

AN EXPERIMENTAL STUDY IN THE
TEACHING OF BUSINESS MACHINES
UTILIZING AN AUDIO-VISUAL-TUTORIAL
LABORATORY APPROACH WITH
CONTINUOUS-LOOP SOUND FILMS

Thesis for the Degree of Ph. D.
MICHIGAN STATE UNIVERSITY

Ronald Kenneth Edwards
1969



This is to certify that the

thesis entitled

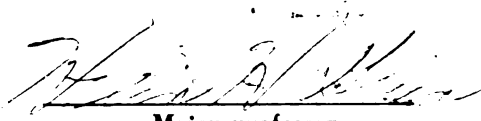
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Utilizing an Audio-Visual-Tutorial Laboratory Approach
with Continuous-Loop Sound Films

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ABSTRACT

AN EXPERIMENTAL STUDY IN THE TEACHING OF BUSINESS MACHINES UTILIZING AN AUDIO-VISUAL MATERIAL PRESENTATION APPROACH WITH CONTINUOUS-LOOP FILMS

by David Kenneth Edwards

Statement of The Problem

The problem of this study was to determine whether the particular office skill of business machines operation could be as effectively learned from filmed demonstrations viewed individually in an unstructured, open-laboratory situation as from a traditional classroom method and environment. In addition, it sought to ascertain whether such an individualized approach would be more effective for the upper- or lower-ability students as measured by the American College Test scores in mathematics, and whether a prior high school course in business machines would provide an advantage for those students over the students without such a course at the end of a one-term college course. A further problem for this study was to estimate student attitudes toward the experimental conditions.

Procedures

A series of 22 eight millimeter films were prepared to demonstrate the operations of the business machines used in the course--the 10-key adding machine, rotary calculator, and the key-driven calculator. The films were loaded in continuous-loop cartridges and a narration was added to a magnetic stripe on one edge of the films.

A handout sheet was prepared and duplicated for each film, briefly explaining the process demonstrated. **ABSTRACT** giving an assignment to be completed before progressing to the next film in the series.

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A handout sheet was prepared and duplicated for each film, briefly explaining the process demonstrated and giving an assignment to be completed before progressing to the next film in the series.

Two college business machines classes, one morning and one afternoon, were used to provide subjects for the experiment. The classes were each randomly divided, with one-half becoming part of the control group and the other, part of the experimental group. The control group met at the regularly scheduled times, receiving instruction by the traditional, rotation-plan method. The experimental group received its instruction individually in carrels from the prepared films viewed on a rear-screen projector. Subjects were allowed to use the films and machines at anytime between 8:00 a.m. and 5:00 p.m.,

except when control classes were in session. They checked their own

work and saw the instructor only when problems could not otherwise be resolved.

At the end of the ten-week college term, both groups took an

identical final examination, consisting of problems to be worked on advantage for students when measured by performance at the end of one each of the machines studied. This examination served as the criterion test. Two separate two-way analysis of variance tests were

computed to analyze the data.

Subjects in the experimental group also completed a questionnaire at the end of the term, giving their opinions about the experimental method of learning.

Experimental subjects generally enjoyed this method of study and a majority would prefer it to the scheduled class if a choice were available. Scheduling flexibility and individual progression rates might be primary advantages of the audio-visual-tutorial system.

Findings

There was a significant difference at the .025 level between the experimental group and the control group in favor of the experimental treatment. No difference was found between groups subdivided by mathematical ability or by whether a high school course in business machines had been completed. The experimental treatment had neither a greater nor lesser effect on these sub-groups than on the experimental group as a whole.

The great majority of experimental-group students had a favorable attitude toward the experimental process, enjoying the freedom provided by the individual approach.

Conclusions

1. The skill of business machines operation was more effectively learned when the traditional method of demonstration was replaced by a series of demonstration films used individually by students.
2. A prior high school course in business machines provided no advantage for students when measured by performance at the end of one college term.
3. Mathematical ability, as measured by the American College Test, was not an indicator of success for this college business machines course within either the control or experimental group.
4. Experimental subjects generally enjoyed this method of study and a majority would prefer it to the scheduled class if a choice were available. Scheduling flexibility and individual progression rates might be primary advantages of the audio-visual-tutorial system.

AN EXPERIMENTAL STUDY IN THE TEACHING OF BUSINESS MACHINES
UTILIZING AN AUDIO-VISUAL-TUTORIAL LABORATORY APPROACH

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to Dr. Nelson H. Green, doctoral committee chairman, for her guidance, encouragement, and patis Ronald Kenneth Edwards

The writer is most grateful to the other members of the committee: Dr. Robert P. Poland; Dr. Stanley E. Bryan; and Dr. Clesseon J. Martin, for their helpful suggestions and advice. Recognition is also due Dr. Peter G. Haines for his valuable support and continued interest in this project.

The receptive attitude of the administration, faculty, and students of Lansing Community College toward this study is acknowledged with gratitude. In particular, the writer is sincerely appreciative of the many hours spent by Dr. A THESIS. Williams, the instructor, in helping to prepare the experimental materials.

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XII. Scores of Students on Final Performance Test

Separated by Experimental or Control Group, and
With or Without a Prior High School Business

Machines Course 150

Schools today are faced with a multitude of problems. Needs upon them are coming at a rapid pace from many groups within our society. Teachers are required to have more education as well as practical experience. They, in turn, are demanding fewer classes of smaller size and higher pay. Students are demanding an education that is more pertinent to their immediate goals with a realization that sometime in the future they will again have to attend school to keep up-to-date. The general public is asking for better education for more people in less space and at less cost.

Colleges, and especially community colleges, are continually faced with these problems as they attempt to train and retrain greater numbers of people for occupational competence in the shortest possible time. Minimum educational objectives are entrance-level skills for each training program. But only a few students who begin a program are totally untrained. They enter with various levels of skill and abilities, ranging from almost none to almost all that are necessary for their immediate occupational objective. In addition, students not only learn at different rates, but have varying demands upon their time. This situation adds to the disparity between progression rates at the community college level.

CHAPTER I

Need for the study. It has long been recognized that the community

college level the STATEMENT AND DISCUSSION OF THE PROBLEM

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I. INTRODUCTION
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Need for the study. It has long been acclaimed at the community college level that students are accepted at various levels of skills and abilities in the office education area and taken from the point of entry to higher levels. This ideal, with various wording, is intimated in the statements of philosophy of community colleges throughout the country. But a legitimate question arises after examining procedures for placing incoming students in a curriculum. Is this ideal being accomplished? Junior, senior college and graduate school should be built

upon. For instance, if a student enters a community college office education curriculum and enrolls in a business machines course, he will probably be required to complete a set number of activities on several machines, even though he may already have demonstrated competency on many of them in high school. It has not been practical to waive a portion of a course for any individual student. Further, even though he would probably be able to complete the required assignments in less time than a student without prior training, he would undoubtedly have to attend class the same number of hours for the same number of weeks. There is apparently no college office education curriculum which can provide all students with those courses and parts of courses needed for vocational competence without including many items that are unnecessary repetitions and redundant in their formal education. and wrote about this kind new method of learning and all writes about the failure of the teaching machine to live

Dr. McKee Fisk pointed to the wasteful practices of repetition in education from one level to another when he discussed the need for more articulation of curriculums: articulation to Meet Change, "Business Education Meets the Challenges of Change, NEA Yearbook, No. 4, 1965, p. 207.

In terms of curriculum, the day has long since passed when each level of education could consider itself independent of those preceding or following it. It is educationally, economically, psychologically, and socially unwarranted for students who have had work in junior high school to be required to "start over" or repeat such work in high school. Similarly, it is indefensible for students to be required to repeat work undertaken in high school when they enroll in junior college or a postsecondary institution. The same statement can be applied to colleges and universities who accept students directly from high school or junior colleges.¹

Dr. Fisk indicated that a business education program should begin at about junior high level and courses taught at the high school, community college, senior college and graduate school should be built upon, thereby requiring, the knowledge and abilities taught at the next lower level. With the population mobility what it is, his method would call for a national curriculum. It would not solve the problem of individual differences, however, and it would not necessarily be automatically adjustable to different rates of progress.

The teaching machine was at one time considered to be the answer to providing adequately for individual differences. It has yet failed to make the impact on education that was promised of it.

Dr. Winger summed up the rise and fall of the teaching machine in one paragraph:

Teachers need to look back only a few years to obtain an excellent example of a new concept that went up in a burst of hot air--the teaching machine. Everyone talked and wrote about this fine new method of learning and all it would do for the individual learner. . . . Now everyone writes about the failure of the teaching machine to live up to its potential, and most of the blame seems to be

¹McKee Fisk, "A Business Curriculum to Meet Change," Business Education Meets the Challenges of Change, NBAA Yearbook, No. 4, 1966, p. 207.

placed at the door of the software department. Things just happened too fast for the development of the types of quality programs needed to accompany the machine.²

In fact, in his very pessimistic article, Dr. Winger noted programmed texts as the only bright spot in contemporary developments.

Dr. Mildred Hillestad also recommended the utilization of completely individualized for every student participating. Each programmed materials in her call for more innovation in business courses within such a curriculum would be divided into as many single education.

In many other fields the effectiveness of programmed learning has been shown, yet very little programming has been done in business subjects. Why couldn't subjects like bookkeeping, the factual presentations for economics, with-general business, or business law be programmed so students could work at their own rates, experience success, and apparently learn more efficiently.³

Programmed texts may have advantages over the typical textbook. Dr. Fox explained some of the possible advantages as efficiency, goal and could reach it with better skills, more competencies, and effectiveness, and consistency.⁴ Other writers have listed more advantages, but nearly all of them relate programmed materials to the even produce. It is feasible that students might be enrolling in and typical classroom. Materials are primarily used before, during, and completing courses every working day of the year. after class, but not instead of. In fact, Dr. Fox made it clear that:

Although PL (Programmed Learning) may lack "snap appeal," if, utilized as an additional assignment or a

²Fred E. Winger, "Emerging Typewriting Curriculum Patterns as Related to Contemporary Developments," Business Education Forum, November, 1967.

³Mildred Hillestad, "Research, Experimentation, and Innovation Needed for Change," NBEA Yearbook, No. 4, 1966, p. 212.

⁴Eugene H. Fox, "Is Programmed Instruction Worthwhile?" Collegiate News and Views, December, 1967, p. 9.

could variety method of learning, it can teach. It should be used to compliment and enrich, not replace conventional textbooks and/or lectures.⁵

Importance of the study. This study was a pilot project in an attempt to determine whether an office education curriculum could be completely individualized for every student participating. Each course within such a curriculum would be divided into as many single concept units as necessary to cover the material and programmed on audio-visual media for use in individual learning carrels. These units could be made available to individual students at their own pace without the rigidity necessitated by the traditional classroom. No two students in any course would be required to follow the same path nor progress at the same speed, yet each would be striving for a specific goal and could reach it with better skills, more competencies, and fewer "gaps" in his knowledge than traditional classroom methods can ever produce. It is feasible that students might be enrolling in and completing courses every working day of the year. This new plan of individualized instruction could have an additional advantage of being more direct and, consequently, less time might be wasted. The amount of material which is given to the student might be increased so that greater coverage of the subject matter could be possible. Any "gaps" or weaknesses in prior education could quickly be eliminated by assigning or repeating specific units. Likewise, any strong areas in an individual's skills or knowledge from prior education

⁵Ibid., P. 10. (emphasis is the author's)

could be omitted from his program, allowing him to progress faster and without needless repetition.

It is conceivable that one large laboratory area might be created so that students at various levels of learning would study business machines, typewriting, shorthand, accounting, and other subjects simultaneously. The present study was concerned with one particular course in the curriculum--a beginning course in business machines.

Purpose of the study. The purpose of this pilot study was to determine whether the particular office skill of business machines operation could be taught effectively by a method which utilizes audio-visual equipment and materials for individual study, completely devoid of the traditional classroom environment.

III. THE PROBLEM

Statement of the problem. In order to accomplish its purpose, this study was divided into a primary problem and three subordinate problems as follows:

- A. The primary problem of this study was to determine the differences, if any, in performance on a criterion test between two groups of business machines students under controlled conditions with one group receiving traditional classroom instruction and the other receiving individualized instruction from continuous-loop sound films in an audio-visual-tutorial laboratory.
- B. Subordinate Problems:
 1. To determine, if possible, whether prior exposure to office machines has a significant effect on final performance.

2. To determine, if possible, whether mathematical ability has a significant effect on the learning of business machines operation.

3. To analyze student attitudes toward the audio-visual-tutorial approach.

Experimental hypotheses. The specific research hypotheses that

this study attempted to accept or reject were:

1. The use of an audio-visual-tutorial approach to provide instruction for the experimental group will result in significantly better performance (as defined statistically) by that group in machine operation, than the group taught by the traditional method.

2. Those students in either the experimental or control groups who have had prior office machines course in high school will score significantly higher on the final performance tests than students without such exposure.

3. Those students in either the experimental or control group who are above the group median in mathematics ability will score significantly higher than those students below the median.

4. Student attitudes toward the audio-visual-tutorial method of learning office machines operation will be generally favorable, and they will prefer this type of instruction to the traditional classroom.

Assumptions. In order to concentrate efforts toward answering the research questions, the following statements were assumed to be

valid for the purpose of this study:

A. Size of group. Group sizes of 28 to 34 subjects would provide sufficient evidence of reliability.

B. Teacher. Since the same teacher who prepared material for the experimental group also taught the control groups, the teacher variable could be disregarded.

C. Time of day. One control group met in the morning and the other in the afternoon, while the experimental

group received instruction any time between 8:00 a.m. and 5:00 p.m. The time of day for instruction would provide no significant difference in performance between the groups.

D. Method of teaching. The only random variable in the experiment would be the use of an audio-visual-tutorial laboratory method of instruction for the experimental group.

Delimitations. No attempt was made to control or measure the amount of extra class time spent by either group on the machine. Each group had equal access to machines for practice purposes and the criterion test was final performance.

IV. DEFINITIONS OF TERMS USED IN THE STUDY

Audio-Visual-Tutorial. (A.V.T.) A term used at Lansing Community College to describe a method of learning in which primary instruction is presented on audio-visual media (cartridged sound films in this study) to one student at a time with additional individual assistance available from a tutor.

Business Machines. Those business machines included in the Business Machines I class at Lansing Community College during the period of this study, namely:

10-key adding-listing machine (Monroe, Model 111E11)
Rotary calculator (Friden, Model STW-10)
Key-driven calculator (Burroughs, Simplex Model)

He. The generic "he" was used throughout the study except for individual references to specific female students.

Student. The term "student" was used synonymously with the term "subject" with reference to the experiment.

V. ORGANIZATION OF THE STUDY

CHAPTER II

The present study is organized in five chapters.

Chapter I has attempted to give the background, need and purpose of the study and to indicate how and why the experiment was carried out.

Several bibliographical indexes were searched in an attempt to construct a bibliography of similar studies to aid in the design and construction of the experiment described in this study. The and some of the literature in the field.

Chapter III presents the methods and procedures used in were reviewed for related studies and literature published during the conducting the experiment and collecting data.

Chapter IV provides an analysis of the data and presents the findings.

Chapter V presents the conclusions drawn from the study, recommendations for further study, and the author's opinions regarding the

The review of studies and literature presented in this chapter is intended to be selective rather than encyclopedic. The chapter is

divided into four parts. Part I reviews the literature and studies concerned with the teaching of business machines. Part II presents a review of the use of film-loops in education. Part III provides a synopsis of contemporary developments and thought connecting cartridge films, tapes and programmed materials to individualized instruction and independent study. Part IV is a summary of the literature reviewed and establishes the basis for attempting the present study.

I. REVIEW OF LITERATURE ON TEACHING BUSINESS MACHINES

CHAPTER II

The teaching of business machines has only recently been considered an area of concern. REVIEW OF LITERATURE

was neglected by prominent teacher educators in a methods text published as late as 1958.¹

Several bibliographical indexes were searched in an attempt to construct a bibliography of similar studies to aid in the design and articles and studies concerning business machines have been listed in the construction of the experiment described in this study. The Dissertation Abstracts, Education Index, and Business Education Index the five-year period from 1964 through 1968, with approximately one quarter of the studies reviewed. None of the studies, however, were reviewed for related studies and literature published during the master's degree studies and involved local surveys. Two studies were past decade. The facilities and publications of the ERIC Clearinghouse and for Vocational and Technical Education at Ohio State University were will be discussed in more detail. utilized, and a separate search through the abstracts of research proposals funded by the U. S. Office of Education was made.

The review of studies and literature presented in this chapter is intended to be selective rather than encyclopedic. The chapter is divided into four parts. Part I reviews the literature and studies concerned with the teaching of business machines. Part II presents a review of the use of film-loops in education. Part III provides a synopsis of contemporary developments and thought connecting cartridge films, tapes and programmed materials to individualized instruction and independent study. Part IV is a summary of the literature reviewed and establishes the basis for attempting the present study.

¹Louis C. Manassay, (ed.) Business Machines in the Classroom, Epsilon, New York, McGraw-Hill Book Co., 1958.

²Brenda Beard, Development and Application of a Programmed Instruction in Seven Basic Operations of the Business Calculator, Unpublished Master's thesis, University of Tennessee, Knoxville, 1965.

I. REVIEW OF LITERATURE ON TEACHING BUSINESS MACHINES

The teaching of business machines has only recently been considered an area of concern by business educators. As an example, it was neglected by prominent teacher educators in a methods text published as late as 1958.¹ In contrast nearly one hundred books, articles and studies concerning business machines have been listed in the five-year period from 1964 through 1968, with approximately one quarter of them being studies.² Most of the studies, however, were master's degree studies and involved local surveys. Two studies were of the experimental type involving the use of programmed materials and will be discussed in more detail.

The materials for the study were developed by the researcher and included seven lessons, each concerning one mathematical problem type--addition, subtraction, multiplication, division, accumulative multiplication, subtractive multiplication, and credit balance. Instructions concerning the operation of the calculator were taped. A workbook containing problems to be worked at the end of each lesson was also prepared. Preliminary testing of the programmed materials was accomplished through the use of 26 students and included six revisions as a result.

The Beard study. A study conducted by Brenda Beard involved testing the ability of taped instructions for teaching the operations of a specific calculator.³ The purposes of the Beard study were:

- (1) to develop a program of taped instructional material of selected problem types for the Marchant automatic rotary calculator; (2) to compare the results of a final test of achievement on the taped program material with the results of the same test given to students having

¹Lloyd Douglas, James Blanford, and Ruth Anderson, Teaching Business Subjects, Prentice-Hall Inc., Englewood Cliffs, N. J., 1958.

²Louis C. Nanassy, (ed.) Business Education Index, Delta Pi Epsilon, New York, McGraw-Hill Book Co., 1964-1968.

³Brenda Beard, Development and Evaluation of Taped Programmed Instruction in Seven Basic Operations of the Marchant Automatic Rotary Calculator, Unpublished Master's thesis, University of Tennessee, Knoxville, 1965.

been taught the same problem types with the same amount of instruction time in the traditional classroom; and (3) to determine the attitude of students in an experimental group toward the use of taped programmed instructional material. (3) The taped programmed material is presented

The materials for the study were developed by the researcher and included seven lessons, each concerning one mathematical problem type-- addition, subtraction, multiplication, division, accumulative multiplication, subtractive multiplication, and credit balance. Instructions concerning the operation of the calculator were taped. A workbook containing problems to be worked at the end of each lesson was also prepared. Preliminary testing of the programmed materials was accomplished through the use of 26 students and included six revisions as a result. Programmed material was approximately three and one-half hours in length. After the several revisions, the programmed material was tested in a classroom situation. Twelve students were taught by an instructor and eleven students worked through the programmed material. Each group was given the same amount of instructional time and each of the 23 students was given the same terminal test of achievement. The gross number of problems worked on the final test of achievement, the number of errors made, and the net scores of each of the experimental group and the control group were compared by using an analysis of covariance.

A prepared evaluation sheet was given to the experimental group after they had completed the programmed material. Based upon the findings, the following conclusions for the study were made: (1) the achievement of the experimental group was slightly superior to that of

the control group; (2) the program of taped material did not provide for the student to progress at his own rate because the individual student could not control the tape recorder as the instruction was being given to a group; (3) the taped programmed material as presented in this study did provide for immediate reinforcement and was easy to understand; (4) the students who worked through the programmed material had better accuracy on problems of credit balance, accumulative multiplication and subtractive multiplication than the students who were taught in the traditional manner. Among her recommendations, Miss Beard mentioned that the programmed material should be tested in a way that would allow the student to start and stop the tape recorder and thereby progress at his own speed.

The Compton study. Judith Compton tested a previously taped program to instruct learners on the I.B.M. Key punch in 1962, also at the University of Tennessee.⁴ Although the keypunch is not a machine student could check his work.

included in a typical business machines course, the study was one of the earliest to use this type of programming to teach a machine skill.

The purposes of the Compton study were: (1) to evaluate a program of taped instruction for the I.B.M. card punch; (2) to compare the I.B.M. aptitude test scores with achievement of individuals using the instructional program; and (3) to see what differences occur in achievement by using two arrangements of practice periods. Methods

⁴Judith Ann Compton, Evaluation of a Program for the IBM Card Punch, Unpublished Master's thesis, University of Tennessee, Knoxville, 1962.

included separating a group of 13 high school students into three sub-groups, each having different amounts of practice and rest periods.

The voice on the tape instructed the students and presented information in very small steps. The students were questioned about the instruction as the program progressed and were requested to respond covertly or overtly as indicated by the taped instructions. The student was also provided with a manual which was used as a supplement to the tape. The answers required were short and the time provided for answering the questions varied with the difficulty of the question.

After the student had time to formulate and answer, the voice on the tape stated the correct answer. If the student missed the question, the taped explanation of the right answer helped him to see immediately the correct answer and to understand why he probably missed the problem and many of the studies were concerned with which machines were used in or question. When a certain overt response was commanded on the tape, business and what uses were made of them. However, Colbert completed the taped answer stated what the student should have done so the student could check his work.

selected office machines for her Master's thesis.⁵
The instructor's responsibility in this program included starting, stopping, and changing the tapes, distributing manuals, answering any questions or assisting the students if the machine should jam. The program provided for individual differences as the student was narration was prepared to explain the operation. She did not presume that operators could be trained from her materials. They were intended only to acquaint students with the types and uses of machines so they might not have access to in the classroom.
A series of tests were prepared by the investigator from a written transcript of the taped program. Three written tests were used to

measure the student's knowledge and five tests were used to measure the student's performance.
Shirley J. Colbert, *The Development of an Audio-Tape Program for the Use in Classroom Education*, Unpublished Master's Thesis, University of Wisconsin, Madison, 1967.

The findings were: (1) the program met the standards of good programmed learning as outlined by Silverman; (2) all of the students in the three groups had high scores on the final tests which presented the basic knowledges for card punches, as indicated by opinions of card punch operators and their supervisors; (3) the aptitude tests did not predict the degree of success for those students making a high score on the aptitude test; (4) there was no significant differences between groups permitted additional practice and those who were not as compared by Siegel's analysis of variance; and (5) based on repeated hearings by the investigator, the instruction was found to be accurate, well organized, complete, comprehensible, and sufficient in length.

Other studies and literature. Much of the remaining literature on each and become acquainted with a wider variety of machines. The and many of the studies were concerned with which machines were used in needs of the slowest learners as well as those of the brightest students and what uses were made of them. However, Colbert completed dents are met by this system since each successive block for an exercise in the development of slide and tape presentation of particular machines increases in difficulty. selected office machines for her Master's thesis.⁵

Miss Colbert's work involved taking slide pictures of various surveys regarding the types of machines used in business, with implications for area schools. One such survey was conducted in the Bay slides pictured the machines in operation, and an accompanying tape City, Michigan, area under the direction of Mrs. Cook and Mallick. narration was prepared to explain the operation. She did not presume in the report of this survey, the authors contended that that operators could be trained from her materials. They were intended only to acquaint students with the types and uses of machines that they might not have access to in the classroom.

⁵Bette J. Colbert, The Development of an Audio-Visual Presentation of Office Machines for use in Classroom Instruction in Office Education, Unpublished Master's thesis, University of Wisconsin, Madison, 1967.

At least one school has managed to individualize the learning of office machines within the confines of a high school schedule and length of school year. The course at Ranier Beach Junior-Senior High School in Seattle, Washington, has a great deal of flexibility, according to Roberts and Christophersen.⁶ In their system, the course of study on each machine is divided into as many as ten separate units which they call "instructional blocks." Each block has a final test that must be passed before the student continues. Sufficiently detailed instructions are provided so that students can work independently. They can, therefore, work at their own speeds. They are also allowed to work through all the programs, or blocks of a few machines for an in-depth knowledge of them, or choose to do only a few blocks on each and become acquainted with a wider variety of machines. The needs of the slowest learners as well as those of the brightest students are met by this system since each successive block for a particular machine increases in difficulty.

As indicated earlier, many of the recent studies were local surveys regarding the types of machines used in business, with implications for area schools. One such survey was conducted in the Bay City, Michigan, area under the direction of Drs. Cook and Maliche.⁷ In the report of this survey, the authors contended that:

⁶Margaret S. Roberts and Raymond Christophersen, "Office Machines Go Modern," Business Education Forum, Vol. XXI, No. 8, May, 1967.

⁷Fred Cook and Eleanor Maliche, Office Machines Used in Business Today, Independent Study, Wayne State University, Detroit, 1965, p. 2.

The operation of certain machines whose use in business has declined, is still being taught today in schools.

For example:

- a. Training in key-driven calculators is still being given in school despite the fact that in the business office they are being replaced by 10-key adding machines. The demand for key-driven calculators has diminished to such an extent that major manufacturers of the equipment have closed out their extensive private training programs.⁸

Since the present study involved the teaching of the key-driven calculator, the credibility of the above statement was important. A search through the remainder of the report failed to reveal supporting evidence for it. Adding-calculating machines were all considered as one type and never separated. Although the survey "Interview Form" conducted in connection with the present study produced approximately required such a breakdown, it was never carried forward into the report. This survey also found more than two hundred key-driven calculators in use by the first seven firms contacted, which

In order to reach a decision on whether or not to include the key-driven calculator in the present study, the results of several other surveys were considered, and an informal survey made of some local firms. Key-driven calculators were found in surveys conducted by Benson,⁹ Benson,¹⁰ and Sevenick,¹¹ and although there were indications and, hence, in the present experiment.

⁸Ibid., pp. 1-2.

⁹John Roman, "Office Machines Survey," The Balance Sheet, Vol. XLIII, No. 3, November, 1961, pp. 122-124.

¹⁰Vernon L. Benson, A Survey of Selected Business Firms in South Dakota to Aid in Determining the Need of Office Machines Training on the Secondary School Level, Unpublished Master's thesis, University of North Dakota, Grand Forks, 1963.

¹¹Antonia M. Sevenick, A Survey of the Office Machines Used in the Port Washington, Wisconsin, Area, Unpublished Master's thesis, University of Wisconsin, 1956.

of a decrease in the percentage of key-driven to other calculators, there were no recommendations to delete them from an office machines class. A survey by Darst produced the same information:

Many of us have been of the opinion that the key-driven calculator and its hard-learned skill were obsolete. In one firm of the eight, the interviewed manager flatly said it was "out," because of the difficulty of hiring and training of competent operators. Two other managers said they felt it was on the way out, but they still had several in use. In contrast, the controller of a grocery firm said a girl with a high school diploma and some Comp skill could find employment there anytime. He praised the key-driven machine at some length as being the best for the kind of routine addition and multiplication jobs they had.¹²

The informal telephone survey of Lansing, Michigan, area firms conducted in connection with the present study produced approximately the same comments. This survey also found more than two hundred key-driven calculators in use by the first seven firms contacted, which were known to have at least some of them. This, of course, does not indicate a mass return to the use of the key-driven calculators, nor was that intended. It does, however, justify the inclusion of that machine in a business machines course offered by Lansing area schools, and, hence, in the present experiment.

II. STUDIES INVOLVING THE USE OF FILM-LOOPS

The use of film-loops in educational research has not been as prolific as that of many other materials. Undoubtedly, this more limited use is due to the expense involved in producing motion picture

¹³Sara C. Stein, *An Experimental Study of the Effectiveness of Motion Pictures in the Instruction of Business Machines*, 1968.
¹²Marian Darst, "Uses of Small Machines in a Computer Era," Business Education World, December, 1968, p. 8.

films and the fact that the film loop is a relatively new innovation. The even more recent improvement of adding sound to eight millimeter film loops, however, should produce a considerable interest on the part of educational researchers, especially in the area of the classes individualized instruction. Only one of the reviews in this section used film loops for individual, tutorial-type study. The loops used also provided the added medium of sound. The other film-loop research being reported involved silent loops, but with live narrations from the instructor.

The Stein study. One of the most helpful studies for the present work was a Doctoral dissertation completed by Sara Stein, at the University of Southern California in 1958.¹³ This study was helpful for two reasons: (1) it concerned the use of film loops for the teaching of the skill of typewriting; and (2) it explained in some detail the production of the original films.

The purpose of the Stein study was to measure quantitatively the effectiveness of the use of 16 millimeter motion picture film loops for instruction in beginning typewriting. The experiment aimed: (1) to ascertain the effects of instruction in beginning typewriting using 16 millimeter motion picture film loops and the effects of instruction in beginning typing without film loops; and (2) to determine the statistical difference in mean gains between an experimental group with

¹³Sara C. Stein, An Experimental Study of the Use of Motion Picture Film Loops in the Instruction of Beginning Typing, Unpublished Doctoral dissertation, University of Southern California, 1958.

the instruction using film loops and a control group without the use of the film loops.

The typewriting classes of two senior high schools and one junior high school were used as experimental groups, and the classes in another senior high school and a separate class in the same junior high school were used as control groups. The senior high school and junior high school groups were considered separately as two different experiments. The scores on timed writings and production tests provided the data for statistical analysis.

In order to conduct her experiment, Dr. Stein needed first to produce the films to be used. A series of 16 film loops were produced on 16 millimeter film. These films were correlated with the first nine lessons of Twentieth Century Typewriting, sixth edition, Southwestern Publishing Company. They were designed to teach the correct motion to beginning typewriting students in the initial stages of learning. The filming was done from an over-the-shoulder view, so that all students could see the demonstration clearly. After processing, each demonstration was placed in a separate continuous-loop magazine that could be attached to regular 16 millimeter projectors. The films were silent and consequently a teacher's manual was developed that included materials and procedures to be followed. In use the teacher spoke the key points at the appropriate times as determined by the researcher.

The measuring instruments were two, three-minute and three, five-minute timed writings administered at specific times during the experiment. Later these writings were checked for gross words and

gross errors. The final five-minute timed writing and a production test were administered at the end of the first semester.

In an analysis of the results, Dr. Stein made a comparison of the gains in speed made by the experimental and control groups on the high school level from the first to the third five-minute writing and found that a significant difference between gains existed in favor of the experimental group. A comparison of the changes in accuracy indicated that there was no significant difference although the control group was slightly more accurate. She suggested that the stricter method for calculating errors by the teacher of the control group indicated that there was greater emphasis placed on accuracy in that group than with the experimental group which may have influenced the results. The final production test had similar results with the experimental group making significantly higher scores than the control group. There was no significant difference between the groups on any of the tests at the junior high level.

The conclusions reached from the study were that: (1) 16 millimeter film loops assisted the senior high school experimental groups typing skill to greater degree than control group methods; (2) film loops did not appreciably help in accuracy; and (3) pupil participation with films is practical. Dr. Stein made the recommendation in 1958 that more research be done on the use of film loops in teaching.

Elwood E. Miller, Director, Single Concept Film Clip Project
Part II, Final Project Report, Michigan State University, 1967.

The Trinklein study. Another study in the use of continuous-loop films grew out of the Single Concept Film Clip Project completed

of Using a Full Film and Short Film
Unpublished doctoral dissertation, Michigan State University, 1968.

at Michigan State University.¹⁴ This project was conducted under a Federal Office of Education grant and its purpose was to study the feasibility of making single concept clips from full-length films that were already produced. The study conducted by Dr. Lloyd A. Trinklein used some of the single concept films that were excerpted from the CHEM Study films prepared and distributed by Modern Learning Aids Incorporated for use in chemistry classes at the high school level.¹⁵

The purpose of the study was to investigate certain modes of instruction, involving single concept films in comparison with the use of a full-length film. Specifically it compared the relative effectiveness of a full film with combinations of excerpts from that film to teach factual information to CHEM Study students. The study was conducted in 16 school systems throughout the lower half of Michigan and involved 18 teachers and 382 students. The media utilized were various combinations of the film BROMINE--ELEMENT FROM THE SEA and excerpts of that film. The film is one of 26 prepared for use in the CHEM Study curriculum. Procedures were to assign each class to one of three treatment groups. The three treatments were: (1) film only; (2) excerpts only; and (3) a combination of the film and the excerpts. The treatment was

¹⁴Elwood E. Miller, Director, Single Concept Film Clip Project Part II, Final Project Report, Michigan State University, December 1, 1967.

¹⁵Lloyd A. Trinklein, A Comparative Study of the Effectiveness of Using a Full Film and Short Format Films to Teach Chemistry, Unpublished Doctoral dissertation, Michigan State University, 1966.

applied during the teaching of Chapter 19 of the CHEM Study text. The filmed material was shown twice to each class during that period of time.

In addition to tests used to equate the various groups, an objective pretest and posttest were prepared and validated by the experimenter and administered to the groups. The null hypotheses stated: There is no significant difference among the means of achievement gains of the three groups of students who had been taught factual information by a film, excerpts from that film, or a combination of the film and excerpts from that film.

The data were analyzed by an analysis of covariance because of significant differences found among the three groups in IQ. An F-ratio was computed and the null hypotheses rejected at far above the .05 level of significance. Scheffe comparisons were made to determine directional relationships between the adjusted means of the three groups. The findings were that the combination film and excerpts treatment produced a significantly greater adjusted mean than either the film or the excerpts treatment alone and the film treatment produced significantly greater adjusted mean than the excerpts treatment.

The author concluded that the combination of a full-length film and excerpts from that film is more effective for teaching factual information than either the film or the excerpts alone. The results of a questionnaire given to students indicated that the students were also most satisfied with the combination treatment.

Speech Reading to Deaf Children, "Audiovisual Communication, March, 1966, pp. 177-181.

speech. Recommendations were made to the effect that the short single concept films could be used in programmed learning situations, and that a study to compare the use of short films individually with classroom use would be profitable.

The Stepp study. Under a NDEA, Title VII research grant, the University of Nebraska produced sound films and tested their ability to teach speech reading (lip-reading) to hard-of-hearing early elementary students.¹⁶ The final format of the films was eight millimeter also in the format. The students responded to the films as if it were with magnetic sound in cartridges for individual use in the Fairchild, a tutorial instruction situation. They sometimes spoke to the filmed teacher, held up objects so that the teacher could get a better view,

A series of three teaching units and one instructional unit, totaling 25 films in all, were originally filmed on 16 millimeter color

Since this was a feasibility study in the use of cartridge film with sound and subsequently reduced to eight millimeter format for eight millimeter sound film, there was no statistical design for the specific cartridge loading projector. The instructional unit was analysis. However, the study proved, according to Dr. Stepp, that it filmed to introduce the learners to the operation of the Fairchild is possible to establish rapport between a film teacher and an acoustically handicapped student similar to the relationship that exists between students could operate the projector. The three teaching units apparently consisted of eight film groups each. The first unit emphasized millimeter sound is practical in teaching elementary children. The single words; the second unit had associated word emphasis, and the third unit had a multiple word emphasis. It was indicated that the term "emphasis" was used specifically in that all units consisted of proof of the applicability of eight millimeter sound films in teaching many words to be taught. The objective of the films were to teach. He stressed that the type and degree of involvement of the learner is important and stated "this style of teaching is a form of programmed

¹⁶Robert E. Stepp, "Programming Eight Millimeter Films to Teach Speech Reading to Deaf Children," Audiovisual Instruction, March, 1966, pp. 177-181.

speech reading to deaf or hard-of-hearing youngsters. The filming was done from the learners' viewpoint--that is, facing the teacher. The teacher would, in the initial units, speak the word of an object and then would hold up the object, like a car or a ball. She would then ask the learner "show me the ball" and, after a pause, would point to the ball to reinforce the response of the learner.

When using the films, the students were in enlarged language learning carrels with the specific objects being taught in the lesson also in the carrel. The students responded to the films as if it were a tutorial instruction situation. They sometimes spoke to the filmed teacher, held up objects so that the teacher could get a better view, and in other ways responded as if the teacher was "live."

Since this was a feasibility study in the use of cartridge eight millimeter sound film, there was no statistical design for analysis. However, the study proved, according to Dr. Stepp, that it is possible to establish rapport between a film teacher and an acoustically handicapped student similar to the relationship that exists in a face-to-face tutorial situation. It also indicated that eight millimeter sound is practical in teaching elementary children. The author pointed out that the children's conduct in the room, their expressions of satisfaction, and the learning growth gave further proof of the applicability of eight millimeter sound films to teaching. He stressed that the type and degree of involvement of the learner is important and stated "this style of teaching is a form of programmed

learning and can be adapted to the film medium as readily as it has been to the printed page."¹⁷

III. CONTEMPORARY THOUGHT AND DEVELOPMENTS

Programmed instruction, team teaching, television, systems approach, and teaching machines have all occupied space in recent business education periodicals and yearbooks. Most of the writing has been explanatory, with programmed instruction being the most widely publicized and the only area of significant research.

Programmed instruction. Programmed instruction is continually being demonstrated as an effective educational tool during the 1960's, although the achievements predicted by Kreiman for this decade have apparently been delayed:

The 1960's will go down as the decade when self-instruction became a reality. Although the teaching machine is still for the most part an experimental item due to its vast appetite for complex and expensive programming, it has turned the attention of the educational world in the direction of self-instruction as an effective educational method. Complex visual aids of auditorium capacity have been supplemented by inexpensive and simple cartridge loading movie projectors using 8mm film. Educators have adopted the individual student booth concept of the language lab into a slightly more spacious concept known as the study carrel. The carrel brings together all these philosophies in a workable situation.¹⁸

¹⁷Ibid., p. 181.

¹⁸R. Kreiman, "Laboratory Learning Methods and Machines," Education, Vol. 85, March, 1965, pp. 399-400.

Self-study through the use of programmed materials has been a reality, however. Gains have been indicated in the amount learned, retention, and by a decrease in time spent. These types of successes must continue if the ever-increasing population is to be continually and adequately educated. Present methods are not capable of meeting these responsibilities according to Stolurow and West, who, in 1961, stated that, "Training more teachers and building more classrooms cannot ever be a sufficient solution" The solution to these problems lies in greater efficiency in the conduct of instruction.¹⁹ Some of this "efficiency" has since been demonstrated. Taylor, in 1963, found that shorthand students learned equally as well if not slightly better when Gregg shorthand theory is presented through programmed instruction materials.²⁰ In the same year, Halverson found that students learned a unit in bookkeeping better with programmed instructional materials have been developed, including those for teaching machines, tapes, texts, and films. Programmed texts used in connection with the classroom are by far the most common, but there

¹⁹Lawrence M. Stolurow and Leonard J. West, "Teaching Machines and Self-Instructional Programming," Delta Pi Epsilon Journal, Vol. III, No. 3, April, 1961, p. 2.

²⁰Helen W. Taylor, Development and Evaluation of Programmed Materials in Presentation of Theory in Beginning Shorthand Classes, Unpublished Doctoral dissertation, University of Tennessee, Knoxville, 1963.

²¹Gaylon L. Halverson, The Development and Evaluation of Programmed Instructional Materials for Use in Supplementing the Teaching of High School Bookkeeping, Master's thesis, State College of Iowa, Cedar Falls, 1963, NBE Quarterly, Vol. 33, No. 1, Fall, 1964, p. 25.

have been found no difference between groups taught business mathematics by traditional methods or self-instructional materials.²²

Shorthand was learned better and in less time from programmed instruction developed by Henson, and the variability of test scores was also reduced.²³

The use of taped programmed instruction has also proven effective in studies other than those by Compton²⁴ and Beard.²⁵ Butler used taped instruction for teaching tabulation in beginning typewriting.²⁶ Her experimental group did not attend regular sessions, but received their instruction individually from the tapes. They apparently learned as well, if not slightly better, and were favorable toward the new methods.

The course consisted of two "live" sessions each week. Individualized instruction. Several types of programmed instructional materials have been developed, including those for teaching machines, tapes, texts, and films. Programmed texts used in connection with the classroom are by far the most common, but there

²²Bernice M. Folz, Self-Instructional Material Versus Traditional Classroom Instruction in Business Mathematics, Master's thesis, University of Minnesota, Minneapolis, 1964, from NBE Quarterly, Vol. 34, No. 1, Fall, 1965, p. 17.

²³Oleen M. Henson, The Development, Utilization and Effectiveness of Programmed Materials in Gregg Shorthand, Unpublished Doctoral Dissertation, Temple University, Philadelphia, Pa., 1964.

²⁴Judith A. Compton, op. cit.

²⁵Brenda Beard, op. cit.

²⁶Wilma L. Butler, Preparation and Evaluation of Taped Programmed Materials for Teaching Basic Tabulation to Beginning Typewriting Students, Master's thesis, University of Tennessee, Knoxville, 1965, from NBE Quarterly, Vol. 35, No. 1, Fall, 1966, pp. 12-13.

have been evidences of attempts at further individualization. Because necessity is the mother of invention, Arizona State University now uses the silent, single-concept film and a rear-screen projection device to provide self-instructional units on the operation and use of other audiovisual equipment.²⁷ In order to overcome a situation of too many lab hours scheduled for the number of teachers available, a system of printed instructions and filmed demonstrations was designed. Junior, senior, and graduate education students pick up a dittoed manual for each unit which informs them of the objectives, materials, and supplies needed, the number of the cartridge film to be used, and the final performance expected. The author concluded that students seem to be learning more effectively and more efficiently than when the course consisted of two "live" lectures and three lab periods each week.

IV. SUMMARY OF RELATED LITERATURE

Oakland Community College, with three campuses in Oakland County, Michigan, has used audio tapes extensively in its plan for independent study. That system, described by Tirrell²⁸ and again by Anderson,²⁹ provides tapes and tutors in a laboratory setting. However, the independent study is sandwiched between large "general assembly sessions," and "small assembly sessions" with a limited number of students, which meet each week.

²⁷V. S. Gerlach, "Self-Instruction in the A.V. Laboratory," Audiovisual Instruction, Vol. XI, February, 1966, pp. 96-97.

²⁸John E. Tirrell, "(Total!) Independent Study at Oakland," Junior College Journal, Vol. XXXVI, No. 7, April, 1966, pp. 21-23.

²⁹Roland A. Anderson, "Let's Look at the Instructional Systems Approach," Business Education World, Vol. XXXVII, No. 6, February, 1967, pp. 19-20, 44-45.

One of the more effective procedures for independent study was initiated at the University Adult High School in Los Angeles.³⁰ Using programmed texts from various publishers, this school was able to provide many courses at four levels to only a few students, each working at his own rate in the same classroom at the same time. The students were also allowed to start a course at any time, and there were no deadlines to meet at the end of semesters. Learning was faster and better, with 54 semester courses completed by 24 individuals and final grades well above average.

IV. SUMMARY OF RELATED LITERATURE

Educators are currently trying new materials and techniques in an attempt to provide more effective instruction to more people in a shorter length of time. The efficiency of traditional teaching methods is being questioned, but very few are willing to question the traditional classroom atmosphere and activities, even though many of the new materials are at a disadvantage in such a setting. Stolurow and West pointed out some of the deficiencies of group instruction, most of which continue to be detrimental whether or not programmed materials are used:

MOTIVATION AND ATTENTION. One purpose of motivation is to secure the learner's attention How often can any live teacher guarantee that every student is indeed paying attention?

³⁰Louis Van Phelan, "A Class Full of Courses--An Unusual Experiment in Programmed Teaching," Audiovisual Instruction, Vol. XI, April, 1966, pp. 251-253.

MAKING THE IMPORTANT CUES PROMINENT. The particular thing to be learned is often swamped in the surrounding verbiage. What is required in instructional materials is that they be stripped of excess baggage so as to give adequate prominence to the important cues.

CONTINUAL ACTIVE RESPONDING. The old phrase "learning by doing" must be taken seriously. The learner must be doing, acting, behaving. In addition to attending, he must be busily making other responses. Typically, however, instruction consists of a teacher talking to students. Much of classroom instruction allows the learner to be passive, let alone inattentive; whereas learning requires active responding by the learner.

IMMEDIATE KNOWLEDGE OF RESULTS. Perhaps the most firmly established (but most often violated) of all requirements for learning is that of immediate "reinforcement" for response (in the form of "knowledge of results"). Under typical conditions "feedback" is often delayed (as when test papers are returned the next day or even later) and it is at best occasional rather than regular.

PACING FOR INDIVIDUAL STUDENTS. We cannot alter the fact that people differ; nor would we wish to. However, with respect to the differences important for instruction . . . no live teacher can conceivably pace instruction at just the right rate for each learner individually; nor can he ever successfully identify and remedy the variety of weaknesses in background present in any group of students.³¹

Most programmed materials have the potential to meet the criteria called for above with factual presentations, if given the opportunity. Easily visible demonstrations on film have also aided the learning process. The advent of the continuous-loop, eight millimeter film cartridges with sound used in a rear-screen projector provides a new medium for individual instruction that deserves more

consideration. The first experiment involved a microscopic reproduction to eight millimeter film from a video-tape master copy.

This process proved unsatisfactory because of the poor quality of the

³¹Lawrence Stolurow and Leonard West, op. cit., pp. 24-25.

final picture did not allow adequate detail to be seen by the viewer.

Individual keys, and hence **CHAPTER III**, could not be determined.

An original eight millimeter filming experiment was equally unsatisfactory for the same reason. Although a more sophisticated

METHODS AND PROCEDURES

This chapter describes the methods and procedures used in this study and is divided into five parts: Part I contains procedures used to develop the experimental materials; Part II describes the method of selecting experimental and control subjects; Part III contains a description of the audio-visual-tutorial method of instruction used with the experimental group; Part IV contains the teaching methods used for the control group; and Part V contains the sources of data used in the study and describes the methods of collection and analysis of the data.

I. THE EXPERIMENTAL MATERIALS

The process involved setting the camera in a position located over the shoulder of the instructor.

Motion picture films which could be satisfactorily adapted to this method provided a filmed demonstration which most nearly matched the learner's view of the actual machine used for practice. Each could not be located for this experiment. Consequently, all materials student would have a clear view of the keyboard and be able to see all used for instructional purposes had to be produced. Initial experiments were run during the summer of 1966 to determine the best method

of producing eight millimeter film which could be used in the use of a zoom lens on the camera. These pieces of film were later continuous-loop cartridges.

inserted into the instructional sequence to indicate the correct answer.

Early attempts. The first experiment involved a kinescopic reproduction to eight millimeter film from a video-tape master copy. This process proved unsatisfactory because the poor quality of the

final picture did not allow adequate detail to be seen by the viewer. Individual keys, and hence hand positions, could not be determined.

An original eight millimeter filming experiment was equally unsatisfactory for the same reason. Although a more sophisticated editing of it, called a work print, was printed for editing purposes. The camera and lens might have been obtained which could have produced better results, the experiment was halted when it was learned that each "scene" into proper sequence within one of twenty-two units. The copies from the eight millimeter originals would not be durable enough for continuous-loop cartridges. A review of one or more past units, a problem, two demonstrations of the complete

The filming process. Professional photographers and equipment were hired during November and December, 1966, to film the demonstrations of the machines on sixteen millimeter color film. The filming was done in sections, or "scenes," rather than a continuous film for a complete unit.

The process of filming machine demonstrations involved setting the camera in a position located over the shoulder of the instructor. This method provided a filmed demonstration which most nearly matched the learner's view of the actual machine used for practice. Each student would have a clear view of the keyboard and be able to see all hand movements properly executed.

Close-up shots of dials and tapes were accomplished through the use of a zoom lens on the camera. These pieces of film were later inserted into the instructional sequence to indicate the correct answers to the problems being solved, decimal placement procedures, and other technicalities peculiar to the machines being taught. The camera was moved away from the instructor in order to provide a

full-length view for initial instruction and a later review on posture and machine placement. for use in continuous-loop cartridges. A

magnetic tape stripe was attached to one edge of the film which would

Editing the film. When the original film was processed a duplicate of it, called a work print, was printed for editing purposes. The

provide the sound track.

The treated and striped eight millimeter film was returned to work print was edited by cutting and splicing the film, and putting

the researcher to be loaded in special cartridges. Each unit was put each "scene" into proper sequence within one of twenty-two units. The

in a separate cartridge around a rotating hub. The beginning and end typical unit contained a title, credits, introductory scene, a partial

of each film were then spliced together with a dry splice making a review of one or more past units, a problem, two demonstrations of the

continuous-loop of the film. The cartridges were then labeled to completion of the problem, close-up shots of the machine dials or tape

indicate the machine and the number of the film within the series for showing the correct answer, a second, related problem, two more demon-

strations with close-ups, and a quick review of the unit. The general

pattern of each unit, other than the introductory and review scenes,

was: (1) to indicate the machine process to be taught and the typical

problems solved by that process; (2) to do a thorough job of teaching

the process; and (3) to review the entire procedure immediately. the

specific. Nearly eight thousand feet of sixteen millimeter film were

required to produce the total of fifty-seven hundred feet of usable

print. This film was previewed and cut into sections ranging from

three to over twelve feet in length. Joining the sections together

in proper sequence required more than six hundred splices. the filmed

units, were recorded on a separate magnetic tape. This tape was

Cartridging the filmed units. When the units were organized

reproduced on the film by a mechanical process

in proper sequence, they were returned to the professional film

after synchronizing the starting points. The edge of the film was

processors where the original film was conformed to the work print. then etched in a spot following the end of the unit to trip the

Reduction prints of eight millimeter size were then produced from the automatic stop mechanism of the projector. With this final step in

original. This film was treated with chemicals by a special process to make it more durable for use in continuous-loop cartridges. A magnetic tape stripe was attached to one edge of the film which would provide the sound track.

Preparing handout sheets. Special instruction sheets for each of the units of the course were prepared and duplicated. Each sheet of the treated and striped eight millimeter film was returned to the researcher to be loaded in special cartridges. Each unit was put in a separate cartridge around a rotating hub. The beginning and end of each film were then spliced together with a dry splice making a continuous-loop of the film. The cartridges were then labeled to indicate the machine and the number of the film within the series for that machine.

Adding the sound. The process of adding the sound to the magnetic stripe on the film began by first preparing a written narrative for each unit. These narratives were then timed, rewritten, and timed again until each part exactly matched the time afforded by the specific scenes on the film. This process was necessary, even though the original filming was timed and scenes were measured to meet as nearly as possible the necessary time requirements for the proposed instructional narration.

The narrations, when completely synchronized with the filmed units, were recorded on a separate magnetic tape. This tape was reproduced on the magnetic stripe of the film by a mechanical process after synchronizing the starting points. The edge of the film was then notched in a spot following the end of the unit to trip the automatic stop mechanism of the projector. With this final step in

the production of each unit completed, the cartridge film was ready for student use.

Two daytime sections of Business Machines I were offered during winter. Preparing handout sheets. Special instruction sheets for each of the units of the course were prepared and duplicated. Each sheet briefly explained the topic to be covered in each instance and gave the problems solved within the filmed demonstrations. In addition, to each sheet provided an assignment to be completed by the student after the film was viewed. The assignment consisted of specific related problems within the text being used. These handout sheets are reproduced in Appendix C. 1:00 p.m. section, for a total of sixty-six

to begin the experiment. During the first few weeks of the term, seven The completed course. The completed program for the Business Machines I course on audio-visual media included a total of twenty-two drop cards, or by failing to attend further classes and test periods. films with a handout sheet for each, a unit test to be completed on Fifty-nine students finished the course and were included as subjects each machine, and a final test. Eight continuous-loop sound films were in the experiment. used to teach the operations on the Burroughs key-driven calculator, and seven films each were used for the Friden rotary calculator and the Monroe 10-key adding-listing machine. Film lengths ranged from three and one-half minutes to over ten minutes, with an average of approximately six and one-half minutes. A complete listing of the films for each machine with the instructional topic and length is provided in Appendix A." written on them. There was an equal number of 1's and 2's

in the container, and the total number of slips equaled the number of students in that section.

Those students holding number "2" were then advised to leave the room and return in half an hour for their initial instruction, while

those with number "1" II. SELECTION OF GROUPS

There were many more students than work stations, most of them accepted

Two daytime sections of Business Machines I were offered during this as a necessary solution to an over-crowded condition. When they winter quarter, 1967, at Lansing Community College. One section was returned, however, they were met outside the door and directed to the scheduled at 11:00 a.m. and the other at 1:00 p.m. Class size is audio-visual-tutorial laboratory located approximately across the hall. normally limited to 18 students because of the number of available machines. The number of class cards printed was doubled, however, to allow students to enroll in either section without prior knowledge of the pending experiment. Thirty-four students originally enrolled for the section of Business Machines I offered at 11:00 a.m. and thirty-two students selected the 1:00 p.m. section, for a total of sixty-six to begin the experiment. During the first few weeks of the term, seven students dropped the course, either formally with an official college drop card, or by failing to attend further classes and test periods. Fifty-nine students finished the course and were included as subjects in the experiment.

Albert Giordano, Copyright 1967, Prentice-Hall, Englewood Cliffs, New Jersey.

For the rotary calculator:

The random selection procedure. At the beginning of the first class period for each section, the instructor met the total group. A random selection procedure was used to divide each section into two equal parts. This procedure consisted of having each student select a folded slip of paper from a container. The slips of paper had either a "1" or "2" written on them. There was an equal number of 1's and 2's in the container, and the total number of slips equaled the number of students in that section.

Those students holding number "2" were then advised to leave the room and return in half an hour for their initial instruction, while

Appendix C.

those with number "1" were asked to remain. Since it was obvious that there were many more students than work stations, most of them accepted this as a necessary solution to an over-crowded condition. When they returned, however, they were met outside the door and directed to the audio-visual-tutorial laboratory located approximately across the hall. For many of these students, this was the point at which they realized prepared introductory paper and a blank schedule sheet were issued to each student. The introductory sheet explained the objectives of the

Textbooks and assignments. The textbooks used and the assignments given were identical for both groups. Three separate texts were used, one for each type of machine studied, and they were the standard texts adopted by Lansing Community College at the time of the study.

The text titles were as follows:

For the 10-key adding-listing machine:

Business Machines Calculation, Volume I
Albert Giordano, Copyright 1967, Prentice-Hall
Inc., Englewood Cliffs, New Jersey.

For the rotary calculator:

Business Machines Calculation, Volume II,
Albert Giordano, Copyright 1967, Prentice-Hall
Inc., Englewood Cliffs, New Jersey.

For the key-driven calculator:

Learning the Burroughs Calculator, Burroughs
Corporation. (A special text supplied by the company.)

The assignments for each group involved the completion of identical problems within the texts. These problems are identified on the handout sheets for the experimental group reproduced in Appendix C.

III. THE TECHNIQUE USED WITH THE EXPERIMENTAL GROUP

Students in the experimental group were first given an introduction to the type of instruction they would receive. This initial introduction provided a demonstration of the use of the rear-screen projector and a discussion of the requirements of the course. A prepared introductory paper and a blank schedule sheet were issued to each student. The introductory sheet explained the objectives of the course, the methods of instruction, the assistance available, testing procedures, and grading policy.

The students were instructed to bring the schedule sheet with them to the laboratory so that the technician could indicate the time and day that each lesson was completed. These documents are reproduced in Appendix B.

The A.V.T. laboratory. Special facilities provided for the experimental group consisted of three carrels, each containing a Fairchild Mark IV rear-screen projector which would accommodate the student in an adjacent carrel. Each student was provided with a cartridged sound films and one of the three business machines to be learned. Because the subjects were all full-time day students, the facilities were made available to them between 8:00 a.m. and 5:00 p.m., Mondays through Fridays. These facilities were located in a room approximately across the hall from the regular machines classroom and designated the A.V.T. laboratory.

Student laboratory assistants were hired to issue the programmed units to the subjects in the experimental group and to assist them in the operation of the audio-visual equipment when such

assistance was requested. These student aides had previously completed the traditional business machines course at Lansing Community College and were, therefore, acquainted with the types of machines used and the problems covered. They were not expected to act as instructors, but occasionally they answered some simple questions concerning the completion of specific problems. If there were incorrect answers,

the subject was advised to rework the problems promptly. Then, after Learning procedures. An experimental subject, upon entering the special room, signed his name and the time on a roster and also indicated the machine and lesson on which he was currently working.

The laboratory assistant gave him the prepared assignment sheet and issued the proper cartridged sound film. The film was taken by the student to the carrel containing the particular machine he was studying and inserted it into the rear-screen projector. The student put on earphones which were plugged into the projector and pushed the lever to start the film. The sound was transmitted through the earphones in order to avoid disturbing another student in an adjacent carrel. Each student was allowed to run the film a second time if he desired; however, few found it necessary. He was also encouraged to work the problem on the business machine in the carrel while viewing the film.

When he was satisfied that he had absorbed the instruction adequately, the subject returned the cartridged film to the assistant. He kept the handout sheet and went to the business machines room to work the assigned problems on the same type of machine shown in the film. It was administered to small groups of experimental subjects

Immediately upon completion of the assigned problems, the experimental subject returned to the audio-visual-tutorial laboratory where he was provided an answer sheet for those problems by the laboratory assistant. He checked his own work at that time and, if the answers were correct, the papers were left with the assistant, who filed them in individual folders. If there were incorrect answers, the subject was advised to rework the problems promptly. Then, after rechecking, the papers were filed.

Individual progress. Subjects were allowed to progress through the units as fast as they wished, as long as all problems assigned were completed. When all units and assignments pertaining to one of the three machines were completed, a performance test was administered by the laboratory assistant. The test was also corrected by the assistant who then forwarded it to the instructor. The instructor consulted with each individual student regarding the results of the test. When areas of deficiency were noted, the students were either advised to review particular units, or were individually shown the proper machine operation at that time. When questions regarding the tests were answered satisfactorily, the tests were filed in the students' folders with the completed assignments.

The final test was administered and corrected by the instructor upon the completion by the student of all work required on the three machines. This test was also a performance test and was used for both the experimental and control groups as the criterion test. Whenever possible, it was administered to small groups of experimental subjects

rather than on a completely individual basis to make the best use of the instructor's time.

The audio-visual-tutorial method was, insofar as possible, completely individualized. The experimental subjects met as a group at the beginning of the course to receive the initial introduction. Several subjects met together to take the final test at the end of the course as a matter of convenience for the instructor. During the term, however, everything was on an individual basis. Instruction was individualized and automated; additional help was on a tutorial basis; and unit tests were administered and discussed with each individual separately.

IV. TEACHING METHODS USED WITH THE CONTROL GROUP

The control group consisted of students enrolled in either of two regular sections of Business Machines I, at Lansing Community College. One section met from 11:10 a.m. to 12:00 noon and the other from 1:10 p.m. to 2:00 p.m. Both sections met on Mondays, Wednesdays, and Fridays for a total of eleven weeks.

The rotation plan. The rotation plan method was used for structuring the classroom activities. The students in each section were divided into three sub-groups for the three types of machines to be taught--the 10-key adding-listing machine, the rotary calculator, and the key-driven calculator.

Instruction began with a demonstration of each type of machine operation to the total sub-group involved. The group would gather around a machine while the instructor demonstrated the proper procedures. The sub-group then dispersed to similar machines in the room and began to work assigned problems from the text. The instructor then repeated the process on a different machine with each of the other two sub-groups. Individual instruction and repetition of demonstrations was provided when necessary. Each sub-group remained at a given type of machine for ten class periods, which included one period for a unit test. On the eleventh and twenty-first class days the students changed machines, but remained with their particular sub-group.

The eleventh week of each term at Lansing Community College is scheduled for final examinations. Each class period is scheduled for one two-hour period during this week on a master schedule for final examinations. The control group, therefore, had a total of twenty-seven instructional periods and three test periods, which included nine instructional and one test period for each type of machine, and, in addition, a two-hour final examination period for the performance test on all machines. The machines room was also available to the students during the remaining hours of each day for additional individual practice at their discretion. Additional hours were not only encouraged, but necessary for a majority of the students, in order to complete the assigned work.

V. DATA COLLECTION AND ANALYSIS METHODS

Sources of Data

Data collected to fulfill the purposes of this study were from five sources: (1) the percentile scores on the English and the mathematical portions of the American College Test (A.C.T.) battery; (2) high school transcripts for all students in both groups; (3) a special questionnaire soliciting personal, vocational, and related information from all students; (4) the final examination for the course taken by all students during the last week of the term; and (5) a second questionnaire, administered only to the experimental group, to solicit opinions regarding the audio-visual-tutorial method of instruction.

The first three sources of information provided data used to determine the degree of equality between the groups at the beginning of the experiment. The first source (A.C.T. scores) was also used to separate the experimental and control groups into sub-groups based on mathematical ability. A second use for source two (high school transcripts) was the division of the groups into sub-groups of prior and no prior courses in business machines. The questionnaire mentioned in source three also asked each student to estimate the time spent on this course.

The final examination for the course (source four) was used as the criterion test in the experiment to determine whether or not the experimental treatment was effective. The second questionnaire was an opinion poll of the experimental group and was used to evaluate student attitudes toward the system.

Collection of Data

A.C.T. scores. The American College Test battery was administered to all incoming freshmen who enrolled at Lansing Community College in the regular manner during the summer and fall of 1966, as a matter of college policy for placement purposes. The scores were available for fifty-two of the original sixty-six students who enrolled in the Business Machines I sections with which this study is concerned. Three of the remaining fourteen students who had not taken the test battery were on special student status; four were transfer students; three had enrolled for the first time during the winter quarter, and four had missed their summer orientation session.

All of the students without A.C.T. scores agreed to take the English and mathematics portion of that test during the second week of the term. The test was administered to twelve subjects at their convenience. The other two subjects were among seven students who dropped the course. The raw scores were converted to percentile rankings from a conversion chart.

High school transcripts. High school transcripts were available from the Student Records Office at Lansing Community College for all but three of the students involved in the experiment. Those students were classified as special students and transcripts were not required for that classification. Many of the available transcripts were incomplete, since applications to the college were made prior to the completion of high school, so twelfth grade subjects and grades were missing. Consequently, telephone calls were made to area high

schools and letters were written to high schools in other states requesting the three missing transcripts and twelfth-grade course information for thirty-two others.

The student questionnaire. A questionnaire was designed to examine the personal background of the subjects in both groups and certain areas that could affect the outcome of the experiment. Such areas as age, sex, length and type of work experience, and the extent of prior office machines used were examined. This questionnaire is reproduced in Appendix D.

This questionnaire was administered to each group during the final examination period of the term. The final question of this instrument requested an estimate of the hours spent in completing the course.

Final examination. The final examination was prepared in order to measure the students' knowledge of the operation of each machine. All operations taught during the term on each machine were required for the completion of all problems on the test. The examination was not designed to measure skill in terms of speed, but rather to measure the performance of each student, indicated by his operational knowledge of each machine and accuracy. The final examination is reproduced in Appendix E.

The final examination was administered to each student during the eleventh week of the term. The two control group sections completed their examinations during the scheduled two-hour period, as printed in the college examination schedule. The experimental group

subjects were allowed a choice of times, but were encouraged to select certain designated periods so that several could be tested together. Since the examination was administered by the instructor, this procedure was adopted to make the best use of the instructor's time. Twenty minutes were allowed for the completion of twenty-nine problems on each machine. This length of time was sufficient for most students to complete all problems and recheck those which caused concern.

Student opinions. Students in the experimental group were asked to give their opinions regarding the audio-visual-tutorial method of instruction. A special questionnaire, called an opinionnaire, was designed to provide information from which attitudes might be estimated. An indication of procedural or functional problems of the system were also solicited by this instrument, which required ranked answers to a majority of the questions. Subjects in the experimental group were asked to complete the opinionnaire anonymously, immediately after taking the final examination. The complete instrument is presented in Appendix F.

Methods of Analysis

Data were collected for three purposes within this study: (1) to determine the degree of equality between the groups at the start of the experiment; (2) to test the hypotheses about differences at the conclusion of the experiment; and (3) to measure student attitudes toward the experimental conditions.

Statistical techniques. The Student t-test was computed, using the combined English and mathematics percentile scores of the A.C.T. in determining the degree of equality between the groups. This test has the advantage of simplicity over other tests that might have been used, and it is considered a reliable measurement device by most statisticians. A second t-test was performed on the ages of participating subjects to determine whether the mean age of each group was similar.

Two separate two-way analysis of variance tests were performed on the final examination data to test the hypotheses of this study. The first analysis of variance was computed to measure any differences between the two total groups; between sub-groups of upper and lower mathematical ability, and to ascertain whether there was an interaction between the mathematical ability and experimental or control group. The statistical design used was the Fixed Effects Model described by Hays.¹

The second two-way analysis of variance was computed to answer the question of whether or not a prior high school course in business machines has any effect on final performance. This analysis also included a comparison of the total groups. The same type of design was used with computational changes to compensate for unequal numbers within the cells.

Non-statistical analysis. The student information questionnaire provided a realistic profile of the experimental and control

¹William F. Hays, Statistics For Psychologists, Holt, Rinehart, and Winston, Inc., New York, 1963, pp. 387-408.

groups. The groups were then compared on the basis of age, sex, work experience, and other non-academic information.

The opinionnaire completed by members of the experimental group provided answers used to estimate student attitudes toward the system. Graded answers were compiled in summary form for analysis purposes. Additional comments by students were reported as given.

CHAPTER IV

ANALYSIS OF DATA

This chapter will attempt to analyze the data collected during the course of the experiment, and is divided into four parts. Part I will discuss the degree of equality between the groups; Part II will present the statistical analysis of the criterion test; Part III will present student opinions regarding the experimental method; and Part IV will summarize the analyses and findings.

I. DEGREE OF EQUALITY BETWEEN GROUPS

A random selection method was used to divide each of the two sections of Business Machines I into sub-groups of equal numbers to provide experimental and control subjects. The method used was to have each student pick a slip of paper from a container with either the number "1" or "2" written on it. Statisticians agree that this method would generally provide groups of equal abilities, providing the samples were large enough and the parent population was normal.

In order to be able to draw definite conclusions about the experimental conditions, however, it was determined that further evidence to substantiate the degree of equality must be provided. Therefore, the ability of each group, as measured by the American College Test battery, was verified. In addition, a profile for each group was constructed on the basis of answers given by each individual on a questionnaire.

A.C.T. Scores

The A.C.T. percentile scores in English and mathematics were obtained for each individual in both groups. A composite score for each subject was determined by adding both percentile scores and then dividing by two. This composite percentile score was used to compute a t-test in an attempt to determine whether significant differences existed between the groups. Table I presents the results of that computation.

TABLE I
COMPARISON OF GROUPS ON THE BASIS OF A COMPOSITE A.C.T.
PERCENTILE SCORE FOR ENGLISH AND MATHEMATICS

	Number	Mean
Control Group	30	35.37
Experimental Group	29	35.71
t-ratio	df=57	.0832

Since it would take a t-ratio in excess of 1.674 to indicate possible differences between groups of this size with an alpha error limit of .05, it can be stated with confidence that the groups were comparable on the basis of English and mathematics ability, as measured by the American College Test.

Group Profiles

A questionnaire was completed by each student at the end of the experiment to further examine the equality of the groups and to make an estimate of the time required for the completion of the

course for each group. (See Appendix D.) The questionnaire examined both the academic and nonacademic background of the subjects relating to prior use or study of business machines. Personal information regarding age, sex, and general educational level was also sought. Answers regarding a prior course in business machines were checked for accuracy by an examination of high school transcripts. The first question on the instrument was used only to determine whether the subject was part of the control or experimental group. There were 29 experimental group subjects and 30 subjects from the control group who completed the course.

Age and sex. Question II on the instrument sought information about the age and sex of each subject. This information, presented in summary form in Table II, indicates that there were three fewer males in the experimental group than in the control group. However, the total number of males in the experiment was small and their distribution as to age was approximately the same in both groups.

TABLE II
COMPARISON OF GROUPS BY AGE AND SEX

Age Groups Sex	Total		17 to 19		20 to 22		23 to 25		Over 25	
	M	F	M	F	M	F	M	F	M	F
Control	9	21	6	17	2	3	1	-	-	1
Experimental	6	23	3	20	2	3	-	-	1	-

All but three subjects were less than 23 years of age, with the great majority in the 17 to 19 age category. Both groups had 23

students in the 17-19 age range, five in the 20-22 range, and one over age 25. The groups, therefore, appeared comparable according to age.

A t-test was computed in an attempt to verify this apparent condition. The age of each student at the beginning of the experiment was determined to the nearest tenth of a year for computational purposes. The results of the t-test are given in Table III.

TABLE III
STATISTICAL COMPARISON OF GROUPS BY AGE

	Number	Mean Age
Control Group	30	19.55
Experimental Group	29	19.15
t-ratio	df=57	.8891

The t-ratio obtained by this computation was much less than the 1.676 ratio necessary to show a difference between the groups, with 57 degrees of freedom and a confidence level of 95 percent. The groups were, therefore, regarded as equal according to age.

College training. In terms of credits earned prior to the experiment, the control group average was 18.4 credits with a range of 0 to 85. The experimental group averaged 18.7 credits earned, and the range was 0 to 54. Included in these averages were 41 credits earned by three control-group subjects, and 38 credits earned by two experimental-group subjects, at other colleges.

The average number of credits carried by control-group subjects during the term of this experiment was 11.7, while the experimental

group averaged 13.4 per student. The range for the control group was 6 to 17 credits, and the experimental group ranged from 6 to 19. The mode for both groups was 13 credits, carried by seven control-group and six experimental-group students.

Work experience. Thirteen experimental subjects indicated that they had been employed in a business office, and ten control group subjects indicated such experience. The largest number in each group was employed full time for six months or less. Table IV shows the number in each employment classification and the length of time employed.

TABLE IV
BUSINESS OFFICE EXPERIENCE OF CONTROL
AND EXPERIMENTAL SUBJECTS

Classification	Length of Employment in Months									
	1 to 6	7 to 12	13 to 18	19 to 24	Over 24					
	C	E	C	E	C	E	C	E	C	E
Full time-40 hr. wk.	4	5	-	-	1	-	-	-	-	1
3/4 time -30 hr. wk.	1	-	-	-	-	-	-	-	-	-
1/2 time -20 hr. wk.	1	2	-	1	-	-	-	-	1	1
1/4 time -10 hr. wk.	-	2	2	-	-	-	-	1	-	-

The type of work performed was also quite similar for the two groups. Filing and typing were the most common types of work with receptionist's duties as a close third. Three students in the control group and one in the experimental group indicated shorthand as part of their employment activities. Accounting, recordkeeping, and

mathematical computations were checked seven times by experimental subjects and four times by control subjects; however, these were not necessarily different students as each subject was instructed to check more than one item if applicable. An itemized account of the type of work performed is given in Table V.

TABLE V
TYPE OF WORK PERFORMED DURING EMPLOYMENT

Work Classification	No. of Subjects	
	Control	Experimental
1. Typing	8	9
2. Shorthand	3	1
3. Accounting	0	1
4. Recordkeeping	3	5
5. Mathematical Computations	1	1
6. Filing	8	11
7. Writing Correspondence	4	5
8. Duplicating	2	5
9. Report Writing	0	2
10. Switchboard	1	0
11. Receptionist	6	6
12. Over-the-counter Customer Service	3	2
13. Other	2	1

Exposure to machines. Item VII of the questionnaire solicited information regarding the types of machines used on the job and the

extent of such use. The 10-key adding machine was by far the most used. This machine was checked by eight experimental subjects and four control subjects. No student had used the key-driven calculator and only one had used a rotary calculator on the job. In the category for other machines, subjects listed copying machines, dictaphone, mimeograph, typewriter, and cash register. Table VI provides a breakdown of responses for the various types of machines and extent of use.

TABLE VI
TYPE AND EXTENT OF MACHINE USE DURING EMPLOYMENT

Type of Machine	Number of Responses									
	Daily		2-4 times a week		once weekly		once in two weeks		once monthly	
	C	E	C	E	C	E	C	E	C	E
10-key adding	3	3		2		2	1			1
Key-driven calculator										
Rotary calculator						1				
Full-keyboard adding			2						1	
10-key calculator				1						
Others, not adding or calculators	1	1	2	3	1					1

Twelve control-group subjects and thirteen experimental-group subjects indicated that they had received a high school course in business machines. A check of high school transcripts failed to verify this in one case within the control group. Upon questioning the student, it was learned that she received acquaintance-level training during one semester of an office practice course.

Two students in each group checked "on-the-job" training as their source of prior business machine knowledge. Three of these students had informal training on the 10-key adding machine and the other learned to operate that machine through self-study. One control-group subject received informal training on the full-keyboard adding machine, and one experimental group subject indicated self-study on the job for the rotary calculator. The remaining seventeen control-group and fourteen experimental-group subjects indicated that they had no prior exposure to business machines. Table VII lists the types of machines studied in high school courses and the number of subjects within each group who received instruction on those machines.

TABLE VII
MACHINES STUDIED IN HIGH SCHOOL COURSE

Machine	Number of Responses	
	Control	Experimental
10-key adding	11	12
Key-driven calculator	7	8
Rotary calculator	7	11
10-key calculator	1	0
Full-keyboard adding	4	6
Duplicating machines	8	11
Transcribing machines	2	2

In addition to the six- or eight-week high school course for one subject, five more control-group subjects received a one-semester course and six had a full year of business machines in high school.

A one-semester course was also received by five experimental-group subjects, and the remaining eight received instruction for a year.

None of the control subjects indicated that they had used business machines for any reason other than those specified earlier in the questionnaire. Two subjects from the experimental group stated that they had used an adding machine while doing homework problems in accounting.

On the basis of the information provided by the students' questionnaire, the profiles of the control and experimental groups were remarkably similar. The groups were therefore considered comparable in terms of age, work experience, college training, and prior exposure to business machines.

Estimated completion time. The last item on the questionnaire asked for an estimate of the number of hours required to complete this course. These estimates were provided by twenty-five control group subjects and eighteen from the experimental group. No actual record of time was kept, either formally or informally; consequently, these answers represent only the length of time students thought they spent on the course.

For the total course, the control-group answer ranged from a low of 30 hours to a high of 100 hours. The mean estimated time was 59.9 hours. The experimental-group estimates ranged from a low of 14 hours to a high of 88 hours, with a mean estimate of 38.4, or more than 20 hours less per student.

Estimates of hours spent in completing the work required for each machine were in proportion to the total. Experimental-group

estimates for the rotary calculator ranged from 5 to 40 hours with an average of 13.9. Control-group estimates for that machine ranged from 9 to 45 hours with an average of 22.5. The key-driven calculator took from 5 to 25 hours to learn, with an average of 13 hours, according to the experimental group, while the control group required an average of 20.1 hours, and estimates ranged from 9 to 40 hours.

The control-group averaged 17.3 hours on the 10-key adding machine with estimates of 9 hours to 33 hours. The range for the experimental group was 4 to 25 hours, and the estimated average was 11.5 hours. According to the great majority of the students in either group, the 10-key adding machine required the least time to learn, and the rotary calculator required the greatest amount of time.

II. FINAL PERFORMANCE

The performance of each group at the conclusion of the experimental period was measured by the final test for the course. The test was identical for each group and was given during the final examination week of the term with the same time restrictions for each student. The test, consisting of twenty-nine problems to be worked on each of the three machines, is presented in Appendix E. The score for each student was the total number of problems completed correctly.

Analysis of variance. A two-way analysis of variance, fixed effects model, was computed to answer the questions of whether there were differences between the groups caused by: (1) the experimental conditions; (2) mathematical ability of the subjects; or (3) a combination or interaction of these factors.

Two control-group scores and one experimental-group score were randomly excluded to provide four sub-groups, or cells, of 14 scores each. The control and experimental groups were divided into sub-groups on the basis of mathematical ability. Those subjects in each group whose mathematical percentile scores from the A.C.T. were above the median were separated from those below the median. The scores and statistical design are presented in Appendix G. The method of computation suggested by Hays was followed.¹ A summary of the computations with the resulting F-ratios is shown in Table VIII.

TABLE VIII
SUMMARY TABLE OF TWO-WAY ANALYSIS OF VARIANCE FOR
EXPERIMENTAL AND CONTROL GROUPS AND UPPER
AND LOWER MATHEMATICAL ABILITY

Source	SS	df	MS	F
Exp. vs cont. (A)	182.1607	1	182.1607	7.13*
High vs low ability (B)	42.8750	1	42.8750	1.68
Interaction (A x B)	24.4465	1	24.4465	.96
Error (within cells)	<u>1328.3571</u>	<u>52</u>	25.5453	
Totals	1577.8393	55		

* $p < .025$

A separate two-way analysis of variance was computed on the basis of prior and no prior business machines course in high school.

¹William F. Hays, Statistics For Psychologists, Holt, Rinehart, and Winston, Inc., New York, 1963, pp. 387-408.

There were twelve control and thirteen experimental subjects with a prior high school course in business machines. Eighteen control subjects and sixteen experimental subjects had no high school machines course. It was therefore necessary again to randomly discard two scores from the control group and one from the experimental group to provide proportional sub-groups for the test. The design of this analysis of variance was similar to the first. Computations were adjusted to the different sizes of sub-groups. The data and design are included in Appendix G. The results of the analysis are summarized in Table IX.

TABLE IX
SUMMARY TABLE OF TWO-WAY ANALYSIS OF VARIANCE FOR
EXPERIMENTAL AND CONTROL GROUPS WITH OR
WITHOUT A PRIOR HIGH SCHOOL COURSE

Source	SS	df	MS	F
With vs without prior course (A)	8.3705	1	8.3705	.31
Exp. vs cont. group (B)	179.3571	1	179.3571	6.57*
Interaction (A x B)	14.7992	1	14.7992	.54
Error (within cells)	<u>1419.6875</u>	<u>52</u>	27.3	
Totals	1648.2143	55		

* $p < .025$

Differences between experimental and control groups. The summary information presented in Tables VIII and IX indicates that computations based on differences between the experimental and control

groups resulted in F-ratios of 7.13 and 6.57 respectively. An F-ratio in excess of 5.32 with one and fifty-five degrees of freedom is sufficient to indicate a difference between groups at the .025 level of significance. It was indicated, therefore, that differences did exist between the groups on the final performance test.

The mean score for the total control group (30 students) was determined to be 76.67. The total experimental group mean score (29 students) was found to be 3.5 points higher at 80.17. The difference indicated by the analysis of variance, then, was in favor of the experimental group.

Differences between high and low ability groups. It was hypothesized that the mathematical ability of learners would affect their performance on business machines, since performance tests involve mathematical computations. The mathematical portion of the A.C.T. battery was used by Lansing Community College as a placement test and was considered a valid indicator of ability. The percentile scores were used to separate the experimental and control groups into equal sub-groups of upper and lower ability. In both groups, students at the 28th percentile and higher fell into the upper-ability sub-group, and those students below that percentile were classified as lower ability.

The scores of individual students were arranged according to sub-group placement to perform the analysis of variance. (Appendix G.) The results of this test are summarized in Table VIII, page 60. The F-ratio obtained was 1.68, which is much less than that necessary

to assert that differences may exist between the groups. In addition, there was no significant difference indicated by an interaction of mathematical ability and control or experimental conditions, as shown in Table VIII, page 60. It must be presumed, therefore, that mathematical ability as measured by the A.C.T. score had little effect upon the learning of business machines by the methods employed in this study.

Differences between prior and no prior course groups. It seemed logical to believe at the outset that students with prior training on business machines would have an advantage over students without such training in a one-term college course, regardless of the method of instruction used. The research hypothesis stated that the performance of high school trained groups would be superior to the non-trained on the final examination.

The evidence presented in Table IX, page 61, does not support that hypothesis. When the subjects were divided into groups on the basis of prior and no prior business machine courses, the F-ratio obtained was less than unity. Furthermore, an interaction of the prior, no prior training groups with experimental and control conditions resulted in an equally insignificant value for F. These results indicate that those students with a high school business machines course had no superiority over the students without such a course when taking the final performance test.

III. STUDENT ATTITUDES TOWARD THE A.V.T. METHOD

The best educational device or system in the world would have little value without acceptance by those who might benefit from it. Consequently, student opinions regarding the audio-visual-tutorial method for learning a basic office skill was considered an item of major importance for this study.

The student opinionnaire. A questionnaire was designed which would provide information to estimate student attitudes about the audio-visual-tutorial method and also to help locate any procedural or functional problems that might be corrected. Subjects in the experimental group were asked to complete the questionnaire immediately after taking the final examination. The complete instrument is reproduced in Appendix F.

The questionnaire contained twelve questions, with the first two providing information about the student, such as age, sex, number of college credits earned previously, and the number of credits carried during the term of the experiment. This data was the same information described in the earlier questionnaire, and there was no need for further analysis.

Questions three through ten required ranked answers according to the opinion and belief of each subject, with some of the questions allowing multiple answers. Question number eleven asked the students whether or not they would prefer a subsequent course by this method, and the final question asked for suggestions on improving the system.

A summary of the responses to questions three through eleven is provided in Table X.

Student Opinions

Regarding amount learned. An analysis of Table X indicated that on question three, nineteen students believed that the films provided an equal or better learning situation than a regular class, while seven felt that they learned less. Three students indicated they were not sure whether there was a difference in learning.

TABLE X
SUMMARY OF STUDENTS OPINIONS REGARDING A.V.T.

Questions	Answers Available	Number of Responses
III. Do you think you learned as much in the AVT section as you would have in a regular section?	1. Much more in AVT 2. A little more in AVT 3. About the same 4. A little more in regular class 5. Much more in regular class 6. Not sure	1 5 13 6 1 3
IV. In addition to the AVT unit instruction, approximately how many times did you have need for specific help with practice problems?	1. More than 10 times 2. About 6 through 10 times 3. About 3 to 5 times 4. About 1 to 3 times 5. Not at all	2 3 8 12 4
V. When specific help was needed, whom did you ask for it? (Check more than one if applicable.)	1. The instructor 2. The lab technician 3. Classmates 4. No help needed 5. Other	2 20 14 3

TABLE X (Continued)

Questions	Answers Available	Number of Responses
VI. Do you feel you were as well prepared to advance to the next AVT unit (practice of skills, review of material) as you would have been in the regular class section?	1. Much better prepared with AVT units	2
	2. A little better prepared with AVT units	8
	3. About the same	11
	4. A little better prepared in the regular class	3
	5. Much better prepared in the regular class	3
	6. Not sure	2
VII. Do you think you will be able to apply what you learned from this course as much as you would have if you had been in the regular section?	1. Much more from the AVT section	2
	2. A little more from the AVT section	6
	3. About the same	14
	4. A little more from the regular section	5
	5. Much more from the regular section	
	6. Not sure	2
VIII. Do you think you spent as much time learning each machine by the AVT method as you would have in the regular class?	1. Much less time spent with AVT method	6
	2. A little less time spent with AVT method	8
	3. About the same	5
	4. A little more time than the regular class	4
	5. Much more time than the regular class	4
	6. Not sure	2
IX. Now that you have directly participated in the AVT section, how do you feel about this as a method of instruction?	1. I enjoyed it very much	11
	2. I enjoyed it somewhat	14
	3. I have no particular feelings about it	1
	4. I disliked it somewhat	3
	5. I disliked it very much	1

TABLE X (Continued)

Questions	Answers Available	Number of Responses
X. To what do you attribute your feelings as indicated in Question IX? (Check more than one if applicable.)	1. Adequate teacher contact	1
	2. Inadequate teacher contact	2
	3. Freedom to schedule own time	21
	4. Inability to "get at it" when I should	6
	5. Opportunity to complete lessons as fast as I wanted	14
	6. The carrel was not available	2
	7. The practice machines were not available when I needed them	1
	8. Other	4
XI. If you were to enroll in Business Machines II and it was available by either the AVT method or the regular class method, which would be your preference?	1. The regular class	11
	2. The AVT section	18

Regarding additional help. All but four students required additional help beyond the instruction provided by the filmed demonstrations. Only five students required assistance more than five times, however, during the course of learning twenty-two operations on three different types of business machines.

The student laboratory technician was asked for assistance by twenty of the twenty-nine students in the experimental group, while only two indicated they sought and found the instructor. This could possibly be explained by the fact that the instructor was teaching the control groups at the regular scheduled times, which were the

hours that the experimental subjects continued to plan for their own instruction. The instructor also had other class commitments which prevented her from being available much of the time when students may have had questions. On the other hand, the technicians were always available whenever the laboratory was open. Each student became quite well acquainted with the technician through the process of checking out the filmed units and turning in his completed work. Also, since paper-checking was done in the presence of the technician, he was the quickest source of information when an error was discovered, which created most questions. Fortunately, foresight was used in requiring the technicians to have previously completed the traditional business machines course successfully, even though the intent was not to have them act as tutors.

Regarding applicability. Twenty-one experimental subjects felt that the units were programmed in such a way that they were equally or better prepared to advance to the next unit than they would have been in a regular class situation. Of this group, ten considered themselves better prepared and two thought that the preparation was much better. Two students were not sure about a difference in preparation.

When asked their opinions about their ability to apply what they had learned, eight students felt that they were better trained to apply their knowledge than if they had been in a regular class, with two indicating much more ability. Five students thought that the traditional class would have provided them with a little more ability, while fourteen, or about half, indicated that it would have been about

the same from either method. Again, two students indicated that they were unsure.

Regarding time required. On the question of time spent in acquiring the skill, fourteen students were of the opinion that they spent less time than they would have in a regular class, and six thought it was much less. Eight students felt they spent more time, however, with four indicating much more.

Once again two students were "not sure" of the answer to this question, which might appear that two subjects had very little opinion about the entire experiment. This might have been true for one student who checked the "not sure" item whenever it was available. For the remainder of the group, however, that item was only checked as much as twice by one student. It was interesting to note that on the next question, the "unsure" individual was one of those who "enjoyed it somewhat," and not the student who had "no particular feelings about it."

Regarding feelings toward the method. Twenty-five of the twenty-nine students indicated that they enjoyed the A.V.T. method of instruction, with eleven asserting that they "enjoyed it very much." The discrepancy in count (30 check marks for 29 students) came about because one student indicated that she "enjoyed it very much," but at the same time, "disliked it somewhat."

Question ten attempted to determine some of the reasons for student like or dislike of the audio-visual-tutorial method.

Twenty-one students indicated that "freedom to schedule own time" was a major factor in their feelings toward the system, and an "opportunity to complete lessons as fast as I wanted" was the second most important item with fourteen check marks. Procrastination was a problem that was admitted by six students. Of the "other" answers, two indicated a problem in understanding the instructions, particularly on the key-driven calculator with division, and one indicated learning "by my own technique" as a reason for favoring the system.

The student who had mixed emotions on the previous question, indicated that she favored the system because of a "freedom to schedule own time," and an "opportunity to complete lessons as fast as I wanted." To explain her dislike of the system she checked No. 8, "other" and specified that "the instructions seem very repetitious." She followed this up with a recommendation in question twelve that it "should not be compulsory to watch all the films, if a student has had previous knowledge in using the machine." This idea, which could be accomplished with a pretest, was part of the original plan for the audio-visual-tutorial system. However, for this initial pilot study, it was deemed inappropriate.

Regarding a future choice of methods. When asked whether they would choose the A.V.T. method or a regular class if a choice were available in a subsequent class, eighteen indicated they would prefer the AVT section and eleven, the regular class. The reasons given for these choices were as follows:

Regular class choice:

1. Explanation of problems other than multiplication, addition, subtraction, and division not explained in AVT, especially in rotary calculator film--interest, percentage of increase, and others.
2. The grades are based on a series of tests, where in the AVT there is only one grade and that is the final. (An erroneous assumption on the part of this student.)
3. I would get it done on time and I would know more about the machines and how to work them. You left out so many things.
4. To see how it differs from AVT--to see if it's more organized.
5. Much more contact and adequate time--more class time.
6. I would spend more time on machines.
7. Mainly, I would be able to have a specific time to work on it.
8. I would be sure of working on my problems at least 3 hours in the week. It is easier when you are working because the room is not always open to AVT students when they can use it.
9. I feel I received a course inferior to the regular class. There are many things that I should be able to do on the machines that I cannot do.

Two students did not give a reason for their choice of the regular class.

The A.V.T. choice:

1. Same as in question X. (Student checked "3" and "5.")
2. Because I can come when I want.
3. Because you can schedule your own time and the teacher isn't hanging over your shoulder. No rushing to get assignments in.
4. I believe I would be able to learn the machines much better if I was in the A.V.T. section.
5. I can work at my own speed and at my own convenience with A.V.T.
6. Because of job conflict--I'd have to be in A.V.T. I liked it much better anyway, as indicated before.
7. I have had the same machines in high school. So much of the regular class is repeat. You can go at your own rate in A.V.T. You can get through faster and attend whenever you want.
8. I liked the A.V.T. lab because I could come and go as I wished. The films were easy to understand. The only trouble I had was trying to find time to come in.
9. I have a heavy schedule and I prefer to schedule my working periods. I found that classmates in regular classes also must work outside their class period to complete their work, and I feel if it is going to be that way, I would prefer an A.V.T. set-up.
10. I like to schedule my own time according to what I feel is more important at that time. I feel I am learning

on my own without an instructor (to a degree), plus the teacher is available when necessary.

11. Because I think I learned much more by A.V.T. than I would have in the regular class. I didn't need to worry about making it to class and I could work at my own speed.
12. I like this section because I can work at my own rate and also schedule my own time to work.
13. Definitely!

Five students did not give a reason for their choice.

Regarding improvement. The final question simply asked for suggestions for improvement of this course on A.V.T. media. Many students did not respond to this question, but it was gratifying that no one suggested that the idea should be dropped. Even those students who disliked the system indicated that, with specific improvements, they might change their opinion.

Comments and suggestions in response to this question were:

1. So many of the films are repeat, but on the whole, it's a pretty good idea.
2. More machines and room availability.
3. Better tapes. (Probably means "better explanations.")
4. Rework your films. Learning the rotary calculator, I found that the film often did not correspond to the assignment. In both the rotary calculator and the key-driven calculator, I believe that too much was taken

for granted. That is, the instructor did not explain things completely. The best example is Film No. 7, Division on the key-driven calculator--"Matching the stroke."

5. The hours of the A.V.T. lab and the machines room should be posted outside the door.
6. I think the explanation of decimal placement on the Friden rotary calculator is a little vague.
7. A few more machines.
8. I enjoyed A.V.T. very much. I liked working on my own and I feel I learned as much if not more than if I had been in class. I do have one objection, however. The film on the Burroughs division was completely unclear to me and I gained nothing from it. I did have the lab technician explain it to me so it worked out, but I do feel that particular film could be improved.
9. Need more teacher contact in A.V.T. because most of the time I didn't know what was required. If I had seen the teacher more often, I could have gotten a little more understanding as to what was required.
10. I don't think it should be compulsory to watch all the films if the student has had previous knowledge in using the machine.
11. Not so much homework. Each lesson had 4 parts and each part approximately 10-25 (or more) problems. Not each part should have to be done.

12. Lab instructor should be there more often.
13. Have a machine available in the A.V.T. lab area.
14. Producing a better film on the Burroughs division process--one that describes and explains the procedure with more detail. Otherwise, the films are great and beneficial.
15. I found it very enjoyable.
16. Better films and the lab technician should know about the machines and how to answer our questions. On the Burroughs division film, you went so fast I didn't know how to do it. In lots of ways I liked the A.V.T., but there are more reasons why I don't.
17. A listing published of the exact hours the business machines room will be open.
18. Have a series of quizzes over each machine and have them count toward the final mark. The films were, for the most part, well done, but the division on the key-driven calculator was confusing. The film put forth the material too fast.

IV. SUMMARY OF DATA

Data presented in this chapter attempted to accomplish three purposes: (1) to determine the degree of equality between the experimental and control groups at the beginning of the experiment; (2) to determine any differences in learning as a result of the experimental

treatment and other factors; and (3) to estimate student attitudes toward the experimental method.

The experimental and control groups were equated on the basis of English and mathematical ability as measured by the American College Test, and on the basis of age, work experience, prior exposure to business machines and prior college training. The analysis in each area indicated that the groups were very much alike.

A t-test computed on the English and mathematics percentile scores indicated a high degree of equality between the groups' abilities in these areas. The ages of individual members of the groups fell predominately within the same ranges, and there was very little difference between groups in the amount and type of work experience. Twelve control subjects and thirteen experimental subjects had prior machines courses in high school, and both groups averaged slightly more than eighteen college credits earned with the majority being earned at Lansing Community College. Nothing within the data examined produced evidence of disparity between the groups, and since none of the students involved in the experiment had any noticeable physical handicap, it was determined that neither group had an advantage over the other in learning the operations of business machines included in this study.

The final test for the course was identical for both groups and administered under similar conditions with the same time restrictions. Two separate two-way analysis of variance tests were computed with the final test scores. In addition to testing for differences between the groups as wholes, the first analysis attempted to determine any

differences between sub-groups based on mathematical ability, and the second analysis included sub-groups divided on the basis of whether or not subjects had received high school training in business machines.

Both analyses indicated a difference between the total experimental and control groups that was significant at the .025 level. This difference was in favor of the experimental conditions. There was a slight difference in final performance between groups divided on the basis of mathematical ability, but it was determined to be insignificant. The interaction factor indicated that neither the experimental nor control conditions had a more favorable effect than the other on mathematical ability sub-groups.

There was no difference indicated between groups divided on the basis of former training on business machines in high school. Comparing sub-groups of control or experimental treatment also provided no difference that could be attributed to prior training on business machines in high school.

The statistical analyses used with the factors considered in this study suggest that the only variable responsible for a difference in final performance was the experimental method of instruction.

Students in the experimental group were asked to react to this type of instruction anonymously after completing the course. Their opinions were collected by means of a questionnaire. A summarization of the answers on the questionnaire indicated a generally favorable attitude toward the A.V.T. method of instruction. The majority felt that they were equally or better prepared than their regular class counterparts, and in less time. Twenty-five of the twenty-nine

students participating stated they enjoyed the experience, particularly because of the scheduling freedom it provided and the opportunity it afforded to progress at one's own speed. They also would prefer a subsequent course by this method by almost a 2 to 1 ratio over a traditional class.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

Purpose of the study. The purpose of this study was to determine whether the particular skill of business machines operation could be taught effectively by a series of eight millimeter sound films in cartridges, used individually by students in an open laboratory situation.

Statement of the problem. The primary problem of this study was to determine the difference, if any, in student performance in the operation of business machines, between two groups of learners with one group (control) receiving traditional classroom instruction, and the other (experimental) receiving individualized instruction in carrels from eight millimeter sound films in continuous-loop cartridges, viewed on rear-screen projectors.

Subordinate problems were: (1) to determine whether a prior high school course in business machines has a significant effect on final performance at the end of one college quarter; (2) whether the experimental treatment has greater success with either the upper or lower ability student, measured by the mathematical portion of the A.C.T. battery, than the traditional class; and (3) to estimate student attitudes toward learning by the experimental method.

Need for the study. Much has been written during the past decade about the need for more consideration for individual abilities and learning rates in education at all levels. Attempts have been made toward that goal by using teaching machines, programmed instruction texts, audio-tapes, and computer assisted instruction. However, much more research is necessary in order to develop educational systems and procedures which will meet individual needs on a mass basis.

Importance of the study. This study was important because it involved two factors on which little or no prior research has been done. First, there was no prior research found which used cartridged eight millimeter sound films to teach an entire course. Secondly, there was no research located in which an entire business education course was taught completely devoid of the traditional classroom environment.

Experimental hypotheses. The specific research hypotheses that this study attempted to accept or reject were:

1. The use of an audio-visual-tutorial approach to provide instruction for the experimental group will result in significantly better performance (as defined statistically) by that group in machine operation, than the group taught by the traditional method.
2. Those students in either the experimental or control groups who have had a prior office machines course in high school will score significantly higher on the final performance tests than students without such exposure.
3. Those students in either the experimental or control group who are above the group median in mathematics ability will score significantly higher than those students below the median.

4. Student attitudes toward the audio-visual-tutorial method of learning office machines operation will be generally favorable, and they will prefer this type of instruction to the traditional classroom.

Procedures. Professional photographers were engaged to film the demonstrations on three types of business machines--a 10-key adding machine, a rotary calculator, and a key-driven calculator--on sixteen millimeter color film. This film was edited and spliced into 22 separate films, each providing an instructional unit on one of the machines. These films were then reproduced on eight millimeter film with a magnetic stripe attached to one edge for sound. The filmed units were then loaded into continuous-loop cartridges and prepared narrations were synchronized and recorded on the magnetic stripe. Duplicated handout sheets explaining each unit and indicating the assigned problems to be worked, completed the experimental materials.

Two groups of college students who had enrolled in a beginning business machines course were randomly divided into a control and experimental group. The control group received the traditional classroom instruction. The experimental group never attended a class but received instruction individually in carrels at their own discretion. The instruction came from the series of cartridge, continuous-loop eight millimeter sound films viewed individually on a rear-screen projector.

The groups were equated on the basis of their A.C.T. scores in English and mathematics as well as certain background information. At the end of the quarter, each group was given an identical performance test. The scores obtained by students on this test were used for

statistical analysis. Two separate two-way analysis of variance tests were computed to determine any differences between the experimental and control groups; groups divided by mathematical ability, and groups separated on the basis of a prior high school business machines course. Student attitudes toward the experimental method were estimated by answers received anonymously on an opinionnaire.

Findings. There was a significant difference at the .025 level between the experimental group and the control group in favor of the experimental treatment. No difference was found between groups subdivided by mathematical ability or by whether a high school course in business machines had been completed. The experimental treatment had neither a greater nor lesser effect on these sub-groups than on the experimental group as a whole.

The great majority of experimental-group students had a favorable attitude toward the experimental process, enjoying the freedom provided by the individual approach.

II. CONCLUSIONS

1. The skill of office machines operation was more effectively learned by replacing the traditional classroom demonstrations and activities with a series of demonstration films which were used individually at the learner's own pace. This new system allowed the student to shift his time and efforts from those machines and processes that he found familiar or easily mastered to those on which he encountered more difficulty.

2. A prior high school course in business machines provided no particular advantage for students in this study when measured by performance at the end of one college term. It could be that the early elementary instructions on each machine created a feeling of self-satisfaction in those students with prior knowledge, which reduced their effort and concentration on later, more advanced operations.

3. Mathematical ability, as measured by the American College Test, a standardized college placement battery, provided no indication of success in a college business machines course. Although performing mathematical computations is an integral part of a business machines course, such performance was evidently not predicted by the A.C.T. scores in mathematics as used in this study.

4. Students generally enjoyed the A.V.T. method of study and a majority would prefer this system to the traditional classroom if a choice were available. Scheduling flexibility and allowance for individual progression rates might be its primary advantages.

III. RECOMMENDATIONS

Four suggestions for further study in the area of audio-visual-tutorial instruction were offered:

1. A replication or replications of this study should be completed in other skill subjects to support or refute its findings.

2. A study replacing lecture-type instruction with programmed audio-visual units is needed to determine their feasibility in non-skill courses.

3. A study should be conducted to compare the audio-visual-tutorial approach to a recognized programmed text on the effectiveness of each for independent study.

4. A study or studies should be completed to determine whether extra time would enable those students who could not meet minimum standards within the normal course period, to meet such standards, and, if so, how much extra time would normally be required.

Five general recommendations for more effective utilization of an audio-visual-tutorial laboratory were made in recognition of student suggestions and shortcomings in planning and conditions for this study.

1. Practice machines should be made available in the same general area as the carrels for student convenience and better supervision.

2. Teachers or teaching technicians should be available in the learning area at all times to answer individual questions as they arise.

3. A functional system to record student attendance, or lack of attendance, should be designed to encourage steady progress without enforcing rigidity.

4. Enrollment procedures should be altered to allow prospective students to begin a course or part of a course at any time, in order to take advantage of the complete flexibility of an audio-visual-tutorial system.

5. Adequate objective-type pretests should be developed to permit the construction of a separate course for each individual student from all available units based on the elimination of redundancy.

IV. IMPLICATIONS

The following paragraphs are offered as implications this study may have for future education. These statements are not necessarily supported by the results of this research, but the study would be incomplete without their inclusion. Many of the implications are present-day facts at Lansing Community College, where this original pilot study has led to continued research in audio-visual-tutorial techniques.

1. The audio-visual-tutorial system provides an instructional method that could possibly be completely individualized on a mass basis. The use of appropriate pretests could easily identify which of the single-concept units within a course must be included in the program of any individual, as well as those units that could be excluded because of prior learning. Practice assignments could also vary according to an individual student's ability to master a subject or technique.

2. Students in traditional classes must absorb whatever amount of education, or acquire whatever degree of skill, that they can within a pre-determined and arbitrarily established period of time. With the audio-visual-tutorial system, the establishment of beginning and ending dates for large groups of students creates no particular advantage. It

would, in fact, be more advantageous to distribute starting times for individual students over a period of time. It would be feasible and appropriate to have a continuous enrollment.

3. With the need for ending dates eliminated, students could be allowed sufficient time to meet minimum standards. Course completion could be more appropriately based on the demonstration of minimum skills or knowledge rather than on the less realistic factor of time. Minimum standards might be determined by job-entry skills, or a degree of skill, ability, and knowledge necessary to advance to a higher level of training. Furthermore, if any one of those advancement criteria was deficient, a student could concentrate his efforts toward improving himself in that one area without needless repetition of the others.

4. Quality demonstrations of proper techniques and procedures present a very real problem in most business education classrooms. First of all, the teacher is not necessarily an expert in all the techniques and procedures she must demonstrate. Secondly, in a typical classroom, only a small percentage of the total class can clearly see the demonstration. The use of filmed units could provide experts to demonstrate a variety of techniques and procedures for any number of skills. The filmed units would also provide each student an over-the-shoulder view, or one from any direction that is determined most advantageous.

5. Many more students can be accommodated with an open laboratory learning system than the same facilities and equipment

could adequately handle with the traditional classroom method. Traditional systems require a fully equipped work station for each student in a class, since all must meet at the same time. For example, a traditional college typewriting classroom of thirty stations will accommodate approximately 150 students in a quarter or semester, with a reasonable number of extra-class practice periods available. The open laboratory system used with the audio-visual-tutorial method might provide education to more than 300 students per quarter or semester, with the same number of work stations.

6. The role of the teacher would not be eliminated or diminished by an audio-visual-tutorial system. On the contrary, it would be expanded and elevated. Supervising, motivating, vocational counselling, and community service are some of the expansion possibilities. Implications for teacher training institutions are that a greater variety of work experiences will be desirable as well as additional knowledge of counselling techniques. It will also be as necessary for business teachers to return to the business world periodically as it will be for businessmen and women to return to school.

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APPENDIX A

CONTENT AND TIME OF FILM LOOPS

CONTENT AND TIME FOR CARTRIDGED EIGHT MILLIMETER
CONTINUOUS-LOOP SOUND FILM UNITS

Cartridge No.	Topic	Time	
		Min.	Sec.
BURROUGHS KEY-DRIVEN CALCULATOR			
1.	Touch addition	6	17
2.	Touch addition (cont.)	4	20
3.	Multiplication I	4	00
4.	Multiplication II	7	04
5.	Multiplication using decimals	9	00
6.	Subtraction of whole numbers	7	25
7.	Division	6	20
8.	Division with decimals	10	30
FRIDEN FULLY-AUTOMATIC ROTARY CALCULATOR			
1.	Addition	7	00
2.	Subtraction	4	56
3.	Addition and subtraction	7	17
4.	Multiplication of whole numbers and decimals	6	11
5.	Semi-automatic-multiplication of whole numbers and decimals	4	47
6.	Division of whole numbers	8	55
7.	Division of numbers with decimals	7	33

Cartridge No.	Topic	Time	
		Min.	Sec.
MONROE 10-KEY ADDING MACHINE			
1.	Touch addition	6	58
2.	Touch addition-home row, 4, 5, 6	5	20
3.	Touch addition-1, 2, 3, 0, plus combination figures	5	50
4.	Subtraction	3	25
5.	Multiplication of decimals	6	28
6.	Short-cut multiplication	7	53
7.	Multiplication of fractions	5	32

APPENDIX B

COURSE SYLLABUS AND SCHEDULE SHEET

**BUSINESS MACHINES I,
NON-SCHEDULED AUDIO-VISUAL-TUTORIAL CLASS**

The pre-requisite for this course is Business Mathematics (Bus. 117) or a working knowledge of the use of fractions, decimals, and percentages.

GENERAL NATURE OF THE COURSE

The course is designed in such a way that the student will learn the basic operations of the adding and calculating machines. It includes instruction in the use of the 10-key adding machine, the rotary calculator, and the key-driven calculator. The following operations are taught on machines listed: (See assignment sheet for specific lessons.)

<u>10-Key Adding Machine</u>	<u>Rotary Calculator</u>	<u>Key-Driven Calculator</u>
1. Addition	1. Addition	1. Addition
2. Subtraction	2. Subtraction	2. Subtraction
3. Multiplication	3. Multiplication	3. Multiplication
Regular Method	Whole Numbers	Decimals
Short-cut Method	Decimals	Whole Numbers
	Fractions	4. Division
	Percentages	Decimals
	4. Division	Whole Numbers
	Whole Numbers	
	Decimals	
	Fractions	
	Percentages	

METHOD OF INSTRUCTION

Instruction in this course is designed to meet the needs of all students. It allows for flexible scheduling on the part of the student, because there is no regularly scheduled class. The course of study can be completed as soon as the necessary skill is mastered by the student, and testing is handled on an individual basis.

The AVT method (Audio-Visual-Tutorial) which is used, means that the various operations on machines are demonstrated on short, carefully prepared films and viewed on individual projectors located in carrels in the machines room. The films can be viewed as many times as necessary. Hand-out sheets, given with each film viewed, review the instruction given, and also act as reminders for proper machine operation.

ASSISTANCE IN INSTRUCTION

The Lab Technician, in addition to the instructor, can give additional individual instruction when necessary. The Lab Technician is available during the periods designated as laboratory periods, when class periods are not in session, from 8 a.m. to 5 p.m. weekdays.

ASSIGNMENTS

All assignments completed can be checked by the student immediately with the help of the Lab Technician. This allows for remedial work at the time that the work has been done. All assignments completed are filed in the student's folder in order to provide review materials for tests.

TESTING METHODS

The student may take a unit test on each machine as soon as he has completed all assignments and indicated sufficient mastery of the operations. Three unit tests will be given. Guideline dates for unit tests will be suggested in order that the student will allow himself enough time to complete all of the work during the term. The Lab Technician and/or the instructor may be contacted for tests.

The final examination may be taken whenever the student has completed all of the assignments and indicates mastery of all machines designated.

GRADING POLICY

Unit tests are used only to indicate whether or not a student has mastered the various operations on a specific business machine. Final examinations covering the course will be given to the student as soon as he is ready. The grade in the course will be determined by the results of the final examination.

MATERIALS NEEDED

Texts: Business Machine Calculation, Volume I, By A. Giordano
(for adding machines and printing calculators)

Business Machine Calculation, Volume II, By A. Giordano
(for rotary calculators)

A special text for the Burroughs Key-Driven Calculator will be provided for you in the classroom.

Student Name _____

Student Number _____

BUSINESS MACHINES I. AUDIO-VISUAL-TUTORIAL CLASS

Key-driven Calculator				Rotary Calculator				10-key Adding Machine			
Lesson	Time	Date	Tech.	Lesson	Time	Date	Tech.	Lesson	Time	Date	Tech.
1.	_____	_____	_____	1.	_____	_____	_____	1.	_____	_____	_____
2.	_____	_____	_____	2.	_____	_____	_____	2.	_____	_____	_____
3.	_____	_____	_____	3.	_____	_____	_____	3.	_____	_____	_____
4.	_____	_____	_____	4.	_____	_____	_____	4.	_____	_____	_____
5.	_____	_____	_____	5.	_____	_____	_____	5.	_____	_____	_____
6.	_____	_____	_____	6.	_____	_____	_____	6.	_____	_____	_____
7.	_____	_____	_____	7.	_____	_____	_____	7.	_____	_____	_____
8.	_____	_____	_____								

APPENDIX C

HANDOUT SHEETS

OPERATION OF THE TEN-KEY ADDING MACHINE--Monroe

TOUCH METHOD--INTRODUCTION

1. The first finger, or forefinger, is used for the 1, 4, and 7 keys.
2. The middle finger is used for the 2, 5, and 8 keys.
3. The third finger, or ring finger, is used for the 3, 6, and 9 keys.
4. The little finger is used for the plus bar, subtraction key, subtotal and total keys.
5. The thumb is used on the zero bar.
6. Home row is 4, 5, and 6 with a small raised dot on the five indicating this position. Reaches are made up or down from home row to the numbers indicated above.
7. Posture and position at the machine are important in the development of an occupational skill on the ten-key adding machine. The machine should be placed slightly to your right of your body and your arm reach should be at a comfortable length from the machine.
8. All problems should be completed twice in order to check the accuracy of the work.
9. Study pages 10, 11, and 12 in Business Machine Calculation, Volume I by Al Giordano for additional information on the parts of the machine, and operation of the 10-key adding machine. (Illustration on the top of page 8 illustrates the Monroe 10-key adding machine.)
10. Check lessons on assignment sheet for the ten-key adding machine.

FILM #1, OPERATION OF THE MONROE TEN-KEY ADDING MACHINETOUCH ADDITION

(Number 4, 5, and 6--HOME ROW)

Problem 1

\$ 5.46
 4.44
 4.54
 5.55
 4.65
 5.64
6.66

Total \$ 36.94

Problem 2

\$ 6.45
 4.46
 5.44
 6.54
 5.45
 4.64
4.56

Total \$ 37.54

POINTS TO REMEMBER:

1. Home row numerals 4, 5, and 6 are depressed as follows: first finger on 4, second finger on 5, and third finger on 6.
2. By depressing the plus bar with the small fingers, the figures are printed on the adding machine tape.
3. The key labelled "T" is the total key and is depressed by the small finger in order to find the total upon completing the problem.
4. The clear lever is pushed up to remove incorrectly entered amounts in the keyboard.
5. The small window indicator, at the front of the machine, shows the number of digits entered in the machine.
6. CLEAR THE MACHINE by depressing the total key before you begin each problem.
7. REPEAT problem for the correct answer.

ASSIGNMENT

Lesson 1-A, Study pages 1-12, Business Machine Calculation, Volume I, Al Giordano.

FILM #2, MONROE TEN-KEY ADDING MACHINE, TOUCH ADDITION,HOME ROW 4, 5, 6 PLUS 7, 8, 9 REACHESProblem 1

\$	7.89	
	8.97	
	9.78	
	<u>8.87</u>	S 35.51
	9.87	
	7.98	
	<u>8.88</u>	
\$	62.24	Total

Problem 2

\$	5.48	
	7.54	
	6.96	
	<u>9.65</u>	S 29.63
	8.69	
	9.85	
	<u>7.64</u>	
\$	55.81	Total

POINTS TO REMEMBER:

1. Use the touch method of operation with a reach up from home row for numbers 7, 8, and 9. The first finger reaches up for 7, the second finger for 8, and the third finger for 9.
2. A subtotal may be taken at any point in the problem. This only indicates that the amount that has been added to that point and does not clear the machine. Addition may be continued and a complete total taken. An "s" appears after the subtotal.
3. Clear the machine each time before beginning a new problem by depressing the total key. A small star-like symbol will appear indicating that the machine has been cleared.
4. REPEAT the problem for correct answers. Check adding machine tape when necessary.

ASSIGNMENT

Lesson 1-B, Business Machine Calculation, Volume I, by A. Giordano.

FILM #3, MONROE TEN-KEY ADDING MACHINE--TOUCH ADDITIONNUMBERS 1, 2, 3, 0, PLUS COMBINATION OF FIGURESProblem 1

(1, 2, 3, 0)

1.23
3.21
2.30
3.00
2.13
1.33
2.23

Total 15.43

Problem 2

(Combination)

5.79
8.31
2.56
4.17
5.48
3.07
6.55

Total 35.93

POINTS TO REMEMBER:

1. Use the touch method of operation with a reach down from home row for numbers 1, 2, 3, and 0. The first finger reaches down for one, the second finger down for two, the third finger down for three, and the thumb for zero.
2. The non-add key is depressed by the little finger. It may be used to indicate numbers of problems but does not add any amounts into calculations made by the machine.
3. Add quickly and accurately without taking your eyes from the copy. Work toward accuracy first, then for speed of operation.
4. REPEAT PROBLEM for the correct answer. Check your adding machine tape when necessary.

ASSIGNMENT

Three-page supplementary problems in Touch Addition. (See Technician.) Lesson 1-D, Lesson 2-A and 2-C, Lesson 3-A, Problems 11-20, Lesson 1-C. Business Machines Calculation, Volume I, by A. Giordano.

FILM #4, MONROE TEN-KEY ADDING MACHINE--SUBTRACTION

Problem 1

233	Minuend
- 129	Subtrahend
104	Difference

Problem 2

564	Minuend
- 321	Subtrahend
243	Difference

POINTS TO REMEMBER:

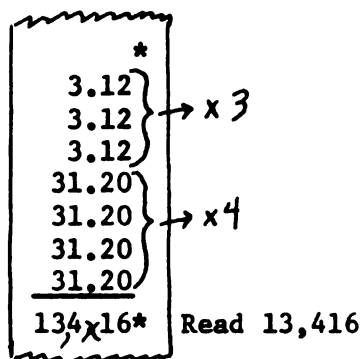
1. Use the touch method of operation for subtraction of numbers on the ten-key adding machine.
2. The Minuend (number to be subtracted from) is entered into the machine with the plus bar. The Subtrahend (or the number to be subtracted) is entered into the machine with the minus bar.
3. The Subtrahend is indicated on the adding machine tape as a minus figure and is printed in red.
4. The Difference is printed on the adding machine tape by depressing the total key after the subtrahend has been entered.
5. The problems illustrated above do not have decimal places. Record answers to problems without decimal points, if the problem is without them. The adding machine prints decimal points--two places--at all times. Record proper decimal places where necessary.
6. CLEAR THE MACHINE by depressing the total key each time before beginning a new problem. A small star-like symbol appears indicating that the machine has been cleared.
7. REPEAT each problem for the correct answer. Check adding machine tape when necessary.

ASSIGNMENT

Lesson 2-B and 2-D; Lesson 3-A, Problems 1-10; Lesson 3-B, 3-C, 3-D; Lesson 4-A. Business Machine Calculation, Volume I, by A. Giordano.

FILM #5, MONROE TEN-KEY ADDING MACHINE, MULTIPLICATION, Decimals

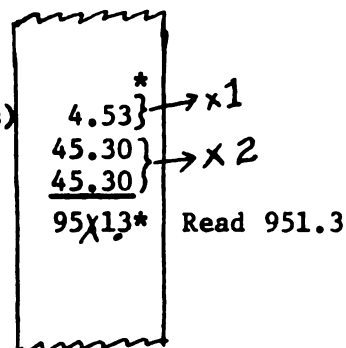
Problem 1
(As tape appears)



OR

312	Multiplicand
x 43	Multiplier
13,416	Product

Problem 2
(As tape appears)



OR

45.3	Multiplicand
x 21	Multiplier
951.3	Product

POINTS TO REMEMBER:

1. The largest number is used for the multiplicand and entered on the keyboard for multiplication. (For example, in Problem 1 the multiplicand is 312 and in Problem 2 the multiplicand is 453.)
2. Read the multiplier figure from right to left. Use the repeat key or (multiplication key) in conjunction with the add bar, depressing both simultaneously the number of times indicated by the multiplier figure. (For example, in Problem 1 the first multiplier figure used is 3; in Problem 2 it is 1.)
3. The repeat key (or multiplication key) is depressed simultaneously with the add bar a total of three times for the multiplication of 312 times 3 for the first problem. (In Problem 2 the number 453 is multiplied once as the first multiplier figure. See the drawing of the adding machine tape to illustrate.)
4. Note that a zero is added after the first multiplication to bring the multiplicand (312) into the next position for multiplication, making the new figure 3120, as in manual multiplication.
5. The second multiplier figure used in Problem 1 is 4. The repeat key (or multiplication key) and the add bar are depressed simultaneously a total of 4 times for the multiplication of 3120 times 4.
6. The clear lever is used to remove the multiplicand from the machine before a total can be taken for the answer or product.

FILM #5, page 2
MTK - Mult.

7. REPEAT EACH PROBLEM.

ASSIGNMENT

Lesson 4-B, 4-C, and 4-D; Lessons 5, 6, and 7-A and 7-B.
Business Machine Calculation, Volume I by Al Giordano.

FILM #6, MONROE TEN-KEY ADDING MACHINE, Short-Cut Multiplication

Problem 1
(As tape appears)

456 Multiplicand
x 28 Multiplier
12,768 Product

*

4.56-	- 2 times
4.56-	
45.60	
45.60	+ 3 times
45.60	
127.68*	

Problem 2
(As tape appears)

845 Multiplicand
x 8.8 Multiplier
7436.0 Product

*

8.45-	- 2 times
8.45-	
84.50-	- 1 time
845.00	+ 1 time
743.60*	

Problem 3
(As tape appears)

953 Multiplicand
x 1.87 Multiplier
1782.11 Product

*

9.53-	- 3 times
9.53-	
9.53-	- 1 time
95.30-	
953.00	+ 2 times
953.00	
1,782.11*	

POINTS TO REMEMBER:

1. If the multiplier figure ends in numbers 7, 8, or 9, use shortcut multiplication.
2. Depress the minus bar and the repeat key (multiplication key) simultaneously for repeat subtract.
3. Depress the plus bar and the repeat key (multiplication key) simultaneously for repeat add.
4. Clear multiplicand out of machine before finding total (answer or product.)
5. Point off decimal places properly, if problem needs a decimal.
6. REPEAT PROBLEM FOR CORRECT ANSWER.
7. Practice below with the following problems containing multipliers with the figures 7, 8, and 9:

327 x 28 (Repeat subtract 2 times; add a zero; repeat add 3 times.)

105 x 39 (Repeat subtract once; add a zero; repeat add 4 times.)

168 x 47 (Repeat subtract 3 times; add a zero; repeat add 5 times.)

867 x 99 (Repeat subtract once; add 2 zeros; repeat add once.)

786 x 188 (Repeat subtract 2 times; add a zero; repeat subtract once; add a zero; repeat add 2 times.)

FILM #6, page 2
MTK - Mult.

ASSIGNMENT

Lesson 7-B, and any other problems in multiplication with multipliers ending in numbers 7, 8, and 9.

Business Machine Calculation, Volume I, by A. Giordano.

FILM #7, MONROE TEN-KEY ADDING MACHINE, MULTIPLICATION--FractionsProblem 1

451 Multiplicand
 $\times 1 \frac{1}{4}$ Multiplier
 563.75 Product

(Convert $1 \frac{1}{4}$ to decimal equivalent
 or 1.25)

Problem 2

989 Multiplicand
 $\times 1 \frac{1}{3}$ Multiplier
 1,318.337 Product

(Convert $1 \frac{1}{3}$ to decimal
 equivalent or 1.333)

POINTS TO REMEMBER:

1. If a fraction appears in a multiplication problem, convert the fraction to a decimal equivalent. Use the supplementary tables wherever necessary.
2. The multiplication key and the add bar are depressed simultaneously the number of times indicated by the multiplier. The multiplier is read from right to left.
3. Add a zero each time a new digit is read in the multiplier. By adding a zero you are moving over your multiplication process, just as in manual multiplication.
4. Be sure to locate the decimal point properly. Relocate the decimal point appearing on the adding machine tape wherever necessary. (The number of places in the multiplicand plus the number of places in the multiplier equals the number of places in the product.)
5. REPEAT EACH PROBLEM TO CHECK ANSWER.

ASSIGNMENT

Lesson 7-C and 7-D; Lessons 8, 9, and 10.

Business Machine Calculation, Volume I, by A. Giordano.

FILM #1, OPERATION OF THE BURROUGHS KEY-DRIVEN CALCULATOR--ADDITION

(Touch Method)

Problem 1

33
34
24
23
<u>22</u>
136 Total

Problem 2

43
32
33
22
<u>34</u>
164 Total

POINTS TO REMEMBER:

1. The keyboard of the Burroughs key-driven calculator is divided by color for dollars and cents. The first two columns are for the ones and tens of cents, the next three columns are for the ones, tens and hundreds of dollars, etc.
2. Odd numbered keys are concave, and even numbered keys are flat. This enables the operator to locate keys by touch--thus, the touch method.
3. All keys have imprinted on them a large number and a small number. Large numbers are used for addition and multiplication, while small numbers are used for subtraction and division.
4. The correct position of the machine is slightly to the right of the operator and low enough on a desk to permit operation with a minimum of fatigue. A pencil should be held between the thumb and the palm of the hand. This enables the operator to record answers quickly, in addition to giving balance to the hand.
5. Addition is accomplished by depressing the large numbered keys. The answer is read in the lower dial. Touch addition (addition by touching keys without looking at the keyboard) permits speed of operation.
6. The fingers are held in a curved position over the keyboard, with the index finger of the right hand used to depress keys in the tens position and the second finger used for the keys in the ones position.
7. Clear the machine before beginning a problem by depressing the plus bar with the little finger. Quick, firm stroking of the keys (one at a time) is necessary for correct operation of the machine.

FILM #1, page 2
BKD - Add.

8. REPEAT EACH PROBLEM in order to check your answer. Record the correct answer on your answer sheet.

ASSIGNMENT

Review the film, plus the above points. Practice locating the keys on the keyboard plus proper stroking of the keys. Read the introduction in the textbook in the classroom, Learning the Burroughs Calculator. View Film #2, Operation of the Burroughs Key-Driven Calculator, Addition Touch Method before beginning your problems.

FILM #2, OPERATION OF THE BURROUGHS KEY-DRIVEN CALCULATOR, ADDITION

(Touch Method)

Problem 1

554
 344
 322
 355
 422
334
 2331 Total

Problem 2

\$ 89.56
 15.34
 14.68
10.89
 \$130.47 Total

POINTS TO REMEMBER:

1. The correct position of the machine is slightly to the right of the operator and low enough on the desk to permit operation with a minimum of fatigue. A pencil should be held between the thumb and the palm of the hand. This enables the operator to record answers quickly, in addition to giving balance to the hand.
2. The fingers are held in a curved position over the keyboard, with the index finger of the right hand used to depress keys in the tens position and to reach over to depress keys in the third column of figures. The second finger is used for the keys in the ones position.
3. The keys from 1 to 5 are used in touch addition. The following combinations of numbers are used for the remaining numbers.

To add 6, depress the 3 key twice.

To add 7, depress the 4 and 3 keys. (4 key first)

To add 8, depress the 4 key twice.

To add 9, depress the 5 and 4 keys. (5 key first)

4. Problems with 4 digits, as in Problem 2 above, should be broken down into two problems of two digits each without clearing the machine after the addition of figures in the first two columns. (Example follows:)

BREAKDOWN OF PROBLEM 2

(1st 2 Columns)

.56
 .34
 .68
 .89

(Columns 3 and 4)

89.
 15.
 14.
 10.

5. Locate a decimal point at two places in the lower dial when adding problems using dollars and cents. Otherwise, locate decimal points where necessary in adding digits. Zeros are not added; a column is skipped over for the zero.
6. Use quick, firm stroking of keys, one at a time. Clear the machine, by depressing the plus bar with the little finger, before beginning a new problem.
7. REPEAT EACH PROBLEM in order to check your answer. Record the correct answer on your answer sheet.

ASSIGNMENT

Lessons 1-6 Addition; Lessons 11, 12, 13 Addition
Textbook in classroom, Learning the Burroughs Calculator

FILM #3, BURROUGHS KEY-DRIVEN CALCULATOR--MULTIPLICATION IProblem 1Machine Method

28 Multiplicand
x 12 Multiplier
 336 Product

Manual Method

28 Multiplicand
x 12 Multiplier
 56 (28 x 2 in the 1st column)
 28 (28 x 1 in the 2nd column)
 336 Product

COMPARE THE TWO METHODS OF MULTIPLICATION. MOVEMENT TO THE NEXT COLUMNS ON THE MACHINE IS COMPARABLE TO THE MOVEMENT TO THE NEXT COLUMN IN MANUAL MULTIPLICATION.

Problem 2Machine Method

19 Multiplicand
x 21 Multiplier
 399 Product

Manual Method

19 Multiplicand
x 21 Multiplier
 19 (19 x 1 in the 1st column)
 38 (19 x 2 in the 2nd column)
 399 Product

POINTS TO REMEMBER:

1. Machine multiplication is repeated addition. Large figures on keys are used and all numbers to be multiplied are depressed at the same time.
2. The rules for placement of fingers on the keyboard in multiplication are as follows:
 - A. Place your fingers on the keys having the highest number of digits. (See Problems 1 and 2 with multiplicands of 28 and 19.)
 - B. Use the least number of key depressions. (See Problems 1 and 2 with multipliers of 12 and 21.)
3. Movement of the hands to the next columns of figures on the machine is comparable to movement in manual multiplication. (See Problems 1 and 2.)
4. Keys should be stroked evenly and firmly. Move both hands in unison across the keyboard. A smooth rhythmical operation is important in multiplication.

FILM #3, page 2
BKD - Mult.

5. Three strokes per second is an acceptable beginning speed of operation.
6. Three seconds for an average multiplication problem is the speed expected from an experienced operator.
7. REPEAT ALL PROBLEMS to check answers.

ASSIGNMENT

Review introductory materials for multiplication on the Burroughs key-driven calculator in textbook, Learning the Burroughs Calculator, pages 24 and 25.

Proceed to FILM #4, before beginning any problems.

FILM #4, OPERATION OF THE BURROUGHS KEY-DRIVEN CALCULATOR

MULTIPLICATION

Problem 1

535 Multiplicand
x 257 Multiplier
 137,495 Product

Problem 2

312 Multiplicand
x 256 Multiplier
 79,872 Product

(USE RULE FOR EASIEST HAND ARRANGEMENT.)

(USE RULE FOR LEAST NUMBER OF KEY DEPRESSIONS.)

POINTS TO REMEMBER:

1. When multiplying numbers of three digits or more, the fingers of both hands are used for firm and even stroking of the keys.
2. The rules for the placement of fingers on the keyboard in multiplication are as follows:
 - A. Hold numbers according to the easiest hand arrangement.
 (Longest finger on the highest figure.)
 - B. Use least number of key depressions.
 (Multiplier will have the smallest digits.)
3. Natural positions for the first two fingers of the right hand (on the first two columns on the keyboard) are as follows:

3 and 5; 3 and 6; 5 and 7; and 7 and 9.
4. Natural positions for the first two fingers of the left hand (columns three and four on the keyboard) are as follows:

53, 65, 75, 97, etc.
5. Problem 1 on Film #4 illustrates the rule for the EASIEST HAND ARRANGEMENT. The first two fingers of the right hand are held on 3 and 5; and the first finger of the left hand is held on 5.
6. Problem 2 on Film #4 illustrates the rule for the LEAST NUMBER OF KEY DEPRESSIONS. The first two fingers of the right hand are held on 5 and 6; and the first finger of the left hand is held on 2.
7. The multiplier is read from the right to left, just as movement of the hands across the keyboard.

FILM #4, page 2
BKD - Mult.

8. REPEAT EACH PROBLEM for correct answer.

ASSIGNMENT

Lessons 1 and 2, Learning the Burroughs Calculator.

FILM #5, BURROUGHS KEY-DRIVEN CALCULATOR, MULTIPLICATION USING DECIMALS

Problem 1 58.3 Multiplicand
 x 2.1 Multiplier
 122.43 Product

Locate
 2 decimal places on the dial.

Problem 2 2.88 Multiplicand
 x .701 Multiplier
 2.01888 Product

Locate
 5 decimal places on the dial.

Problem 3 FIRST METHOD
 2.74 Multiplicand
 x 63.7 Multiplier
 174.538 Product

Locate
 3 decimal places on the dial.

Problem 3 SECOND METHOD
 63.7 Multiplicand
 x 2.74 Multiplier
 174.538 Product

Locate
 3 decimal places on the dial.

Problem 4

 1.28 Multiplicand
 x 4.61 Multiplier
 5.9008 Product (5.901)

Locate
 4 decimal places on the dial.

POINTS TO REMEMBER:

1. Multiplication using decimals is accomplished in the same manner as multiplication of whole numbers. Stroke keys evenly and firmly moving both hands in unison across the keyboard.
2. Using the decimal pointers at the base of the machine, locate decimal places on the Burroughs key-driven calculator before beginning to multiply. Begin at the extreme right of the machine and move the decimal indicator one dial to the left for each place in both factors in the multiplication problem.
3. Various hand combinations may be used in order to allow for the EASIEST HAND POSITIONS AND/OR THE LEAST NUMBER OF KEY DEPRESSIONS. These are illustrated on Film #5 as follows:
 - A. Reverse combinations of fingers with the longest finger on the highest number. (Hands are turned inward with elbows raised slightly.)

FILM #5, page 2
BKD - Mult.

- B. Interposed combinations of fingers. (Left or right-hand finger combinations held between numbers of opposite hand.)
 - C. Cross-hand combinations of fingers. (Right-hand finger combinations in columns 3 and 4 and left-hand combinations in columns 1 and 2.)
 - D. Natural combinations. (3 and 5, 3 and 6, 5 and 7, and 5 and 9.)
- 4. Copy all answers to three decimal places. If the fourth decimal figure is 5 or more, add 1 to the third decimal figure of the answer.
 - 5. REPEAT PROBLEM to check answers.

ASSIGNMENT

Lesson 3, Learning the Burroughs Calculator.

FILM #6. BURROUGHS KEY-DRIVEN CALCULATOR--SUBTRACTION OF WHOLE NUMBERS

Problem 1 156 Minuend
 - 67 Subtrahend (66)
 89 Difference

Problem 2 5625 Minuend (503)
 - 504 Subtrahend
 5121 Difference

Problem 3 8652 Minuend
 - 999 Subtrahend (xx8)
 7653 Difference

Problem 4 684 Minuend
 - 90 Subtrahend (8x)
 594 Difference

(NOTE: In the above problems the subtrahend is always minus one. If a 9, appears as the last digit in the subtrahend, after one has been subtracted, this column is omitted. (See Problem #4.) If nines appear as digits in any other column, these are also omitted. (See Problem 3.)

POINTS TO REMEMBER:

1. The process of subtraction is finding the difference between two numbers. The MINUEND (The number to be subtracted from) is entered into the machine using the large figures. The SUBTRAHEND (the number to be subtracted) is entered into the machine with the small figures, minus one.
2. After entering the minuend and the subtrahend on the machine, subtraction is completed by depressing the subtraction control key immediately to the left of the amount being subtracted. (For example, if two digits are subtracted, the third subtraction control key is depressed. If three digits are subtracted, the fourth subtraction control key is depressed.)
3. If the number 9 appears in the subtrahend, skip over the column in which this number appears. However, this column is counted when the subtraction control key is used. (In Problem 3, for instance, even though you are skipping over columns, you will use the fourth subtraction control key.)
4. If a zero appears in the subtrahend, use the small zero indicated on the key. No zeros appear in the larger digits, however, which are used for the minuend.
5. Stroke the keys firmly and evenly.
6. Check each answer by REPEATING every problem.

ASSIGNMENTS

Lessons 8 and 9, Learning the Burroughs Calculator.

(BE SURE TO CHECK ALL LESSONS AFTER THEY ARE COMPLETED. SEE TECHNICIAN.)

FILM #7, OPERATION OF THE BURROUGHS KEY-DRIVEN CALCULATOR--DIVISION

<u>Problem</u>	32475	÷	25	=	1299.00
	(DIVIDEND)		(DIVISOR)		(QUOTIENT)

POINTS TO REMEMBER:

1. Division on the Burroughs key-driven calculator is repeated subtraction.
2. The dividend is entered on the left side of the keyboard with the larger figures.
3. The divisor is entered on the left side of the keyboard with the small figures minus one, as in subtraction.
4. Proper placement of the decimal point is necessary before the division operation begins. (Check the rules below.)

RULES FOR THE PLACEMENT OF THE DECIMAL POINT IN DIVISION

- A. Begin by locating the decimal point in its original position in the dividend. Move the decimal point indicator on the machine to the left for as many places as there are whole numbers in the divisor. (For example, $32475 \div 25 =$) You would move the decimal point from the end of the dividend at 5, a total of two places to the left (because there are two whole numbers in the divisor 25) so that the decimal point would appear between the 4 and 7 or 324.75.
 - B. Move the decimal indicator, ONE DIAL TO THE RIGHT, for each significant preceding zero in the divisor. (For example, $32475 \div .025 =$) You would move the decimal point from the end of the dividend at 5, a total of one place to the right (because there is one significant zero in the divisor, .025) so that the decimal point would appear over one position or 324750.
 - C. If there are neither whole numbers nor significant preceding zeros in the divisor, the decimal indicator would remain in its original position in the dividend. (For example, $32475 \div .25 =$) You would not need to move the decimal point because there are neither whole numbers nor significant preceding zeros in the divisor, .25.
5. The proper steps in division must be followed in order to arrive at the correct answer.

FILM #7, page 2
BKD - Div.

THREE STEPS TO BE FOLLOWED IN DIVIDING ON THE KEY-DRIVEN CALCULATOR

MATCH OR EQUAL THE STROKE WHEEL

Stroke the divisor keys until the number of key depressions is equal to the stroke wheel number. This is the number which appears on the dial immediately to the left of the column which is being held as the divisor.

If the number which you are trying to match, or equal, increases while you are depressing keys, you must continue stroking as many times as is necessary to equal the stroke wheel indicated. (Be sure to count the number of strokes made on the keyboard so that you will remember whether you have matched the stroke.)

REDUCE THE REMAINDER

Reduce the numbers in the dials immediately beneath your fingers, which are on the divisor, until numbers in the dials are smaller than the divisor. (Remember that even though you may be holding a number 24, your divisor is still 25, because you have subtracted one from the divisor.)

MOVE OVER

Move all fingers held on the divisor one column to the right and repeat the process again, beginning with matching the stroke or the number which appears on the dial immediately to the left of the column which is being held as the divisor.

ASSIGNMENT

Lesson 18, Learning the Burroughs Calculator for study and review.

FILM #8, OPERATION OF THE BURROUGHS KEY-DRIVEN CALCULATOR--DIVISIONWITH DECIMALS

Problem 1 $619.44 \div 116 = 5.34$

Problem 2 $.44574 \div .51 = .87400$

Problem 3 $.42784 \div .00056 = 764$

POINTS TO REMEMBER:

1. Division on the key-driven calculator is repeated subtraction.
2. The dividend is entered on the left side of the keyboard with the larger figures.
3. The divisor is entered on the left side of the keyboard with the small figures minus one, as in subtraction.
4. Proper placement of the decimal point is necessary before the division operation begins. (Check the rules below.)

RULES FOR THE PLACEMENT OF THE DECIMAL POINT IN DIVISION

- A. Begin by locating the decimal point in its original position in the dividend. Move the decimal point indicator on the machine to the left for as many places as there are whole numbers in the divisor.
- B. Move the decimal indicator, ONE DIAL TO THE RIGHT, for each significant preceding zero in the divisor.
- C. If there are neither whole numbers nor significant preceding zeros in the divisor, the decimal indicator would remain in its original position in the dividend.

(For example with regard to the above rules, see your sheet for Film #7, Division of Whole Numbers.)

5. Fingers of one hand or both hands are used to stroke the divisor keys quickly and firmly.
6. The three steps used in dividing on the key-driven calculator are indicated on the next page.

FILM #8, page 2
BKD - Div.

THREE STEPS TO BE FOLLOWED IN DIVIDING ON THE KEY-DRIVEN CALCULATOR

MATCH OR EQUAL THE STROKE WHEEL

Stroke the divisor keys until the number of key depressions is equal to the stroke wheel number. This is the number which appears on the dial immediately to the left of the column which is being held as the divisor.

If the number which you are trying to match, or equal, increases while you are depressing the keys, you must continue stroking as many times as is necessary to equal the stroke wheel indicated. (Be sure to count the number of strokes made on the keyboard so that you will remember whether you have matched the stroke.)

REDUCE THE REMAINDER

Reduce the numbers in the dials immediately beneath your fingers, which are on the divisor, until the numbers in the dials are smaller than the divisor. (Remember that even though you may be holding a number 24, your divisor is still 25, because you have subtracted one from the divisor.)

MOVE OVER

Move all fingers held on the divisor one column to the right and repeat the process again, beginning with matching the stroke or the number which appears on the dial immediately to the left of the column which is being held as the divisor.

ASSIGNMENT

Lessons 19 and 20, Learning the Burroughs Calculator, located in the room.

(This completes our study of the Burroughs key-driven calculator. Plan to take your test on this machine.)

FILM #1. FRIDEN FULLY-AUTOMATIC ROTARY CALCULATOR--ADDITION

<u>Problem 1</u>	189	<u>Problem 2</u>	\$ 25.45
	72		32.56
	26		189.30
	131		<u>4.50</u>
	<u>249</u>		
Total	667	Total	\$251.81

POINTS TO REMEMBER:

1. Before beginning a problem in addition, check the following:
 - A. The carriage should be positioned to the extreme left of the machine. Clear the machine by depressing the Keyboard Clear Key and the Carriage Clear Key.
 - B. The Add Lever should be in the down position and the Keyboard Lock Lever should be in the up position.
 - C. If there are decimals in the problem, move the keyboard and upper dial decimal indicators to the proper position.
2. Remember the following:
 - A. The touch method of operation is not used. You will need to locate the proper numbers.
 - B. You can depress more than one digit key at a time to increase the speed of operation.
 - C. After digits have been entered on the keyboard for each item, the plus bar is depressed with the little finger.
 - D. The answer to an addition problem is read in the upper dial, or long dial.
 - E. REPEAT each problem.

ASSIGNMENT

Lesson 1-A; 2-A; Problems 1-4; Lesson 5-A, Problems 1-5. Study pages 8, 9, 10. Business Machine Calculation, Rotary Calculators, Volume II, by Al Giordano.

FILM #2. FRIDEN FULLY-AUTOMATIC ROTARY CALCULATOR—SUBTRACTION

Problem 1 3864 Minuend
 - 1372 Subtrahend
 2492 Difference

Problem 2 530.62 Minuend
 - 215.30 Subtrahend
 315.32 Difference

POINTS TO REMEMBER:

1. Before beginning a problem in subtraction, check the following:
 - A. The carriage should be positioned to the extreme left of the machine. Clear the machine by depressing the Keyboard Clear Key and the Carriage Clear Key.
 - B. The Add lever should be in the down position and the Keyboard Lock lever should be in the up position.
 - C. If there are decimals in the problem, move the keyboard and upper dial decimal indicators to the proper position.
2. Remember the following:
 - A. The touch method of operation is not used. You will need to look at the keyboard to locate the proper numbers.
 - B. The minuend (number to be subtracted from) is entered on the keyboard first; then the plus bar, which is depressed with the little finger, registers the amount into the machine.
 - C. The subtrahend (number to be subtracted) is then entered on the keyboard; the minus bar, which is depressed with the little finger, registers the amount into the machine.
 - D. The answer to a subtraction problem is read in the upper dial, or long dial.
 - E. REPEAT each problem.

ASSIGNMENT

Lesson 1-B; Lesson 2-A, Problems 5-10; Lesson 5-B, Problems 6-10.
Business Machine Calculation, Rotary Calculators, Volume II,
 by Al Giordano.

FILM #3, FRIDEN FULLY-AUTOMATIC ROTARY CALCULATORADDITION AND SUBTRACTION

<u>Problem 1</u>	62.10	<u>Problem 2</u>	1.00
	8.4 -		.98 -
	35.921		2.35
	<u>2.48</u>		33.66 -
Total	92.101		<u>5.00</u>
		Total	26.29 -

POINTS TO REMEMBER:

1. Before beginning a problem in addition and subtraction, check the following:
 - A. The carriage should be positioned to the extreme left of the machine. Clear the machine by depressing the Keyboard Clear Key and the Carriage Clear Key.
 - B. The Add lever should be in the down position and the Keyboard Lock lever should be in the up position.
 - C. If there are decimals in the problem, move the keyboard and upper dial decimal indicators to the proper position.
2. Credit balances on the Friden rotary calculator are indicated by nines preceding the complement of the answer. (Whenever this occurs a bell will ring on the machine.) To convert this complement of the true negative balance to a credit balance you will need to follow these steps:
 - A. Enter on the keyboard all numbers appearing in the upper dial, using as many nines as the keyboard will allow.
 - B. Place the Add lever in the UP position.
 - C. Depress the Minus bar two times, quickly. (Be sure that only two subtractions are made.)
 - D. Read the credit balance in the upper dial.
3. REPEAT each problem.

ASSIGNMENT

Lesson 1-C and 1-D; Lesson 2-A, Problems 11-15; Lesson 5-K, Problems 70-75. Business Machines Calculation, Volume II, by Al Giordano.

FILM #5. OPERATION OF THE ROTARY CALCULATOR, FRIDEN SEMI-AUTOMATICMULTIPLICATION OF WHOLE NUMBERS AND DECIMALS

Problem 1 182 Multiplicand
 x 75 Multiplier
 13,650 Product

Problem 2 25.5 Multiplicand
 x 4.05 Multiplier
 103.275 Product

POINTS TO REMEMBER:

1. Multiplication on the Friden semi-automatic rotary calculator is completed in the following manner:
 - A. First, push the add key in the UP POSITION.
 - B. After entering the multiplicand on the keyboard, DEPRESS THE ADD BAR as many times as indicated by the first digit in the multiplier, reading from right to left. (For example, in Problem 1 you would depress the add bar 5 times.
 - C. Depress the CARRIAGE SHIFT BAR once, which will locate the carriage at the next position. Multiply by depressing the add bar again as many times as indicated by the second digit, reading from right to left. (For example, in Problem 1 you would depress the add bar 7 times.)
 - D. Continue the preceding step for as many times as there are numbers in the multiplier.
 - E. Read the answer in the Upper Dial. The multiplier appears in the middle dial. The multiplicand is held on the keyboard until it is cleared out for the next problem.
 - F. Clear the machine before beginning the next problem.
2. Multiplication with decimals entails a location of decimal places on the machine as follows:
 - A. Locate the number of places on the keyboard for the number of places shown in the multiplicand figure.
 - B. Locate the number of places in the middle dial for the number of places shown in the multiplier figure.
 - C. Locate the number of places in the upper or answer dial for the total number of places in the multiplier and multiplicand. The product will then appear, in the upper dial, decimally correct.
3. REPEAT each problem.

FILM #5, page 2
FSA - Mult.

ASSIGNMENT

Same assignments as shown on sheet for Multiplication on Fully-Automatic Friden Rotary Calculator.

Business Machine Calculation, Volume II, by Al Giordano.

FILM #6, FRIDEN FULLY-AUTOMATIC ROTARY CALCULATORDIVISION OF WHOLE NUMBERS

Problem 1 14,436 ÷ 12 = 1,203.000
 (Dividend) (Divisor) (Quotient)

(Locate three decimal places in quotient or lower dial and three places in the dividend or upper dial.)

Problem 2 12,444 ÷ 122 = 102.0000
 (Dividend) (Divisor) (Quotient)

(Locate four decimal places in quotient or lower dial and three places in the dividend or upper dial.)

POINTS TO REMEMBER:

1. The DIVIDEND BAR is used for entering the dividend into the machine. The DIVIDEND FIGURE is shown in the UPPER DIAL. Both division bars are depressed simultaneously to carry out the process of division after the divisor has been entered.
2. Decimal places should be located before the problem is entered on the machine. Small numbered keys beneath the lower dial indicate the number of places in the quotient. One key must be depressed for decimal location, then decimal points may be moved on the dials.

RULE FOR DECIMAL PLACEMENT:

TOTAL NUMBER OF DECIMAL PLACES LOCATED ON THE KEYBOARD	<u>PLUS</u>
<u>TOTAL NUMBER OF PLACES LOCATED IN THE LOWER OR SHORT DIAL</u>	<u>EQUALS</u>
TOTAL NUMBER OF PLACES THAT ARE LOCATED IN THE UPPER DIAL	

$$\text{KBD} + \text{SD} = \text{UP}$$

3. The following order is followed in division:
 - a. Enter the dividend on the keyboard.
 - b. Depress Enter Dividend bar, and read dividend in upper dial.
 - c. Enter the divisor on the keyboard.
 - d. Depress division bars simultaneously to carry out division.
 - e. Read answer in lower dial.
4. REPEAT EACH PROBLEM. CHECK DECIMAL PLACEMENT, KEYBOARD LOCK IN UP POSITION AND ADD KEY IN DOWN POSITION.

ASSIGNMENT

Lesson 3-B, 5-D, 5-E, Division of Whole Numbers
Business Machine Calculation, Volume II, by Al Giordano.

FILM #7, FRIDEN FULLY-AUTOMATIC ROTARY CALCULATOR--DIVISIONNUMBERS WITH DECIMALS

Problem 1 456.32 ÷ 125.4 = 3.63891
 (Dividend) (Divisor) (Quotient)

(Locate two places on the keyboard five places in the quotient or lower dial, and seven places in the dividend or upper dial.)

Problem 2 195.326 ÷ .15 = 1,302.17333
 (Dividend) (Divisor) (Quotient)

(Locate three places on the keyboard, five places in the quotient or lower dial, and eight places in the upper dial.)

POINTS TO REMEMBER:

1. The DIVIDEND BAR IS USED FOR ENTERING THE DIVIDEND INTO THE MACHINE. The DIVIDEND FIGURE is shown in the UPPER DIAL. Both division bars are depressed simultaneously to carry out the process of division after the divisor has been entered.
2. Decimal places should be located before the problem is entered on the machine. Small numbered keys beneath the lower dial indicate the number of places which can be indicated in the quotient. One of the numbered keys must be depressed for the number of places to be carried out in the answer. Decimal indicators may then be moved on dials to indicate locations of decimals.

RULE FOR DECIMAL PLACEMENT:

TOTAL NUMBER OF DECIMAL PLACES LOCATED ON THE KEYBOARD PLUS
TOTAL NUMBER OF PLACES LOCATED IN THE LOWER OR SHORT DIAL EQUALS
 TOTAL NUMBER OF PLACES THAT ARE LOCATED IN THE UPPER DIAL

$$\text{KBD} + \text{SD} = \text{UP}$$

3. The following order is followed in division: (with decimals)
 - a. Enter the dividend on the keyboard around the decimal point.
 - b. Depress Enter Dividend bar, and read dividend in upper dial.
 - c. Enter the divisor on the keyboard, around the decimal point.
 - d. Depress division bars simultaneously to carry out division.
 - e. Read answer in lower dial pointed off decimally correct.
4. REPEAT EACH PROBLEM. CHECK DECIMAL PLACEMENT, KEYBOARD LOCK IN UP POSITION AND ADD KEY IN DOWN POSITION.

FILM #7, page 2
FFA - Div.

ASSIGNMENT

Lesson 3-C, 3-D, 4-A, 5-F, and all other remaining problems with regard to division with decimals.

Business Machine Calculation, Volume II, by Al Giordano.

YOU ARE NOW READY TO COMPLETE ALL OF THE REMAINING LESSONS ASSIGNED IN VOLUME II. COMPLETE ALL LESSONS 1 THROUGH 10.

APPENDIX D

STUDENT QUESTIONNAIRE

BUSINESS MACHINES I
LANSING COMMUNITY COLLEGE
STUDENT QUESTIONNAIRE

- I. Machines Section:
Check the section in which you are enrolled.
- A. 11:00 a.m. _____
B. 1:00 p.m. _____
C. AVT _____
- II. A. Age: 17-19 _____, 20-22 _____, 23-25 _____, over 25 _____
B. Sex: M _____ F _____
- III. A. No. of Credits at L.C.C. prior to Winter term 1967 _____
B. No. of College Credits other than L.C.C. _____
C. No. of Credits carried this term _____
- IV. A. Have you had business office experience?
_____ Yes
_____ No
- V. If answer to Question 4 is "yes," indicate the approximate number of months of employment for each of the categories listed below: (Check one or more columns.)

EMPLOYMENT CLASSIFICATION

LENGTH OF EMPLOYMENT IN MONTHS

	1-6 mo.	7-12 mo.	13-18 mo.	18-24 mo.	over 24 mo.
Full-time (40 hours per week)					
3/4 time (30 hours per week)					
1/2 time (20 hours per week)					
1/4 time (10 hours per week)					

- VI. What type of work did you perform? (Check one or more items.)
- | | |
|------------------------------------|--|
| _____ 1. Typing | _____ 8. Duplicating |
| _____ 2. Shorthand | _____ 9. Report Writing |
| _____ 3. Accounting | _____ 10. Switchboard |
| _____ 4. Record Keeping | _____ 11. Receptionist |
| _____ 5. Mathematical Computations | _____ 12. Over-the-Counter
Customer Service |
| _____ 6. Filing | _____ 13. Other |
| _____ 7. Writing Correspondence | |

STUDENT QUESTIONNAIRE
Page 2

VII. What kinds of machines did you use on the job: Check one column for each type of machine used.)

TYPE OF MACHINE	EXTENT OF USE				
	Daily	2-4 times a week	Once weekly	Once in two weeks	Not over once a month
1. 10-Key Adding Machine					
2. Key-Driven Calculator					
3. Rotary Calculator					
4. Full Key-Board Adding Machine					
5. 10-Key Printing Calculator					
6. Others (except duplicating or transcribing machines--such as mimeograph or dictaphone)					
7. _____					
8. _____					
9. _____					

VIII. What previous training have you had in or on office machines:

- ☐ A. High School Course
☐ B. On-the-job Training
☐ C. None

IX. If you have had on-the-job training, check the type of machine used and kind of study instruction you received.

TYPE OF MACHINE	FORMAL COURSE	INFORMAL, ON-THE-JOB	SELF-STUDY
1. 10-Key Adding Machine			
2. Key-Driven Calculator			
3. Rotary Calculator			
4. 10-Key Printing Calculator			
5. Full Keyboard Adding Machine			
6. Others, specify:			

STUDENT QUESTIONNAIRE
Page 3

- X. A. If you had a machines course in high school, what was its length? (Check one item.)

- ☐ 1. 6 weeks
- ☐ 2. 1 semester
- ☐ 3. 1 year
- ☐ 4. 3 semesters
- ☐ 5. Other - (Specify length)

- B. What types of machines did you use in your high school machines class? (Check one or more items.)

- ☐ 1. 10-Key Adding Machine
- ☐ 2. Key-Driven Calculator
- ☐ 3. Rotary Calculator
- ☐ 4. 10-Key Printing Calculator
- ☐ 5. Full Keyboard Adding Machine
- ☐ 6. Duplicating Machines
- ☐ 7. Others, (specify)
- ☐ 8. _____
- ☐ 9. _____
- ☐ 10. _____

- XI. If you have used any business machines for personal use, or for reasons other than those indicated previously, please indicate briefly the purpose of using these machines.

- XII. A. FOR REGULAR CLASS STUDENTS ONLY:

Approximately how many hours, including regular class sessions, did you need to complete the required work for this course? _____ hours

- B. FOR A.V.T. STUDENTS ONLY:

Approximately how many hours did you need to complete the required work for this course? _____ hours

- XIII. Estimate, as nearly as possible, what portion of the above total was spent on each of the following machines: (Complete all three items.)

- 1. Monroe 10-Key Adding Machine _____ hours
- 2. Burroughs Key-Driven Calculator _____ hours
- 3. Friden Rotary Calculator _____ hours

Name _____

APPENDIX E

FINAL EXAMINATION

Business Machines I

Final Examination

TEN-KEY ADDING MACHINE

1. 460	2. 344	3. 236 x 24 =	4. 45.67	5. 3.77
329	9,322		<u>- 9.23</u>	5.18
721	3,418	6. 458 x .25 =		-6.95
475	235			-1.70
600	<u>3,698</u>	7. 2530	8. 565	<u>1.25</u>
583	S	<u>3541-</u>	151	
291	336		867	
746	7,833		707	
568	636	9. 2,073	499	
<u>530</u>	7,135	57	890	
	<u>5,436</u>	440	351	
	S	34	497	
	9,338	<u>68</u>	560	
	37	S	<u>200</u>	
	534	2,700		
	486	15		
	<u>95</u>	106	10. 457 x 35 =	
	T	51		
		<u>901</u>	11. 15.65	
		S	<u>-11.75</u>	
		255		
		660		
		3,297	12. 159 x 300 =	
		945		
		<u>1,525</u>		
		T		
13. 18.01		14. 3541	15. 651	16. 894 x 206 =
10.53		<u>5872-</u>	129	
- 4.08			673	17. 55.74
- 2.18			105	<u>-21.46</u>
<u>25.37</u>			432	
			856	
			497	
			421	
			683	
			<u>509</u>	

- | | | | | | | | |
|-----|---------------|-----|--------------|-----|-------------|-----|---------------|
| 18. | 130 | 19. | 6,295 | 20. | 357 x .49 = | 21. | 165.10 |
| | 688 | | 6,545 | | | | 690.02 |
| | 66 | | 2,687 | | | | -125.40 |
| | 6,083 | | 4,567 | | | | 28.85 |
| | <u>7,072</u> | | <u>5,644</u> | | | | <u>- 8.88</u> |
| | S | | S | | | | |
| | 4,070 | | 3,492 | | | | |
| | 230 | | 1,668 | | | | |
| | 25 | | 6,456 | | | | |
| | 61 | | 4,666 | | | | |
| | <u>770</u> | | <u>5,646</u> | | | | |
| | S | | S | | | | |
| | 26,268 | | 4,456 | | | | |
| | 88 | | 645 | | | | |
| | 430 | | 162 | | | | |
| | 845 | | 743 | | | | |
| | <u>963</u> | | <u>456</u> | | | | |
| | T | | T | | | | |
| 22. | 12542 | 23. | 199 | 24. | 138 | 25. | 375 x 540 = |
| | <u>12588-</u> | | 438 | | 259 | | |
| | | | 440 | | 705 | 26. | 422 x 220 = |
| | | | 187 | | 140 | | |
| | | | 699 | | 860 | 27. | 8.13 x 20.4 = |
| | | | 350 | | 347 | | |
| | | | 180 | | 150 | 28. | 6.74 x 2.9 = |
| | | | 775 | | 268 | | |
| | | | 368 | | 144 | 29. | 65.7 x .32 = |
| | | | <u>492</u> | | <u>655</u> | | |

KEY-DRIVEN CALCULATOR

Final Exam

- | | | | |
|--------------------|----------------------|------------|----------------------|
| 1. 332 | 2. 729 x 37 = | 7. 233 | 8. 8,192 x 22 = |
| 323 | | 232 | |
| 356 | 3. 654 | 621 | 9. 899 |
| 151 | <u>-385</u> | 411 | <u>-609</u> |
| 544 | | 415 | |
| 118 | | 252 | |
| 442 | 4. 415.0650 ÷ 82.6 = | 258 | 10. 409.05 ÷ 9.09 = |
| 443 | | 444 | |
| 112 | 5. 809 x 14 = | 252 | 11. \$81.45 |
| 732 | | 262 | <u>- 9.99</u> |
| 443 | 6. 958 | 444 | |
| 111 | <u>-780</u> | 211 | |
| 474 | | 373 | |
| 755 | | 745 | |
| <u>225</u> | | <u>125</u> | |
| 12. 431 | 13. 212 | 14. 342 | 15. 44.76 |
| 333 | 344 | 344 | <u>-10.01</u> |
| 457 | 458 | 458 | |
| 444 | 445 | 511 | 20. .5125 ÷ .09 = |
| 555 | 435 | 144 | 21. 2,275 x 1.1 = |
| 444 | 445 | 251 | |
| 585 | 263 | 163 | 16. 690.99 ÷ .93 = |
| 232 | 553 | 333 | 17. 4,111 x .30 = |
| 712 | 921 | 251 | 18. 8,700 |
| 111 | 142 | 146 | <u>-3,090</u> |
| 223 | 122 | 333 | |
| 114 | 211 | 122 | 19. 70.7277 ÷ 2.81 = |
| 564 | 653 | 855 | |
| 348 | 526 | 935 | |
| <u>533</u> | <u>111</u> | <u>514</u> | |
| 23. 37.818 ÷ 9.9 = | 27. 545 | 28. 341 | 29. 555 |
| | 234 | 565 | 521 |
| 24. 900 x .804 = | 362 | 545 | 264 |
| | 516 | 624 | 851 |
| 25. .003 x .40 = | 242 | 296 | 141 |
| | 693 | 663 | 223 |
| | 623 | 312 | 827 |
| | 938 | 932 | 617 |
| | 214 | 138 | 481 |
| | <u>158</u> | <u>953</u> | <u>433</u> |

Business Machines I

Final Examination

ROTARY CALCULATOR

1. 231	2. 673	3. 485	4. 411	5. 376	6. 376
589	394	262	646	385	385
789	674	512	891	555	555
111	221	351	567	581	581
294	161	279	893	778	778
613	194	548	581	887	887
416	782	789	883	263	263
415	169	234	389	184	184
657	894	125	203	943	943
<u>946</u>	<u>415</u>	<u>567</u>	<u>666</u>	<u>555</u>	<u>554</u>
7. 195	8. 883	9. 821	10. 728	11. 921	12. 30.625
259	174	<u>-345</u>	<u>-509</u>	<u>-702</u>	<u>- 9.1667</u>
397	333				
575	771				
666	355	13. .4167	14. 69.25	15. 226.1	
526	157	<u>-.0833</u>	<u>-15.5833</u>	<u>-195.01</u>	
711	341				
235	675				
661	347	16. 106 x 794 =		17. 629 x 630 =	
<u>341</u>	<u>341</u>	18. 684 x 542 =		19. 533 x 611 =	
		20. 505 x 444 =		21. 914 x 613 =	
22. 335 x 581 =		23. 5,096 ÷ 365 =		24. 9,020 ÷ 44 =	
25. 2,610 ÷ 29 =		26. 783 ÷ 92.5 =		27. 1,126.15 ÷ 330.146 =	
28. 215,782 ÷ 54.103 =				29. 35.25 ÷ 8.44 =	

APPENDIX F

A.V.T. OPINIONNAIRE

BUSINESS MACHINES I

A.V.T. Student Opinionnaire

Read each statement carefully. Select the alternative for each that most nearly represents your own opinion or feelings. Indicate your choice with a check mark in the space provided.

- I. A. Age: 17-19____, 20-22____, 23-25____, over 25____
B. Sex: M____ F____
- II. A. No. of Credits at L.C.C.____
B. No. of College Credits other than L.C.C.____term hours
____semester hours
C. No. of credits this term____
- III. Do you think you learned as much in the A.V.T. section as you would have if you had been in the regular section?
- ____1. Much more in the A.V.T. section
____2. A little more in the A.V.T. section
____3. About the same
____4. A little more in the regular class
____5. Much more in the regular class
____6. Not sure
- IV. In addition to the A.V.T. unit instruction, approximately how many times did you have need for specific help with practice problems?
- ____1. More than 10 times
____2. About 6 to 10 times
____3. About 3 to 5 times
____4. About 1 to 3 times
____5. Not at all
- V. When specific help was needed, whom did you ask for it? (Check more than one if applicable.)
- ____1. The instructor
____2. The lab technician
____3. Classmates
____4. No help needed
____5. Other

A.V.T. Student Opinionnaire
Page 2

VI. Do you feel you were as well prepared to advance to the next A.V.T. unit (practice of skills, review of material) as you would have been in the regular class section?

- ☐ 1. Much better prepared with A.V.T. units
- ☐ 2. A little better prepared with A.V.T. units
- ☐ 3. About the same
- ☐ 4. A little better prepared in the regular class
- ☐ 5. Much better prepared in the regular class
- ☐ 6. Not sure

VII. Do you think you will be able to apply what you learned from this course as much as you would have if you had been in the regular section?

- ☐ 1. Much more from the A.V.T. section
- ☐ 2. A little more from the A.V.T. section
- ☐ 3. About the same
- ☐ 4. A little more from the regular section
- ☐ 5. Much more from the regular section
- ☐ 6. Not sure

VIII. Do you think you spent as much time learning each machine by the A.V.T. method as you would have in the regular class?

- ☐ 1. Much less time spent with A.V.T. method
- ☐ 2. A little less time spent with A.V.T. method
- ☐ 3. About the same
- ☐ 4. A little more time than the regular class
- ☐ 5. Much more time than the regular class
- ☐ 6. Not sure

IX. Now that you have directly participated in the A.V.T. section, how do you feel about this as a method of instruction?

- ☐ 1. I enjoyed it very much
- ☐ 2. I enjoyed it somewhat
- ☐ 3. I have no particular feelings about it
- ☐ 4. I disliked it somewhat
- ☐ 5. I disliked it very much

X. To what do you attribute your feelings as indicated in Question IX? (Check more than one if applicable.)

- ☐ 1. Adequate teacher contact
- ☐ 2. Inadequate teacher contact
- ☐ 3. Freedom to schedule own time
- ☐ 4. Inability to "get at it" when I should
- ☐ 5. Opportunity to complete lessons as fast as I wanted
- ☐ 6. The carrel was not available when I needed it
- ☐ 7. The practice machines were not available when I needed them
- ☐ 8. Other (please specify) _____
- ☐ 9. _____

XI. If you were to enroll in Business Machines II and it was available by either the A.V.T. method or the regular class method, which would be your preference?

- ☐ 1. The regular class
Reason:

- ☐ 2. The A.V.T. section
Reason:

XII. What would be your suggestions for improving this course on A.V.T. media?

APPENDIX G

FINAL EXAMINATION SCORES

TABLE XI

SCORES OF STUDENTS ON FINAL PERFORMANCE TEST SEPARATED BY WHETHER
THE STUDENT SCORED ABOVE OR BELOW THE GROUP MEDIAN ON THE A.C.T.
MATHEMATICS SCORE AND BY EXPERIMENTAL OR CONTROL GROUP

Group	Mathematics Ability	
	Above Median	Below Median
Experimental	79	80
	83	75
	84	85
	81	74
	82	67
	79	79
	85	81
	79	84
	81	81
	83	82
	78	73
	84	79
	82	81
	85	81
	<u>1145</u>	<u>1102</u>
Control	79	78
	72	61
	79	80
	69	80
	78	79
	81	82
	77	65
	75	80
	74	81
	82	68
	83	82
	65	78
	81	76
	81	80
	<u>1076</u>	<u>1070</u>

TABLE XII

SCORES OF STUDENTS ON FINAL PERFORMANCE TEST SEPARATED BY
EXPERIMENTAL OR CONTROL GROUPS, AND WITH OR WITHOUT A
PRIOR HIGH SCHOOL BUSINESS MACHINES COURSE

	Group	
	Experimental	Control
With prior high school course	80	78
	75	61
	85	80
	74	80
	67	79
	79	82
	83	79
	84	72
	78	79
	82	69
	79	78
	85	81
	<u>951</u>	<u>918</u>
Without prior high school course	79	85
	81	72
	84	81
	81	68
	82	82
	73	82
	79	76
	81	80
	81	77
	79	75
	81	74
	83	82
	78	83
	84	65
	82	81
	85	81
	<u>1293</u>	<u>1224</u>

APPENDIX H

STATISTICAL FORMULA AND CALCULATIONS

COMPUTATIONS FOR TWO-WAY ANALYSIS OF VARIANCE
WITH EXPERIMENTAL AND CONTROL GROUPS
SUBDIVIDED BY MATHEMATICAL ABILITY*

$$A = \sum_j \sum_k \sum_i x^2 = 346,193$$

$$B = \frac{\sum_j \left(\sum_k \sum_i x \right)^2}{N} = 344,615.1607$$

$$C = \frac{\sum_k \left(\sum_j \sum_i x \right)^2}{Rn} = 344,797.3214$$

$$D = \frac{\sum_j \left(\sum_k \sum_i x \right)^2}{Cn} = 344,658.0357$$

$$E = \frac{\sum_j \sum_k \left(\sum_i x \right)^2}{n} = 344,864.6429$$

$$\text{SS Rows (Exp. vs Cont. Groups)} = C - B = 182.1607$$

$$\text{SS Columns (Upper vs Lower Math. Ability)} = D - B = 42.8750$$

$$\text{SS Interaction (Ability and Treatment)} = E - C - D + B = 24.4465$$

$$\text{SS Error (Within Cells)} = A - E = 1328.3571$$

$$\text{SS Totals} = A - B = 1577.8393$$

* Design and scores are in Table XI, p. 149; summary table, Table VIII, p. 60.

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