the page, the answer "smaller" appears, along with the next frame which asks, "Why is it difficult to see powder particles?" Once more the page is turned, the answer is, "They are too small to be seen easily." And in this manner the program proceeds to more difficult material.

The idea is for the student to progress at his own pace, and like the pigeons, he is reinforced with each step he takes by correctly answering simple questions. Programs have been particularly useful with rote material, like basic arithmetic and spelling. The teacher is freed from the drudgery of drills.

Skinner believed that for a program to function effectively it needed to be run through a machine, and this should be some sort of simple, durable, inexpensive device that in appearance could resemble a small record player. The student would turn a knob, and a frame of the program would appear in the window of the machine. After studying the material, the student would write his answer to a question. He turns the knob once more; his answer moves up under a piece of glass so he cannot change it, and the correct answer then appears.

Limitless Possibilities

Programmed instruction never has aroused much enthusiasm in the schools, although it is widely used in industrial training programs. The academic programs often have been boring and poorly put together, and they have not been sold along with the simple, cheap teaching machine of the kind envisoned by Skinner. Instead, in 1960 the encyclopedias got into the act, and their salesmen hawked teaching machines and programs door to door in an appeal to parents who feared something was wrong with their children. Their high-pitched salesmanship glutted the market and many purchasers were disappointed with results.

But now excitement over teaching machines once again is rising because of the computer. Here the possibilities seem limitless. As the child sits at his typewriter and begins the dialogue with his computer-tutor, the machine will sense out his weaknesses and provide him with remedies. Instruction will be tailored to each individual. There will be no classes, nor, for that matter, any need for schools. The student can sit at home. In the morning he will dial into the computer and ask for French. After half an hour of this, he will switch to the library (all the books will be stored in computers) and get the machine to print out parts of *Paradise Lost,* which he will study, and then dial another computer to answer some questions about the poem. Once a semester a student can go along to a learning center for discussion groups and a chat with his counselor. The counselor already will have asked the computer for an audit on the student, and will be prepared to discuss his progress and qualifications for jobs. It will be interesting to compare the student's actual progress with the computer's predictions of his progress, which in most cases will have turned out to be all too accurate. This is not science fiction. However, more research is needed to bring down the costs and make the machinery more sophisticated before it is likely to take place on any wide scale.

Recently I saw some of the new teaching machinery. One widely publicized device is the "talking typewriter," developed by Drs. O. K. Moore and Richard Kobler. It has been quite successful in teaching three- and four-year-olds how to read, write, and touch-type. It looks much like a regular typewriter. The child is left alone with it, and as he explores it, he will hit, say, the letter M. A voice from the machine says "M," and by playing about with the keyboard, the child gets to know the different letters. As he gets the hang of the machine, the voice may ask him to put together different letters until they make a word. Preschool children at Mount Vernon, New York, were having great fun with the

machine which asked them to spell out "Batman." These machines cost $30,000 each and, until the OEO grants, only 10 of them were in use. They are made by the McGraw-Edison Co., and sold by Responsive Environments Corp.

At the Learning Research and Development Center at Pittsburgh, Dr. Aubrey Holland is preparing a device for teaching youngsters in the city's Head Start program. A child will sit before a screen that looks like it came from a TV set. A slide projector flashes a picture of two blue-colored balls across the top half of the screen; across the bottom there appear the numbers, 1 in red, 2 in blue, and 3 in yellow. The idea is for the youngster to line up the two blue balls with the number 2 also colored blue. When he makes this association, he is to hit the number 2 with his hand, and a red light flashes and a gong goes off. This is meant to encourage him and he goes on to progressively harder work. This machinery, which Dr. Holland had jury-rigged, could be duplicated by a Westinghouse computer which is located in the center.

The computer can also give spelling lessons. The student sits at a console, which consists of a typewriter keyboard and a television-type screen. Off to one side is a speaker. The teachers are hidden by oneway mirrors at the back of the room. The spelling program begins. A man's voice says, "Please spell smile." As the student types each letter it is printed on the screen in front of the keyboard. If he hits the wrong letter, the machine refuses to print the letter, and the voice says, "wrong." If he keeps hitting the incorrect letter, the machine says "wrong" and finally spells the word correctly. Then the voice says, "Now you try." If the student does not respond, the machine patiently says, "Please type correctly, please type correctly, please type correctly," until either the word is spelled out properly or somebody turns off the computer. This machinery may be tried out in a Pittsburgh elementary school next fall.

I also got a chance to have a dialogue with a couple of different IBM computers. I sat at a typewriter console in the company's Washington office. The typewriter was hooked up by leased lines to various IBM computers around the country. First, the engineer dialed one in Poughkeepsie, New York, and after a brief whirl at a number-squaring exercise, I got him to switch that one off and dial into Yorktown Heights, New York, where there are more intriguing programs. To get into Yorktown, I had to give a student number and a secret code word. Then Yorktown printed out a course directory which included vocabulary, word recognition, German, biochemistry, physics and history. I chose history.

"Name the British commander who captured Fts. Ticonderoga and Edward," said the computer.

"Cornwallis," I typed back.

"No," said the computer, "Cornwallis was defeated at the Battle of Yorktown later in the war. Try again."

"Burgoyne."

"Correct."

Moving on, the computer asked, "A legend connects Betsy Ross to George Washington; according to the story what did Betsy Ross do?"

"I do not know."

"Try again, making your answer an affirmative statement."

"Betsy Ross made flags."

"Whose flag? Which flag?"

"She made US flags."

"The US did not exist as such until after 1870. This legend refers to an earlier period. Whose flag? Which flag?"

"She made American flags."

Then the computer began to give hints:

"She made —— ——— American flag. Try again."

"She made the first American flag."

"Right, she made the first American flag."

Tiring of this, I switched to a German course which asked me to translate "the ring is round." Since I did not know any German the engineer showed me how to get the computer's dictionary, and on request it translated the words into German.

IBM has developed a method called "Coursewriter," which enables teachers who don't understand how computers work to revise and update programs by using simple procedures.

The new 1500 systems which will go into the East Palo Alto first grade include television screens and head phones, as well as typewriter keyboards. Children can also answer questions by pointing their light pens at the right answers on the television screen. The computer can read the pen's signals.

IBM computers have been used in other research experiments. In Project Essay Grade at the University of Connecticut, a computer was filled with a dictionary of 1,000 commonly misspelled words, then told how to detect misused words, errors in punctuation and grammar as well as certain style flaws. The idea was for the computer to simulate a panel of English teachers who must grade papers for college boards, and the project was sponsored in part by the College Entrance Boards. The computer graded papers along with three human judges and the results of all four were said to be practically indistinguishable.

Dr. Robert D. Tschirgi, dean of planning for the University of California system, feels computers can help universities get on with their real job. The primary business of any university, he says, is the creation, storage, manipulation and dissemination of information. Once all the libraries at universities are hooked together through computer systems, there will at last be the "great composite university which is truly universal." To those who are frightened of machines, Dr. Tschirgi has these words of encouragement: "A book is an inanimate, unresponsive friend at best, yet love and attachment are well recognized emotions to be displayed toward books. Why should it be surprising, therefore, that a reactive, facile, responsive computer may also generate a form of affection in its human users? Is it any less comprehensible to imagine a generation with nostalgic memories of one's old computer-tutor than to have cherished remembrances of ivy-covered walls?"

What It Costs

Despite such enthusiasm, widespread use of computers as teachers is a long way off. The machines still are clumsy and very expensive. IBM's 1500 series costs from $6,000 to $12,000 a month to rent for a computer that can handle 32 children. There are few inspired programs that are published in books, let alone interesting ones for computers. It can cost as much as $10,000 per hour of instruction to write, test and revise a good program, and it may well take three or four years to do the job properly.

Big companies which are diversified enough to stay in the race 15 or 20 years are the ones most likely to succeed in education. IBM seems sure to be a leader, though its spokesmen speak conservatively about computer-assisted instruction. At the very best, they say, computers can perform simple drills in subjects like arithmetic and spelling which will help take a bit of the load off teachers. IBM hopes to sell 12 of its new systems over the next two years. They probably will go into the colleges and universities where the company has been developing research; they will be used mainly for more research.

Thus, the outlook for making a fast buck is not good. In their eagerness to stake out a claim in the education market, businessmen have invested close to half a billion dollars within the past year or so. Yet they are shooting at a market at best worth $1.5 billion a year—including textbooks. (Most of the money spent on education goes for teachers' salaries and for construction of school facilities.)

This market will need to be expanded, partly to make more money and because the systems approach won't make any sense unless business can get into and influence areas that now are controlled by the educators. For example, industry almost certainly will have to move into teacher training. One reason innovations in educational materials are slow to catch on is because teachers don't know how to use them in their classes or are too hidebound to try out new things. Already some companies in education are beginning to work at bringing around the teachers. IBM's subsidiary, Science Research Associates, which writes programs for IBM's computers, also will instruct the teachers in how to write their own courses using the "Course-writer" methods, and how to revise existing computer courses. Through its subsidiaries, Xerox writes programs and publishes the *Weekly Readers*—the droopy, children's magazines. Thus, it gets directly at the students and teachers; the company also holds two-week seminars for teachers where they learn how to lay out a course of programed instruction.

Companies may find it good business to own and operate networks of vocational schools and community colleges. Businessmen know much more about vocational education than the public schools. IBM spends $60 million a year on internal training of employees. There is a great need for competent and inexpensive schools in expanding areas such as health. Already business is getting experience running school systems by operating the Job Corps camps for the poverty program. Litton Industries, which runs a Job Corps center on the West Coast, also designed a community college at Oakland, Michigan.

Litton put together instructional materials and showed the teachers how to use them.

The new industry is eager to get at young children. CBS bought Creative Playthings, a firm that makes educational toys. Raytheon is interested in making a similar acquisition. The poverty war's Head Start program has been such a success it would not be surprising to find companies beginning to package and sell Head Start type preschool systems to the middle class. Home study is another market. Four million people take correspondence courses. If business could get the public educators to accept the idea of granting an external degree, this business would open up. CIT Financial Corp. has a scheme for communities that are short of cash for education. Through a series of arrangements with manufacturers, it will build, equip and lease school rooms, libraries and labs.

These markets will expand or contract depending on the amounts of money the government puts into them. The education industry is likely to unravel in imitation of the aerospace industry, where some of these firms have worked. The government sought a greater commitment by business to education, and now that business is in with both feet, the Administration can scarcely let them down. The only course will be to make more money available. Quite probably the firmest supporters for more federal aid to education will be the big industrialists. The new industry has a good friend in Louis Bright, associate commissioner of education in charge of research. He comes from Westinghouse. Francis Keppel, the former commissioner, will have a major hand in shaping the direction of the Time-GE venture called the General Learning Corp. where he is soon to take a job. In two weeks the Defense Department will hold an unusual conference for industrialists on education technology. The Pentagon now spends $4 billion a year on education and training, and while this money is spread among the different commands, there are indications that Mr. McNamara wants to get hold of some of it to knit together the Department's training efforts. Mr. Morris, the Assistant Secretary for Manpower, says the Department wants to bring advanced technology to bear on training; he picks out computer-assisted instruction as an example of what he means. This will be another market where industry can test new products.

All of this should be bracing to the public education establishment; at long last it will have a bit of competition. The emergence of this new industry also raises some interesting questions for the government which will be channeling its development. For instance, 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. Industry's keen interest in the education market means that new departures will not be discussed publicly before they are announced. Information about new products and markets is considered proprietary. In two weeks of discussions I found people in the business reluctant to discuss future markets and products except in the most general terms. In the end, the future of education may be decided by a handful of corporation vice presidents.

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