

ARCHITECTURAL

ASPECTS OF EDUCATION

BISHOP

AN INVESTIGATION
of
ARCHITECTURAL ASPECTS OF EDUCATION
using
TECHNOLOGY FOR THE FUTURE

Architectural Thesis
1960
Robert C. Bishop

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MONTANA STATE COLLEGE
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PREFACE

Education is a means through which our country achieved its highest objectives and dreams. With the ever-increasing complexities in technical progress of these fast-changing times, a lack of education for all of the people, or inferior education for a substantial number threatens the very perpetration of our country.

The relative expansion of our population compared with the number of professional teachers that will be available to teach them, has caused many educators to be concerned with the problems of how to cope with this situation.

This is the reason for this paper, on the investigation of future technology as it affects education and architecture.

By perusal of printed sources, and books, an attempt has been made to try and understand some of the possible ways that education may be influenced by our rapidly changing technology.

Because of the broad field of coverage, it would be impossible to explore every implication that one thought or idea might have on the other, therefore I will have to call upon the reader to use his imagination to bridge the gaps that may be between these concepts and ideas.

The first part of the text deals with the problem, namely the lack of teachers and lack of school classroom

space. The second deals with technology and psychology, with inclusions of some information that the author feels is pertinent to the subject. The third and fourth part deals with educational television and some of the aspects of architecture caused by it. The last part deals with a form of philosophy which has been the foundation of the electronic brains, computers, and programmers which are being used to further our knowledge of everything that takes place around us.

Special attention must be given to the help and information afforded me by Mr. Hardy Berry, Director of the Information Office; Dr. John L. Fell, Assistant Director of the Film and Television Center; Dr. James F. Nickerson, Dean of the Education Department; and Dr. Myron G. Arcand, Assistant Professor of Chemistry, all of Montana State College, for their time, references and personal interviews.

Mr. Hugo G. Eck, Associate Professor of Architecture, and Mr. David Wessel, Associate Professor of Architecture, both at Montana State College, deserve special mention for their aid in forming the scope of this paper and the method of studying the problem.

Mr. Vern Dusenberry, Associate Professor of English at Montana State College, gave valuable assistance in writing the final draft.

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I. INTRODUCTION

Until quite recently the schools and colleges of our nation have been able to keep abreast of the changing conditions. But there is an accumulation of evidence that time is running out.

Public school enrollment has been increasing by approximately 1,200,000¹ a year. To visualize more clearly this large number of young people starting school, think of all the people in a city the size of Houston, Cleveland, Baltimore, or St. Louis. This is approximately the additional increase over the preceeding year.

With this huge increase, it is easy to see that the educational and physical plant requirements of our nation are tremendous, and with this phenomenal continuing growth of the number of persons to be educated in our country, it is time to look at the condition of our educational facilities.

Many of the school buildings in use today were built in the decade starting the 1900's. From that time until the end of World War II, our population growth was not so rapid as to warrant these facilities to be considered obsolete. Since the end of that war, the number of births has risen

¹Dr. William G. Carr, "Birthrates and Birthrights," National Education Journal of U. S., May 1957, p. 322.

more than fifty percent, and each year for the past five years it has hovered around the four-million mark, which is one and one-half times the level of the depression decade of the thirties.¹ This large number of enrollments was thought by many to be a temporary phenomenon, but now educators realize the problem will be with us for the foreseeable future.

As of January 1, 1960, the Census Bureau figured the Nation's population at 179,254,194 at 8 a.m.² on this first day of the year, and every twelve seconds thereafter, there is one net addition to our total population.

Because of the postwar birth increase, the schools started to feel the pressure starting in the middle of the 1950's. "In 1958 there was over 29,000,000 pupils in our elementary schools, 8,000,000 in our secondary schools, and 3,000,000 in our colleges."³ This means that one out of every four of our people goes to school or college.

By 1965 there will be approximately 36,000,000 pupils in our elementary schools, 12,000,000 in our secondary schools, and 4,500,000 in our colleges.⁴

To make matters worse, the normal attrition of buildings due to obsolescence, structures that are condemned because they are deemed unfit or unsafe for school use, plus structures

¹Alexander J. Stoddard, Schools for Tomorrow: An Educator's Blueprint (New York: Fund for the Advancement of Education, 1957), p. 14.

²Great Falls Tribune, January 2, 1960.

³Stoddard, op. cit., p. 15.

⁴Ibid., p. 16.

destroyed by fire, flood, and other natural causes, which can take place in the over 1,000,000 classrooms now in use, has kept ahead of the normal building of new replacement structures. Just replacement of existing structures alone would require from 14,000 to 20,000 new classrooms to be built every year.¹

To get a clearer picture of this problem, by the Fall of 1960, this country will need 407,000 additional classrooms for optimum ratios of students to teachers, but by the Fall of 1960, only 240,000 will be the total that can possibly be constructed.² The problems identified with adequately educating our young people have begun to pyramid.

In this phenomenal growth since 1955, there has been over two million pupils in excess of building capacity.³ The long term projection of our population is an increase of over fifty million people in the next fifteen years. This means that our probable population in 1975 will be in excess of 229,300,000 or 21,300,000 more than the present population of Soviet Russia.⁴ This means that more schools will have to be built to accommodate the vast increase in population, and at the same time the nation will be faced with the dilemma of having half the necessary qualified

¹Carr, op. cit., p. 322-323.

²Ibid., p. 323-324.

³Ibid., p. 324.

⁴Montana Standard, February 7, 1960.

teachers and instructors.¹ By 1965, there will be a need for 350,000 more teachers than there are now. The shortage of teachers will approximate 250,000 by 1965 if present conditions continue.²

To top off this phenomenal growth of students and the need for more teachers, is the fact that we are undergoing a rapid change in the subject nature. There is a dramatic increase in the range of knowledge today's students will have to acquire in order to live intelligently in the space age. Not only are there more new things to be learned, but the nature of these things is becoming much more complex.

Because the problems look insurmountable to some educators, they have become restless and concerned about the possibility that much of our present educational machinery may be outmoded in this changing world of ours. These educator's concern is reflected in a favorable attitude toward experimentation, designed to find out what the conditions are that threaten the educational program, and once these are determined, to formulate programs to meet and overcome these conditions before they may cause the schools and colleges to bog down.

It is in the realm of this experimentation that I have chosen to write this thesis. A good deal has already been written about educational television. My stand will be

¹Teaching By Television (New York: Ford Foundation, 1959), p. 2.

²Stoddard, op. cit., p. 17.

that it has proved itself to be successful as a tool because so far, it is the most powerful medium of communication yet devised by man. I will endeavor to point out some of the strong points, as well as some of the weaknesses of ETV, and at the same time elaborate on some topics that would in my estimation add more impetus to the solution of our vast educational problem. Also I will try to elaborate on some of the architectural aspects of this growing problem with regard to psychology, class room size, and the application of mathematical logic to school plant design.

II. TECHNOLOGY FOR THE FUTURE

The challenge of quantity has largely been met. Most of America's youth are in school and most classrooms have teachers; but the challenge of quality is much more difficult to meet.

Right now the schools are in the midst of a time when they need more teachers than was thought possible, also a higher level of teaching is needed. There are not only more persons to be educated, but also there is so much more that must be learned, and much of that which must be learned is more complicated and difficult to learn than before. The situation is even more challenging because there is not enough school space in which to do the teaching properly. Moreover, many of the building facilities are outmoded and illadapted to the needs of a modern program of education.

Among the arrangements to which educational institutions may resort when pressed by increasing numbers of students, is that of a change in class size, or to change the manner¹ or method in which the class is taught. Curiously, class size is extremely flexible in practice, but the attitudes of faculty toward any change from what has been regarded as traditional, are highly inflexible.²

¹Italics by author.

²Better Utilization of Teaching Resources (New York: Fund for the Advancement of Education, 1959), p. 35.

Notwithstanding the fact that class size can be changed at will, most faculty members and a substantial number of students, when asked about the desirable size of a class, indicated their preference for small groups. Intangible benefits are claimed for the closer relationship of faculty and students in small groups which do not show up in test results, but are nevertheless educationally important.

Tests so far have indicated that under typical group--teaching procedures, mere size of class has little significant influence on educational efficiency, as measured by achievement in academic subjects.¹

Many experimental programs concentrated on the aspect of better utilization of teaching facilities, directed their main energy at discovering how large class teaching may be made most effective. In general they started with the assumption that an increasing student body and an inadequate supply of good teachers will of necessity result in larger classes, and therefore the immediate problem is, to find ways of preventing a deterioration in quality of education or, hopefully, of improving it while increasing the student-teacher ratio.

To this author it seems that many changes in methods of teaching designed to improve the students' education might be equally or more effective in small classes, if the resources used for teaching could be used by a small class

¹Ibid., p. 35.

as well as a large one. The peculiar advantage of large classes over small ones might fall into one of two groups. The first includes those advantages inherent in the large group, such as the statistical probability that it will contain more capable students than a smaller group chosen at random, and consequently, that class discussion may be on a higher plane in a large than in a small group. This advantage has been claimed by law schools, which characteristically have larger than average classes. The second advantage accruing to large classes is the fact that it is financially and physically more feasible to provide enough good teachers for a few large classes than for a large number of small ones, and because some helpful visual aids and equipment, for example, slides, can be used more efficiently with one large group than in many small ones.

It is not by accident in this period of technical advancement, which has nurtured such advances as television, atomic fission, and space exploration, and great medical discoveries, that education is undergoing a mutation in the complexities of how best to educate the people. Along with many other wizardries of the electronic computer brain age, you might expect that education too might become one of the stepchildren of this fast and growing field. The concept of "machine teaching" almost invariably arouses initially a strong emotional reaction. To conjure the vision of brains being processed on an assembly line to be moulded and conformed into identical dimensions of rough and slick surfaces is a revolting one.

Curiously though, machines used as teaching tools make for more individuality in teaching and learning, and can remove from classrooms the drudgery of essential repetition in basic subjects, leaving the teacher free for more interpretative and challenging teaching while at the same time permitting students to learn at their own rate, progressing as fast as their capabilities permit.

Right here on our campus at Montana State College an extensive use is made of a so called "teaching machine", which is made up of a tape recorder and other visual-aid equipment. Students in the experimental sections of a botany course work without an instructor present in three out of five class periods per week. Their room is equipped with two specially devised machines, an improved tape recorder synchronized with a slide projector and a unique test scoring machine. Plant materials, microscopes, and other laboratory materials and equipment are in the room and students use them while listening to the lecture, which had previously been recorded on tape. Illustrative materials are automatically projected on a screen at appropriate times during the lecture. Provision also is made for individual use by the students of slide materials and a simple machine on which they can score their own daily tests. During the two remaining class periods in each week, the students meet with faculty members for discussion and interpretation of course materials.

The results of this experiment, even after being tried for one year, were striking in both the quality of student

performance and the satisfaction students and faculty derived from the method. A considerable amount of faculty time was released from routine chores, for more essential instruction.

More complex ideas and concepts have been cropping up here and there to offer more grist to the mill of efficient educational endeavor.

The recent exchange visits of Khrushchev and Eisenhower, has motivated four members of the President's Cabinet, Secretaries Benson of Agriculture, Anderson of the Treasury, Mitchell of Labor, and Seaton of Interior, to undertake privately a newly designed course in "Instant Russian." This new fast language course not only provided a quick conversational mastery of Russian for these men in the President's Cabinet, but it dramatized the acceptance at highest level, of a new teaching method that soon may bring about an exciting revolution in all fields of learning.

The principle involved is one that psychologists have recognized for years stemming from Pavlov's experiments with motivation and response. The concept of "reinforced learning" has been known for some time, but it took Lew Robbins to develop its use into a more efficient system. This system has been proved successful and more efficient than older methods in teaching typing, Morse code, electronics, and all other factual studies to which it has been applied so far. Large corporations such as I.B.M. and R.C.A. have started to use it in some of their industrial training programs.

To illustrate, a hypothetical example would be: A hungry man is facing two vending machines, one black, and

the other red (stimuli). Both machines appear to have stocks of bananas, but, actually, one machine is empty. The man selects a machine at random and deposits a coin (response). If the red machine is chosen, his coin is returned and he gets no banana (absence of reinforcement). He then drops his money in the black machine and receives a banana (positive reinforcement). After eating the banana, he deposits a second coin in the black machine and receives a second banana. Thereafter, every time the man wishes a banana, he deposits his coin in the black machine. The principle established here is common to all animal behavior: responses to stimuli which receive reinforcement are strengthened and responses which do not receive reinforcement are extinguished. By applying this principle, results have been achieved in many unrelated fields.

For instance in teaching French vocabulary, the standard method has the student memorize the words and associate them, over and over, with their English translations. The "reinforced learning" system not only saves time, but it does away with this conscious memorization. Using records or tape-recorded lessons, it furnishes the student with an invisible tutor. The stimulus is the instructor's voice on the tape. It speaks the foreign word or phrase. There is a pause, while the student guesses its meaning (response). Then the tape announces the correct answer (reinforcement). If the student guessed right he feels rewarded and tends to remember the correct answer. Wrong guesses, since they are not reinforced, tend to be forgotten, especially if, on the

next try at the same word or phrase, a correct guess is made and reinforced.¹

Another teaching machine has been developed by Professor B. F. Skinner of Harvard. To describe it briefly, it is a method of presenting to the student, material printed on paper tape, to which he responds by writing on an exposed piece of another tape. After he has written his response, he moves a lever which exposes the correct response and simultaneously moves his written answer under a transparent cover, where he can see but not revise it. The operation of the machine permits return of any given material to the student so that after the entire tape has been exposed he has the opportunity to make corrections if he has judged his first response to be incorrect. However, the material on any tape is so constructed that students are helped to arrive at knowledge of the right answer. Each question is based on earlier ones and the steps through which a student is led cause him to progress towards mastery of content and understanding of the subject.

A second technique in programming a subject for learning by this machine is called "vanishing", which involves presentation of a complete item, as for example a poem to be memorized, and the subsequent removal of increasing portions of the item until the student is able to reproduce the entire item without a prompt. The leading technique is useful in teaching material in which reasoning is an important factor; and the vanishing technique that in which memory is of prime

¹American Weekly, November 8, 1959.

importance.¹

At this time the use of teaching machines is just in its infancy, but those using the machines are confident that with refinements, the "self-teaching machine" can materially assist students in independent study and will yield good results in learning. The experiments with these various self-teaching machines suggest that the ability of students to learn for themselves can be reinforced and increased with the help of modern technology, and that effective learning can take place without the presence of a teacher.

While the mechanical and electronic devices described above were intended primarily for the use of the individual student working alone, instructional film and television are intended chiefly to reach large numbers of students meeting in groups rather than studying individually. That some of these techniques will be used in televised classes will depend to a large extent on the ability and foresight of those planning the format of the programming and their understanding of interrelating various techniques and teaching devices.

¹Better Utilization of Teaching Resources, op. cit., p. 26.

III. PSYCHOLOGY AND HOW WE LEARN

Learning consists fundamentally of two phases. The first has to do with the gathering of the raw materials of learning through one or more of the senses. The second involves doing something about or with one's sensations, that is, turning these emotional stimuli into the finished products of knowledge, understanding and wisdom. The first phase might be called perception and the second phase thinking.¹ This description of learning as a two-step process is of course an oversimplification. The processes as they actually go on become more and more complex as a person grows in knowledge and wisdom. Also at some stages of learning the experience may actually be physical and at other times the experience may be intuitive as a vicarious experience of a highly emotional or intellectual nature without any actual physical relationship.

At Cornell University, in a joint project with the Institute of Motivational Research, headed by Dr. Ernest Dichter², has done some research which may greatly effect our thinking with regard to the subconscious learning mechanism. It was found that even in the subconscious mind, learning results from experience and this experience is the result of the process of adaptation; it is the interaction

¹Italics by author.

²Fortune, June, 1956, p. 147.

of the human energy system with other energy systems in its environment.

Certain phenomena might be discussed to show in a few ways the propensity of the subconscious mind.

Your hearing is more acute while you are asleep. Originally it was a defense mechanism, a life-saving necessity, protecting the sleeper from the perils of the night which might overtake him. Even today after much evolution of civilized living, sounds are magnified to such an extent that even the drip of a faucet can become truly intolerable. Part of this is due to the quiet of the night during which small sounds seem infinitely larger because of the person's frame of reference, namely the quiet and solitude of his surroundings.

An exhausted mother can sleep through earthquakes and buzz bombs, but her babies slightest sneeze will awaken her. A boiler maker can easily catch a nap in the boiler factory. Millions of people can sleep next to highways and railroad tracks and never be awakened by the movements of traffic. In India a dozen bull elephants can bellow all night without causing the herd boy to move a muscle, but let one mouse scratch in the straw and he will be alerted instantly.

Sound has an amazing influence on all of the other senses as well. For instance, patches of color, so distant as to be indistinguishable, can be brought into the subjects field of vision by the mere sounding of a tuning fork near his ear. Many subjects can read barely legible print

with ease and speed when a certain musical tone accompanied his effort. Taste, odors, and touch are similarly affected by different sounds.¹

In contrast, the perception of sound is also affected by color and brightness. For example, the ticking of a watch has been found to become clearer under the influence of red, and considerably less distinct in blue surroundings.² As a result a tinny alarm clock would seem much louder in a red room than in a blue one.

Music also exercises a very definite effect.³ Depending on its pitch, intensity, and timber, it can make blood pressure rise or fall, and when music is piped into hospital rooms, doctors have found that classical music can be soothing, relaxing, and conducive to the promotion of pleasant dreams. Both mind and body are affected by what we hear; the rousing march has stirred the blood of men going into combat; low-down "blues" can induce a blue or melancholy mood.

It would seem from the above examples that the subconscious mind can interpret vague and infinitesimal signals. If we assume that man does have a subconscious mind, then it is possible to postulate how this subconscious mind might be bent to the advantage of society or the individual. Because, if the first big hurdle that the teacher must pass before

¹S. Howard Bartley, Principles of Perception (New York: Harper and Brothers, 1958), p. 57.

²Ibid., p. 58.

³Ibid., p. 69.

actual teaching begins can be conditioned in the student through his subconscious intellect, then the job of getting the student's interest will be for the most part accomplished, leaving the greater part of the teachers energy to formulate what is to be taught, and the methods to be used.

What then, are the tools that the psychologist might develop for the teacher to cut down the wall of indifference which to some degree is between the pupil and teacher, and subject?

Today's subconscious intellect can be mechanically controlled through three contingent processes: (1) subliminal perception, (2) sleep learning, (3) hypnosis.

Subliminal perception is really not a new substance or knowledge, actually it is a psychological phenomenon which has been known for some years by psychologists working in the fields of motivation and response. What actually is subliminal perception? It is an awareness, the ability to absorb sights or sounds that are too fleeting to be detected by the conscious mind, but definite enough to cross the threshold of the subconscious mind. In actual practice this principle has been put to practical application by a motivational research worker, James Vicary, who coined the word, "subliminal perception", now usually referred to as S. P. The device Mr. Vicary invented, flashes a word or at most a slogan or phrase at 1/500 of a second at intervals of 1/5 second or 1/3000 of a second at intervals of every second,¹ on a moving pic-

¹Business Week, September 21, 1957, p. 30.

ture or television screen. The effect is that a person's subconscious mind is able to perceive the message without his conscious mind being aware of it.

According to Dr. Dichter,¹ "The most easily explained mechanism of S. P. is a form of hypnotism, utilizing a device for flashing a limited number of words or ideas on a screen." As such, its application would be best noted in the use of a slogan. In the classroom where television is a definite part of the educational program, and if ethical problems could be solved, S. P. could most likely be used to a great advantage in the gaining of student participation and enthusiasm.

Looking back to the learning machines of the last chapter, it seems possible to me that reinforced learning might be given an additional boost if the student were to receive the correct answer via S. P. to the subconscious mind. This mechanism would cut down the statistical probability of random guessing about unfamiliar subjects, and at the same time help in the reinforcement of the material to be learned.

A similar analogy could also be derived in the leading technique where aural rather than visual S. P. could possibly be utilized in the learning process of this system.

Possibly the vanishing technique could be used with both visual and aural subliminal perception, so that, more than a few words or phrases could be perceived by the

¹Nation, October 5, 1957, p. 206.

subconscious intellect; in other words, a person might be able to receive pertinent parts of a whole concept through this medium, without being consciously aware of it. I would not care to stand as judge and jury on the many ethical problems that could arise from the use of such a system, because in truth it is a diabolical example of brain washing or brain conditioning to a very high degree. In the academic sense, only, is brain washing considered the destroying of a person's frame of reference, and then the rebuilding of a new frame of reference to fit the ends desired. This would not be the case as applied to the postulated learning process as described above. What I would like to point out is, that the technology is at hand for much more efficiency in educating our young people; the big and real problem will be for us to use it wisely.

Other devices and techniques might possibly be used to help the student to learn more material faster and with a higher degree of retention. Sleep learning for an example, is a process by which a person listens to a tape recording of material he wishes to learn about, while he is supposedly asleep, and then in the morning by a process of inforcement, the learner learns the material more thoroughly. Tests at Cornell University¹ show that this method of learning is actually a mechanical form of hypnotism and that the learner is not actually asleep during the learning process. They proved this by the use of an electroencephalograph and by

¹Newsweek, October 10, 1955, p. 89-93.

measuring the brain waves of the person being tested. In the experiment, it was found that when the subject was actually asleep there was only the beta wave present, but when the person was awake or hypnotized, both the alpha and beta waves were present. The conclusion after extensive tests were that the learning process in sleep learning took place when the alpha waves were present, but not when only the beta waves were indicated. The use of sleep learning in an educational system would have the same implications as using hypnotism, something that has been resisted in the schools up to the present.

Hypnotism as a tool of the physician and psychologist is very useful and can do many things. At times one may be led to believe that it is a cure-all for nearly everything. Actually if it is used for good it can be very beneficial. One of the uses for hypnotism in the area of education is in the building of good study habits and in the sublimination of bad ones.

My reason for delving into these topics is because I believe that they represent one of the attacks or approaches to teaching, especially in the method part of an educational program. Furthermore, I am trying to outguess as far as I can, the future trends in the methods of education, because to a large degree the design of the school of tomorrow will depend on the type of program to be presented, and how it is presented.

The subconscious mind may prove to be a very fertile field to cultivate; it may open the door to more achieve-

ment for more people through the more efficient distribution and utilization of educational information.

IV. EDUCATIONAL TELEVISION

"Ten years ago, there were only a few thousand ^{TV} receiving sets in American homes. Today there are more than fifty million."¹

Within a decade this powerful means of communication of sight and sound, unified in common concept, has become an intimate part of most of the homes of the land. Every viewer is having his life affected by this new mass media. The average child spends about as much time seeing and hearing television programs as going to school.²

Television has probably done more to promote a common culture among our people than all the educational forces of the past. For better or for worse, it has had a tremendous impact on the education of the children of America.

The direct educational value of the new medium was recognized early, and the Federal Communications Commission set aside some 250 channels for educational purposes.

Educational television is now nearly seven years old; the first station, KUHT at Houston, began operations on May 25, 1953. Educational television has grown almost as fast as commercial television. Presently there are fifty

¹Teaching by Television, op. cit., p. 2.

²Stoddard, op. cit., p. 27.

educational stations in operation, and twelve more under construction. In addition, "A recent survey by the Joint Council on Educational Television and the American Council on education indicated that there are more than 150 closed--circuit installations in the schools and colleges throughout the country."¹ Besides the use of closed circuit television in the schools, several hundred other similar systems are used in industry.

The effectiveness of television in education is sometimes difficult to understand. We know that television is good at combining sight and sound into understandable interesting experiences, but there is something more, something that is very effective psychologically about television experience that is difficult to understand or express. There is a closeness, an intimacy, a personal something about television experience that is not just seeing and hearing.

At first, some educators were prone to believe that television would turn educational experience from active participation by the learner, in a conventional educational experience, to a passive sitting before a television set, merely looking and listening to vicarious experiences ready-made for the purpose. Now the general consensus of opinion is that learning actually takes place after the television set is turned off and the classroom discussion between the students and the teacher has begun.

¹Teaching by Television, op. cit., p. 3.

Educators in the television movement generally believe that television in the classroom is just as effective as the actual experience. They have noted that much of the learning process of human beings, at all age levels, comes from participation in experiences in which the involvements of the learner is mental and emotional and not always physical activity. As a rule the use of television, even with very large classes or groups, should not rule out discussion, review, and recitation, and the interplay of reactions between the teacher and pupils.

The most desirable situation seems to be made up of from twenty to thirty five minutes of televised instruction, with the remainder of the period being taken up with the interplay of discussion, explanation and recitation, with the classroom teacher controlling this phase of the class period.

Although no accurate figures are available as to the number of primary, secondary, and college students receiving part of their instruction over television this year, a conservative estimate for the group would place the number at well over 500,000 students.¹ Class instruction by television, is being taught by some 125-150 educational institutions. Practically every course in the school and college curriculum, from first grade arithmetic to college post graduate courses have been televised. Twenty one military establishments also use educational television in

¹Ibid., p. 5.

their instruction and training programs.

The unique advantages of using television as a medium of instruction is that it can vastly extend the reach of the nation's best teachers. Students can have the educational experiences that are quite beyond the potential of conventional means of instruction, and because the programming is being done by experts, there is the in-training, and general upgrading and improvement in teaching techniques of the teachers participating, especially among the young, rather inexperienced teachers.¹

Televised courses have been much more carefully planned and organized than conventional courses, and the combination of the skills of the studio teacher and of the classroom teacher has made possible a cooperative teaching effort that in some cases is far better than either teacher could have achieved alone.

Television is not a teacher, but merely a conveyer of teaching, it can transmit the good, as well as the bad. It stands to reason, that a good teacher on television can be much more effective in stimulating learning than a mediocre teacher in the intimate environment of a classroom. As time goes on, I believe, that this powerful new tool, television, will enhance the art and prestige of teaching, and bring both the student and the teacher a richer, broader, and deeper learning experience.

One of the big factors that has kept educational television from spreading more rapidly is the initial

¹Ibid., p. 13.

cost of equipment, and the operating expenses of the program. Actually the cost of television if figured on a cost per student basis would not be so great. It may be that television can more than pay its way by offsetting the cost involved in additional personnel and buildings that would be needed if present schooling arrangements were continued, but may not be needed or necessary if television is used.

It does not cost any more or even as much to provide adequate closed-circuit television equipment in a new school building, or in an old one, as is frequently spent on equipment for a shop, laboratory, library, cafeteria, gymnasium, or some specialized classroom.¹

One new experiment which we are bound to hear more about was released by the Midwest Council on Airborne Television Instruction on October 16, 1959.

A group of nationally prominent educators from the Midwest today announced an airborne instructional television experiment to help lift quality and efficiency of education in a six-state region involving 5,000,000 students and 13,000 to 17,000 schools and colleges. With school and college personnel in the region closely associated with all phases of the experiment. In the fall of 1960 classroom courses on video tape taught by outstanding teachers recruited from all across America will be televised from a DC-7 aircraft some 20,000 feet over the north-central part of Indiana.

Individual schools and colleges will participate on a voluntary basis. Estimated coverage from the "flying TV station" will be a circle of 300-400 miles in diameter, reaching from Milwaukee and Detroit to Cincinnati and Louisville. It embraces parts of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin.²

These programs will be transmitted from the television facilities on the ground at Purdue University in Lafayette,

¹Stoddard, op. cit., p. 31.

²Midwest Council on Airborne Television Instruction, News Release from Memorial Center, Purdue University Campus, Lafayette, Indiana, October 16, 1959, p. 7.

Indiana, to the circling four-engine aircraft, which will in-turn retelecast to schools and colleges throughout the region which choose to participate.

At present nearly 48,000,000¹ people, are now within reach of operating educational television stations. This experiment at Purdue if successful will be the forerunner of a more comprehensive plan which will utilize five or six such aircraft to blanket the entire continental United States, excluding Alaska and Hawaii, with educational television programs. This experiment is an attempt to cope with the national problem of how to provide increasing quality of education on an economically feasible basis for America's rapidly expanding school population.

The estimated cost of the experiment for the tooling-up and the first year of broadcasting is nearly \$7,000,000.²

It was the Westinghouse engineers who developed the concept of blanketing an entire region from a television transmitter aboard a high-altitude airplane. Their famous "stratovision" experiment from a transmitter in a modified B-29 during a three-year period pioneered the way for the Midwest airborne project.³

Along with this experimentation came new advances in channeling of broadcasting. Westinghouse engineers found a way to split one channel so that eight separate programs

¹Stoddard, op. cit., p. 31.

²Midwest Council on Airborne Television Instruction, op. cit., p. 3.

³Ibid., p. 4-5.

could go out on each channel. Another narrow-band method was developed by Columbia Broadcasting System laboratories, with cooperation from Minnesota Mining and Manufacturing Company, which splits a standard channel into two special narrow-band channels. In effect this narrow-band technique is a sort of coaxial cable of the air.

The effect of this new technique might be more thoroughly understood by comparing it with conventional wide-band transmissions. Open-circuit broadcasting, in which the signal is sent out from a transmitter, has the advantage of being able to cover a wide area, and thus it can reach many school systems. The wide-band transmission has the disadvantage of being limited to one program or lesson at a time. This means, for example, that in the course of a six-hour school day, only twelve 30-minute lessons could be broadcasted, the equivalent of only one for each grade level. Closed-circuit broadcasting, in which the signal is carried by coaxial cable, has the advantage of being able to transmit several lessons simultaneously, but it has the disadvantage of not being able to cover a wide geographic area except by the use of microwave relays or long line telephone wires, both of which are relatively expensive. Now with this new aerial coaxial cable, it is possible to have up to seventy-two thirty-minute lessons in a six-hour school day.¹ Specially designed receivers of course will be needed to receive the narrow-band programs.

¹Ibid., p. 6.

Dr. Brownell, chairman of the Midwest Council on Airborne Television Instruction, said

The organization was formed because of the concern of educators in this region, as in the rest of the country, over the challenge which faces American education today.

It is the challenge to provide sufficient quantity of educational opportunities for a fast-growing population along with improved quality of instruction, and to provide both quality and quantity within feasible costs.

The council has turned to instructional television as one now-proven method of bringing quality instruction to a large number of students. It was decided to conduct a major pilot experiment with airborne telecasting as one method of reaching even greater numbers of students than is now possible by means of ground-based transmitters.

Far from imposing uniformity and rigidity upon local curricula, we believe airborne television can help to provide greater richness and variety than now exists and can further unleash the creativity and initiative of local teachers.

One of the advantages of instructional television is that it is entirely voluntary on the part of the user and therefore makes available the advantage of improved materials and methods without centralized control.¹

To summarize, the proponents of educational television, believe that it can give students educational experiences which often are beyond the scope of conventional means of instruction; for example, demonstrations involving costly laboratory equipment, which is normally available at only a few times or places. They believe that it will broaden the curriculum of the smaller schools which are unable financially to offer as complete an educational program as they would like to; for example, instruction in foreign languages, advanced algebra, science, art, and music.

If airborne television for the greater part of the United States is to be successful, it will have to help stretch the available school dollar still further, and at

¹Ibid., p. 7.

the same time improve the quality of instruction.

Historically the states have reserved the right unto themselves to control the educational programs within their boundaries. It is entirely feasible that one way for both airborne television and the state educational systems to live in harmony, is for the states to provide a panel of reviewers of the material being broadcasted over their areas, or for each state to set up a central control station with which to monitor and transmit material within their area.

An example might be in Montana for instance: An airplane in the Midwest might televise a program to another plane circling the Montana region. This second plane could transmit the program to a vidio tape receiver at any location.

The program as televised could be allowed to be transmitted directly to the schools of the state, or if desired, the program could be taken down on vidio tape at a central station to be later transmitted when proper programming might possibly be more feasible. Meanwhile, over this area, other programs transmitted from the central station to an airplane might be televised by the aircraft over narrow--band channeling, utilizing the channels reserved to the various areas for this purpose. In this way the central station could act as a programmer and expediter, and also could exercise control over the material being released in that area. Because of the nature of the material that would most likely be televised, I would nominate a college or university campus as the location for such a central station. This would not rule out the possibility and ad-

vantage of other schools of the University System from adding and contributing to the total programming of the state. This could be done, by utilizing the aircraft as the liaison or connecting link.

The reasons that I would choose the Montana State College campus at Bozeman as a likely location are: (1) its relative central location with regard to the population centers of the state, (2) the fact that there is a film and television center already organized at Montana State College, (3) educational television is already being used at this institution.

Right here at Montana State College, a freshman chemistry course is being conducted over closed-circuit television. Starting with last fall quarter, more than four hundred students participated in one of the basic freshman chemistry courses. The project got underway during winter quarter, 1958, when Dean of Education James Nickerson, and Hardy D. Berry, head of the Film and Television Center, piloted the program of finding a suitable, practical, application of a closed-circuit system on the campus. Many problems of circuitry and equipment installation were solved by Mr. Bob Barnard of the chemistry department and Dr. John Fell, assistant professor of the Film and Television Center. Dr. Myron Arcand, assistant professor of chemistry, is the television teacher.

Many hours of planning and rehearsal go into the television lesson. Besides rehearsing three times a week, Dr. Arcand spends from five to ten hours, in preparing the

lectures.¹

Of special note is the fact that television receivers are spaced so that students can see and hear well with no set having more than twenty pupils per set. According to Dr. Arcand, besides the maintaining and repair of equipment and administrative and technical details, lack of color and a definite lack of student-teacher rapport are disadvantages inherent in the present television medium. Advantages are that a single televised class can reach an unlimited number of students, and the close-up nature of the televised demonstrations make it possible for all of the students to have equal opportunity to see the experiments, special problems, and general material that is often not observed in even a medium sized class.

In talking with Dr. Arcand, he expressed, that color television would be more desirable than other technological advances including steriophonic sound and three-dimensional television.

A relatively new invention, vidio tape, may revolutionize the educational television programming of tomorrow, although it is rather costly now, it can be produced in color. It has an added advantage of being produced instantaneously. In producing the tape, any mistakes may be removed with the press of a button, which means that the sequence can be edited and a re-run made immediately on the spot. Thus it can improve the efficiency and content of a television

¹"Freshman Chemistry Lectures Conducted Over Closed--
Circuit TV", Montana Collegian, January, 1960, p. 6-7.



ARCHITECT:

1 1/2 J BOURBON

1/2 J ITAL.VERMOUTH

dash ANGOSTURA BITTERS

dash PEYCHAUD do

dash PERNOD

CONTRACTOR:

1 J GIN

1 J FRENCH VERMOUTH

1/4 J CREME DE MENTHE

1/2 J PERNOD

dash ORANGE BITTERS

pour over cracked ice

SHAKE

STRAIN

SERVE

the



ULTIMATE GIBSON!

2 J GIN

1/4 J BRANDY

1/2 J FRENCH VERMOUTH

dash LEMON

dash PEYCHAUD or ORANGE bitters

STIR

STRAIN

PEARL ONION



program. Programs put on this tape can be stored for future use, or can be re-used many times, during its expected life-span of from six to eight years.

The significance of the value of a picture over the printed word was expressed in a Chinese proverb that, "One picture is worth more than ten thousand words." To this we might add that one colored picture tells more than eighty black and white pictures. Dr. Arcand in an interview with this writer, expressed his thoughts about the possible use of color television, especially in science productions, could increase the effectiveness of the medium approximately eighty percent.

Color vidio tape is a system by which particles and molecules of iron oxide and other alloys, have been placed on a plastic tape, wherein the molecules are rearranged in a manner very similar to the sound tape recorder system; although the equipment for rearranging the molecules is much more complex, the translator equipment is relatively similar in character to a tape recorder.

V. ARCHITECTURAL ASPECTS OF THE EDUCATIONAL PLANT

Do the schools and colleges already know how to teach effectively? This is a question that many of our leading educators are asking today. Our educational system, with its emphasis on social adjustment, produced eight Nobel prize winners in physics, and nine in physiology, in twenty--six years, the highest score of any country.

If educational television is to become an effective part of our educational team, it will have to do more than just replace existing facilities, it will have to bring enrichment to the education process that is not at all possible without it, and it will have to aid some phases of teaching better or more efficiently than some other alternate method.

Educational television can only act as a tool, it can transmit the good as well as the bad, therefore, it is up to the educators to control and use well this new medium of mass communication. Part of the effectiveness of educational television lies in our ability to translate educational content into a dramatic form fitted to television, and part depends on having the necessary facilities and equipment to utilize the attributes and characteristics of television to the best advantage of an educational program.

I envision a balance or scale, one side of which is

weighted with:

METHODS, AND TEACHING PROCEDURES
THAT MAKE UP THE CURRICULUM OF A
SCHOOL

on the other side of the scale are the

CLASSROOM SPACE SIZES, THE OVERALL
CHARACTER OF THE BUILDING, AND THE
PROVISIONS, IF ANY, FOR THE USE OF
MODERN SCIENTIFIC AIDS TO TEACHING.

This scale will be in balance or equilibrium if all the components on one side are in accord with all of those on the other. In an architectural sense, I believe, that this equilibrium is a necessary and proper requirement of functional design.

In this era filled with change, it is becoming more important for an architect to have a thorough understanding of the possibilities of the trends that education is taking now and what is most likely to take place in the future, if he is to design wisely, efficiently and well, the educational abode. I feel it is his responsibility to provide a setting for the student that is conducive to the learning processes, and yet has the character and atmosphere of being human in scale and warm in feeling.

One of the biggest defects in most school buildings being built today, according to educators who would like to utilize more fully modern training aids and techniques, is the lack of provision for the utilization of television as an integral part of the school program.¹ They also claim that besides facilities and provisions for the use of modern

¹Stoddard, op. cit., p. 26.

aids to teaching, the design of the buildings should incorporate more dual purpose types of areas, and more flexibility of space sizes.

It is very possible that there would not be a teacher shortage, if the prestige of the profession could be raised and if wages were commensurate with responsibilities, namely educating our most prized possessions, our children.

No other profession is so demanding as teaching, for no other profession requires its members to play so many different roles. Yet the other professions, although restricted in scope, have made far greater use of assistants, aids, specialists, and technicians in order to allow the professional individual to give his major attention to primary responsibilities. The physician can delegate many of his responsibilities to his secretary, nurses, and technicians. The lawyer too can delegate work to secretaries, clerks, and junior associates. The architect makes use of draftsmen and designers. But the public school teacher often is expected to do sub-professional duties and chores which in some cases a secretarial assistant or a competent secretary could do better.

It may be possible that the professional status of the professional teacher could be greatly enhanced if there were more depth in the instructional staff structure. The need is great to relieve the already harassed teachers of much of the stenographic and busy work which does not contribute to actual teaching. If besides general teachers and teaching specialists; staff specialists, instruction assistants,

community consultants, general aids and clerks were incorporated in a school staff structure, they could do much to take the overburden from the teacher and at the same time increase the prestige and efficiency of the profession.

In the sport's world there is a fairly long list of athletes who are paid more than the president of the United States.¹ Twenty-three year old Swat Howard, a six-foot, seven-inch baseball player, has recently signed a contract with the Brooklyn (Los Angeles) Dodgers with a bonus of \$103,000. Also recently a golfer received \$50,000 for making a hole in one. It is too bad that there are no such fringe benefits associated with the teaching profession. If outstanding performers on the athletic field are worth these added blandishments, then it seems reasonable to assume that outstanding performers in the field of education should also be eligible for bonuses. It is quite possible that the television teaching specialist, who in temperament must both be actor, statesman, and teacher may possibly be the professional teacher who will first receive such accolade.

If we are to judge from what has already been done, it looks as if the use of television for direct teaching at the college and university level will grow rapidly. It is quite possible that television, both open and closed-circuit, will have a profound influence on the college curriculums within the near future, and this in turn will have an effect on the buildings and other facilities as teaching programs are geared to larger classes both on and off the campus.

¹Montana Standard, February 24, 1960, p. 4.

The problem of school buildings, with their equipment, and other physical facilities in which the educational program functions, has probably had a:

greater deterrent influence on school progress than almost any other factor involved. It is difficult to think in terms of different sized groupings of children, co-operative projects between teachers and classes, of enriched curriculums, of the ready use of aids for instruction, of classroom libraries, and of projects of continuing value, in schools made up of uniform cubicles called classrooms, narrow hallways, large adult auditoriums, inadequate play-rooms and cafeterias, or none at all.

Most of our present buildings and facilities were provided for another type of educational program and philosophy and are ill-adapted to schools of today and tomorrow.¹

One conclusion may be that because of the changes taking place in educational programming and philosophy, it is becoming increasingly more important to attempt to incorporate some of the precepts, that modern technology is establishing in the architectural design and room arrangements of our schools.

Since the end of World War II, the building of school buildings has been increasing in national importance. In the past few years, except for commercial buildings and single-family housing, more square feet of buildings are being built for educational purposes than for any other type of structure.²

It can be a gratifying and exciting thought for a future architect to be able to participate in the construction of new schools at a time when new educational ideas are emerging that require facilities quite different from what were being built only a few years ago. It is a challenging

¹Stoddard, op. cit., p. 51.

²Frank G. Lopez, "Schools for New Needs", Architectural Record, 1948, p. 12.

time too, because for the most part schools are built with local funds to meet local needs, and in most cases, only limited funds are available. Therefore as we change our building design criteria to more nearly conform to the technical and technological advancements of education, we must become aware of more ways to improve building economy and quality.

Before it is possible to determine some of the design criteria, it is important to have some idea of the scope of what a school of the future most likely will have, need, and contain, as well as an introspective understanding of the changes that are and will be taking place.

In my research concerning education, certain trends stand out that indicate the possible educational facilities of the school of tomorrow. It probably will no longer be just a school building and its grounds. Space within the building or in the building complex, will most likely be planned for what will be taught in it, and how it will be taught.

Because class groups will probably vary in size, the school plant in many instances will have to provide rooms and areas for groups of ten, twenty, thirty, sixty, one hundred or possibly more students. Most of this change in class orientation will probably take place in the post--primary grades. Instead of cubicles designed to contain thirty students and one teacher, a variety of instructional and resource areas will most likely replace the present series of standard, stacked classrooms.

Study halls as we now know them will probably be transformed or will not exist. Instead there will be study-resource rooms, which in some ways would be similar to the reference section of a modern library, only containing teaching devices engendered by the latest in learning-machine technology. In this type of study-resource room or area, students may read, listen to and view tapes, observe films and slides, work on self-teaching and self-appraisal machines, use scientific and other types of equipment. Here they will be able to think, write, and participate in other more or less individual study activities.

Because of the number and type of changes that this future school will likely have to undergo, it will be very difficult to make an intelligent estimate of the number, kind, shape, characteristics, and sizes of rooms or areas that will be needed in the future school.

The one important feature of this future school is that technology will make available to the students as far as possible, all of the avenues of attaining knowledge, appreciation, and understanding. Textbooks and student-teacher recitations will be enhanced by the use of television, radio, disc and tape recordings, films and slides, mock-up models, and other materials that are not now readily available to students.

Instructional films and video and sound tapes will likely originate from a central studio. It will no longer be necessary to move projectors, screens, tape and record equipment from room to room. Full cable installations will

probably be provided for closed-circuit television, or for any other kind of audio or video communications. In special fields such as language courses, language laboratories will be able to make use of some aural-visual-oral resources which should become more available.

A high degree of space utilization could make the school plant an economical one. Because of the variety of methods of instruction and the variety in group sizes, it is reasonable to expect the school of tomorrow to have: flexibility of space, equipment, and furniture. Large rooms could have features which would allow them to be divided into small seminar rooms for small-group areas, so that they can be utilized for a greater part of the school day.

Educational physical plant facilities of the future should be functional, flexible, pleasant, and utilitarian. Buildings should have improved acoustics, better light and ventilation control, and in some cases readily movable partitions. In all the architects, engineers, scientists, and educators will have to work together to design better equipment, and structures which will be needed to house the new concepts and techniques in education.

Some things have been established as desirable for inclusion in new school structures. The Fund for the advancement of Education, in its book, Schools For Tomorrow: An Educator's Blueprint, pointed out what they thought should be included in all new school building being built.

Some of these are:

The new elementary school should have the following:

1. Two or three large rooms, to seat comfortably from 100 to 300 pupils each, equipped with television receiving apparatus, properly sound-proofed, and with all the other aids available to large groups for instructional purposes.
2. A large pupils' auditorium to seat 100-200 pupils, with a small stage and an activities space in the front of the room.
3. Play facilities, preferably a covered space outdoors, where from 100-200 pupils can play at any time of day.
4. A television studio and closed-circuit apparatus and connections for telecasting to all parts of the building and play spaces.

The new junior or senior high school should contain the following:

1. Several large rooms, to seat comfortably from about 200 to 500 students each, equipped with television apparatus, properly sound-proofed, and with all the other aids to large group instruction available today.
2. One or more television studios for closed-circuit telecasting to all parts of the building or buildings. Of course, this assumes proper cable connections to make this possible, or to state these conditions more positively...the following four sets of suggestions are offered as requirements to be met in planning for the physical plant facilities:

FOR NEW BUILDINGS:

- a) Good acoustics in each room.
- b) Indirect lighting.
- c) Provision for good ventilation. (Venetian blinds which do not flap in the wind in warm weather. Window shades which cut off the air in warm weather are not good.)
- d) A good antenna installation.
- e) Built-in coaxial cables and antenna lines.
- f) Built-in high quality speakers in each room.
- g) Built-in 24" television sets, properly ventilated to prevent overheating; one or more in each room (mounted on pull-out rollers for maintenance).
- h) Central sound system with talk-back arrangement.

- i) Closed-circuit television equipment.
- j) Radio-television studio and control room with associated equipment.

FOR BUILDINGS NOW IN USE:

- a) Portable television sets with large speakers in each room mounted on stands with 4" wheels.
- b) Installation of antenna, coaxial and wire leads.
- c) Adaption of radio workshop or auditorium stage for closed-circuit studio.
- d) Installation of closed-circuit equipment.
- e) Improvements of acoustics where necessary.
- f) Improvements of lighting where necessary.
- g) Improvement of ventilation where necessary.

FOR ORIGINATION ROOMS:

The particular requirements of a school would determine the ratio of television origination rooms to receiving rooms. Have one room on each floor of building or in each cluster of classrooms set up to originate television presentations. Provision would be made to connect all the rooms on each floor or in each floor or in each cluster by coaxial cable.

With four originating rooms in the building it would be possible to televise four lessons simultaneously and by means of a suitable distribution system send these lessons over the same cable to any room in the building. In a given classroom you would simply tune in the receiver to the desired channel.

At the minimum level, a television origination room can be any classroom to which additional lighting is added to bring the level up to that required for television cameras (with the present vidicon type of cameras 125 to 250 foot-candles of light are desirable for best results). Experience has shown that some modification will greatly improve the flexibility and quality of operation,

- a) Acoustical tile should be applied to the ceiling and front and rear walls of the room. Some drapes may also be desirable.
- b) The walls could be of a deep cream or light green, or some similar color rather than white.
- c) Forced air ventilation is necessary and air-conditioning is desirable.
- d) If seats for students are desired in the origination room they should be movable.
- e) If the room has windows, venetian blinds in channels should be provided.
- f) Pipes 2" in diameter should be placed across the room near the ceiling at the front and middle and rear to carry spotlights and floodlights.
- g) If a professional type of vidicon system is to be used which involves two cameras and television

- film projection, a control room about 20' by 15' should be located near the origination room. It would be helpful if a window could be provided between the two rooms, but this is not essential.
- h) The size of the origination room depends on the type of programs to be originated, but a room about 20' by 30' is adequate for most types of classroom presentations.
 - i) Provision should be made for installing camera and other cables between the control room and the origination room.
 - j) An adequate supply of power for the television cameras and lighting units should be available.

FOR TELEVISION RECEIVING CLASSROOMS:

A number of these conditions should be taken into account when designing classrooms for television receiving (as well as for general regular use).

- a) Ceilings and rear walls should be treated with acoustical tile.
- b) Venetian blinds in channels should be provided to control exterior light.
- c) Movable seats should be used for maximum flexibility in seating arrangements.
- d) Forced air ventilation should be provided and air-conditioning is desirable.
- e) Artificial lighting fixtures should be mounted against the ceiling (not suspended) to reduce reflections on television receivers. It would be desirable to wire these on several circuits so that the light could be reduced to a level comfortable for television viewing (about 12 foot-candles). AC outlets should be provided for television receivers.
- f) It would probably be helpful if some of these rooms had sliding walls so that two rooms could be combined to make one larger room.
- g) Provisions should be made for ducts to carry coaxial and audio cables as well as telephone and other utilities. Removable panels could be installed in hall walls, or the ceiling of the halls could be furred down to give the necessary space for duct work.¹

Because I think some of the above ideas would create a burden on the building and maintenance of duplicate provisions in each school, and because these provisions probably could be handled as well if not better from a central station

¹Stoddard, Op. cit., p 52-54.

serving the various schools in its area, I would recommend some changes in the above listing.

Of the twenty-two colleges and universities that have a part or whole interest in television stations, seven are commercial as well as educational, and fifteen are wholly educational. These fifteen, by public demand, are acting as central programming centers. They receive a good part of their opporating expenses through subscriptions by public and private schools for televised classes.¹

With this in mind, instead of having an origination studio in every school, a much wiser decision would probably be a central facility to service these school needs. This would allow much repetition of class instruction and duplication of equipment and effort to be cut down. With such a central television station, it would be possible to have a much more complete library of "canned" material than would be economically possible in each individual school. Also there is a greater likelihood of being able to obtain better qualified instructors for the larger audience. To facilitate the use of such a central station, a microwave installation such as the Adler television translator system² could be utilized to service such a network of schools. The advantages of such a system are: (1) the relatively inexpensive cost of equipment, installation and maintenance,

¹Joint Council on Educational Television, Educational Television Today (Washington: Joint Council on Educational Television, 1959), p. 1-40.

²Letter from Adler Electronics, Inc., 121 S. Monroe Street, Spokane, Washington, 1959.

(2) in the relative merits indemic to a system which can broadcast either from a transmitter or from a microwave generator, as compared to the use of coaxial cable or telephone wires.

In this age of electronic technology we should be mindful of the fact that the field is changing very rapidly; it is dynamic, not static, therefore it will behoove us to plan for and expect new discoveries that are not yet conceived, but when once known may affect our future ideas and concepts.

Space stations orbiting the earth are not now inconceivable, if such a station could be utilized for the transmission of television programs, it may happen that one day programs originating in India, Peru, or Afghanistan could be viewed simultaneously by a world audience.

VI. ALGEBRAIC LOGIC AND THE FUTURE

I feel that this author would be remiss in the coalescence of this thesis if a discussion of the use of mathematical logic, logic machines, and digital computers were to be excluded, because they are the tools with which the scientists of today are creating the technology of the future.

I do not think that such machines can be developed which have that which we call the esthetic sense. I do believe that they can be used to find the basic components and truths which are inherent or analogous, but not necessarily apparent or perceived as visible parts of a structure.

Some of these truths become parts of what is generally recognized as a cliché, wherein certain desirable relationships are at one time or another perceived or recognized, and then once having been recognized, are repeated so many times that they become stereotyped. Simplification of this nature through the use of logic, or a machine capable of its manipulation, would probably be of the greatest use in the field of standardization.

The relationships between various components of a structure are transitory in the design stage. The architect recognizes that in a building complex, when he changes one component of that complex, he changes the entire relationship of all of the components with each other and with the newly

changed component. Therefore if we assume that certain parts of each component have certain unvarying equal values which we could call characteristics or identities, then it would be possible through the Boolean algebra mathematical logic process to find these characteristics or identities. For such manipulation to be feasible it would be necessary to be able to describe at least a few attributes, and then with the necessary vocabulary be able to word these attributes in such a way as to form postulates and propositions which are capable of precise proofs, which in most cases are set up in syllogistic form.

To many it may seem strange to discuss the possibility of exposing ideas or qualities that do not have specific meaning to a stringent mathematical process. In fact it is a rather difficult concept to really appreciate. The significance of algebraic logic was expressed by the noted mathematician and philosopher, Augustus De Morgan.

~~That~~ That the symbolic processes of algebra, invented as tools of numerical calculation, should be competent to express every act of thought, and to furnish the grammar and dictionary of an all-containing system of logic, would not have been believed until it was proved in Laws Of Thought.¹

The reason that I do not believe that a machine can be created that possesses esthetic sensitivity is that a machine is inherently devoid of comparative feeling, it feels no pain nor anger, neither can it appreciate love or hate except as a mathematical formula, therefore, I do not think that it is possible for a machine to have an intuitive aesthetic sense

¹J. E. Whitesitt, Boolean Algebra and Its Applications, (Bozeman: Montana State College, 1958), p. 1.

or feeling which is necessary in the esthetic design of a structure. The best that could be hoped for is that it could be used to determine the most favorable conditions, or relationships of a group or of a group of groups, and to this end could possibly be used to determine the most favorable conditions and ethnic relationships that might possibly be achieved in the interrelationships of components in a structure.

It is of interest to note that Boolean algebra, and machines capable of the necessary involution are especially helpful in applications pertaining to the Laws of Diminishing Return, and can be used to find the most efficient probable economic move to make, within a given frame of reference.

For an illustration assume a proposition: A planter is placed along a walk which leads to the entrance of a house. The planter is so constructed that it continues on into the structure of the house in such a way that a window divides the planter nearly in half. Furthermore assume the relationships are desirable, i.e., that the relationship of the planter to the entry way, the relationship of the planter to the window, the relationship of the carry-through of the indoors and outdoors through the lines established by the planter and allowed by the transparency of the window, and the relationship of the formal rigidity of the planter extending into the non-rigid natural outdoors. Probably many other relationships could be found that could be used in the comparative logic form.

Next try to establish the relationships between these three components namely, the window, the planter, and the

walkway. For illustration, a Venn diagram is used; it is somewhat comparable to the free body diagram in vector analysis.

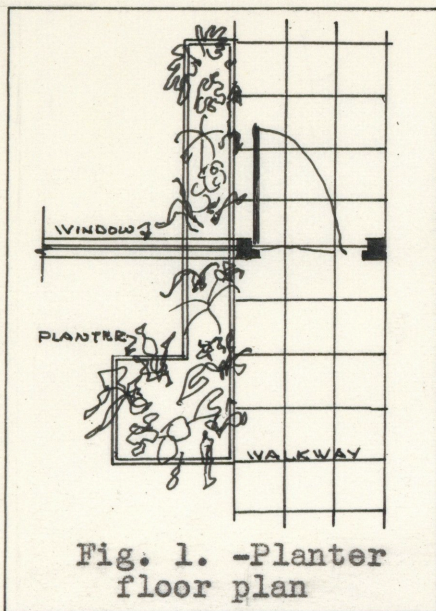
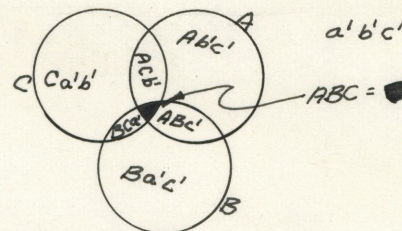


Fig. 1. -Planter floor plan



Let: A equal window
B equal planter
C equal walkway
then the area outside the circles is considered for this application to contain no A, B, or C, this is noted by a' , b' , c' .
(a' is read the absence of A)

Fig. 2. -Venn diagram

Note that the area $A B C$ is the area or significant relationship which is common to all three areas. To pursue the matter further it is necessary to have a vocabulary for the terms used in manipulation of this peculiar form of algebraic logic:¹

$\cup$ class sum is called "cup". It has properties somewhat like the plus sign used in ordinary algebra.

$\sim$ or $'$ are considered as symbols of negation, read: the absence of...

$\cap$ class product is called "cap". It has properties somewhat like the times sign in ordinary algebra. It is read: the intersection of...

$\subset$ means contained in, the symbol that follows ($B \subset A$ is read: B is contained in A)

$\bullet$ or $\cdot$ means and; is used as a conjunction.

¹Martin Gardner, Logic Machines and Diagrams (New York: McGraw-Hill Book Co, Inc., 1958), p. 52.

$\supset$ means that something is implied (If something..... then.....)

$\equiv$ is read if and only if then....(is thought of as equivalence)

$\neq$ is read either or but not both; it is considered an exclusive disjunction ($B \neq C$ is read either B or C but not both)

$\vee$ is read "either.....or.....or both; it is considered a disjunction alternation

$|$ is read "not both....and.....; it is considered a non-conjunction.

Furthermore it is necessary to understand the different traditional logic forms. These are often referred to as "moods", and are the different forms of argument, that can arise by combining different propositions.

Also it should be noted that two inferences are in the same mood, that is they are of similar construction, if they can be made identical by replacing each term everywhere it appears in one of them by some term, x, and/or interchanging its premises. Thus $Aab \cdot Aca \supset Acb$ and $Aba \cdot Acb \supset Aca$ are exactly in the same mood.

From these moods we establish the four different categorical propositions:¹

1. The universal affirmative.
2. The universal negative.
3. The particular affirmative.
4. The particular negative.

To this we should add the concepts of classes, propositions, and inferences. If we determine that a design feature is in a class which is either inclusive or exclusive, then it should be possible to make a categorical statement

¹James T. Culbertson, Mathematics and Logic for Digital Devices (New Jersey: D. Van Nostrand Co., Inc., 1958), p. 90.

or proposition, and when two or more such propositions are suitably linked together, an inference or logical argument can be formed.

Example 1: If all building components are nonmortal, and beams are building components, then all beams are nonmortal..

Example 2: If all structural components are opaque, and all girders are structural components, then all girders are opaque.

Example 3: If all plant holders are a desirable connecting link between indoors and outdoors, and all planters are connecting links, then all planters are desirable.

It can be shown that the validity of the inference does not depend upon factual truth of its categorical propositions.

Example: If all vegetables are green, and all bricks are vegetables, then all bricks are green.

An example is given for each of the four moods in Table 1. There are exactly thirty-two moods of immediate inference between two propositions. They can be shown as listed in Table 2.

The sixteen moods in which the term-order is the same in the consequent as in the antecedent are in the first figure, the other sixteen are in the second figure. This comes about because there are four ways of choosing X, four ways of choosing Y, and two ways of choosing a, b.¹

There are 256 moods in three propositions and 2,048 moods in four propositions.

¹Ibid., p. 93.

T A B L E 1

Categorical Proposition		Name	Read	Means
<u>Axy</u>	Ab'c'	Universal Affirmative	All Ab'c' is A	Every member of class Ab'c' is a member of class A
<u>Exy</u>	BCa'	Universal Negative	No BCa' is A	No member of BCa' is a member of A
<u>Ixy</u>	ABc'	Particular Affirmative	Some ABc' is A	At least one member of ABc' is a member of A
<u>Oxy</u>	Ab'c'	Particular Negative	Some of Ab'c' is not ABc'	At least one member of Ab'c' is not a member of ABc'

An immediate inference in any argument of the form $Xa'b'$ Ya',b' where X may be either A or E or I or O; and Y may be either A or E or I or O; and a',b' represents either $a'b'$ or $b'a'$.¹

$Xa'b'$ is called the antecedent and Ya',b' is called the consequent or conclusion.

¹Culbertson, op.cit., pp.122,123.

T A B L E 2¹

First Figure or A		Second Figure or B	
Mood	value	Mood	value
Aab > Aab	1 or valid	Aab > Aab	0 or invalid
Aab > Eab	0 or invalid	Aab > Eba	0 or invalid
Aab > Iab	1	Aab > Iba	1
Aab > Oab	0	Aab > Oba	0
Eab > Aab	0	Eab > Aab	0
Eab > Eab	1	Eab > Eba	1
Eab > Iab	0	Eab > Iba	0
Eab > Oab	1	Eab > Oba	1
Iab > Aab	0	Iab > Aab	0
Iab > Eab	0	Iab > Eba	0
Iab > Iab	1	Iab > Iba	1
Iab > Oab	0	Iab > Oba	0
Oab > Aab	0	Oab > Aab	0
Oab > Eab	0	Oab > Eba	0
Oab > Iab	0	Oab > Iba	0
Oab > Oab	1	Oab > Oba	0

¹Culbertson., p93.

You will probably note that in the preceeding illustration that only the combinations inherent in the A and B part of the Venn diagram in figure 2^{P.50} were used. When the three parts, A and B and C, are compared, there are 256 moods of the syllogism. This can be explained by showing that there are four ways of choosing X, four ways of choosing Y, and four ways of choosing Z; also there are two ways of choosing a, b and two ways of choosing c, b therefore $4 \cdot 4 \cdot 4 \cdot 2 \cdot 2$ equals 256.

In determining validity by 1 and invalidity by 0, it is understood more rapidly when it is realized that electric circuits can be expressed as being either on or off which can be translated very easily to 1 or 0.

It should also be understood that most electronic calculators are based on the binary system which has a radix equal to two. For comparison, our decimal system has a radix equal to ten. With the binary system, the digits used are 0 and 1 and in the decimal system, the digits used are 1, 2, 3, 4, 5, 6, 7, 8, 9 are used. It should be noted that in the binary system, counting is done in columns of two. An illustration is:

<u>Decimal</u>	<u>Binary</u>
1.....	00001
4.....	00100
5.....	00101
9.....	01001
10.....	01010
11.....	01011
19.....	10011
20.....	10100
25.....	11001
190.....	010111110

To change Boolean algebra to a binary vocabulary it is necessary to establish several identities:¹

Of Classes:

- a) The variables are classes a, b, c...
- b) The operators are $\neg, \cap, \cup, \subset$ where $\neg$ indicates if.... is present....then....is present.
($b \subset c$ means if B is present, then C is present)
- c) The two possible values of any variable are:
 - 0 D_f The null case
 - 1 D_f The Universal

Of Propositions:

- a) The variables are propositions p, q, r...
- b) The operators are $\sim, \cdot, \vee, \supset, \equiv$
- c) The two possible values of any variable are:
 - 0 D_f A false proposition
 - 1 D_f A true proposition

Similarly the Venn diagrams in figure 3 will show a corresponding relationship.²

Begin by constructing a truth table that will show four possible true-false combinations for two terms A and B using 1 for true and 0 for false. Assume the following order is adopted:

A	0	1	0	1
B	0	0	1	1

then $A \vee B = 0111$
 $A \neq B = 0110$
 $A \cap B = 1110$
 $A \supset B = 1011$
 $B \supset A = 1101$

A	F	T	F	T
B	F	F	T	T

Thus it is possible to adjust a digital computer so that when it is fed a series of premises, they are expressed in binary numbers. It will combine these numbers and arrive at a designation number that expresses the combined premises. The "ones" in this final designation number will tell which

¹Ibid., p. 161.

²Gardner, op. cit., p. 52.

- NOTATION
- $\cdot$ Conjunction ("and")
 $\supset$ Implication (if...then....)
 $\vee$ Disjunction, alternation (either...or...or both)
 ∇ Exclusive disjunction, non-equivalence (either...or...but not both)
 $\equiv$ Equivalence (if and only if) or iff.
 $|$ Non-conjunction (not both...and...)
 $\sim$ Negation (not)

- 57 -

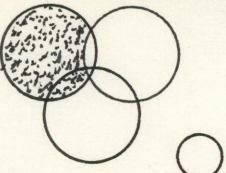
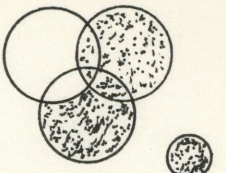
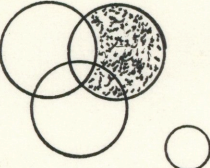
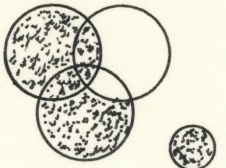
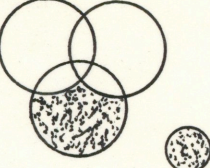
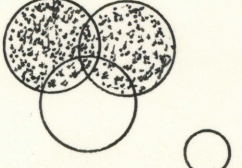
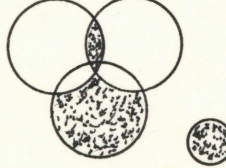
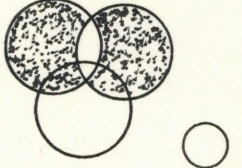
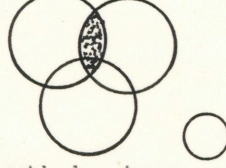
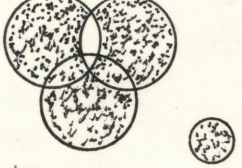
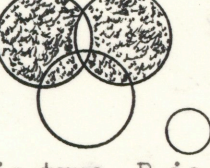
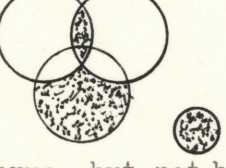
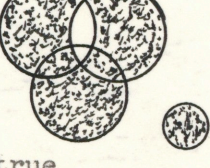
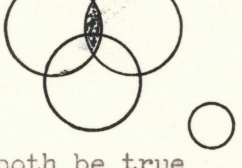
BINARY RELATION	NEGATION
$A \supset B$  If A is true, then B is true	$A \nabla \sim B$  A is true and B is false
$B \supset A$  If B is true, then A is true	$B \nabla \sim A$  B is true and A is false
$A \vee B$  Either A or B is true, or both	$\sim A \nabla \sim B$  Both A and B are false
$A \nabla B$  Either A or B is true, but not both	$A \equiv B$  If and only if A is true, B is true
$A B$  A and B cannot both be true	$A \nabla B$  Both A and B are true
$A \equiv B$  If and only if A is true, B is true	$A \nabla B$  Either A or B is true, but not both
$A \nabla B$  Both A and B are true	$A B$  A and B cannot both be true

Fig. 4

Let us now consider a simple three-term problem involving the following premises: Implies = truth, but may also imply false

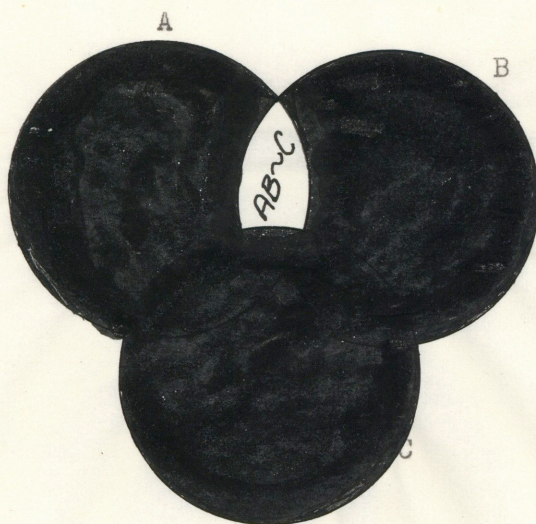
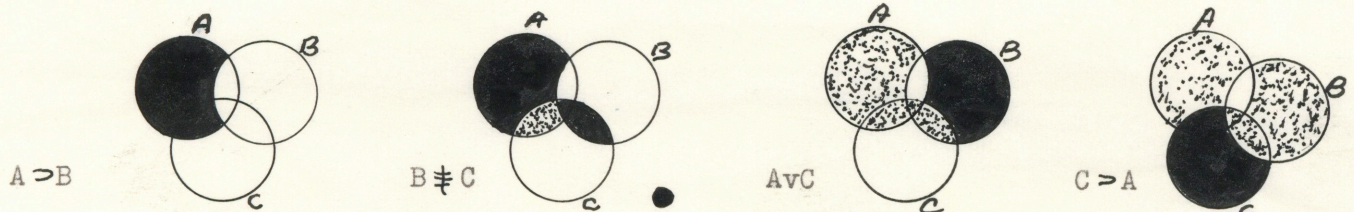
- $A \supset B$ (A implies B)
- $B \neq C$ (either B or C but not both)
- $A \vee C$ (either A or C or both)
- $C \supset A$ (C implies A)

From the preceeding page you can note the binary relations, and also the negations. If you add the shadings of each successive premis when indicating truth of the relationship the final white space that is left indicates the conclusion of the test.

Let A = Window
B = Planter
C = Walkway

- Then:
- $A \supset B$ ie. Window implies Planter aids impression.
 - $B \neq C$ ie. Either Planter or Walkway aids impression but not both.
 - $A \vee C$ ie. Either Window or Walkway or both aids impression.
 - $C \supset A$ ie. Walkway implies that Window aids impression

From the figures on the preceeding page, combine the shadings for each true statement.



Conclusion: aided by the four premises.

A and B must be true and C is false.

Fig.5

lines of the final truth table are valid.

A	0	1	0	1	0	1	0	1
B	0	0	1	1	0	0	1	1
C	0	0	0	0	1	1	1	1

3-TE2/AS

From the preceeding information, it was shown that the logical analysis for using Boolean algebra can be handled effectively and in a much shorter time with the use of a digital computer, rather than working each one out individually. If four parts were to be compared there would be 2,048 moods of the syllogism, and if five were compared the number of moods would be 16,384. It is easy to see that if fifty combinations were to be compared with each other, the analysis would be humanly impossible to conduct. In fact, it is quite likely that to compare members within fifty families or fifty families within a class would tie up a digital computer for a fairly long time.¹ It would take approximately one year at seven moods per second.

The real problem in the investigation of such a problem is within the vocabulary of, and the determination of the variables and principles that the operator desires to compare.

In an abstract thing like the desirable characteristics of a planter, it may well be that the desirable relationships would be quite difficult to define, but once defined, it most likely would be possible to find what part of those relationships are universal in all similar classes, families, or members of families that you might wish to compare. Be-

¹Ibid., p. 132.

cause the system is both inclusive and exclusive, it would also be possible to find that which is present in only one, or a few of, or unique to only one member of a class, family, member, or group, or groups of: classes, families, members of families, or members.

The thought of using an expensive digital computer to find the above relationships is of course ridiculous, it might be compared to using an elephant to pick up a tooth pick, and besides there is much more important work for the computers to be used for.

At present (1960) as far as can be determined, the Soviet Union has made greater strides than any other nation in the use of such symbolic logic, and logic machines. According to The New York Times, November 25, 1957., Russia's All-Union Institute of Scientific and Technical Information, and another Russian agency, The Institute of Scientific Information have been investigating materials of construction with some type of computer.¹

Russia has seriously limited the section sizes of their steel members being produced, to be used in the construction of buildings, to only a few basic sizes and lengths. Outwardly, this could lead one to assume that it is only an extreme type of economic measure. The fact that they have already produced many books of tables to be used with these limited steel sections, could possibly indicate that both the tables, and the fewer steel section sizes, may have been subjected to, and

¹Ibid., p. 145.

arrived at through some form of symbolic logic.

The first logic machine was invented by Ramon Lull, a Spanish visionary and theologian in 1274. His aim was to use symbolic logic in his writings to prove the validity of the leading dogmas of Christianity, including the trinity, and incarnation. His many books used symbolic notation to demonstrate what he considered irrefutable arguments. His, was the first recorded attempt in the history of formal logic to employ geometrical diagrams for the purpose of discovering non-mathematical truths. While establishing what he considered the certainty of the dogmas of the Christian faith, he also devised arguments to show discrepancies in other, but mainly the Moslem faith.¹

Since then many different forms of mechanical and electrical logic machines have been invented, mostly by students of logic and cybernetics.

One example is a simple logic machine called the "Geniac" which is capable of solving some of the simpler forms of propositions in two moods, but it is impractical to try to use it on more difficult problems.

For the most part such machines have been developed for use as a recreational project or a past time. Because of the time that it takes to translate a problem into a form the machine can handle, and the answer translated back into circuit theory, the same problem could have been solved by the use of more conventional methods using pencil and paper. It can be used though, to check formalism of theory, especially binary circuits.

¹Ibid., pp.1-8.

It could be amusing to speculate on what might happen to speculative philosophy if progress in semantics could someday permit the symbolic codification of systems of metaphysics. An electronic computer might then be fed with the required axioms and factual data so that the machine could examine the systems for inconsistencies, make new deductions, and translate its verbal expression into expression of another system. By such action it might be possible for whole new systems of philosophy and religion to be constructed by merely twiddling a few dials and letting the machine explore the implications of new combinations of axioms.

I feel that the real worth to the architectural profession of the use of symbolic logic and electronic computers, may well be within the realm of building components and modular sizes, and the standardization and simplification of building components through generalization of parts of building components and the standardization of components which may be used by different groups for the same or different purposes.

Likewise, in the diminishing return aspect, buildings such as hospitals and schools, where there is a certain duplication of facilities and functions dependent on variables, such as the number of: patients, nurses, technicians, teachers, students, class size, room and building size, and the like, I feel that algebraic logic might be utilized to find the most efficient combinations of numbers of rooms and sizes, nurses and patients, teachers and students, and other dependent groupings.

VII. UTILIZATION OF FUTURE TECHNOLOGY

The architect in dealing with education complexes, must be aware of new developments in methods, techniques, and technology, as they affect both architecture and education. Many of these new concepts are foreign to what we now accept, and at times our reaction might be to ignore them, hoping that by some fluke they will disappear from the horizon just as innocuous as they appeared.

In the past six chapters I have tried to explore many different things that: do, will, or may, affect how we design and build better educational plant facilities in the future. It is the hope of this author that of those who read this thesis, someone, might possibly be intrigued as I was with some facet or part, and on his own pursue it further.

We began by deciding that there is a problem to be faced, and met, namely; our expanding population, which is putting an increasing load on the educational facilities of our country, has not deemed it necessary to make the teaching profession attractive enough for capable young people to enter. Therefore the forecast is that there will be fewer capable professional people remaining in the teaching profession to augment the addition of students caused by our rapid population growth.

With this in mind many educators are casting about, looking for substitutes - 63 -

looking for substitutes for teachers that will allow fewer teachers to do the job of educating our young people. It becomes basically a problem of man-power, or machine-power, methodology, or technology, or both.

To explore further the implications of the use of technology and machines used for teaching, it was necessary to explain something about them. This does not mean that teaching machines are the answer to the problem, they only add to the probability and complexity of the changes that are liable to be brought about because we do not have the teachers nor the classrooms to adequately accommodate a huge influx of our young people.

Assuming that the use of machines is one alternative to solving the problem, it is not much of a deviation to go into the propensities of the thought processes and how we learn, and how these learning processes might be developed or utilized within the scope of a machine.

One thought was impressed upon this author that may have not come clear in the text, and that is: as our means of communication become better and more diversified, and with the use of many new developments in machines and technology, that we may have at our disposal, the greatest single economy that may possibly evolve from the use of these, is the centralization of certain parts of our educational machinery. This could alleviate much of the duplication of effort, and release more of the teachers time to actual teaching.

One of the tools of technology of the future has already

carved a niche for itself in our every day life. This friend-or-foe, grey-eyed monster, television, is bound to be with us for quite a while. Because it is a medium that has united sight and sound, it has been heralded as the greatest advancement in tools to aid education since the invention of movable type.

Television is gaining more acceptance in the education plant; this has come about because it has been found to aid teachers without replacing them. It is gaining recognition as a teaching tool or device and as such will have to be planned for when new schools are being designed and built, but television is only one of the many new devices that may have a direct influence on both the educational and architectural fields.

The sixth chapter deals with algebraic logic. This formal system of thought may well be the fountainhead of newer technologies.

I included this chapter because of the many facets of innuendo and implication that one field or idea may have on another, and because this system allows one to enucleate problems that do not readily allow themselves to be solved by any other method.

There are probably many aspects of architecture that could be compared with algebraic logic, although the outcome would probably be of interest only in the purely logic sense. The real worth of using this system would probably accrue in the standardization and simplification of components used in construction.

As a future architect in viewing all of these new

advancements, I feel that there is a tremendous challenge to meet new ideas with clear and open minds, and to accept the challenge of gaining knowledge to understand and use these technological advances wisely and well.

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