MEMORANDUM
on
EDUCATIONAL CLOSED-CIRCUIT TELEVISION

by

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INTRODUCTION

The idea that television may be made use of in the teaching-learning process is capturing the imagination of professional educators and laymen generally throughout the country. Some view it with misgivings, as a mechanization of what we all like to regard as one of the most important of human relationships. Others hope to find in it a tool which will spread the influence of the truly gifted teacher over larger numbers of students, without loss of dimension or personality, and thus upgrade the quality of general education, and as a secondary but not incidental benefit, help to meet the growing crisis in teacher supply.

It is generally true that when a new technology is about to be applied to an old problem, initially a profound gap exists between those who thoroughly understand the problem and those who are conversant with the new technology: its scope, its versatilities or lack of them, its potentialities and limitations, and its cost. The existence of this inevitable initial gap can result in false starts, ill-considered experimentation, and probably a good deal of waste of time and money.

The purpose of this memorandum is to try to bridge the gap between pedagogy and technology, between what is educationally needed and what is technically feasible. It is certainly not in the scope of this memorandum to assess the merits or demerits of teaching by television or to evaluate the results. Those appraisals must be made by society. For several years this company has made a major part of its business the transmission of moving images by electrical impulses over cable to a multitude of viewers. As a leading manufacturer of community antenna or wired television systems, we are increasingly approached to help solve problems of educational closed circuit television. A further purpose of this memorandum, therefore, is to bring together into one place concisely what we have learned so far of the teaching and curriculum problems that our equipment may be called upon to meet.

THE TEACHING AND LEARNING PROCESS AS A TECHNICAL PROBLEM IN COMMUNICATION

President James Garfield said in the often misquoted address to the Williams College Alumni: "Give me a log hut with only a simple bench, Mark Hopkins on one end and I on the other, and you may have all the buildings, apparatus, and libraries without him." Granting the well-deserved compliment to a great teacher inherent in this proposal, it leaves something to be desired from the practical standpoint. There simply are not enough Mark

Hopkins' or, for that matter, enough log cabins either. If the survival of a free and democratic society like ours depends upon the character and enlightenment of all its people, and through these upon the wisdom with which they meet the new and old challenges in an insecure world, then we can ill afford to turn our back upon any promising tool or "apparatus" which may lift and broaden the educative processes; nor can we afford to limit the reach of a gifted teacher to a pupil-teacher ratio of one to one or indeed 30 times one to one.

In a private report in the late 1920's Dr. Vannevar Bush separated all communications into four basic modes: from one individual to one individual, from one to many, from many to one and--very rare--from many to many. He went on to cite four basic means of communication: by sound, by sight, by writing and by electrical impulse. The teaching-learning process embodies the first three modes and uses the first three means.

Direct classroom teaching represents in the first instance communication from the one to the several. We have long ago extended this mode of communication beyond the means of sight and sound. The written lesson in books or indeed even in correspondence courses merely expands the area of communication from one to a larger many. Television, also, simply applies an additional means to this basic mode of communication, but with the advantage of preserving the impact of image and voice. This rather natural extension is both technically easy and financially inexpensive.

The recitation period--the question and answer--is at a minimum communication back from the one student to the teacher; but if the recitation is well led and spirited, the whole class becomes involved so that communication may truly be said to be taking place from many to the one teacher. To remote this return communication through television and at the same time retain its vitality and pace with both sound and image is much more difficult. The technologies are available: television signals can now be carried in opposite directions over a single transmission line simultaneously, but the cost of this operation in terms of camera and audio equipment is very high.

As a summary generalization, then, we have found that the problems of circuitry and distribution system layout involved in applying the medium of television to normal educational communication are much simpler than those inherent in a community antenna television system.

THE INFLUENCE OF BROADCAST TELEVISION

Wisely the Federal Communications Commission has reserved channel space for educational broadcast television. Such stations now in operation are performing a valuable public service. With a few specific exceptions, however, these stations thus far provide informal rather than formal subject matter content and are beamed to the general public and not to the student public. Even where courses are offered for credit or where programs, as in some instances, are part of the local public school structure, the scope is limited by the fact that only one channel is available. Thus, even if a television broadcast station is wholly available for school use during the school day, only a small fraction of the total curriculum material being taught during that day can be taught by television.

Also, broadcast television techniques are heavily influenced by the need on the part of commercial television to attract viewers. It is only recently that we have come to recognize that teaching by television can originate in the classroom and with very little in the way of staging, properties and "production."

Inherently teaching at the elementary or secondary or college level is not a "broadcast" activity, but a highly selective communication of particular and specific subject matter to highly selected age and achievement level groups. It belongs, in our opinion, on closed, not open circuits.

VIDEO AND RF

A second influence of broadcast television is probably found in the initial inclination of those planning educational closed circuits to plan their transmission of images at video frequencies. We believe the wisdom of such planning is open to very sharp challenge. It is true that commercial broadcasters, where they are required to transmit signals within their studios or for relatively short distances, do transmit at video, but their circumstances are quite different from those of the more extensive educational closed circuit. In the first place, the distances are short which simplifies transmission at video; secondly, there is only one channel to be dealt with; thirdly, if a duplication of cables does become necessary, the cost is an insignificant part of the total cost of the installation. In the case of a school or a system of schools, distances mount rapidly, thus very greatly increasing the problem and increasing the cost of transmitting at video. In the second place, if the use of television for teaching purposes in the school system is to be more than nominal in amount, not one but many channels will be needed, with the result that if transmission at video frequencies is adhered to, duplication of transmission lines at prohibitive costs is unavoidable.

Many different kinds of information must be carried by air or by cable to transmit a picture electrically. The electrical impulses into which the information is converted for transmission purposes vary in frequency from 30 cycles per second to four and one half million cycles per second. This is the video band. These impulses, however, may be put, for transmission purposes, on carriers of much higher frequency. Thus the band of carrier frequencies for Channel 2 is six million cycles wide, extending from 54 to 60 million cycles per second. The VHF and UHF broadcast frequencies all lie within the area of frequencies referred to as RF or Radio Frequencies. Although attenuation or loss of signal strength, either over a cable or through the air, is greater at RF than at video, other problems are much more easily solved in those bands. Line equalization, which is an acute problem at video, is relatively simple at RF, and reamplification in order to compensate for line losses is very costly at video and relatively inexpensive at RF. Since coaxial cables can transmit all frequencies up to many million cycles per second, many channels of television communication can be carried at RF to numerous and widely scattered schools, dormitories and other reception points over a single transmission line.

To the suggestion that direct transmission of video signals is essential to clarity of picture and that satisfactory picture quality cannot be secured for educational purposes when the signals are transmitted over RF carrier bands, we do not agree. In our opinion, if the resolution of the final picture in an RF closed circuit distribution system is unsatisfactory, the cause lies in inadequate camera equipment, inadequate receivers or improper transmission and distribution equipment.

ORIGINATION - TRANSMISSION - RECEPTION

These are, of course, the three basic components of any closed circuit system. Individuals considering the establishment of a closed circuit activity appear, we have found, to be principally concerned with the ends of the circuit and not with the middle. Their investigations seem to center on originating and receiving equipment: on questions of the size, quality and versatility of such equipment, where it should be located and how easy or difficult it is to operate. These are essential considerations, but it is just as important to recognize at the outset that the usefulness of the originating and receiving equipment in a closed circuit is absolutely and permanently conditioned by the quality and capacity of the transmission distribution system connecting them. Money spent for high quality camera chains and high resolution receivers is substantially wasted if the interconnecting transmission system fails to preserve signal quality intact.

Equally important with quality in the transmission system are dependability and maintenance. An outage in an educational television system not only disrupts the teaching period in which it occurs, it can have a lasting affect on the confidence and satisfaction with which both teachers and students look at this new medium and on their willingness to accept it. A system which requires constant adjustment, tuning and maintenance on a daily basis is not only costly to operate, but because of its greater dependence on the human factor, it is just that much more subject to failure. Teachers and pupils should be able to take their closed circuit for granted. It should be as sure functioning as the blackboard and as foolproof as the period bell.

Many considering an educational television closed circuit do not seem to be aware of the great flexibility and capacity available in transmission distribution systems of the kind manufactured by this company. We have found no insurmountable obstacles in providing for the transmission of many channels from many points of origin to many points of reception, located at widely scattered places. For example: A closed circuit which embodied the following unique characteristics was proposed by us and accepted by the school department of a New England city: Teaching could be conducted from any classroom in the entire school system and received by all other classrooms, or, as would normally be the practice, by all classrooms in the same grade level as that from which the teaching was going on. Furthermore, the point of origination--the live teaching classroom--could be changed from day to day or week to week in rotation at the decision of the school administration and faculty. At least twelve such activities could be carried on for the entire school department simultaneously all day long. In addition to this a channel was available for the type of communication which would be received by the entire school, such as an address by the superintendent, a current event, etc. In this particular community the educational closed circuit was tied in with a community antenna system with the result that provision could be made for adult education or for children at home ill who through the television closed circuit could be kept up with their class work.

The question of system capacity and versatility should be looked at not only in terms of the initial and somewhat experimental steps planned for today, but also in relation to the programs which the system may be called upon to implement in the future should the use of television for teaching become generally accepted.

CURRICULUM AND CHANNEL CAPACITY

How do we measure those potential demands? Let us consider for a moment a secondary school, grades nine through twelve, with five class periods per day. Five basic subjects are taught five days a week to all grades. At two grade levels, however, these subjects have different curricula for the commercial and college courses. Thus for the five basic courses we have six grade levels or thirty grade-subject-periods per day or one hundred and fifty different material content periods per week. Add to this two periods a week of art for four grades, and two periods per week of music for four grades, or sixteen additional periods, and we have a total weekly grade--subject matter--period load of 166. Each of these 166 teaching periods has different subject matter content.

One television channel operating continuously through a five-period day provides for five subject matter periods and in a week for twenty-five. Thus the number of television channels which would be required to carry the total curriculum load arrived at in the above paragraph would be $166 \div 25$ or 7. This would require, of course, very tight scheduling indeed. In order to relax course scheduling to some extent and to make provision for other televised material--opening exercises, current events and the like--one or more additional channels should be added to the capacity of the system.

Turn for a moment to the elementary level and assume seven periods per day. Let's assume also that we will teach only arithmetic and English in all eight grades and science in grades 6, 7 and 8, and that English and arithmetic are divided into a fast and slow section in grades 6, 7 and 8.

Thus we have 11 grades of English, 11 grades of arithmetic and three grades of science, or 25 grade subjects per day. In this example all are taught five days a week, resulting in 125 grade - subject matter - periods per week. Each television channel in a seven-period-per-day school provides, of course, 35 teaching periods per week. Thus for this rather restricted television program in this hypothetical elementary school system and at optimum scheduling, a minimum of four channels is needed.

FLEXIBILITY AND BUILDING FOR THE FUTURE

The transmission distribution system in an educational closed circuit represents the smaller portion of the total installed cost of the whole system. In a fairly small program with, let us say, one point of origination, and ten receiving rooms in two buildings a half mile apart the cost of circuitry is less than 25% of the total cost. As and if the program grows the circuitry, if properly engineered, absorbs the increased load with little or no increased cost so that the proportionate cost of the transmission-distribution system shrinks downward from this 25%.

However, this important point should be taken into account at the very beginning: Camera equipment and receivers are mobile; they are replaceable and interchangeable at no labor cost. As far as such equipment is concerned an educational closed circuit television program can be expanded more or less indefinitely by the mere addition of more equipment. Exactly the opposite is true of the transmission-distribution system. A fairly high labor cost is involved in its installation. Building modifications may be necessary. Expensive underground conduit is sometimes desirable. Once the system is in it is extremely costly to replace it or modify it.

The early community antenna systems were built with equipment with a capacity limit of one to three channels. Today, many of these systems in order to provide their subscriber with adequate service are now faced with the necessity of adding two or more channels. The engineering, labor, and equipment cost involved in these conversions approaches the original cost; and it is needless expense since it could have been avoided in the first place by forward-looking layout of the system and by the selection of equipment with built-in spare capacity.

No college or school knows, today, how far teaching by television may or may not go in the future. The device has tremendous potential, but it would be foolish to pretend that it does not have limitations; and we will simply have to pick our way among these and learn as we go. But in laying out even a first step project we should build for the future. We must build into that part of the project which is fixed and immobile--the distribution-transmission system--provision to handle a vastly expanded program should that become desirable. The difference in cost between a system which is sharply limited in capacity and thus inflexible and one with capacity which for all practical forseeable purposes is unlimited is a very nominal difference. Thus selection in the first instance of a system which will meet future as well as present needs will not only save many thousands of dollars in the end, but will also make it easier to find those areas of usefulness of this new medium where its advantages outweigh its limitations.

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