A STUDY OF THE EFFECTIVENESS OF FOUR INSTRUCTIONAL TECHNIQUES OF TEACHING ARC WELDING AT THE UNIVERSITY LEVEL

APPROVED:

Graduate Committee:

Major Professor

Minor Professor

Committee Member

Committee Member

Dean of the School of Education

Dean of the Graduate School

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By

Joseph P. Chrisman, B.A., M.A.
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CHAPTER I

INTRODUCTION

The burst of new knowledge, population, and technology, plus the rise of new nations and the world rivalry of new ideologies, have precipitated a demand for new and imaginative techniques of teaching (31). These events, along with increased awareness of the importance of education to a successful life, have intensified certain problems in education. Specifically, the number of students enrolled in college today far exceeds that of a decade ago and the perplexities of faculty recruitment and improvement of instruction exist together in both public and private institutions, and the two problems are not unrelated (33). The task faced by colleges today is to provide quality instruction to an increasing student population and still make available to them the personal contact between instructor and student (33).

The area of educational technology has provided educators with an assortment of teaching devices designed to aid in accommodating more students and in maintaining, even though limited, a personal contact between instructor and student. Some of these devices offer hope for improving education and may become as common as the chalk board, while others may be only of a passing nature. These devices include teaching machines, programed instruction materials, computers, and motion pictures.

In the same vein, the development of other audio and/or visual devices, such as 8-mm film loops, has added yet another dimension to educational technology. One of the more recent visual devices available to educators is the single-topic film loop, which is a short, continuous film in a plastic, self-contained cartridge. The use of film loops has attracted the attention of science teachers and educators at schools such as Dallas County Junior College, Dallas, Texas, and Purdue University, Lafayette, Indiana.

Producers of educational media, such as The Jam Handy Organization in Detroit, Michigan, also have given attention to the use of single-topic film loops. As enrollments increase and knowledge expands, the use of single-topic film loops may play an ever increasing role in the teaching-learning process.

Statement of the Problem

The problem was to study the effectiveness of four instructional techniques of teaching arc welding at the university level.

Purposes of This Study

The purposes of this study are stated as follows:

1. To determine the combined effectiveness of single-topic film loops, programed instruction, lectures, and demonstrations in teaching arc welding.

2. To determine the combined effectiveness of single-topic film loops and programed instruction in teaching arc welding.

3. To determine the combined effectiveness of single-topic film loops, lectures, and demonstrations in teaching arc welding.

4. To determine the combined effectiveness of programed instruction and lectures and demonstrations in teaching arc welding.

5. To determine which of the four instructional techniques would enable students in four groups to complete four required welds in the least number of class hours.

6. To determine the extent of student preference for the teaching technique by which they received arc welding instruction.

Consistent with the purposes of this study, four arc welding classes were used. Each class was taught by one of the four instructional techniques cited above. To determine the effectiveness of the various experimental conditions each student was given a pretest, a posttest, a retention test, and an attitude scale, and each student made four different styles of welds. Each student undertook to learn arc welding as the major objective of the course, and the experimental variables were different in each class.

Hypotheses

The hypotheses listed below were formulated and tested in order to evaluate the four instructional techniques. This process involved the following sections and variables: experimental group one used single-topic film loops, programed instruction, lectures, and demonstrations; experimental group two used programed instruction and single-topic film loops; experimental group three used lectures, demonstrations, and single-topic film loops; and experimental group four used lectures, demonstrations, and programed instruction.

The hypotheses were

I. When tested for mean gain score, the following will be shown to exist:

A. Experimental group one will make a significant mean gain from the pretest to the posttest.

B. Experimental group two will make a significant mean gain from the pretest to the posttest.

C. Experimental group three will make a significant mean gain from the pretest to the posttest.

D. Experimental group four will make a significant mean gain from the pretest to the posttest.

II. When tested by greater mean gain score, the following will be shown to exist:

A. Experimental group one will make a significantly greater mean gain from the pretest to the posttest than will (1) group two, (2) group three, or (3) group four.

B. Experimental group two will make a significantly greater mean gain from the pretest to the posttest than will (1) group three, or (2) group four.

C. Experimental group three will make a significantly greater mean gain from the pretest to the posttest than will group four.

D. Experimental group one will make a significantly greater mean gain from the posttest to the retention test than will (1) group two, (2) group three, or (3) group four.

E. Experimental group two will make a significantly greater mean gain from the posttest to the retention test than will (1) group three, or (2) group four.

F. Experimental group three will make a significantly greater mean gain from the posttest to the retention test than will group four.

III. When the required welds are evaluated by the judges, the following will be shown to exist:

A. Experimental group one will show a significantly greater mean score on the four welds than will (1) group two, (2) group three, or (3) group four.

B. Experimental group two will show a significantly greater mean score on the four welds than will (1) group three, or (2) group four.

C. Experimental group three will show a significantly greater mean score on the four welds than will group four.

IV. When the time required to develop and apply arc welding skill is computed, the following will be shown to exist:

A. Experimental group four will show a significantly greater mean time needed to develop and apply arc welding skill than will (1) group one, (2) group two, or (3) group three.

B. Experimental group three will show a significantly greater mean time needed to develop and apply arc welding skill than will (1) group one, or (2) group two.

C. Experimental group two will show a significantly greater mean time needed to develop and apply arc welding skill than will group one.

Limitations of the Study

For the purposes of this study, the following limitations were established.

1. This study was limited to those male students who enrolled in Industrial Arts 236, General Welding, during the summer and fall semesters of 1969, at North Texas State

University, Denton, Texas. Only male subjects were used as no females enrolled for this course.

2. The time allowed for skill attainment and development of knowledge about metallic arc welding was limited to twenty-four clock hours for two reasons. First, the number of film loops used and the length of the prepared program were to be completed in no more than twenty-four clock hours, and second, after the experimental instructional unit was complete, all students had ample time to complete other course requirements.

Basic Assumption

The basic assumption of this study was that all uncontrolled variables would have an equal effect on all students in this study.

Definition of Terms

The following definitions were formulated for the purpose of this study.

1. Effectiveness.--This term refers to the fact that if the test results and welds evaluated by a five-member jury in experimental groups two, three, or four were equal or superior to those in experimental group one, the film loops and/or programed instruction would be considered effective.

2. Single-topic film loop.--This term refers to a single loop of film loaded into a plastic, self-contained

cartridge. The showing time of a single-topic film loop was limited to a maximum of four minutes, and the content of the loops was centered on a specific topic. Each film loop could be viewed many times without having to stop the projector.

3. Lectures and demonstrations.--This term refers to the teaching technique whereby a teacher presented from lesson plans a lecture and a demonstration, using actual machines, models, or other devices, to an entire group of students and covered one or more operations or manipulative techniques.

4. Self-instructional programed booklet.--This term refers to a booklet prepared for this study which contained arc welding instructional content. The booklet was based on the Skinnerian linear scheme of programed instruction (18, p. 9). During the instructional period, this programed booklet was referred to variously as the program, the booklet, or programed instruction.

5. Four welds.--This term refers to the four different welds required of the students. They were square edge butt weld, flat positioned t-fillet weld, positioned t-fillet weld, and single bevel 30° "v"-butt weld.

6. Matched student groups.--This term is used to indicate that groups were matched by group means on the criterion test (4, 8, 22, 28). The matching was done to

exclude data secured from those students whose participation in the study might alter the findings.

7. Group one.--This term refers to the group that used single-topic film loops, programed instruction, lectures, and demonstrations.

8. Group two.--This term refers to the group that used single-topic film loops and programed instruction.

9. Group three.--This term refers to the group that used single-topic film loops, lectures, and demonstrations.

10. Group four.--This term refers to the group that used programed instruction, lectures, and demonstrations.

Background and Significance of Study

In 1964 the book, An Integrated Experience Approach to Learning, was published, its senior author being S. N. Postlethwait, Professor of Biological Science, Purdue University. This book described the inception and implementation of an audio-tutorial approach to teaching freshman botany on the campus of Purdue University, Lafayette, Indiana, during 1961. This approach incorporated the use of pre-recorded tapes, individual study booths, textbooks, workbooks, and single-topic film loops. During the first year of operation of the audio-tutorial laboratory, Postlethwait made available to students a table on which to conduct botany experiments and materials with which to make microscope slides. These items were not available when this program began.

A restructuring of the class hours resulted in the elimination of the traditional fifty-minute class periods, and students were able to use the botany laboratory any time between the hours of 7:30 A.M. and 11:00 P.M., Monday through Friday, and 12:00 noon to 11:30 P.M. on Saturdays. Students studied botany lessons via the instructional media made available to them. This, in effect, provided each student with his own private tutor and allowed students the opportunity to decide for themselves on what days and at what hours they would earn their botany course credit. The audio-tutorial approach also utilized small group sessions called Small Assembly Sessions (SAS) when pertinent botany topics were discussed or quizzes were taken. Each week a General Assembly Session (GAS) was held for the purposes of outlining the work for the next week, viewing a full-length film, or hearing a guest lecturer. At the conclusion of the first year of working with the audio-tutorial approach, Postlethwait concluded, ". . . audio-programed lessons . . . can make a contribution to the improvement of instruction" (22, p. 6).

It was realized that certain aspects of the audio-tutorial approach described by Postlethwait had implications for the use in industrial arts laboratories. Five full-time staff members of the Industrial Arts Department, North Texas State University, Denton, Texas, were queried as to the potential use of all or part of the audio-tutorial approach for industrial arts. The consensus was that the use of film loops might have potential for an audio-tutorial program for teaching industrial arts.

When plans were made for conducting this study (November, 1967), 8-mm single-topic film loops in the area of industrial arts were not available. At this time in the development of single-topic film loops, the only complete sets of loops available were in the areas of science and health education. Consequently, plans for producing a set of industrial arts film loops were made, and an instructional area in which this evaluation was to take place was identified. Upon completion of one single-topic film loop, it became apparent that the time and cost required to produce an entire set of films would be prohibitive and abandonment of the study was considered. However, at this time (January, 1968), The Jam Handy Organization in Detroit, Michigan, producers of educational media, released a set of fourteen film loops for use in the area of arc welding. Permission to use commercially prepared films for investigative purposes was obtained from the advisory committee of this study, and correspondence with The Jam Handy Organization was begun.

This correspondence resulted in Jam Handy granting permission to use the arc welding film loops in this study. A sufficient number of film loops to conduct this study was provided by this company on a loan basis.

After the film loops were previewed and evaluated, four questions were identified. They were (1) How was the content of the film loops determined? (2) What were the objectives of a single-film loop? (3) What were the objectives of the entire set of film loops? and (4) Who determined the welding techniques shown in the film loops? When the answers to these questions were evaluated and the film loops were re-evaluated, it was concluded that the film loops could be incorporated into this study.

To assess the effectiveness of film loops as an aid to students in learning how to arc weld, three primary questions were formulated which provided a base upon which this study was designed. They were (1) Will the films be an aid to students in developing arc welding skill? (2) Will the films enable students to gain technical knowledge in arc welding? and (3) Will the film loops reduce the amount of time necessary for students to develop arc welding skill and attain technical knowledge?

Five industrial arts staff members from North Texas State University, Denton, Texas, indicated that if the use of these film loops resulted in a positive answer to any one or a combination of these questions, industrial arts teachers could support the inclusion of this medium in their instruction. Thus, the above three questions provided the framework for this study.

The next phase was a determination of how best to isolate the effectiveness of the film loops. The questions posed to ascertain this were to what degree did the film loops benefit student learning and at what rate was this accomplished? The answers to these questions required a "before and after" evaluation. To meet this criterion, it was necessary to develop an appropriate measuring instrument because of the lack of available measuring instruments in the area of arc welding. A full description of the development of this instrument is presented in Chapter III.

It also was recognized that merely comparing a class taught with lectures and demonstrations (the conventional method) to a class taught with the film loops would be inadequate due to the lack of specific information about the effectiveness of the conventional method. Therefore, the effectiveness of the conventional method would have to be determined as well as the effectiveness of the film loops. In order to meet this requirement, an assessment of the conventional method was needed, and this resulted in the development and preparation of an arc welding programed text booklet. This booklet provided a means whereby the conventional method could be evaluated and resulted in the use of four classes in the study. A full description of the development of this programed text is presented in Chapter III. The above number of classes and variables permitted the evaluations of the teaching techniques and, at the same time, facilitated collection of data.

Finally, the following three individuals each reported a need for further research directed toward the use of single-topic film loops. John L. Feirer, editor, Industrial Arts and Vocational Education, indicated that, although the projectors needed for utilizing single-topic film loops have not been standardized, film loops do have a great potential for industrial arts (12). Charles Hocking, Audio-Visual Director of the Oconomowoc, Wisconsin Public Schools, stated that the use of 8-mm film loops in industrial arts is limited only by the imagination of the teacher using the films (14). Reid and MacLennan, editors, Research in Instructional Television and Film, indicated that future research should be directed toward the utilization of 8-mm film loops (23).

Description of Instructional Media, Instruments, and Evaluations

The film loops used in the study were provided on loan from The Jam Handy Organization, 2821 East Grand Boulevard, Detroit, Michigan. These film loops were produced by professional personnel. No research had been conducted using these film loops until this study was completed.

A criterion test was developed for use in this study, and a detailed description of the development of this test is in Chapter III. A copy of the test is included in Appendix A. The test used had a reliability coefficient of .85 and a validity coefficient of .34.

Each student was required to make four different styles of welds using the metallic arc welding process. The welds were made using hot, rolled steel measuring three-sixteenths of an inch by one inch by six inches. One of each set of welds was selected by the students, and these welds were evaluated by a panel of five judges. The judges for this evaluation were experts in the field of welding. Each judge evaluated the welds on a five-point scale in which five points equalled a letter grade of A, four points a B, three points a C, two points a D, and one point an F.

Each student kept track of the total time needed to complete the four required welds. This resulted in identifying those students who were able to complete the instructional unit in less than the allotted time.

All students responded to a fifteen-item attitude scale in order to assess student attitude toward the teaching techniques used in the various groups. A copy of this scale is presented as Appendix B, and a description of the development of the scale is presented in Chapter III.

Three of the four groups used a programed, instructional booklet prepared for this study. A copy of sample pages of the program is included as Appendix C, and a description of the development of the program is presented in Chapter III.

Organization of the Remainder of the Study

The remainder of this paper is organized as follows: Chapter II contains a review of related research; Chapter III describes the course, the pilot study, development of the criterion test, development of the programed instructional booklet, development of the single-topic film loops, development of the attitude scale, development of miscellaneous instruments used, and the procedures used for the collection of the data; Chapter IV is a presentation of the data; and Chapter V contains a summary, findings, conclusions, implications, and recommendations.

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CHAPTER II

REVIEW OF RELATED RESEARCH

The rapid growth of the use of programed instruction, instructional television, and sound motion movies in education is attested to by the amount of literature pertaining to these devices (9, 11, 12, 23, 30, 38, 43, 46, 51). Much of this literature is comprised of studies conducted in educational settings using a myriad number of research techniques. As stated by Greenhill concerning the extensiveness of film and television research,

> These [educational] historians may also note that this research [film and television] was stimulated largely by a predicted and actual shortage of competent teachers and by the need to educate a rapidly growing population which had to learn more than ever before because of the explosion of human knowledge during this period (38, p. 1).

With respect to programed instruction, Schramm pointed out that since the advent of Skinner's now historic article "The Science of Learning and the Art of Teaching" (45), which was written in 1954, approximately 190 reports of original research on programed instruction have been written. Of this total, 165 have appeared since 1959 (43, p. 1). Thus, the period from then until the present is recognized as the period of most intensive research on programed instruction, instructional television, and film.

When A. A. Lumsdaine's book entitled Student Response in Programed Instruction was published in 1961, the first step toward unifying the voluminous amount of research about programed instruction had been taken. This book was the culmination of the work spent gathering information on such programed instructional variables as practice, participation, prompting, motivation, feedback, transfer, and retention. The methodological techniques used with these variables were films, flashcards, recordings, and drill machines (43). Lumsdaine's book represents a comprehensive collection of research conducted in the area of programed instruction.

Types of Programs

Various sources identify various numbers of programed instructional techniques. Stolurow identified eleven programing techniques (51, pp. 96-101), while Schramm identified four (43, pp. 3-4). Hughes, rather than limiting programed instruction to a certain number or kind, identified two factors for differentiating between programs: mode of response or sequence of frames. He stated that "all existing programs can be classified according to these two characteristics" (23, p. 9).

The following review of programed material is based on programs developed by two eminent authorities associated with programed instruction--Skinner and Crowder. Their programs can be classified under one of the two characteristics identified by Hughes, but no attempt was made to categorize the following programed instructional research.

Skinner Programs

The programs developed by Skinner are founded on the principle of reinforcement. Participants enter responses to a Skinner program in an appropriate place and are informed immediately of the rightness or wrongness of the response (46). This immediacy of feedback is what constitutes the reinforcing element demanded of Skinnerian programing. Skinner's programs are further referred to as linear, or straight-line, programs. The information presented in a linear program is broken into small, chronologically arranged segments of information (46). A program proceeds from very simple concepts of a subject to the more complex concepts, and each recorded response immediately is revealed as to its correctness or incorrectness. The information presented in a Skinnerian program is so constructed that at least 90 per cent of the time a respondent's response is correct (46). The efficiency of correct responses provides the needed reinforcement in a Skinner program (46).

Crowder Programs

The Crowder programs are referred to as "branching" or "intrinsic" programs (23, p. 10). Crowder suggested that his system allows for diverse ranges of educational backgrounds and more fully recognizes individual differences (10).

As a student works a Crowder program he answers multiple choice questions. The answer to a given multiple choice question is used to direct a student to new, or review, material. When a correct answer is selected, a student is directed to a certain page in the program which presents new material. An incorrect answer directs students to material in the program which explains why the selected answer is incorrect. After this review, the student is directed back to the original question, whereupon the correct selected answer directs the student to new material (10).

Learning from Programs

Possibly the earliest recorded piece of research concerned with programed instruction was conducted by J. K. Little in 1934. According to Hughes, Little's study was conducted in an education psychology class on the college level, and it compared a group taught with the conventional method to a group taught with the use of a Pressey type machine. The comparison of final examination grades in this experiment indicated a seventeen-point superiority of the experimental group over the conventional group (23, p. 43).

Since Little's research much has been written about programed instruction. The following is only illustrative of the recorded literature that is concerned with programed instruction.

In Keislar's (27) study of elementary mathematics as taught to fourth and fifth grade students, two matched groups were used. One group received instruction by the conventional method, while the other received instruction from a multiple-choice program. On the final examination the experimental group did significantly better than the control group. Porter (36) likewise reported similar results in spelling as taught to second and sixth grade students using the same technique.

Meyer (33) reported that junior high school students learned word prefixes in significantly less time with programed instructions than with the conventional method.

A study conducted in the Pittsburgh Public High Schools, which was reported by Hughes (23, p. 44), supported the contention that learning from programed materials is highly feasible. In this study, fifteen experimental groups were formed from the 400 students who participated. These groups received instruction based on regular classroom techniques, which included textbook assignments, laboratory work, classroom instruction, and the Harvey White TV films, plus a planned program. The subject in which the experiment took place was physics, and the specific topic studied was optics. The achievement test scores of the experimental groups were compared with achievement test scores of students in previous years. The experimental student groups had significantly higher achievement scores than had student groups in previous years.

Blyth (4) reported that the use of programed instruction in a university logic course resulted in two benefits: (1) students took about one-third less time to complete the course, and (2) students who used the programed material averaged higher test scores than students not using programed materials.

After comparing a linear with a branching program, Roe (39) reported no significant difference between methods but did report significant learning from the two programs.

Hively (19) reported that the use of teaching machines (mechanical adaptations of programed instructions) with pre-schoolers has great potential. He successfully used such a machine to teach pre-schoolers to make visual color discriminations.

Barcus, Hayman, and Johnson (3) conducted a study of the teaching of elementary Spanish by comparing a programed text group to a teaching machine group and a group taught with conventional techniques. The teachers in this study had varying amounts of training and experience. The authors concluded that there was no significant difference between the group taught with the conventional method and the group taught with the programed text method. However, the group taught with the teaching machine did significantly better than the other two groups. The authors also pointed out that "the level of teachers' training was directly proportional to the amount of learning from the programed texts, indicating that motivation supplied by the teacher is an important element in the students' individual work" (3, p. 271).

Cantor and Brown (5) reported that the traditional method of teaching naval electronics was inferior in certain intellectual aspects to either a punchboard tutor or a trainer-tester specially designed program. Yet in the laboratory the traditionally-taught group, in some cases, proved to be superior.

In comparing the effectiveness of a programed book and of a teaching machine in a basic course for telephone company technicians, Holt and Hammock (20) reported no significant differences between the two. In the same vein, Eigen and others (13) reported that no significant differences were found when a program was presented on a machine and when it was presented as a mimeographed, programed book.

In a study involving education students enrolled in a course on "The Contemporary Secondary School," Hough (21) reported no significant differences between pretest and posttest results of a control group taught by the lecture-discussion method and those of an experimental group taught with a teaching machine. However, a 47 per cent saving of time was realized by the group that used the programed material. Similarly, Oakes (35) reported no significant differences between test results of one-half of an "Introductory Psychology" class allowed to use a teaching machine for review and of the other half of the class not allowed to use the teaching machine. The entire class, however, was taught in the conventional manner.

Reed and Hayman (37) reported no significant overall difference in learning between a group of tenth grade English students who received instruction from a linear program and a group that received instruction in the conventional manner. However, Reed and Hayman pointed out that high-ability students did significantly better with the programed materials, while low-ability students did significantly better when taught by the conventional method. Similarly, Smith (48) reported no significant learning differences between a group of sixty-five freshmen at the U.S. Air Force Academy who were taught statistics by a programed statistics book and a like number taught in the conventional manner. The group that used the programed book, however, required less time to complete the course.

Austwick (2) revealed inferior posttest results from a group taught with a program as compared to a group taught in the conventional manner. This, he believed, was somewhat attributable to the fact that the program used was his first attempt at writing programs. On a retention test several weeks later, however, the programed group did better than the conventional group, but this difference was not significant.

Summary of Programed Instruction

In summary, programed instruction has been tested on all levels of schooling and under varying conditions. Some research reported that programed instruction is more effective than conventional teaching methods (4, 19, 23, 27, 33, 36), while other research reported no significant differences (3, 5, 13, 20, 21, 35, 37, 48). Some research on programed instruction indicated less learning (2).

Films

The use of audio-visual devices, such as television, 16 mm sound motion pictures, overhead projectors, slides, film strips, record players, and, lately, 8 mm film loops, has become common. Some of these techniques are even combined, and this practice, too, is increasing in acceptance (15, 17). Research related to the uses of television, 16 mm sound motion pictures, overhead projectors, slides, film strips, and record players is abundant. Research about 8 mm single-topic film loops, however, is limited.

Learning from Films

Numerous studies have been conducted to determine the amount of learning gained from films and the conditions under which this learning takes place (1, 8, 16, 24, 26, 28, 31, 32, 38, 41, 53, 55).

In studying the effectiveness of various ways to present a film, investigators at the Commonwealth Office of Education, Sydney, Australia (8), concluded that the silent film they prepared was superior to a "twin" sound film. This was due primarily to the face-to-face discussion and supplemental activities provided by the teacher for the students of the silent film group. Although the students in the sound film group received the same information on the film as the students in the silent film group, they had no opportunity for face-to-face discussions with the teacher. The students in the silent film group thus had an opportunity to make immediate relationships of film content to the classroom activities while the students in the sound film group did not.

Tendam (52) used 369 college students to evaluate a set of brief demonstration films used in an introductory college physics course. During the first year of the study, the students who used the films had a significantly (.01) higher posttest score than students who did not use the films. During the second year, however, there were no significant differences, and the investigators did not offer any reason for this.

In determining whether learning from a short film is, or is not, increased if filmic devices (loud noises or brightly colored arrows) are used to gain attention at important points, Noall and Winget (34) used 2,631 Army and Navy recruits. From the use of films with both sound and visual irrelevant features, it was concluded that attention gaining devices which do not add information do not increase learning.

To determine the effectiveness of various methods of training 426 trainees in the proper technique of wearing cold-weather clothing, three versions of a film were prepared. One version presented the techniques through humor; one version substituted blank film for the humorous sections of the humorous films; and one version had main titles and subheadings in place of the humorous segments. The investigator stated the following: "(1) films did teach trainees how to wear cold weather uniforms, (2) trainees learned significantly more from film with titles than from film with no titles, and (4) trainees did not learn more from non-titled versions than from the humorous version" (31, p. 292). Consequently, trainees learned more when humor was replaced with titles.

Shettel (44) indicated in his study that the use of filmed demonstrations was as effective as the live demonstration of the Air Force B47 maintenance program and that, economically, the film's ease of transportation and savings in man-power was of significant value. This demonstration had been previously conducted using elaborate and expensive models and mock-ups, and much time was spent setting these up. The author concluded that the filmed demonstration could adequately take the place of elaborate mock-ups and still achieve proper maintenance of the B47.

In assessing whether or not prior experience in viewing instructional films helped, VanderMeer stated that "the film viewing practice results in improvement of the ability to learn from other films of the same subject field" (54, p. 132). That is, if students have experienced learning from instructional films in a given subject, their chances of learning from a non-instructional film, on the same subject, is increased.

Twyford (53) stated that evidence he collected while developing a film profile supports the contention that students realize when they are learning from a film during either the first or the second viewing of a film. He determined this when 276 students viewed films and indicated how they believed: "(1) I am learning from this film, (2) I predict I will learn from this film, and (3) I like-dislike this film" (53, p. 180). Students used a film analyzer to record their responses. This was done during both the first and second viewing of a film. The correctional analysis used supported the hypothesis that students do realize when they are learning from a film.

In testing the hypothesis that dull students learned more from motion pictures than did bright students, Smith concluded from a sample study of 1,298 students in American history, world history, and general science that ". . . the correlation between intelligence and gain in information tended to be significantly different than zero. That students with high ability learned or gained more from the films than did equally intelligent students in face-to-face sections" (47, p. 255).

In determining the amount of learning acquired from repeated film showings, McTavish (32) used about 1,000 students (freshmen in college, high school chemistry students, and junior high science students). Students representing each grade level were divided into four groups. Each subgroup saw one film one time, one film twice, one film three times, and one film four times. Students took a pretest and posttest content information test based on each of the films used. McTavish concluded the following:

> The increase of learning from viewing a film a second time was significant at the .001 level; three viewings over two viewings resulted in a significance from .01 for freshmen to .05 for the junior high students. These were mean gains and were only one-fourth of the mean gains from one to two viewings. There was a slight increase in learning when four viewings was compared with three viewings. However, this was non-significant (32, p. 130).

In assessing the amount of learning of a manipulative skill, Carpenter and others (6) developed a film test to be used in place of paper and pencil tests designed to measure skill attainment. The skill tested was the removal of a power plant from a medium tank. The investigators concluded the following:

1. Motion picture tests yielded high reliability.
2. Little differences were found between paper and pencil test results and film test results.

3. Film tests are practical to administer and objectively scored, and they enable tests in areas of performance not amenable to paper and pencil tests.
4. There is no confirmation of the hypothesis that film tests would minimize the importance of verbal ability.
5. Situation tests, with the use of films, indicated an ability to discriminate among students (6, p. 43).

The use of films for testing in courses where the development and application of a manipulative skill is a major objective has interesting possibilities according to Carpenter.

Champa (7), in ascertaining the effectiveness in ninth-grade science of learning from instructional television, face-to-face demonstrations, and film presentations, concluded that students were quite favorable to using instructional television and films. No significant differences were found in achievement scores between groups. However, boys had higher test scores than girls in their respective groups.

Color versus Black and White Films

In a study investigating color versus black and white instructional films, VanderMeer stated that "some sex differences were found but overall there were no differences in learning between black and white and color films. Students preferred color to black and white films, but there was little correlation between preferring color films and learning more from color films" (54, p. 134).

Drawing a similar conclusion, Hudson (22) used ten African tribes, numbering 147 workers. Hudson made two versions of one film--one in color, the other in black and white. The ten tribes were studied for four months and this study did not substantiate the notion that color films are superior to black and white films in aiding the learning process.

In a study of 368 trainees taking electronics and photographic lessons at Port Monmouth, New Jersey, the investigators, Kanner and Rosenstein, reported that ". . . overall, the tasks to be learned were learned equally well by all participants whether or not they viewed color films or black and white ones" (25, p. 248). Out of the eleven tests, only one test showed a significant difference (.05) in favor of the color film group. A trend, however, seemed to be at work. The low-ability group tended to gain more from the color version of the film, while the high-ability group tended to gain more from the black and white version of the film.

In their study, Rosenstein and Kanner (40) used 116 enlisted men, officers, and civilians at the Ordnance Guided Missile School, Huntsville, Alabama. Of the fifteen guidance and repair lessons of Nike missiles, neither black and white nor color films resulted in any significant differences in learning. The authors concluded that there were no definite trends favoring either group nor any indications that low- or high-ability personnel learned better using either black and white or color films.

In defining the viewing parameters of a small motion picture screen, Ash and Jaspen concluded the following: "The optimum area for viewing a motion picture on a small screen was a cone sixty degrees wide (twelve screen widths) and eighteen feet deep. Performance of those who sat in this area was significantly better than that of those who sat outside this area" (1, p. 27). In the optimum viewing area the motion picture was best viewed in daylight operation. Outside of this area, however, darkness was superior. The use of 8-mm film loops makes possible the use of the sixty degree cone, in which the viewing student will be less than eighteen feet from the projected image. This type of use will enable students to view 8-mm motion picture loops in the classroom without necessitating any special darkening of the room (1).

Film Loop Research

The reported research concerned with film loop usage is limited (16, 24, 26, 28, 41, 50). This may be due to the recency of the perfection of film loops or the hesitancy of teachers to use loops because they are not familiar with them. The film loop research as presented here results from an exhaustive search of the literature.

To test the effectiveness of film loops Karsner (26) used 120 college men in a badminton course. He used the following three experimental situations: (1) explanation and demonstration of each stroke by the instructor, followed by a film loop while the instructor explained each stroke, (2) a film loop of each stroke while the instructor explained the stroke, and (3) an explanation and demonstration of all strokes by the instructor, followed by student's practice of all strokes, followed by all of the film loops while the instructor explained the strokes being projected. With the use of written pretests and posttests, motor tests, and tests of general badminton knowledge, it was concluded that ". . . the loops did not affect learning or motivation more than not using loops" (26, p. 1082.

To determine the effectiveness of typing film loops, Stein used junior and senior high school typing students. Students in the designated experimental sections were taught with the use of sixteen film loops, while the control sections were taught with face-to-face presentations. On the final, timed typewriting test of the experiment, the senior high students in the experimental group made significantly higher scores than did the students in the control sections. However, there were no significant differences between the final, timed typewriting tests of the junior high students (50).

Harby (16), in his study, believed that film loops depicting tumbling were about as effective as face-to-face demonstrations. The films used were two minutes long, and the skill to be learned from the films was tumbling. Harby suggested that mass viewing of a film was inferior to film viewings with tumbling practice interspersed between viewings.

In using film loops in a junior high woodworking laboratory, LeMaster (28) used six control and experimental groups of students. In the experimental groups, a film loop of a planned demonstration preceded the demonstration given by the instructor. In the control group, the instructor simply presented his demonstration, and students did not see the film loops. LeMaster's conclusions were "On the basis of differences in scores on the three instruments used, it was concluded that the film presentation helped pupils to learn more related technical information, helped pupils to use manipulation skills more effectively, and reduced the number of individual repeat demonstrations required of the instructor" (28, p. 165).

In his study of the audio-tutorial laboratory at Dallas County Junior College in Dallas, Texas, Russell concluded:

> While the differences between conventional methods of instruction and the audio-tutorial system do not differ in most respects, additional studies need to be made, especially with respect to the internal functioning of the audio-tutorial system itself (41, p. 100).

Russell also indicated that although the use of film loops is increasing, no objective evaluations of this media have been made (41, p. 8).

Welser, at Purdue University's Research Foundation, is investigating single-topic film loops in terms of their effectiveness as a review aid, and their worth as a substitute for prosected and/or fresh dissected materials. This investigation is being conducted in the veterinary medicine department at Purdue, and at this writing the project had yet to be completed (56).

Kallan and Mooney, in a project conducted at El Camino Junior College, El Camino, California, reproduced segments of a 16-mm chemistry film onto 8-mm film loops, and they made these available to students in the library as an independent study aid. The showing time of the loop films ranged from nineteen to twenty-four minutes, and their use as a study aid was helpful (24).

In his study using "Teacher Produced Instructional Films for Group Presentations in Teaching Perceptual Motor Skills," Snyder reported that ". . . the use of films provided magnification of minute details as an important factor in teaching a perceptual motor skill to students in industrial arts" (49, p. 507).

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CHAPTER III

METHODS AND PROCEDURES

Course Title and Course Description

The title of the course in which the study was conducted was Industrial Arts 236, entitled General Welding, at North Texas State University, Denton, Texas. This course is one of seven courses in metalworking available to students majoring in industrial arts. The overall objective of this course was to provide experiences which would enable students to develop skill in metallic arc and oxy-acetylene gas welding and to attain a knowledgeable background of these welding processes. The one prerequisite for this course was completion of Industrial Arts 122, Basic Metals. Previous welding experience was not a requirement for enrollment in this course.

The total length of the course was six weeks during the summer session and eighteen weeks during the fall and spring semesters. During the summer session, class periods were held for three hours each day, five days a week, for a total of ninety class hours. The fall and spring semester classes met according to one of two class plans: (1) if the class met as a Monday, Wednesday, and Friday class, the class periods were two hours in length for a total of 108 hours for the semester, or (2) if the class met as a Tuesday, Thursday class, the class periods were three hours in length for a total of 108 hours for the semester. A break was made available during each class session.

The subject matter content of the class was planned to provide students with technical knowledge of, and skill in, oxy-acetylene gas welding and metallic arc welding. Included in the course were provisions for students to learn the proper procedures required of the welding equipment used, to solve various welding problems, to ascertain the welding process best suited to various welding situations, and to provide the opportunity for students to visit industrial welding firms.

The course was divided into two major divisions of instruction: (1) metallic arc welding and (2) oxy-acetylene gas welding. The division of instruction in which the study was conducted was metallic arc welding, referred to in the remainder of the study as arc welding.

The arc welding division was subdivided into five specific class activities, including (1) making proper settings of an electric arc welding machine, (2) making various welds using differing joint construction, (3) studying the various properties of metals, (4) using supportive arc welding equipment such as grinders, and (5) exercising proper operation of arc welding equipment.

Required Welds

Each student in the study was required to make one each of these four welds: (1) square-edge butt weld, (2) flat-t fillet weld, (3) positioned-t fillet weld, and (4) 30 degree, single-bevel, single-"v" butt weld.

These welds are defined as follows:

Square-edge butt weld.--A square-edge butt weld is made when two pieces of metal are placed within one-eighth inch of one another, as illustrated in Figure 1. This type of

Fig. 1--Square edge butt weld

weld does not require that the metal pieces be of the same thickness, nor do the welded edges require special edge preparations such as being ground to a specified angle on a grinder. The square-edge butt welds made in this study were made from pieces of metal having the same thickness, and special edge preparations were not required. During welding, only one pass with the electrode was necessary. When welded, one half of the weld bead (molten base metal and added molten electrode) should have appeared in one piece of metal, and the other half of the bead should have appeared in the other piece of metal.

Flat-t fillet weld.--A flat-t fillet weld is made when two pieces of metal are placed at right angles to each other, as illustrated in Figure 2. This type of weld does not

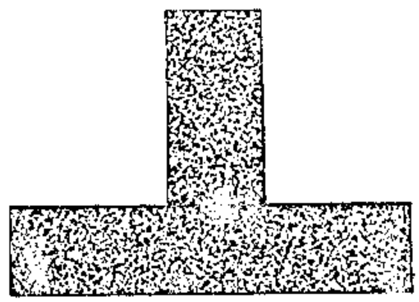

Fig. 2--Flat-t fillet weld

require that the metal pieces be of the same thickness, nor do the welded edges require special edge preparations such as being ground to a specified angle on a grinder. The flat-t fillet welds made in this study were made from pieces of metal having the same thickness, and special edge preparations were not required. During welding, only one pass of the electrode was necessary. When welded, one half of the weld bead should have appeared in the horizontal piece, and the other half of the bead should have appeared in the vertical piece. The weld bead of this joint is laid in the corner of the two pieces of contracted metal in a plane parallel to a table top.

Positioned-t fillet weld.--A positioned-t fillet weld is the same as a flat-t fillet weld except that the bead is laid in a plane which is at an angle to the table top. This is referred to as "down hand" welding. This type of weld does not require that the metal pieces be of the same thickness, nor do the welded edges require special edge preparations such as being ground on a grinder to a specified angle.

30-degree, single-bevel, single-"v" butt weld.--The 30-degree, single-bevel, single-"v" butt weld is similar to the square-edge butt weld in that the two pieces to be welded are placed within one-eighth inch of one another. The two pieces of this weld, however, are ground on a grinder to form a 30-degree angle, as illustrated in Figure 3. This

Fig. 3--30-degree, single-bevel, single-"v" butt weld

type of weld does not require that the metal pieces be of the same thickness; however, this weld does require special edge preparation. The 30-degree, single-bevel, single-"v" butt welds made in this study were made from metal pieces of equal thickness. This style weld required more than one (usually three) pass of an electrode to complete the weld. The first pass of an electrode should join the pieces together. Half of the first bead should appear in one piece of metal, while the other half should appear in the other piece of metal. The second pass, if used, of an electrode should be deposited equally between one piece of metal and the first pass. The third pass, if used, of an electrode should be deposited equally between the remainder of the first bead and the other piece of metal.

Each student was required to turn in one of each of the described welds. Each student selected one required set of welds from the total welds he had attempted. For example, if a student attempted a square-edge butt weld nine times, he was allowed to select the one square-edge butt weld he wanted to have evaluated. This selection procedure was used for all welds by all students. Each student's complete set of four welds was evaluated by a five-member jury of welding experts.

No limitations were placed on the number of welds attempted by any of the students, but those welds which were not completed or selected by the students for evaluation were not collected.

The Pilot Study

A pilot study was conducted during the fall semester of 1968. The purpose of this miniature study was to develop the criterion test and programed instructional booklet, and to establish the best procedure for using the film loops and projectors.

The criterion test was administered to students in the pilot study in order to ascertain the clarity of the questions. Those test items with more than one plausible answer were restated to eliminate such duplicity of answers. Those items that appeared ambiguous also were restated to eliminate the ambiguity. The test was not ready for statistical treatment at this time.

The programed instructional booklet was treated in a manner similar to the criterion test. The program was written, typed, and duplicated on eight and one-half inch by eleven inch paper. This arrangement required the use of a mask to conceal the correct response until the student had responded. The mask proved to be clumsy and unworkable, and the booklet later was altered to exclude the need for a mask. As students worked with the program, two suggestions were offered: (1) include drawings and charts and (2) include additional technical information for clarity and continuity. These items were included in the revision of the booklet.

After the format of the programed booklet had been changed and the suggested modifications made, two welding instructors at North Texas State University, Denton, Texas, reviewed the booklet and offered suggestions for improvement. The program was revised again to incorporate these suggestions and reviewed a second time by the welding instructors. The final review indicated that the program was ready for use in the study.

The most feasible procedure for using the film loops and projectors was determined from observations of students using these devices. Two benefits were realized from these observations: (1) projector cords should be kept off the floor and (2) this equipment could be adequately stored on a three-deck moveable cart.

The experience gained from the pilot study greatly aided the administration of the final study. The suggestions and recommendations derived from this small study were incorporated into the final study.

Description and Development of the Criterion Test

The test used in this study was developed from three sources of information pertaining to metallic arc welding: (1) the instructional content of the first four weeks of the general welding course at North Texas State University, Denton, Texas, (2) a test written by a welding instructor at Eastern New Mexico University, Portales, New Mexico, and (3) classroom tests written by a welding instructor at North Texas State University, Denton, Texas.

The final criterion test was composed of seventy-eight items, which were divided into two sections. Section one, items one through thirty-two, were multiple choice items with four plausible answers, while the second section, items thirty-three through seventy-eight, were true-or-false items.

According to Micheels and Karnes (5, p. 102), a good test must be valid, reliable, objective, discriminative, comprehensive, and easy to administer. In order to meet these criteria of a good test, the following procedures were used.

Validity

Two kinds of validity were identified as necessary: (1) curricular validity and (2) statistical validity. Curricular validity means that a test represents the objectives of the curriculum studied by the students (2, p. 379). Curricular validity was established by having four full-time staff members of the Industrial Arts Department, North Texas State University, Denton, Texas, review the test to assess how well the test reflected the objectives of the general welding course. The four instructors expressed agreement that the test did reflect adequately the objectives of the general welding course.

Statistical, or empirical, validity involves collection and analysis of test data. The data were collected from an administration of the test to those students completing the general welding course during the spring semester of 1969. Forty-three students took the criterion test (M = 63, S.D. = .97). At the close of the spring semester, the criterion test results were converted to letter grades on a five-point scale (M = 3, S.D. = 77) and were correlated with the students' final course grades on a five-point scale (M = 3.6, S.D. = 1.11). Using the Pearson product-moment correlation method (2, p. 275), the validity coefficient was found to be *r* = .34. Using Garrett's "Table of Values of *r*" (3, p. 466) with forty-one degrees of freedom, *r* was significant at better than the .05 level. This significance indicated that the relationship between what the test was intended to measure and what it did measure was significantly different from zero. Borg (1, p. 280) stated that "statistical significance when referred to a correlation usually describes whether or not the correlation obtained is different from a zero at a given level of confidence. If the correlation is not significantly different from zero then it must be assumed that no relationship exists between variables."

Reliability

The reliability coefficient of the criterion test was determined from the same data which was used to determine the validity coefficient. Results of test scores also were obtained from the advanced welding class students. By using this class, the N value was increased from 41 to 59. The split-half technique was used to determine the coefficient of reliability. The test results were split into odd-numbered answers and even-numbered answers. The odd-numbered answers (M = 28.59, S.D. = 3.7) were correlated with the even-numbered answers (M = 30.89, S.D. = 11.3). Using the Pearson product-moment correlation method (3, p. 275), the reliability coefficient was found to be *r* = .74. Using Garrett's "Table of Values of *r*" (3, p. 466) with 59 degrees of freedom, *r* was found to be significant at better than the .01 level. However, Cronbach (2, p. 131) suggested applying the Spearman-Brown prophecy formula to the coefficient of reliability derived from the split-half method of determining *r*. This, Cronbach said, would compensate for the shortness of the two half-tests used. After applying the Spearman-Brown prophecy formula to the coefficient of reliability, *r* = .74, the resultant coefficient was found to be r_{12} = .85. Using Garrett's "Table of Values of *r*" (3, p. 466) with 59 degrees of freedom, r_{12} was significant at better than the .001 level. Accordingly, Borg (1) pointed out that an *r* which is statistically significant can be interpreted as having a relationship which is significantly different from zero.

Objectivity

A properly designed test should be objective, and "it must be fair to the students" (5, p. 102). The objectivity requirement of this test was met because the test content was based on material to which all students had been exposed.

Discrimination

Good test items will differentiate between good students and poor students (5, p. 102). An item analysis discrimination count was conducted, and this count revealed which items should be excluded due to the frequency of correct responses by poor students and the frequency of correct responses by superior students.

Comprehensiveness

In order to sample adequately student knowledge about a given topic, a test should be long enough to provide breadth of the topic being tested. As stated by Micheels and Karnes, a test ". . . must be long enough to do the job" (5, p. 102). Although there are no set rules as to how long a test should be, the criterion test was composed of seventy-eight items.

Ease of Administration

The test was made up of six stapled pages thus making the ease of administration quite simple. The instructors passed out the tests and answer sheets, and students recorded their answers by circling the selected letter on the answer sheet and coloring in the circle. This procedure made possible the use of a cut-away answer key for scoring the tests. The length of time required for scoring was one minute per answer sheet. Students required a maximum of forty-five minutes to take the test.

Standard Error of a Score

In addition to satisfying the preceding test criteria, the standard error of a test score was computed. The standard error of a test score provides a more precise idea of the stability of a score than does the coefficient of reliability alone (3, p. 393). The standard error of a test score on the criterion test was 1.78, indicating that a test score would not miss its true theoretical score by more than ±1.78 points.

The criterion test was used in the study as the pretest, posttest, and retention test.

Description and Development of the Programed Booklet

The programed booklet used in the study was developed from the instructional content taught during the first four weeks of a normal semester and was a revision of the initial program used in the pilot study. The program contained fifty-nine frames, and it was titled "Beginning Arc Welding, A Programed Text." The program had two characteristics: (1) it was linear, and (2) it was a source of instructions. The content of the program was broken down into small, chronologically arranged segments of information. Students entered their responses in a space following each question, and they were informed immediately of the accuracy of their response. At times, students were required to leave the programed booklet and obtain information or perform a manipulative task outside of the booklet. Thus, the program was linear in presentation of content and instructional when indicating to students when to obtain information or perform tasks outside of the program.

When students were instructed to leave the program, it was for the purpose of putting into practice the information completed in the program. As an example, upon completion of the fifty-first frame of the program, students were directed by instructions to obtain instruction sheet number one from their instructor. This instruction sheet explained in specific terms where the metal for the first weld was to be obtained, what special preparations of the metal were required, what should be accomplished, what film loops should be viewed (if applicable), and what should be done upon completion of a particular manipulative task. These instruction sheets were used in all four groups, and samples of these sheets are found as Appendix D.

The programed text format was of a "flip page," straight-line configuration. The frames were presented on the right hand pages, and the accompanying questions, with space for answers, were presented immediately under the frames. The answers to the questions were on the back of a page in use. Students "flipped" a page to check answers. The pages in the program were numbered consecutively, and, on twenty-five of thirty-four pages, two frames plus a question and response space were printed one above the other. The frames were numbered consecutively, and frames one through thirty-four appeared on the upper half of the pages, while frames thirty-five through fifty-nine were presented on the lower half of the pages. This particular format was selected for two reasons: (1) to prevent clues from being discovered in the next frame in the program which could be used in answering a present frame, and (2) to eliminate the need for a mask. Students worked all the way through the booklet, responding to the frames presented on the upper half of the pages. Upon completion of frame thirty-four, page sixty-seven, students were directed back to frame thirty-five, page one to continue with the program. Sample pages of the programed booklet are presented as Appendix C.

Description and Development of Arc Welding Film Loops

The set of film loops used in the study was produced by The Jam Handy Organization, Detroit, Michigan. The complete set of films consisted of fourteen film loops, of which only the first seven film loops were used in the study. The titles of the film loops used were (1) Starting the Arc, (2) Padding a Plate, (3) Square-Edge Butt Weld, (4) Flat-t Fillet Weld, (5) Positioned-t Fillet Weld, (6) Thirty-Degree "v" Butt Weld, Part One, and (7) Thirty-Degree "v" Butt Weld, Part Two. The films were produced on super eight millimeter, silent, color film. Superimposed on several films were diagrams depicting the movement of the electrode being shown and/or the current setting used on the type of weld being shown. The average showing time of the film loops was two and one-half minutes. The production of the film loops was done under the direction of a certified welding instructor.

The film loops were provided on a loan basis from The Jam Handy Organization, without whose help the study would not have been possible.

Development and Description of the Attitude Scale

A fifteen-item attitude scale was developed to investigate student attitude toward the various instructional techniques used. The scale was a Likert-type summated scale (7, p. 366). The students responded to each item by using one of the following responses: (1) Strongly Agree, (2) Agree, (3) Undecided, (4) Disagree, and (5) Strongly Disagree. Student responses were recorded on machine-scorable answer sheets. Data obtained from the attitude scale are presented in Chapter IV. A copy of the scale is listed as Appendix B.

Description and Development of Miscellaneous Instruments Used

Instruction Sheets

The instruction sheets used in the study were developed as a source of information for students to use to go from one activity to another and back again. Three sets of instruction sheets were prepared: (1) one set was used in groups one and two, (2) a different set was used in group three, and (3) a third set was used in group four. The need for different sets of instruction sheets was due to the varying techniques used in the groups. A set of sample instruction sheets used in the study is listed as Appendix D.

Student Information Sheets

Student information sheets were prepared and used to identify those students who had prior experience in the area of arc welding. Those students with prior experiences were allowed to participate in class activities; however, the data from these students were not used. A copy of a student information sheet is listed as Appendix E.

Judge's Rating Sheets

To assist the judges in evaluating welds, a rating sheet was prepared. This sheet was used to provide consistency of weld evaluations throughout as well as convenience to the judges. A copy of a rating sheet is listed as Appendix F.

Student Time Sheets

When students completed the four required welds, they indicated on a time sheet the date that the welds were completed. When the time sheets had been collected, the number of days required to complete the welds were converted into hours for statistical purposes. A copy of a student time sheet is listed as Appendix G.

Methods and Procedures for Collecting and Treating the Data

The Soloman four-group design was used to conduct the study, which was concerned with comparing the effectiveness of four different techniques used in teaching the first, four-week instructional unit of the course, general welding at North Texas State University, Denton, Texas. Experimental group one received instruction using single-topic film loops, programed instructions, lectures, and demonstrations. Experimental group two received instruction using single-topic film loops and programed instruction. Experimental group three received instruction using single-topic film loops, lectures, and demonstrations. Experimental group four received instruction using lectures, demonstrations, and programed instructions. Both the students participating in the study and the procedures used for collecting and treating the data will be described briefly on the following pages.

Students Participating in the Study

The participants were students who took Industrial Arts 236, General Welding, to meet degree requirements. Group one, group two, and group four completed the general welding course during the September 19, 1969 to January 27, 1970 period. Group three completed the general welding course during the June 4, 1969 to July 11, 1969 period. Students were allowed to register on an individual basis, and no attempt was made during registration to match groups. Therefore, intact groups were used in this study.

Procedures for Collecting the Data

During the first class day in each group, each student completed a student information sheet, which has been discussed previously. The criterion test was administered upon collection of the student information sheets. The information sheets revealed which student data should be eliminated from the study, and the criterion test results were used for two purposes: (1) as a means of matching groups on a non-significant difference of group means and (2) as a pretest measure. These test results also were necessary in evaluating the tenability of Hypotheses I-A, I-B, I-C, I-D, II-A, II-B, and II-C. Upon completion of this administration of the criterion test, students were excused from class until the next class period.

During the second class day in each group, each student received the various materials used in the different groups.

An instructor was present all of the time in each of the groups. Also, students were neither encouraged nor discouraged from offering assistance to one another on the techniques of arc welding. Close observation by instructor was maintained to ensure that the welds turned in were completed by the student.

Group one.--The eighteen students in this group received instruction using lectures, demonstrations, programed materials, and single-topic film loops. The instructor gave a programed booklet to each student and assigned four students to a projector and film loop set. This same group of four students was divided into two two-member units, and these student units were assigned the use of a specific arc welding machine. This was followed by a lecture and demonstration by the instructor of the first manipulative task required of the students. The students then completed the first fifty-one frames of the programed booklet and requested instruction sheet one, which has been described previously. The remainder of the instructional unit was conducted in a similar manner.

A record was kept by each student of the starting and stopping dates needed to complete the four welds. The stopping dates that occurred prior to the end of the instructional unit were dependent on acceptability of welds as determined by the instructor. At no time were students allowed to use the welding laboratory at times other than when their particular class met.

After the instructional unit was completed, the posttest was administered to determine how much technical information was learned. A retention test (the same as the pretest and posttest) was administered four weeks after the completion of the instructional unit. Students spent the time between the posttest and the retention test doing additional welding as prescribed by the course outline. However, the basic information taught during the instructional period was not retaught. After the posttest was administered, all students responded to an attitude scale, which has been described.

Group two.--The seventeen students in this group received instruction using single-topic film loops and programed instructions. The instructor gave a programed booklet to each student and assigned four students to a projector and film loop set. This same group of four students was divided into two, two-member units, and these student units were assigned the use of a specific arc welding machine. Each student then completed the first fifty-one frames of the program and requested instruction sheet one.

Students in group two worked with the programed instruction booklet, film loops, and instruction sheets, and the instructor was free to circulate around the laboratory and offer assistance when needed. A record was kept by each student of the starting and stopping dates needed to complete the four welds. The stopping dates that occurred prior to the end of the instructional unit were dependent on acceptability of welds as determined by the instructor. At no time were students allowed to use the welding laboratory at times other than when their particular class met.

After the instructional unit was completed, the posttest was administered to determine how much technical information had been learned. A retention test was administered four weeks after the completion of the instructional unit. The time between the posttest and the retention test was spent by students doing additional welding as prescribed by the course outline. However, the basic information taught during the instructional period was not retaught. After the posttest was administered, all students responded to an attitude scale.

<u>Group three</u>.--The ten students in this group received instruction using single-topic film loops, lectures, and demonstrations. The instructor presented lectures and demonstrations and had students view film loops related to the presented lectures or demonstrations. Students were assigned to projectors and welding machines in the same manner as were the students in groups one and two. Each student in this group also made four welds, took a pretest, posttest, retention test, and attitude scale, and kept a time record.

<u>Group four</u>.--The eleven students in this group received instruction using lectures, demonstrations, and programed instructions. The students worked the first fifty-one frames of the program and received a lecture and demonstration related to the information in the program. Once again, instruction sheets were used whereby students knew whether to work in a booklet, make a weld, or request a lecture or demonstration. As was the case in groups one, two, and three, students were assigned to welding machines, made the four required welds, took a pretest, posttest, retention test, and attitude scale, and kept a record of time.

To summarize the processes of gathering the data, the following events took place in each of the four groups:

1. Students filled in student information sheets.

2. Instructor administered pretest at start of instructional period.

3. Students received instruction by the technique used in their particular group.

4. Instructor collected welds to be evaluated.

5. Instructor administered posttest at end of instructional period.

6. Instructor administered attitude scale after posttest.

7. Instructor administered retention test four weeks after posttest.

These data were posted to IBM Keypunch Worksheets. Student names were arranged in alphabetical order within each group. Each student's name then was assigned a corresponding number, the first name on the list being assigned number one, the second number two, and so on through all student names in each group. A letter represented the method used (A, B, C, or D) and preceded each name. This coding made it possible to identify the group in which any student in the study had participated.

Once all the data were entered on the worksheet they were punched into IBM cards for treatment by the Computer Center, North Texas State University, Denton, Texas. The treatment of these data is described in the following paragraphs.

Procedures for Treating the Data

The tenability of the hypotheses of the study were determined from the data collected from students of the four groups. The statistical analysis used with these data was simple analysis of variance. In order to meet the requirement of testing hypotheses with simple analysis of variance, the research hypotheses were restated as null hypotheses, and the statistical hypotheses of no significant differences were rejected at the 5 percent level for groups one, two, and four, and the 2 percent level for group three.

To determine if there were any significant differences in the four groups concerning each student's level of information about arc welding before the study began, a check was conducted using the group means of the pretest. A test of the significance of the differences of pretest means was performed with the use of simple analysis of variance with procedures as defined by Garrett (3, pp. 253-264), using the following formula:

$$F = \frac{MS_{bg}}{MS_{wg}}$$

F = the ratio which determines whether a t test should be computed.

MS_{bg} = mean of the squares between groups.

MS_{wg} = mean of the squares within groups.

The level of significance for the F ratio was obtained from Underwood and others (8, pp. 233-234) and from McNemar (4, pp. 431-433).

The next step consisted of determining the significance of the mean gain within each group from the pretest to the posttest. This was the test of Hypotheses I-A through I-D. The test of significance used was Fisher's *t* ratio as defined by Underwood and others (8, pp. 165-166) and by McNemar (4, pp. 81-82), and was performed using the following formulas:

$$\underline{t} = \frac{M_1 - M_2}{S_{M_D}}$$

M = mean of pretest scores. d.f. = N - 1.

M = mean of posttest scores.

S_{M_D} = standard error of the difference between correlated means.

$$S_{M_D} = \sqrt{S_{M_1}{}^2 + S_{M_2}{}^2 - 2\underline{r}_{12}\, S_{M_1} S_{M_2}}$$

S_{M_D} = standard error of the difference between correlated means.

S_{M_1} = standard error of the mean of one group.

S_{M_2} = standard error of the mean of the other group.

$\underline{r}_{12}$ = the Pearson product-moment correlation coefficient between the two measures.

The level of significance for the *t* ratio was obtained from Underwood and others (8, p. 230) and from McNemar (4, p. 430).

Hypotheses II-A through II-F, III-A through III-C, and IV-A through IV-C, were all tested with the use of simple analysis of variance with procedures as defined by Garrett (3, pp. 253-264), and by using the following formula:

$$F = \frac{MS_{bg}}{MS_{wg}}$$

Where:

F = the ratio which indicated whether *t* tests should be computed.

MS_{bg} = mean of the squares between groups.

MS_{wg} = mean of the squares within groups.

The level of significance for the F ratios was obtained from Underwood and others (8, pp. 233-234), and from McNemar (4, pp. 431-433).

In testing Hypotheses II-A through II-F, III-A through III-C, and IV-A through IV-C, the statistical computational results had to reach the .02 level of significance when group three data were used for rejection of the null hypotheses. The purpose of this control was due to the time that group three students had for participation in the study. During the summer session, the total available elapsed time for students of group three from the pretest to the retention test was six weeks, while the total available elapsed time for groups one, two, and four, during the fall semester, was eight weeks. All students completed the instructional unit (from the pretest to the posttest) in twenty-four clock hours. Therefore, when data of group three were compared with data from groups one, two, or four, the level of significance used for rejection of the null hypotheses was the .02 level rather than the .05 level.

A graphic summary presentation of the methods used for collection of the data is depicted in Table I.

TABLE I

SUMMARY PRESENTATION OF THE METHODS OF COLLECTING THE DATA USED IN THE STUDY

Hypotheses	Technique of Data Collection	Comparisons Made
I-A through I-D Mean gain within groups from pretest to posttest	Pretest to posttest means	Pretest to posttest within group one
		Pretest to posttest within group two
		Pretest to posttest within group three
		Pretest to posttest within group four
II-A through II-C Mean gain between groups from pretest to posttest	Pretest to posttest means	Group one with groups two, three, and four
		Group two with groups three and four
		Group three with group four
II-D through II-F Mean gain between groups from posttest to retention test	Posttest to retention test means	Group one with groups two, three, and four
		Group two with groups three and four
		Group three with group four

TABLE I--*Continued*

Hypotheses	Technique of Data Collection	Comparisons Made
III-A through III-C Means of the weld scores between groups	Means of weld scores	Group one with groups two, three, and four Group two with groups three and four Group three with group four
IV-A through IV-C Means of time, in hours, to meet weld criterion	Time means	Group four with groups one, two, and three Group three with groups one and two Group two with group one

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CHAPTER IV

PRESENTATION OF THE DATA

Introduction

An analysis of the data was made to determine the effectiveness of four instructional techniques of teaching the first four-week unit of metallic arc welding at the university level. The four combinations of teaching techniques investigated were (1) lectures and demonstrations plus single-topic film loops plus programed instruction used by students in one class designated as group one; (2) single-topic film loops plus programed instruction used by students in one class designated as group two; (3) single-topic film loops plus lectures and demonstrations used by students in one class designated as group three; and (4) lectures and demonstrations plus programed instruction in one class designated as group four. A total of fifty-six students participated in the study. Group one consisted of eighteen students, group two consisted of seventeen students, group three consisted of ten students, and group four consisted of eleven students.

The tenability of the hypotheses of the study as set forth in Chapter I was determined from a statistical analysis of the collected data. The data, collected from the students of the four groups, were punched into IBM cards, and computations were made by the Computer Center, North Texas State University, Denton, Texas. The research hypotheses were restated in the null and were rejected at the .05 level.

Before the study began, a check was made to determine if there were any significant differences in the level of student information about arc welding between the four groups. Once this determination was made, the first statistical analysis of the data concerned the mean gain scores within each group from the pretest to the posttest; the second and third analyses concerned the mean gains between groups from the pretest to the posttest, and from the posttest to the retention test; the fourth analysis concerned the mean difference between groups of the scores on the welds made by the students in each group; and the fifth analysis concerned the mean time in hours between the groups to meet the weld criterion. An attitude scale was administered to the students in each group, and these results are presented at the end of this chapter.

Comparisons of the Level of Information of Arc Welding of the Students in Each Group Before the Study Began

The first analysis of the data was to determine if there existed any significant differences in the level of knowledge of arc welding of the students in the four groups before the study began. This check was made using pretest means. A comparison of the means and standard deviations of each group on the pretest is presented in Table II.

TABLE II

MEANS AND STANDARD DEVIATIONS OF THE PRETEST SCORES USED TO DETERMINE THE STARTING LEVEL OF ARC WELDING KNOWLEDGE OF STUDENTS IN THE FOUR GROUPS

Groups	N	Pretest Mean	Pretest S.D.
One	18	52.33	5.79
Two	17	52.64	5.64
Three	10	53.10	7.31
Four	11	50.72	3.13

Table II presents the pretest means of students in each group. The technique of simple analysis of variance was used as the test of the significance of the differences between the means of the four groups on the pretest.

Table III is a summary of the results of the simple analysis of variance used to match the four groups on a non-significant difference of group means.

TABLE III

SUMMARY OF SIMPLE ANALYSIS OF VARIANCE COMPARING THE PRETEST MEANS OF THE STUDENTS IN THE FOUR GROUPS

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	Level of Significance
Between	35.52	3	11.84	.34	NS
Within	1788.98	52	34.04		
Total	1824.50	55			

The F ratio required for significance with 3 and 52 degrees of freedom associated with the numerator and denominator, respectively, is 2.78 at the 5 percent level. As indicated in Table III, a value of F = .34 was obtained. Using the allowed degrees of freedom, the F value was not significant. Thus the differences of the pretest means of the students in the four groups were not significant and the probability that the four groups were not significantly different on the basis of arc welding knowledge was validated.

In summary, the technique of simple analysis of variance was used as the test of the significance of the differences between the four groups on the pretest means. The results confirmed the belief that the students in the four groups did not differ significantly in familiarization with the content of the instructional unit.

Mean Gain Scores

The second analysis of the data involved a comparison of the mean gain scores within each of the four groups. This comparison resulted in the calculation of the mean of the pretest and posttest in each of the four groups. The mean gain score was the difference between the means of the pretest and the posttest. A summary of these data is presented in Table IV.

Table IV includes the means, standard deviations, mean gains, $\underline{t}$ values, and levels of significance of difference of the pretest and posttest within each group.

TABLE IV

MEANS, STANDARD DEVIATIONS, MEAN GAINS, t VALUES, AND LEVELS OF SIGNIFICANCE OF EACH GROUP

Groups	N	Pretest		Posttest		Gain		t Value	Level of Significance
		Mean	S.D.	Mean	S.D.	Mean	SDM*		
One	18	52.33	5.79	59.77	4.19	7.44	5.36	5.71	.01
Two	17	52.64	5.64	60.76	5.83	8.11	3.86	8.40	.01
Three	10	53.10	7.31	60.40	3.82	7.30	5.62	3.89	.01
Four	11	50.72	3.13	57.90	5.77	7.18	5.16	4.39	.01

*Standard error of the difference between correlated means.

A test of the significance of the mean gain score within each of the four groups was computed using the *t* test of the significance of difference between correlated means. The purpose of this test was to determine if the mean gains of the students in the four groups were significantly different from zero. A summary of these results is presented in Table IV.

Table IV contains the *t* value and level of significance of the obtained *t* value within each of the four groups of the mean gain scores from the pretest to the posttest. The *t* value of each of the four groups was significant at the .01 level. It was concluded that the mean gain score in each of the four groups was significantly different from zero, and that other comparisons utilizing the mean gain scores would be suitable.

Summary of the Mean Gain Scores Within Each of the Groups

Research hypotheses I-A, I-B, I-C, and I-D were accepted as stated. The mean gain scores within each of the four groups were significantly different from zero. The level of the significance of the mean gains was the .01 level, and the t test of the significance of the difference between correlated means was the statistical treatment used with this set of hypotheses. From this analysis, it was concluded that other comparisons utilizing the mean gain scores would be suitable.

Comparisons of the Mean Gain Scores Between the Four Groups from the Pretest to Posttest

Hypotheses II-A, II-B, and II-C were stated as follows: "When tested by greater mean gain, group one will make a significantly greater mean gain from the pretest to the posttest than will group two, group three, or group four; group two will make a significantly greater mean gain from the pretest to the posttest than will group three, or group four; and group three will make a significantly greater mean gain from the pretest to the posttest than will group four." The criterion for this hypothesis was the mean gain score from the pretest to the posttest between the four groups. The technique of simple analysis of variance was used as the test of the significance of the differences between the mean gain scores of the four groups. A summary of these results is presented in Table V.

TABLE V

SUMMARY OF SIMPLE ANALYSIS OF VARIANCE COMPARING THE MEAN GAIN SCORES OF THE FOUR GROUPS FROM PRETEST TO POSTTEST

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	Level of Significance
Between	7.77	3	2.58	.09	NS
Within	1381.94	52	26.57		
Total	1389.71	55			

The F ratio required for significance with 3 and 52 degrees of freedom associated with the numerator and denominator, respectively, is 2.78 at the .05 level. As indicated in Table V, the F Value was not significant at the .05 level.

Since the obtained F ratio was found to be non-significant, the null hypothesis that there would be no significant differences between the mean gain scores of the four groups from the pretest to the posttest could not be rejected. Therefore, it was concluded that there were no significant differences between the four groups in terms of the mean gain scores from the pretest to the posttest and the appropriate research hypotheses were rejected.

Comparisons of the Mean Gain Scores Between the Four Groups from the Posttest to the Retention Test

Hypotheses II-D, II-E, and II-F were stated as follows: "When tested by greater mean gain, group one will make a significantly greater mean gain score from the posttest to the retention test than will group two, group three, or group four; group two will make a significantly greater mean gain score from the posttest to the retention test than will group three or group four; and group three will make a significantly greater mean gain score from the posttest to the retention test than will group four." The criterion for this hypothesis was the mean gain score between the four groups from the posttest to the retention test. The technique of simple analysis of variance was used as the test of the significance of the differences between the mean gain scores of the four groups. A summary of the results is presented in Table VI.

TABLE VI

SUMMARY OF SIMPLE ANALYSIS OF VARIANCE COMPARING THE MEAN GAIN SCORES OF THE FOUR GROUPS FROM THE POSTTEST TO THE RETENTION TEST

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	Level of Significance
Between	109.05	3	36.35	2.63	NS
Within	703.93	51	13.80		
Total	812.98	54*			

*The df figure was reduced by one as one student withdrew from school between time of posttest and retention test.

The F ratio required for significance with 3 and 51 degrees of freedom associated with the numerator and denominator, respectively, is 2.78 at the 5 percent level.

As indicated in Table VI, the F ratio was not significant at the .05 level. Although the F ratio was not significant at the .05 level, *t* values between combinations of groups were computed due to a difference of only .15 of 1 point of the obtained F ratio from being significant at the .05 level.

When group one was compared with groups two, three, and four, there were no significant differences. When group two was compared with group three, a *t* value of -2.67 was found. The obtained *t* value was significant at the .02 level but in favor of group three an not group two, as hypothesized. It was inferred that the single-topic film loops plus lectures and demonstrations teaching technique produced a greater mean gain from the posttest to the retention test than the hypothesized teaching technique of single-topic film loops plus programed instruction. Thus, the null hypothesis for this comparison could not be rejected, yet the research hypothesis, as stated, could not be accepted. When group three was compared with group four there was not a significant difference between the two groups.

Summary of Mean Gain Scores

Research Hypotheses II-A, II-B, and II-C were rejected as stated. The null hypotheses of no significant differences were not rejected. Research Hypotheses II-D, II-E, and II-F were rejected as stated. However, a significant difference between groups two and three existed and the null hypothesis for this comparison could not be rejected; yet the research hypothesis, as stated for this comparison, could not be accepted.

The significance of the differences between the mean gain scores of the four groups was determined from simple analysis of variance which provided an F ratio. The obtained F ratio was not significant, however, a *t* value between groups two and three was significant at the .02 level.

Comparisons of the Means of the Scores of the Four Welds Evaluated by the Judges

Hypotheses III-A, III-B, and III-C were stated as follows: "When the required welds are evaluated by the judges, group one will show a significantly greater mean score of the four welds than will group two, group three, or group four; group two will show a significantly greater mean score of the four welds than will group three, or group four; and group three will show a significantly greater mean score of the four welds than will group four." The criterion for these hypotheses was the mean score of the welds of the four groups derived from the scores awarded by the jury. The technique of simple analysis of variance was used as the test of the significance of the differences between the weld mean scores. A summary of the results is presented in Table VII.

The F ratio required for significance with 3 and 52 degrees of freedom is 2.78 at the .05 level. The obtained F ratio of 1.36 was not significant at the .05 level.

TABLE VII

SUMMARY OF SIMPLE ANALYSIS OF VARIANCE COMPARING THE MEAN SCORES OF THE WELDS OF THE FOUR GROUPS

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	Level of Significance
Between	455.93	3	151.98	1.36	NS
Within	5816.63	52	111.86		
Total	6272.56	55			

Since the obtained F ratio was found to be non-significant, the null hypothesis that there would be no significant differences between the mean scores of the four groups on the four welds could not be rejected. Therefore, it was concluded that there was a non-significant difference between the mean weld scores of the students in the four groups and the appropriate research hypotheses were rejected.

Summary of the Means of the Welds

Research Hypotheses III-A, III-B, and III-C were rejected as stated, and the null hypotheses were not rejected. The significance of the differences between the mean scores of the welds was determined from simple analysis of variance which provided an F ratio. The obtained F ratio was of a non-significant value and this concluded the computations involving the mean scores of the welds of the students in the four groups.

Comparisons of the Mean Times of the Four Groups

Hypotheses IV-A, IV-B, and IV-C were stated as follows: "When the time required to develop and apply arc welding skill is computed, group four will show a significantly greater mean time in hours than will group one, group two, or group three; group three will show a significantly greater mean time in hours than will group one or group two; and group two will show a significantly greater mean time in hours than will group one." The criterion for this hypothesis was the mean time in hours needed by students in each of the four groups to learn how to weld and successfully complete four different welds. The technique of simple analysis of variance was used as the test of the significance of the differences between the mean times of the four groups. A summary of these results is presented in Table VIII.

TABLE VIII

SUMMARY OF SIMPLE ANALYSIS OF VARIANCE COMPARING THE MEAN TIMES REQUIRED BY STUDENTS TO COMPLETE FOUR DIFFERENT WELDS

Source	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	Level of Significance
Between	57.24	3	19.08	2.90	.05
Within	341.60	52	6.57		
Total	398.84	55			

Since the obtained F ratio was found to be significant, the null hypothesis that there would be no significant differences between the mean times of the four groups on completion of the four welds was rejected. Therefore, it was concluded that there was a significant difference between the mean times of the four groups.

Because the F ratio was found to be significant, t tests were computed to determine the significance of the differences between the mean times of the four groups using various pairs of groups. These group comparisons were group four with groups one, two, and three; group three with groups one and two; and group two with group one.

Hypothesis IV-A was that group four will show a significantly greater mean time than will group one, group two, or group three. The criterion for this test was the mean time needed by students of the four groups to develop the necessary skill to successfully arc weld the four joints and have the instructor's consent that the welds were acceptable.

Table IX contains the mean times needed by the students in the four groups to develop and apply arc welding skill as previously discussed, the mean time differences, standard deviations, t levels, and levels of significance. An inspection of Table IX will reveal that the difference between group four and group one was 1.88 points. A t value with 27 degrees of freedom must reach 2.05 to be significant at the .05 level. The obtained t value was not significant.

TABLE IX

MEAN TIME NEEDED, MEAN TIME DIFFERENCES, STANDARD DEVIATIONS, t VALUES, AND LEVELS OF SIGNIFICANCE OF THE MEAN TIME DIFFERENCES BETWEEN GROUPS FOUR, THREE, TWO, AND ONE

Groups	Mean Time (Hours)	Mean Difference	S.D.	df	t Value	Level of Significance
Four One	20.45 22.33	1.88	3.08 2.42	27	1.92	NS
Four Two	20.45 21.17	.72	3.08 2.62	26	.73	NS
Four Three	20.45 23.40	2.95	3.08 1.20	19	2.63	.02

Thus, the null hypothesis that there would be no significant difference between the mean times of group four when compared to group one could not be rejected. It was concluded that there was a non-significant difference between the mean times of groups four and one.

An examination of the data presented in Table IX will reveal that the mean time difference between group four and group two was .72. A t value with 26 degrees of freedom must reach 2.05 to be significant at the .05 level, and the obtained t value of .73 was not significant at that level. The null hypothesis that there would be no significant difference between the mean times of group four when compared to group two could not be rejected. The research hypothesis as stated was rejected. It was concluded that there was a chance difference between the two groups, but that this was a non-significant difference.

When the data in Table IX are studied, in relation to groups four and three, a significant difference between the mean times of these two groups will be revealed. The difference between these two means is 2.95, with a t value of 2.63. A t value with 19 degrees of freedom must reach 2.09 to be significant at the .05 level, and 2.53 to be significant at the .02 level. Thus, the difference between groups four and three was significant at the .02 level.

An inspection of Table IX will reveal that group four had a mean time of 20.45 hours and group three a mean time of 23.40 hours, and this difference was found to be significant. Thus, the null hypothesis that there would be no significant difference between the mean times of group four and group three was rejected. It was concluded that there was a significant difference between the mean times of group four and group three but that group four, and not group three, as hypothesized, needed significantly less time to complete the four welds. The research hypothesis was therefore rejected.

Since group four had a significantly smaller mean time than did group three, it may be inferred that the lectures, demonstrations, and programed instruction teaching technique produced a smaller mean time than did the lectures, demonstrations, and single-topic film loops teaching technique.

Hypothesis IV-B was that group three will show a significantly greater mean time than will group one or group two. The criterion for this test was the mean time needed by students of the three groups to develop the necessary skill to successfully arc weld the four joints and have the instructor's consent that the welds were acceptable.

Table X includes the mean times needed by the students of groups four, three, and two to develop and apply arc

TABLE X

MEAN TIME SCORES OF TIME NEEDED, MEAN TIME DIFFERENCES, STANDARD DEVIATIONS, t VALUES, AND LEVELS OF SIGNIFICANCE OF THE MEAN TIME DIFFERENCES BETWEEN GROUPS THREE, TWO, AND ONE

Groups	Mean Scores	Mean Difference	S.D.	df	t Values	Levels of Significance
Three One	23.40 22.33	1.07	1.20 2.42	26	1.05	NS
Three Two	23.40 21.18	2.22	1.20 2.62	25	2.18	.05*

*Not accepted as significant.

welding skill as previously discussed, the mean time differences, standard deviations, t values, and levels of significance of the t values.

An examination of Table X will reveal that the mean time difference between groups three and one was 1.07.

A *t* value with 26 degrees of freedom must reach 2.05 to be significant at the .05 level. The obtained *t* value was not significant at the .05 level. Thus, the null hypothesis that there would be no significant difference between the mean times of group three when compared to group one could not be rejected. It was concluded that there was a difference between the mean times of group three and group one but that this was a non-significant difference and the appropriate research hypothesis was rejected.

An inspection of the data presented in Table X will disclose that the mean time difference between groups three and two was 2.22. A *t* value with 25 degrees of freedom must reach 2.06 to be significant at the .05 level, and 2.48 to be significant at the .02 level. The obtained *t* value of 2.18 was significant at the .05 level but not significant at the .02 level. Since group three comparisons were required to be significant at the .02 level for acceptance, it was concluded that the difference between these two groups was non-significant and therefore the null hypothesis that there would be no significant difference between the mean times of group three when compared to group two could not be rejected. The research hypothesis as stated was rejected.

Hypothesis IV-C was that group two would show a significantly greater mean time than would group one. The criterion for this test was the mean time needed by students of the two groups to develop the necessary skill to successfully arc weld the four joints and have the instructor's consent that the welds were acceptable.

Table XI contains the mean times needed by the students of the two groups to develop and apply arc welding skill as

TABLE XI

MEAN TIME SCORES OF TIME NEEDED, MEAN TIME DIFFERENCES, STANDARD DEVIATIONS, t VALUES, AND LEVELS OF SIGNIFICANCE OF THE MEAN TIME DIFFERENCES BETWEEN GROUPS TWO AND ONE

Groups	Mean Scores	Mean Differences	S.D.	df	t Value	Level of Significance
Two	21.18	1.15	2.62	33	1.33	NS
One	22.33		2.42			

previously discussed, the mean time differences, standard deviations, t levels, and levels of significance.

An examination of Table XI will reveal that the mean difference between these two groups was not significant at the .05 level. Thus, the null hypothesis that there would be no significant difference between the mean times of group two when compared to group one could not be rejected. It was concluded that there was a difference between the mean times of groups two and one, but that this was a non-significant difference.

Summary of Mean Times

When the mean times of the four groups were tested, a significant difference between the groups existed. This was confirmed by the size of the F ratio obtained from the simple analysis of variance. Since the obtained F ratio of 2.90 was significant at the .05 level with 3 and 52 degrees of freedom associated with the numerator and denominator, respectively, *t* tests were computed between pairs of groups.

The results of the group comparisons are as follows. When group four was compared with groups one and two, the obtained *t* values were not significant. When group four was compared with group three, the obtained *t* value was *t* = 2.63 and this *t* was significant at the .02 level. However, group four needed significantly fewer hours to meet the weld criterion than did the hypothesized group, group three. Thus, the null hypothesis for this comparison could not be rejected nor could the research hypothesis be accepted. It was concluded that the lectures and demonstrations plus programed instruction teaching technique produced a significantly smaller mean time to meet the weld criterion than the lectures and demonstrations plus single-topic film loops teaching technique. When group three was compared with group one, the difference between the two groups was not significant. When group three was compared with group two, the *t* value was 2.18, which was significant at the .05 level, but not significant at the .02 level. Thus, it was concluded that a non-significant difference existed between groups two and three. When the *t* value between groups one and two was computed, it was concluded that a significant difference did not exist between the two groups.

Summary of the Presented Data

Research Hypotheses I-A, I-B, I-C, and I-D were accepted as stated. The mean gain scores within each of the four groups was significantly different from zero.

Research Hypotheses II-A, II-B, and II-C were rejected as stated. The null hypotheses of no significant differences were not rejected. Research Hypotheses II-D, II-E, and II-F were rejected as stated. However, a significant difference between groups two and three existed and the null hypothesis for this comparison could not be rejected; yet the research hypothesis, as stated for this comparison, could not be accepted. Group three (single-topic film loops, lectures, and demonstrations) had a significantly greater mean gain from the posttest to the retention test than did group two (single topic film loops and programed instruction). Thus it was inferred that the students who used the single-topic film loops along with the lectures and demonstrations, made a significantly greater mean gain from the posttest to the retention test due to these techniques than the students in the group that used the single-topic film loops and programed instruction.

Research Hypotheses III-A, III-B, and III-C were rejected as stated. The null hypotheses of no significant differences were not rejected.

Research Hypotheses IV-B and IV-C were rejected as stated. The null hypotheses of no significant differences were not rejected. Research Hypothesis IV-A was not accepted as stated. Hypothesis IV-A involved three comparisons, group four with groups one, two, and three. When group four was compared to groups one and two there were no significant differences between the groups. When group four was compared to group three, a t value significant at the .02 level was found. Even though a significant difference existed between groups four and three, the null hypothesis for this comparison could not be rejected yet the research hypothesis could not be accepted. Thus it was inferred that the students who participated in lectures and demonstrations and used programed instruction achieved the weld criterion in significantly fewer hours than did the students that participated in lectures and demonstrations and used single-topic film loops.

As the data were analyzed, a trend by group two became apparent. The following is a summary of how group two compared with the other groups in terms of group means.

Means of the weld scores:

Group two greater than group three

Group two smaller than groups one and four

Pretest means:

Group two greater than groups one and four

Group two smaller than group three

Posttest means:

Group two greater than groups one, two, or four

Retention test means:

Group two greater than groups one or two

Group two smaller than group three

Mean times (in hours)

Group two smaller than groups one and three

Group two greater than group four

Although only one of the above comparisons was significant (group two with group three on mean gain from posttest to retention test), and one other comparison approached significance (group two with group three on mean time), it should be pointed out that the students of group two did not participate in lectures and demonstrations but students of the other three groups did. Thus, the single-topic film loop plus programed instruction teaching technique enabled students of that group to do as well as the students in the other groups without the benefit of normal classroom procedures of lectures and demonstrations.

Attitude Scale Scores of Students of the Four Groups

A indicated on page 77, an additional statistical procedure was to present the data of the student responses of the attitude scale. Appearing on the following pages are these data.

Table XII presents the percentages of student responses to the choice "strongly agree." A previously explained, the attitude scale used in the study was made up of fifteen

TABLE XII

PERCENTAGES AND NUMBERS OF STUDENTS WHO RESPONDED TO THE CHOICE "STRONGLY AGREE"

Item No.	Percentages and Numbers of Student Responses									
	Group 1		Group 2		Group 3		Group 4		Total	
	%	No.	%	No.	%	No.	%	No.	%	No.
1	6	1	18	3	50	5	27	3	21	12
2	--	--	6	1	--	--	9	1	4	2
3	--	--	18	3	20	2	81	9	25	14
4	6	1	18	3	50	5	46	5	25	14
5	--	--	24	4	20	2	27	3	16	9
6	12	2	6	1	40	4	27	3	18	10
7	6	1	--	--	--	--	--	--	2	1
8	--	--	--	--	--	--	--	--	--	--
9	17	3	12	2	70	7	--	--	21	12
10	--	--	--	--	--	--	--	--	--	--
11	6	1	18	3	30	3	--	--	12	7
12	6	1	--	--	20	2	--	--	5	3
13	--	--	--	--	--	--	--	--	--	--
14	--	--	--	--	--	--	--	--	--	--
15	12	2	24	4	50	5	27	3	25	14

items. Students responded to the items of the attitude scale using the following choices of response: "Strongly Agree," "Agree," "Undecided," "Disagree," "Strongly Disagree."

An examination of Table XII will reveal that item nine--"The teaching aids used in this class presented good examples of correct welding techniques"--was strongly agreed with by three students (17 percent) of group one, and seven students (70 percent) of group three. Item five of the attitude scale which stated, "The teaching aids in this class were of a very high quality," and item fifteen which stated, "I would enjoy taking another class that used these types of aids," were both strongly agreed with by four students (24 percent) of group two, while fourteen students (25 percent of the total group) used "strongly agree" to item fifteen. Item three, which stated, "I learned more by this method than I thought possible," was strongly agreed with by nine students (81 percent) of group four and fourteen students (25 percent) of the total. Item four, which stated, "The aids used in this class were a real help to me in learning how to weld," was strongly agreed with by fourteen students (25 percent) of the total group of students.

Table XIII presents the percentages of student responses to the choice "agree." An inspection of Table XIII will disclose that item one of the attitude scale, which stated, "Personally, I liked this method of teaching," was agreed with by twelve students (66 percent) of group one, five students (50 percent) of group three, and twenty-nine students (52 percent) of all students. Item five, which stated, "The teaching aids in this class were of a very high quality," and item eleven, which stated, "I enjoyed using the teaching aids in this class," were both agreed with by five students (50 percent) of group three, while twenty-seven students (48 percent) of all students agreed with item eleven. Item

TABLE XIII

PERCENTAGES AND NUMBERS OF STUDENTS WHO RESPONDED TO THE CHOICE "AGREE"

Item No.	Percentages and Numbers of Student Responses									
	Group 1		Group 2		Group 3		Group 4		Total	
	%	No.	%	No.	%	No.	%	No.	%	No.
1	66	12	30	5	50	5	64	7	52	29
2	17	3	30	5	--	--	--	--	14	8
3	34	6	18	3	30	3	19	2	25	14
4	38	7	30	5	40	4	36	4	36	20
5	45	8	30	5	50	5	55	6	43	24
6	45	8	42	7	30	3	46	5	41	23
7	22	4	58	10	--	--	--	--	25	14
8	--	--	24	4	--	--	--	--	7	4
9	34	6	30	5	30	3	91	10	43	24
10	17	3	24	4	--	--	--	--	12	7
11	56	10	18	3	50	5	82	9	48	27
12	34	6	24	4	30	3	82	9	39	22
13	12	2	46	8	10	1	9	1	21	12
14	17	3	30	5	--	--	--	--	14	8
15	38	7	30	5	30	3	46	5	36	20

seven, which stated, "I did not care for this teaching method was agreed with by ten students (58 percent) of group two. Item nine of the attitude scale, which stated, "The teaching aids used in class presented good examples of correct welding techniques," was agreed with by ten students (91 percent) of group four, and twenty-four students (43 percent) of the total number of students.

Table XIV presents the percentages of student responses of the attitude scale to the choice "undecided."

TABLE XIV

PERCENTAGES AND NUMBERS OF STUDENTS WHO RESPONDED TO THE CHOICE "UNDECIDED"

Item No.	Percentages and Numbers of Student Responses									
	Group 1		Group 2		Group 3		Group 4		Total	
	%	No.	%	No.	%	No.	%	No.	%	No.
1	12	2	12	2	--	--	9	1	9	5
2	34	6	18	3	--	--	9	1	18	10
3	38	7	24	4	30	3	--	--	25	14
4	17	3	12	2	10	1	9	1	12	7
5	34	6	24	4	20	2	9	1	23	13
6	34	6	30	5	20	2	18	2	27	15
7	22	4	12	2	10	1	18	2	16	9
8	6	1	6	1	--	--	--	--	4	2
9	27	5	18	3	--	--	--	--	14	8
10	22	4	30	5	--	--	9	1	18	10
11	17	3	34	6	20	2	9	1	21	12
12	12	2	24	4	30	3	9	1	18	10
13	12	2	6	1	10	1	--	--	7	4
14	34	6	18	3	10	1	9	1	19	11
15	27	5	24	4	20	2	18	2	23	13

A study of Table XIV will disclose that item three, which stated, "I learned more by this method than I thought possible," was responded to by seven students (38 percent) of group three and fourteen students (25 percent) of the total number, as "undecided." Item eleven, which stated, "I enjoyed using the teaching aids in this class," was responded to as "undecided" by six students (34 percent) of group two and by twelve students (21 percent) of the total number. Item twelve, which stated, "The teaching aids used in this class presented clearly the best uses to be made of welding equipment," was responded to as "undecided" by three students (30 percent) of group three and ten students (18 percent) of the total number. Item three, which stated, "I learned more by this method than I thought possible," was responded to as "undecided" by three students (30 percent) of group three.

Item six, which stated, "The kinds of teaching aids used in this class have, to me, great potential for use in other classes," was responded to as "undecided" by two students (18 percent) of group four and by 15 students (27 percent) of the total number. Two students (18 percent) of group four also responded "undecided" to item seven, which stated "I did not care for this teaching method," as did nine students (16 percent) of the total number. Item fifteen, which stated, "I would enjoy taking another class that used these types of aids," was responded to as "undecided" by two students (18 percent) of group four and by thirteen students (23 percent) of the total number.

Table XV presents the percentages and numbers of student responses to the items of the attitude scale where the response "disagree" was used.

TABLE XV

PERCENTAGES AND NUMBERS OF STUDENTS WHO RESPONDED TO THE CHOICE "DISAGREE"

Item No.	Percentages and Numbers of Student Responses									
	Group 1		Group 2		Group 3		Group 4		Total	
	%	No.	%	No.	%	No.	%	No.	%	No.
1	17	3	30	5	--	--	--	--	14	8
2	50	9	34	6	50	5	46	5	45	25
3	27	5	34	6	20	2	--	--	23	13
4	38	7	34	6	--	--	--	--	23	13
5	22	4	12	2	--	--	--	--	11	6
6	11	2	18	3	10	1	--	--	11	6
7	50	9	18	3	40	4	55	6	39	22
8	78	14	46	8	40	4	81	9	63	35
9	22	4	24	4	--	--	--	--	14	8
10	50	9	24	4	60	6	55	6	45	25
11	17	3	30	5	--	--	--	--	14	8
12	34	6	46	8	20	2	--	--	29	16
13	78	14	34	6	20	2	55	6	50	28
14	27	5	30	5	40	4	36	4	32	18
15	22	4	24	4	--	--	9	1	16	9

An inspection of Table XV will reveal that items eight and thirteen,which stated, "The teaching aids used in this class were too technical," and "The teaching aids used in this class were a bother to use," were both disagreed with by fourteen students (78 percent) of group one, while thirty-five students (63 percent) of the total number disagreed with item eight and twenty-eight students (50 percent) of the total number disagreed with item thirteen. Item eight and item twelve were both disagreed with by eight students (46 percent) of group two and nine students (81 percent) of group four disagreed with item eight. Item ten, which stated, "The teaching aids used in this class were too elementary," was disagreed with by six students (60 percent) of group three.

Table XVI contains the percentages and numbers of student responses to the items of the attitude scale with the response of "strongly disagree."

An examination of Table XVI will reveal that groups one and three tended not to use the choice "strongly disagree," whereas groups two and four tended to use the "strongly disagree" response at least once on most of the items. Also, group four figures disclose a fairly frequent number of responses where only one student used the "strongly disagree" choice. This event occurred six times out of a total of fifteen items to be answered.

Table XVI also reveals that four students (22 percent) strongly disagreed with item fourteen, which stated, "I hope I never take another class where this method is used," while nineteen students (34 percent) of the total group responded in the same manner. Item fourteen was also strongly disagreed with by four students (24 percent) of group two, and six students (55 percent) of group four. Item eight, which stated, "The teaching aids used in this class were too

TABLE XVI

PERCENTAGES AND NUMBERS OF STUDENTS WHO RESPONDED TO THE CHOICE "STRONGLY DISAGREE"

Item No.	Percentages and Numbers of Student Responses									
	Group 1		Group 2		Group 3		Group 4		Total	
	%	No.	%	No.	%	No.	%	No.	%	No.
1	--	--	12	2	--	--	--	--	4	2
2	--	--	12	2	50	5	36	4	19	11
3	--	--	6	1	--	--	--	--	2	1
4	--	--	6	1	--	--	9	1	4	2
5	--	--	12	2	10	1	9	1	7	4
6	--	--	6	1	--	--	9	1	4	2
7	--	--	12	2	50	5	27	3	18	10
8	17	3	24	4	60	6	18	2	27	15
9	--	--	18	3	--	--	9	1	7	4
10	12	2	24	4	40	4	36	4	25	14
11	6	1	--	--	--	--	9	1	4	2
12	17	3	6	1	--	--	9	1	9	5
13	--	--	12	2	60	6	36	4	21	12
14	22	4	24	4	50	5	55	6	34	19
15	--	--	--	--	--	--	--	--	--	--

technical," was strongly disagreed with by four students (24 percent) of group two, six students (60 percent) of group three, and fifteen students (27 percent) of the total number. Item thirteen, which stated, "The teaching aids used in this class were a bother to use," was strongly disagreed with by six students (60 percent) of group three, and twelve students (21 percent) of the total number.

Item one, which stated, "Personally, I liked this method of teaching," and item three, which stated, "I learned more by this method than I thought possible," were strongly disagreed with by two students (12 percent) and one student (6 percent), respectively, of group three. Table XVI also shows that item fifteen, which stated, "I would enjoy taking another class that used these types of aids," was not strongly disagreed with by any of the students in the study. This same item, however, was disagreed with by nine (16 percent) of the total number of students.

Summary of the Attitude Scale

The frequency of responses of the attitude scale were as follows: Items one, three, four, five, six, nine, eleven, twelve, and fifteen were stated in a positive manner, such as "I enjoyed using the teaching aids in this class." These types of items were responded to as "strongly agree" 95 times, agreed with 203 times, "undecided" 97 times, disagreed with 87 times, and strongly disagreed with 22 times by the total number of students.

Items two, seven, eight, ten, thirteen, and fourteen were stated in a negative manner, such as "I did not care for this teaching method." These items were responded to as "strongly agree" 3 times, agreed with 53 times, "undecided" 46 times, disagreed with 53 times, and strongly disagreed with 81 times by the total number of students. Table XVII contains the summary of the total number of available responses and their frequency of use.

TABLE XVII

SUMMARY OF TOTAL NUMBER OF AVAILABLE RESPONSES AND THEIR FREQUENCY OF USE

Type of Response	Nine Positive Items	Six Negative Items	Total
Strongly Agree	95	3	98
Agree	203	53	256
Undecided	97	46	143
Disagree	87	153	240
Strongly Disagree	22	81	103
Total	504	336	840

Thus, the identifiable trends of the responses of the students to the attitude scale of the various items were that the greatest number of responses to the positive items were of an agreeable nature, while the negative items were more frequently responded to with "disagree."

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CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The study was concerned with the effectiveness of lectures and demonstrations, single-topic film loops, and programed instruction in the general welding course in the Industrial Arts Department at North Texas State University, Denton, Texas. The unit of instruction within the course which was selected as the experimental instructional unit was the first four-week unit of metallic arc welding.

The study consisted of three phases. The first phase consisted of the development of a criterion test to be used as the pretest, posttest, and retention test. The second phase consisted of the development of a programed instruction booklet. The third phase consisted of the investigation of student achievement, as measured by the criterion test, a set of four welds evaluated by a jury, and the number of clock hours required by students in the groups to meet the weld criterion. An additional phase consisted of the development and administration of an attitude scale.

The problem was to study the effectiveness of four instructional techniques of teaching arc welding at the university level. The techniques compared were (1) lectures and demonstrations plus single-topic film loops plus programed instruction; (2) single-topic film loops plus programed instruction; (3) single-topic film loops plus lectures and demonstrations; and (4) lectures and demonstrations plus programed instruction. The purposes of the study were (1) to determine the combined effectiveness of single-topic film loops, programed instruction, and lectures and demonstrations in teaching arc welding; (2) to determine the combined effectiveness of single-topic film loops and programed instruction in teaching arc welding; (3) to determine the combined effectiveness of single-topic film loops, lectures, and emonstrations in teaching arc welding; (5) to determine which of the four instructional techniques would enable students to complete four required welds in the least number of class hours; and (6) to determine the extent of student preference for the teaching technique by which they received arc welding instruction.

The students who participated in the study were fifty-six male students who completed the general welding course during either the summer session of 1969 or the fall semester of 1969-1970.

On the first day of the experimental instructional unit the pretest was administered to all participating students. The initial results of the pretest were used to match the students of the four groups on a non-significant difference of group means. This check was made with the use of simple analysis of variance which provided an F ratio. The obtained F ratio was not significant and thus the four groups were not significantly different in terms of knowledge about arc welding prior to the start of the study.

The first statistical treatment concerned the mean gain of the students within the four groups from the pretest to the posttest.

The second statistical problem concerned the mean gain between the four groups from the pretest to the posttest. The third problem concerned the mean gain between the four groups from the posttest to the retention test. The fourth statistical procedure was a comparison between the mean scores of the four welds made by each student. The fifth problem concerned the mean time in hours needed by students in the four groups to satisfactorily complete the four welds. An investigation of student attitude toward the various instructional techniques used was also conducted.

The mean gains from the pretest to the posttest within each of the four groups were tested by the use of the $\underline{t}$ test of the significance of difference between correlated means. The mean gain scores between the four groups, the mean differences between the four groups of the weld mean scores, and the mean differences between the four groups of the time needed to meet the weld criterion were all tested with the use of simple analysis of variance and $\underline{t}$ tests. Levels of significance were determined for all F ratios and t values. The findings of the statistical treatments are presented below.

Findings

1. Hypotheses I-A, I-B, I-C, and I-D stated that the students within the four groups would make a significant mean gain from the pretest to the posttest. The statistical treatment of the data of the four groups confirmed this and the research hypotheses were accepted as stated.

2. Hypotheses II-A, II-B, and II-C stated that there would be a significant difference between the four groups on the mean gains from the pretest to the posttest. The statistical treatment of the data of the four groups did not confirm that a significant difference existed between the mean gains of the four groups. Thus the research hypotheses were rejected.

3. Hypotheses II-D, II-E, and II-F stated that there would be a significant difference between the four groups on the mean gains from the posttest to the retention test. The statistical treatment did not confirm that a significant difference existed between the mean gains of the four groups. Thus the research hypotheses were rejected.

4. Hypotheses III-A, III-B, and III-C stated that there would be a significant difference between the four groups on the mean scores of the weld criterion. The

statistical treatment of the data of the four groups did not confirm that a significant difference existed between the mean weld scores of the four groups. Thus the research hypotheses were rejected.

5. Hypotheses IV-A, IV-B, and IV-C stated that there would be a significant difference between the four groups on the mean time needed to meet the weld criterion. The statistical treatment confirmed that a significant difference did exist between the four groups on the mean time needed to meet the weld criterion. The first two comparisons of Hypothesis IV-A were groups one and two with group four. There were no significant differences between these groups and the research hypotheses were rejected. When group four was compared with group three, a significant difference did exist but not as hypothesized and the hypothesis was therefore rejected. Hypotheses IV-B and IV-C resulted in nonsignificant differences; thus the research hypotheses, as stated, were rejected.

In summarizing the findings, the following were the results of the study:

1. All four groups made a significant mean gain from the pretest to the posttest.

2. No significant differences were found between the mean gains of the four groups from the pretest to the posttest, or from the posttest to the retention test. There

were no significant differences between the four groups on the means of the weld scores.

3. A significant difference was found between groups three and four on the mean number of hours needed to meet the weld criterion.

4. The effectiveness of single-topic film loops as a supplement to the lecture demonstration teaching technique was confirmed.

5. The effectiveness of programed instruction as a supplement to the lecture demonstration teaching technique was confirmed.

6. The combined effectiveness of single-topic film loops and programed instruction is an effective technique for teaching metallic arc welding.

7. When compared with the lectures and demonstrations plus single-topic film loops plus programed instruction teaching technique, the single-topic film loops plus programed instruction teaching technique reduced the amount of time needed by students to meet the weld criterion by approximately 12 percent. This was a comparison of the mean time needed between groups one and two.

8. When compared with the lectures and demonstrations plus single-topic film loops teaching technique, the programed instruction plus single-topic film loops teaching technique reduced the amount of time needed by students to meet the weld criterion by approximately 15 percent. This

was a comparison of mean time needed between groups two and three.

9. The achievement of the students in the four classes indicated that the four instructional techniques were equal in effectiveness when utilized to teach metallic arc welding.

Conclusions

The conclusions of the study should be generalized to students in classes similar to the classes of students used in the study, and relevant to those teaching situations where the attainment of knowledge about, and skill in, metallic arc welding are two course objectives.

1. The combined use of single-topic film loops and programed instruction is an effective technique for teaching metallic arc welding.

2. The use of single-topic film loops and/or programed instruction will enable instructors to reduce the number of lectures and demonstrations used when teaching metallic arc welding, thus allowing more time for instructors to participate in individual instruction.

3. Although each of the combinations tested for teaching metallic arc welding did not differ significantly in terms of student achievement, the single-topic film loops plus programed instruction technique allowed the students who used that technique to meet the weld criterion in fewer hours, and attain equal student achievement, than the lectures and demonstrations plus single-topic film loops

plus programed instruction, and the lectures and demonstrations plus single-topic film loops technique. Thus, it was concluded that the combined use of single-topic film loops and programed instruction, is an effective technique for reducing the amount of time needed by students to develop knowledge of, and skill in, metallic arc welding.

Implication

The implication derived from the study is the following:

The instructional period of four weeks may have been too short a period of time for evaluation of the programed instruction and single-topic film loops used in the study.

Recommendations

Based upon the findings and conclusions of the study, the following recommendations are made.

1. The teaching technique used in the course General Welding at North Texas State University be supplemented with single-topic film loops and/or programed instruction.

2. Research should be conducted which would result in the construction of a comprehensive, standardized test for use in the area of metallic arc welding.

3. A replication of this study be made wherein classes of thirty or more students participate and use the various combinations of lectures and demonstrations, single-topic film loops and programed instruction.

APPENDIX A

WELDING ACHIEVEMENT TEST

DIRECTIONS: Each of the questions or incomplete statements are followed by several suggested answers. You are to choose the one response which you think is correct. Using the separate answer sheet, circle the letter of your selected answer, and color in the circle. The following is a sample question and answer.

10. Acetylene is made from: (A) sodium carbide and water (B) calcium carbide and water (C) potassium carbide and water (D) sodium sulphate and water.

The correct answer is B, so the answer should appear on the answer sheet as, #10. A B C D. The B is circled and the circle is colored in. Answer the questions to the best of your ability. Do not linger too long on any one question.

GENERAL

1. To minimize metal warping while welding, prior to welding, one should: (A) heat the metal and then quench it (B) temper the metal (C) preheat the metal (D) anneal the metal.

2. The term fusion refers to: (A) depth of penetration (B) depth of heating (C) combining of molten metal (D) a brazing technique.

3. Tensile strength of a material refers to the amount of pressure it takes to: (A) bend the material (B) stretch the material (C) pull the material apart (D) deform the material.

4. The highest welding temperature can be obtained by using which of the following? (A) oxy-acetylene (B) arc (C) inert gas arc (D) air-acetylene.

5. Metal which is galvanized is coated with: (A) nickel (B) tin (C) lead (D) zinc.

6. To be able to see a layout line after the metal becomes red hot, one should mark it with: (A) chalk (B) crayon (C) pencil (D) soapstone.

7. Pig iron is made in the: (A) Bessemer furnace (B) electric furnace (C) basic-oxygen furnace (D) blast furnace.

8. The purpose of capping a welded joint is to: (A) prevent oxidation (B) reinforce the weld area (C) help transmit heat away from the joint (D) prevent melting through the joint.

9. The spark test is used by a welder to identify: (A) aluminum alloys (B) copper alloys (C) plain carbon steels (D) lead alloys.

10. The width of a bead is determined by: (A) the speed of progression (B) the depth of penetration (C) the thickness of the metal being welded (D) both A and C.

11. The simplest form of weld joint is the: (A) flange joint (B) butt joint (C) fillet joint (D) single V-joint.

12. As the temperature of a metal rises: (A) its tensile strength increases (B) the metal becomes ductile (C) its strength decreases (D) both B and C.

13. If the electrode is positive and the ground is negative on a D.C. welding machine, while welding: (A) there is more heat on the work (B) there is more heat on the electrode (C) the heat is evenly divided (D) the heat varies from one to the other.

14. Successful arc welding is dependent upon the current: (A) increasing as the weld continues (B) decreasing as the weld continues (C) remaining steady (D) fluctuating as the weld continues.

15. To reduce warpage while arc welding, one should (A) increase the amperage (B) increase the size of the electrode (C) use skip welding techniques (D) weld with reverse polarity.

16. Rule of thumb states that proper length of arc is about: (A) equal to the diameter of the electrode (B) greater than the diameter of the electrode (C) less than the diameter of the electrode (D) twice the diameter of the electrode.

17. Varying the speed of travel affects the: (A) arc (B) amount of electrode deposited (C) purity of the puddle (D) tensile strength of the metal.

18. The technique of "weaving" in arc welding is used to: (A) speed up weld travel (B) control the molten puddle (C) prevent slag from forming (D) decrease the size of the bead.

19. A common fault of holding the arc length too long is: (A) excessive penetration (B) spatter (C) insufficient penetration (D) overheating the metal.

20. Traveling too slow when arc welding thin gauge metal will result in: (A) the arc going out (B) a wide bead (C) insufficient penetration (D) both A and B.

21. One advantage of using a coated electrode over a bare electrode is that coated electrodes: (A) last longer (B) prevent oxidation (C) require less current (D) use a shorter arc.

22. The tensile strength of a weld using an E-6010 electrode is: (A) 40-50 thousand lbs./sq. in. (B) 50-60 thousand lbs./sq. in. (C) 60-70 thousand lbs./sq. in. (D) 80-90 thousand lbs./sq. in.

23. To improve the purity of the molten puddle in arc welding, the current should be: (A) an alternating current (B) standard or straight polarity (C) set very low (D) of reverse polarity.

24. Electric metallic arcs reach maximum temperatures of approximately: (A) 750 degrees f (B) 1500 degrees f (C) 3000 degrees f (D) 6500 degrees f.

25. If the ground of a D.C. metallic arc welder is of negative polarity and the electrode is of positive polarity, the machine has been set for: (A) standard polarity (B) reverse polarity (C) alternating polarity (D) standard-alternating polarity.

26. A D.C. arc welder either requires a generator or: (A) a rectifier (B) an amplifier (C) a stabilizer (D) a pulsator.

27. Once the arc has been started, the necessary voltage to maintain the arc: (A) is less (B) is greater (C) remains the same (D) increases slowly then decreases.

28. Heavy plate material is generally welded with: (A) a butt weld (B) flange weld (C) a lap weld (D) a double V-weld.

29. A properly arc welded joint: (A) will not break in the weld area (B) has a flat cap (C) will have a cap width of 1/2 the thickness of the metal (D) has fusion but no penetration.

30. The best remedy to control magnetic arc blow is to: (A) increase the current setting (B) change to AC welding (C) increase the voltage (D) increase the arc length.

31. Most cracking occurring in beads is attributed to: (A) low welding temperature (B) high welding temperature (C) high carbon content of the metal (D) low carbon content of the metal.

32. Electric arc flashes give off: (A) infrared rays (B) ultra-violet rays (C) radioactive rays (D) supersonic rays -- which are very harmful to the eyes.

INSTRUCTIONS: The following items are true and false. If any part of any item is false the entire item should be considered as false. On the answer sheet, circle A, and color in for true statements and circle B for false statements. The following is an example.

66. Copper is very ductile.

As copper <u>is</u> very ductile, the letter A opposite 66 would be circled and colored in. 66. A B.

33. The voltage pressure setting on the metallic arc welding machine controls the arc length.

34. When the electrode is negative, D.C.S.P., the current is understood to travel from the base metal to the electrode.

35. The cable containing the electrode holder is attached to the negative terminal in a straight polarity set up.

36. In D.C.S.P., the electrons flow from negative (cathode) to the base metal and return to the positive (anode) of the machine.

37. In D.C.S.P., approximately two-thirds of the heat is released at the base metal and one-third at the electrode.

38. In D.C.R.P., the current flows from the negative (cathode) to the base metal and returns to the positive (anode) of the machine from the electrode side of the arc.

39. The lap joint is a common joint but should be avoided when possible.

40. The proper/correct position of the electrode for welding in horizontal position is approximately twenty degrees toward the direction of travel.

41. The "lead" from the machine to the work is known as the "work" (ground) lead and the "lead" from the electrode to the machine is known as the "electrode lead."

42. The more common electrode wire sizes are: 1/8", 5/32", 3/16", 7/32", 1/4", 5/16", and 3/8" in diameter.

43. Electrodes are usually packed in one hundred pound packages.

44. The most commonly used electrodes are made of mild steel, but electrodes are made from many alloys such as: low alloy steel, nickel steel, chrome-moly steel, manganese-moly steel, nickel-manganese-moly steel, nickel-moly-vanadium steel, aluminum, copper-aluminum, lead-bronze, and phosphorous bronze.

45. Flux, which forms the covering on electrodes, commonly consists of asbestos, feldspar, mica, steatite, titanium dioxide, calcium carbonate, magnesium carbonate and other aluminas.

46. Questionable electrodes, such as those exposed to moisture, should be "baked" at 250 degrees f for several hours before using them.

47. The transformer type A.C. welder is most popular of the A.C. machines.

48. The distinct advantage of the A.C. arc welding machine is that virtually no "magnetic arc blow" exists in the machine.

49. The temperature of the electric arc machine is at least 6,000 degrees f.

50. There is little difference in the performance of the A.C. and the D.C. welding machines.

51. A number ten color or shade lens is used for arc welding helmets.

52. Arc length refers to the distance the end of the electrode is from the base metal.

53. The electric metallic arc machine produces a temperature of at least 7,500 degrees f.

54. The "arc blow" is virtually non-existent when using A.C. current as a source of power supply.

55. The D.C. generator, with variable-voltage characteristics, is the most widely used D.C. arc welder and is the most economical generator available.

56. The welding transformers in room 126, Industrial Arts Building, North Texas State University, are classed as "heavy duty."

57. Flux combines with any oxide that may have formed during welding, lowers its melting point and therefore helps to dissolve it.

58. Penetration is the depth the added or filler metal penetrates into the base metal.

59. The welding operator is not concerned with the current values except in a few cases.

60. Generally, for flat work, the electrode would be inclined approximately fifteen degrees from the vertical position of the electrode.

61. There are two major types of rays produced by the electric arc machine.

62. The electric arc will affect the skin up to twenty feet and the eyes up to forty feet, and further, in some cases.

63. The abbreviation for American Welding Society is: A.W.S.

64. Tensile strength is the amount of directly applied pull that a part will stand before it breaks.

65. For any weld to be successful, whether in production or repair, the welder must know the kind of metal, its general characteristics, and its behavior under varying temperatures.

66. An A.S.T.M. steel of 2340 classification would be: nickel steel, 3% nickel, and 40% carbon.

67. The elastic limit is the point at which permanent deformation begins.

68. A ductile material is one that can be permanently deformed without failure.

69. A brittle substance is one that fails without any appreciable permanent deformation, has low shock resistance on loads suddenly applied.

70. A tough material is one that can withstand considerable stress, slowly or suddenly applied, often or continuously applied, and will deform before failure.

71. Hardness is the resistance a substance or material has to forceable penetration by another object.

72. There are four basic tests for identifying metals: appearance, spark, chip, and blowpipe or torch.

73. Joint design consists of two distinct phases: (1) design of the cross section of the weld, and (2) design of the manner in which the structure parts come together.

74. The flux coatings of electrodes usually contain compounds such as silican, borium, calcium, magnesium, and iron oxide.

75. Carbon is the most important alloying element from the standpoint of its effect upon the alloy which it is combined with.

76. The higher the carbon content of iron/steel, the lower the ductility.

77. Pure iron, compared ot its alloys, is soft, ductile, and has a rather low tensile strength.

78. A fillet t-joint is a joint that is formed by two pieces placed at right angles to each other.

ANSWERS FOR CRITERION TEST

Name ______________________________ Date __________ Score _________

Industrial Arts _____, Section _____ Instructor _____________

ANSWER SHEET

1. A B C D	21. A B C D	41. A B	61. A B
2. A B C D	22. A B C D	42. A B	62. A B
3. A B C D	23. A B C D	43. A B	63. A B
4. A B C D	24. A B C D	44. A B	64. A B
5. A B C D	25. A B C D	45. A B	65. A B
6. A B C D	26. A B C D	46. A B	66. A B
7. A B C D	27. A B C D	47. A B	67. A B
8. A B C D	28. A B C D	48. A B	68. A B
9. A B C D	29. A B C D	49. A B	69. A B
10. A B C D	30. A B C D	50. A B	70. A B
11. A B C D	31. A B C D	51. A B	71. A B
12. A B C D	32. A B C D	52. A B	72. A B
13. A B C D	33. A B	53. A B	73. A B
14. A B C D	34. A B	54. A B	74. A B
15. A B C D	35. A B	55. A B	75. A B
16. A B C D	36. A B	56. A B	76. A B
17. A B C D	37. A B	57. A B	77. A B
18. A B C D	38. A B	58. A B	78. A B
19. A B C D	39. A B	59. A B	
20. A B C D	40. A B	60. A B	

APPENDIX B

DIRECTIONS: Please put your name on the answer sheet in the space provided. Do not mark on this or the next page. On the next page are fifteen statements which you are asked to respond to. Please respond to them in the following manner using the provided answer sheet.

If you strongly agree with the statement, fill in the #1 response.

If you agree with the statement, fill in the #2 response.

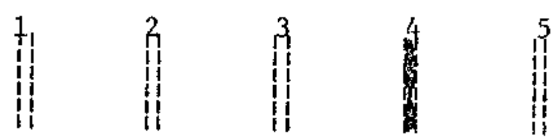
If you are undecided about the statement, fill in the #3 response.

If you disagree with the statement, fill in the #4 response.

If you strongly disagree with the statement, fill in the #5 response.

EXAMPLE:

A. Blue is a warmer color than Red.



Since blue is considered a 'cool' color, this response disagrees with the statement that blue is a warm color. However, due to various applications of the color blue, it might, on accasion, be interpreted as more warm than cool. Consequently, the respondent felt this was the case and disagreed rather than strongly disagreed, which would have precluded any use of the color blue as being warm.

1. Personally, I liked this method of teaching.

2. The teaching aids in this class were of a very low quality.

3. I learned more by this method than I thought possible.

4. The aids used in this class were a real help to me in learning how to weld.

5. The teaching aids in this class were of a very high quality.

6. The kinds of teaching aids used in this class have, to me, great potential for use in other classes.

7. I did not care for this teaching method.

8. The teaching aids used in this class were too technical.

9. The teaching aids used in this class presented good examples of correct welding techniques.

10. The teaching aids used in this class were too elementary.

11. I enjoyed using the teaching aids in this class.

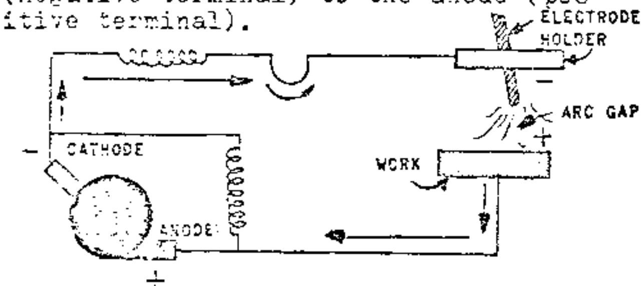
12. The teaching aids used in this class presented clearly the best uses to be made of welding equipment.

13. The teaching aids used in this class were a bother to use.

14. I hope I never take another class where this method is used.

15. I would enjoy taking another class that used these types of aids.

9. The electric current used for welding may be direct current (DC) or alternating current (AC). The welding circuit diagram, below, depicts direct current straight polarity (DCSP). The electrons are flowing from the cathode (negative terminal) to the anode (positive terminal).



9. In DCSP, the electrode is the ______________ (+:-) terminal.

42. The first problem encountered in starting the arc is that of 'freezing' the rod to the base metal. This happens when the electrode and base metal are touched and the rod sticks or freezes to the work. If the rod freezes, it may be freed by a quick twist of the electrode.

42. Many times when a beginner first attempts to strike an arc the electrode tends to ______________.

17

Answer #9

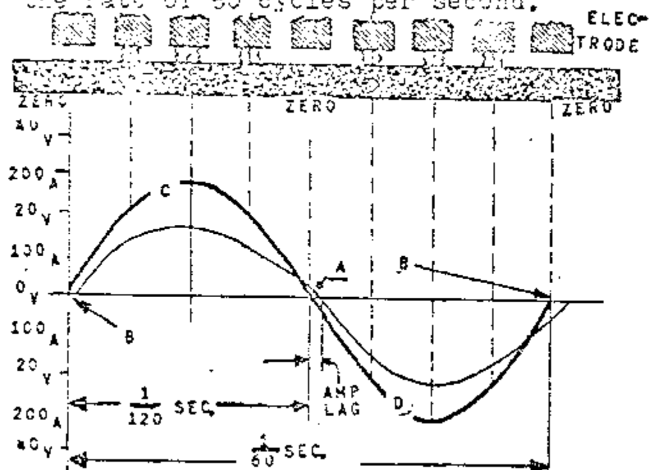
negative terminal

Answer #42

freeze or stick

18

18. Most AC arc welders are of the transformer type which step down the line voltage and increase the current for welding purposes. The following diagram depicts what happens at the arc in one cycle of a typical AC transformer type arc welder. The voltage at A and B is zero, then the voltage builds up to a maximum in one direction to point C and then back to zero at point A. The voltage then builds up to a maximum in the other direction to point D then back to zero again at point B. This action is repeated at the rate of 60 cycles per second.



18. How many times in one cycle does the voltage drop to zero? ________.

Answer #18

two or three

23. There are several types of AC transformer arc welding machines.

A. Adjustable reactor type.
B. Movable coil type.
C. Movable core type.

The adjustable reactor type welder is adjusted through the use of reactors. These reactors are moved automatically inside the welding machine by an electric current. They may be adjusted by the operator with the use of an extension cord. The reactance is controlled by either hand or foot. When reactance is increased, current flow decreases. The windings and core are held in a constant position and the reactors are moved in relation to them. This is known as a constant voltage machine.

23. What happens to the current flow when reactance is decreased? ______________________.

GO ON TO PAGE 47

STOP: REFER TO INSTRUCTION SHEET #1 AND RUN A NUMBER OF BEADS ON A PIECE OF 3/16" X 4" X 4" MILD STEEL. AFTER YOU FEEL YOU CAN RUN A GOOD BEAD, CHECK WITH YOUR INSTRUCTOR FOR FURTHER WORK.

Answer #23

current flow is increased

APPENDIX D

INSTRUCTION SHEET #2

GROUPS ONE AND TWO

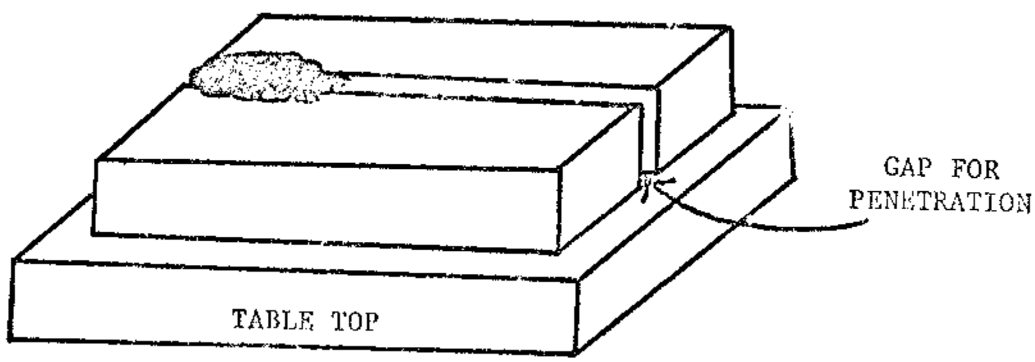
Now that you are able to start the arc and keep it going, you are ready for the first actual weld joint--a square edge butt weld. Secure at least six pieces of 3/16" x 1" x 4" hot rolled steel and weld a number of square edge butt welds using a one-eighth inch diameter electrode. Once you have completed a number of these, check with your instructor to see if you should continue on to the next weld or do additional work on this weld.

If you do not understand fully what was presented in the film or booklet, review the booklet or see the film again.

THE FILM TO VIEW FOR THIS WELD IS:

NUMBER THREE, SQUARE EDGE BUTT WELD

View the film as often as you feel necessary.



Square Edge Butt Weld

Upon completion of this operation return to the programed instruction booklet and continue in it until you are referred to instruction sheet number three.

INSTRUCTION SHEET #3

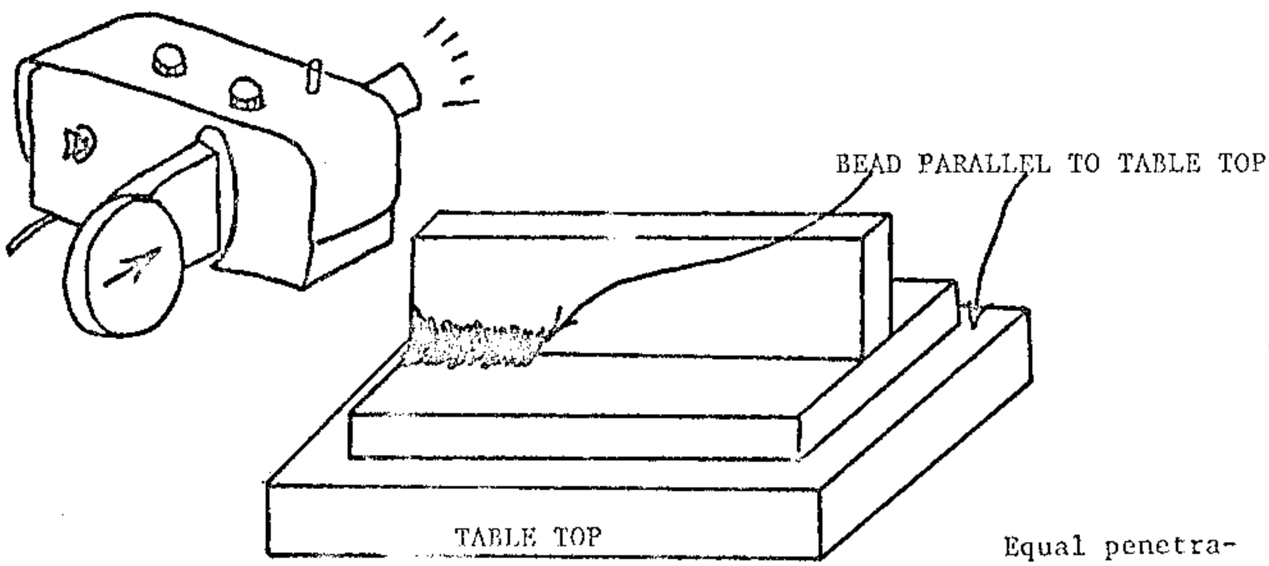
GROUP THREE

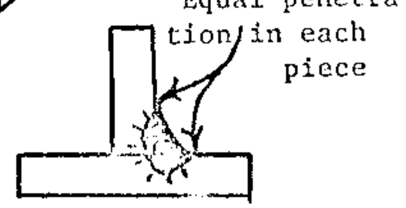
This weld is referred to as a flat-t fillet weld. The bead is run in the corner formed by the two pieces of metal placed at right angles to each other. The material should be so positioned that the weld will be run in a plane parallel to the table top.

Secure several pieces of 3/16" x 1" x 6" hot rolled steel and weld a number of flat-t fillet welds using a one-eighth inch diameter electrode. Once you have completed a number of these, check with your instructor to see if you should continue on to the next weld or do additional work on this weld.

If you do not understand fully what was presented in the film or demonstration please ask for assistance or view the film again.

Upon completion of this operation consult with your instructor for further instructions.





Flat-t Fillet Weld

THE FILM TO VIEW FOR THIS WELD IS:

NUMBER FOUR, <u>FLAT T FILLET WELD</u>

View the film as often as you feel necessary.

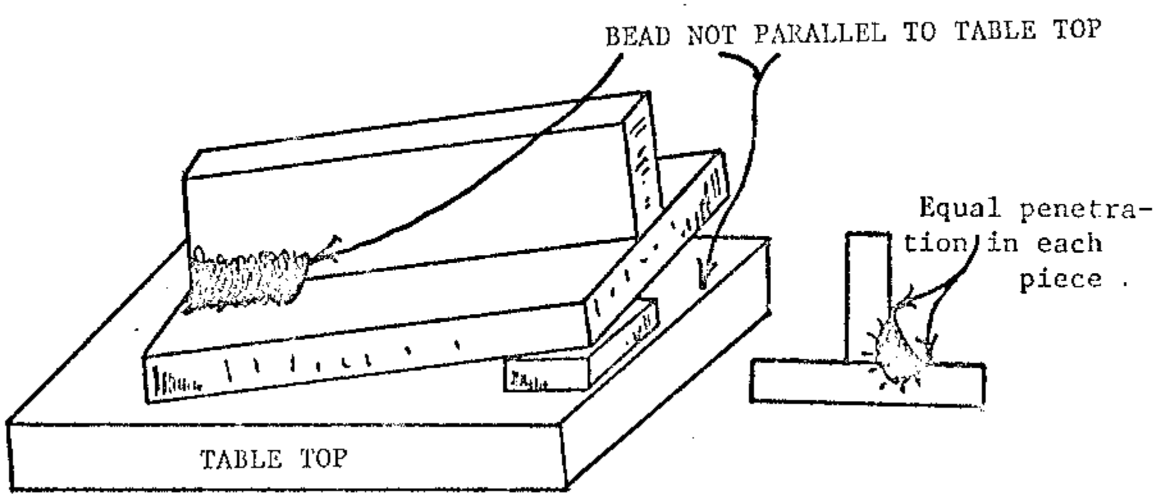
GROUP FOUR

This weld is referred to as a positioned-t fillet weld. The bead is run in the corner formed by the two pieces of metal placed at right angles to each other. The material is placed so that the point where the two pieces of metal come into contact with each other is at an angle to the table top and not parallel as in the flat-t fillet weld.

Secure several pieces of 3/16" x 1" x 6" hot rolled steel and weld a number of positioned-t fillet welds using a one-eighth inch diameter electrode. Once you have completed a number of these, check with your instructor to see if you should continue on to the next weld or do additional work on this weld.

If you do not fully understand what was presented in the film or demonstration please ask for assistance or view the film again.

Upon completion of this operation consult with your instructor for further instructions.



Positioned-t Fillet

THE FILM TO VIEW FOR THIS WELD IS:

NUMBER FIVE, POSITIONED FLAT FILLET

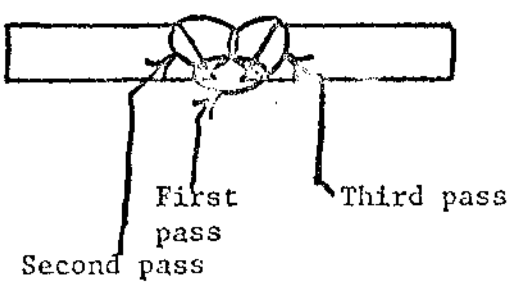
View the film as often as you feel necessary.

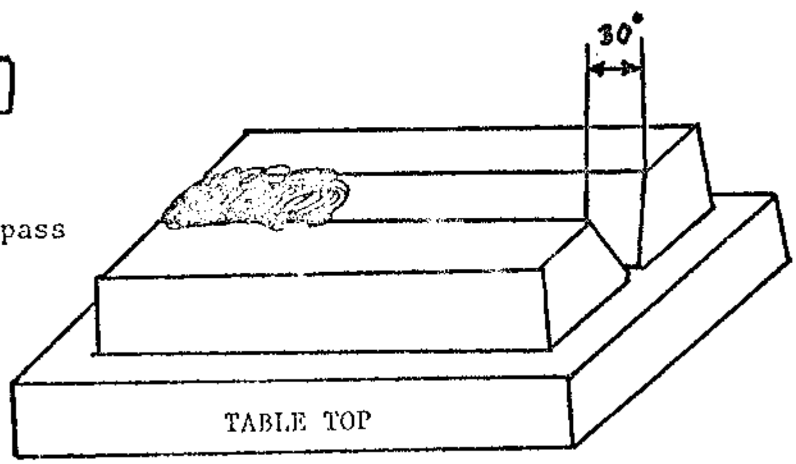
INSTRUCTION SHEET #5

GROUP FOUR

This weld is referred to as a 30° single bevel, single-v, butt weld. The bead is run in a manner similar to the square edge butt weld, however, the metal should be ground on a grinder (see figure below) so that a larger surface is exposed for fusion during welding. It will be necessary that you run more than one bead to complete this type of weld. The amperage setting for the first bead on this weld is less than on succeeding beads, and you may use either the 'closure' technique or 'stringer bead' technique to complete this weld. The ground edge should be a 30° bevel. Secure several pieces of 3/16" x 1" x 6" hot rolled steel and grind one edge of each piece. Do several 30° v-butt welds using a one-eighth inch diameter electrode. Once you have completed a number of these, check with your instructor to see if you should go on to the next weld or do additional work on this weld.

If you do not fully understand what was presented in the demonstration please ask for assistance before beginning, or review the programed instruction booklet.





30° Single v-Butt Weld

Upon completion of this operation check with your instructor for further work.

APPENDIX E

FALL, 1969-1970

STUDENT INFORMATION SHEET

Please answer all items and record the information by your neatest method

NAME ____
Last First Middle (initial ok)

HOME ADDRESS ____

CITY & STATE ________________________________ ZIP ________

DENTON ADDRESS ____________________________ PHONE __________

AGE ________ MAJOR ______________ SEX M F ______ (circle one)

List all courses related to welding that you have completed in high school, trade school, business school, etc.

COURSES SEMESTERS COMPLETED

____ . ______________

____ . ______________

____ . ______________

List all of your employment in which you have utilized any form of welding to fulfill the requirements of your employment. Please explain how welding was integrated into your procedures.

____

____

____

____

____

Please list any other activities you have had which would involve any welding processes.

____

____

APPENDIX F

JUDGE'S RATING SHEET

Student #________________________________

Instructions: Assign a rating for each exercise completed on the following basis:

1. Smooth, even ripple bead, good penetration, good fusion.
2. Bead approximately 1/4" to 3/8" in width, approximately 1/8" high, no inclusions, slag pockets, craters, or spatter marks. Has a smooth surface where the joint is formed.

If a weld meets all the requirements above, assign a grade of A.

If a weld lacks one of the requirements above, assign a grade of B.

If a weld lacks two of the requirements above, assign a grade of C.

If a weld lacks three of the requirements above, assign a grade of D.

If a weld lacks four of the requirements above, assign a grade of F.

Arc Welding Exercises*	A	B	C	D	F	Points
Square edge butt weld						
Flat-t fillet weld						
Positioned-t fillet weld						
30°, single bevel, single v butt weld						
	Total Points Earned					

*Place a √ in the appropriate box.

APPENDIX G

STUDENT TIME SHEET

Student Name ____

Date Started ____

Date Completed ____

Number of Days ____________________ Number of Hours _______

Comments ____

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