

**COMPARISON OF THREE MODES
OF INSTRUCTION FOR THE
OPERATION OF A COMPLEX OSCILLOSCOPE**

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FOREWORD

This report represents a portion of the exploratory development program of the Technical Training Branch, Training Research Division, Behavioral Sciences Laboratory. The research was documented under Project 1710, "Human Factors in the Design of Training Systems", Task No. 171007, "Automated Training and Programmed Instruction".

Dr. Gordon A. Eckstrand was the project scientist. Dr. Ross L. Morgan was task scientist. Mr. John P. Foley, Jr., was contract monitor. The research was conducted under Contract No. AF 33(615)1414 with Applied Science Associates, Inc., Valencia, Pennsylvania. Dr. John D. Folley, Jr. was the principal investigator. Mr. Robert H. Woods and Mr. Frank J. Trudo were the on-site representatives of Applied Science Associates, Inc. Dr. Andrew P. Chenzoff of Applied Science Associates performed the data analysis and made substantial editorial contributions to this report. The study was conducted in cooperation with the 6940 Security Wing, (USAFSS) Goodfellow Air Force Base, Texas. The research covered by this report was performed between February 1964 and February 1966.

This technical report has been reviewed and is approved.

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ABSTRACT

A field experiment was conducted to compare the effectiveness of three modes of instruction in the use of the AF 1807 oscilloscope (Tektronix 545A). Skilled electronic technicians of the U.S. Air Force Security Service served as subjects. One group was trained with an audio-visual instructional program, and a second group with a book form of the same program. The program combined verbal instruction and responses with practice on an oscilloscope. A third group was trained in the manner normally used at the school where the study was conducted. Analysis of variance on test scores indicated superiority of both forms of the program over the conventional instructions with no difference in effectiveness between programs. Electronic aptitude, as measured by the Airman Qualifying Examination, correlated significantly with test scores for the conventionally trained group and for all subjects together.

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SECTION I

INTRODUCTION

Programmed instruction has established itself as a separate technology for the modification of behavior to achieve specified objectives. Although the basics appear to be well established, the many variations possible in programming have produced and continue to spawn many studies dealing with specific problems of method or technique, program style, content, organization, and presentation.

This study deals with the last problem--that of mode of presentation. The topic of instruction was operation of the AF 1807 oscilloscope (Tektronix Model 545A), a relatively difficult procedural task involving some fairly fine visual discriminations and discrete perceptual-motor operations.

This inquiry is of interest for at least four reasons:

It includes an attempt to program material that requires physical interaction between the learner and a piece of equipment, with operation of the equipment an integral part of the program.

The study was done in a non-laboratory environment at a military training school; therefore, the requirements of the study had to be meshed with those of the school.

Differences in overall cost of using and maintaining audio-visual presentation equipment as compared with printed presentation materials emphasizes the need to know what differences, if any, exist in their effectiveness.

An earlier study by Folley, Bouck, and Foley (1964)¹ showed no difference in effectiveness between audio-visual and printed modes of instruction for a simple manipulative procedural task. The effects of substantially increased task complexity are of interest.

¹ Folley, J.D., Jr., A.J. Bouch, and J.P. Foley, Jr., 1964. A Field Experimental Study of Programmed Instruction on a Manipulative Task, AMRL-TR-64-90 (AD 608 296), Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, pp vii + 39.

SECTION II

PROBLEM

The problem was to compare the effectiveness of two modes of presentation of an instructional program with one another and with the level of performance achieved by students who received the present mode of instruction in operation of the AF 1807 oscilloscope.

Four questions were asked:

How effective was the program?

Was the audio-visual or programmed book form superior?

How much did the trainees learn about operating the AF 1807 in the existing laboratory training, compared with what they learned from the program?

To what extent is electronics aptitude related to learning to use this oscilloscope?

SECTION III

APPROACH AND METHOD

Identification of Behaviors

The AF 1807 oscilloscope is a versatile test instrument with many capabilities. The first step was to select those capabilities that would be included in the training. An analysis of the specific operations performed with the instrument by the population of technicians, who would serve as subjects, would have permitted a closer agreement between program content and the content of the normal instruction being given in the training school. Security restrictions, however, made this analysis impossible.

A task analysis of the more common capabilities of the oscilloscope was initiated to serve as the basis for the instructional program. Five technicians, identified by the school as being among the best qualified at that location in the use of the AF 1807 oscilloscope, provided the task data. They described and demonstrated the operation of the scope and identified the kinds of uses to which the oscilloscope could be put and the activities required of the technician to perform the various operations. This analysis produced a set of 5 task blocks, including 15 definable tasks, which were broken down into some 74 activities. These activities, in the proper sequence, amounted to the desired behavioral outcomes of the training.

The 5 task blocks and 15 tasks are given in Table I. Appendix I is a detailed breakdown of the tasks.

Program Development

Program segments were developed for each of the five major task blocks that resulted from the task analysis. A section was added providing an introduction to the controls and displays on the scope face prior to getting into the actual activities of using the scope for measurements.

The philosophy of programming can best be described as eclectic, using principles of linear, branching, and mathetic programming where they were judged to produce the most effective presentation. As each part of the basic program was written, it was pretested in the usual manner by administering sections of it to one or more individuals, recording questions asked and errors made, and revising it accordingly. The experimental comparison of the audio-visual and printed modes of presenting the program served as the first large-scale test and validation of the program.

TABLE I.

SUMMARY OF TASKS IN OPERATION
OF AF 1807 OSCILLOSCOPE

Task Block 1: Preset and Calibration of the Scope

- Tasks: 1.1. Preset controls
1.2. Position and focus display
1.3. Evaluate amplitude, waveshape, frequency

Task Block 2: Voltage Measurement

- Tasks: 2.1. Define measurement problem
2.2. Obtain display
2.3. Evaluate display

Task Block 3: Frequency Measurement

- Tasks: 3.1. Combine 1.1, 1.2, 1.3 and 2.1
3.2. Obtain display
3.3. Evaluate display

Task Block 4: Comparison of Waveshape to Waveshape Standard

- Tasks: 4.1. Combine 2.1 and 3.2
4.2. Evaluate waveform

Task Block 5: High Accuracy Time Base Measurements and Comparisons

- Tasks: 5.1. Display selected portions of wave form using both time bases
5.2. Amplitude comparison of two wave forms using dual trace display
5.3. Time base comparison of two wave forms using dual trace display
5.4. Frequency comparison of dual trace waves.

To provide a reasonable range of signals for both training and testing in the laboratory, a small signal generator was devised and built for use in testing and training. The generator was a battery-powered triggered multivibrator with two frequency ranges and fine tuning. It provided ample signals for training and for two parallel forms of the criterion test. Technical information on the signal generator is given in Appendix II.

Both versions of the program required the subjects to work with the oscilloscope and its accessories as part of the learning process. Written responses were also required, but were used to obtain evaluable responses in support of the performance of the actual task behaviors, not in place of them.

Samples of the sheets on which the subjects wrote the required written responses are included in Appendixes III and IV, along with the samples from the program.

The Audio-Visual Program

This mode of the program was designed for presentation on the Graflex Audio-Graphic machine. This commercially-available device can present recorded audio material by means of preloaded tape cartridges that give about 30 minutes of playing time on each of two sides of the tape. Removal and insertion of cartridges is simple, making it feasible for trainees to change the cartridges so the program can progress from one cartridge to the next quite readily.

The visual presentation is done with 35 mm. slides projected onto a ground-glass screen from the rear. The slides are changed automatically upon occurrence of signals previously recorded on the tape. The slide cartridges are also readily changed by the trainees.

The program used in this study used seven tape cartridges and two slide cartridges. The full length of tape was not used in all cartridges, so that cartridge-changing could be done at convenient stopping points. The first slide cartridge contained 29 slides, the second, 33 slides, for a total of 62 slides for the entire program. Most of the slides were in color, except some photographs of black-and-white drawings.

Figure 1 shows the Graflex machine as it was used during training with the audio-visual (AV) program. This figure also shows the oscilloscope and the signal generator mentioned earlier. Appendix III contains a sample of the script with black-and-white prints of slides used in this program, and a sample of the response sheet used by the subjects.

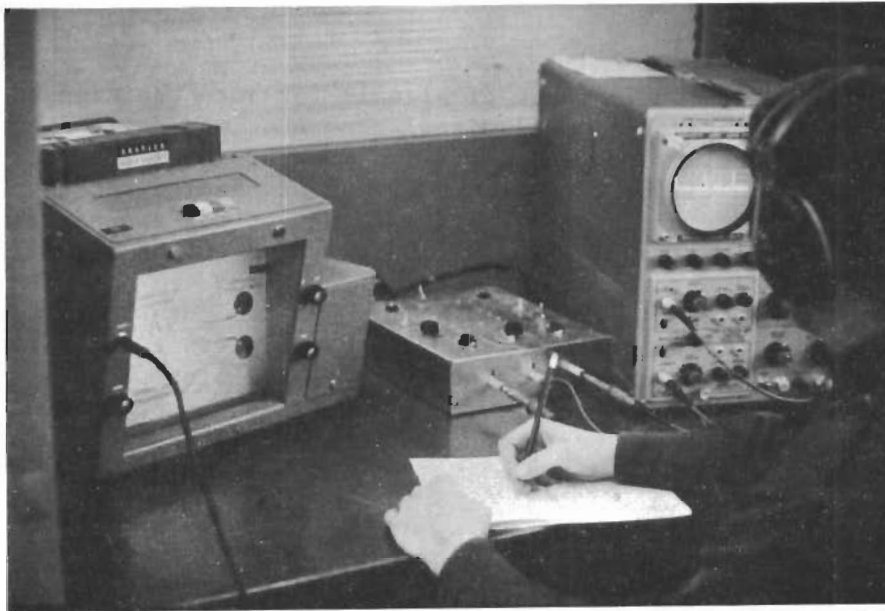


Figure 1. Subject at Work
Position

The Programmed Book

The contents of the book program were essentially the same as the contents of the AV program. Instructions on cartridge changing were omitted, but instructions on use of the templates for the illustrations were added. Figure 2 shows the programmed book which includes the frames on the right side of the folder and the supporting illustrations on the left.

The book was bound in a hard cover. The program frames were bound at the top of the inside of the back cover. As the subject proceeded through the frames, he would flip the finished pages upward.

The inside of the front cover contained the illustrations used in the program. They were of two kinds: (1) black-on-silver drawings or printed material, or (2) a combination of a black-on-silver illustration of the front of the oscilloscope and a transparent template with red overprinting to point out or emphasize certain parts of the oscilloscope.

No illustrations in the book were in color, except for the red templates just mentioned. The difference between the book and AV programs with regard to the color of illustrations was recognized as a realistic difference likely to occur in other programs. Four-color printing of a book substantially increases its cost. Colored slides, however, cost little more than black-and-white slides. Colored illustrations were used in the AV program because they will probably be commonly used in AV presentations. Book illustrations will generally be black and white.

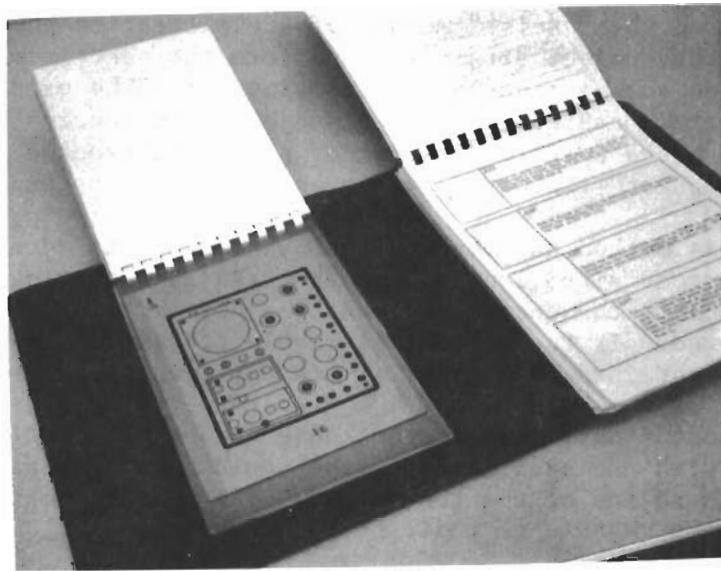


Figure 2. The Programmed Book and Supporting Illustrations

A book program consisted of 256 frames divided into 6 sections. A sample page of the book program is given in Appendix IV.

Criterion Tests

Performance test questions were devised to measure the ability of subjects to perform all of the tasks identified in the task analysis. The nature of the operation of the oscilloscope is such that, in some cases, more than one task, or parts of more than one task, can be included in a single test item.

Since some subjects were to be tested twice as specified by the experimental design, two forms of the test were developed. There were two differences between the two forms of the test.

The items, which appeared to be essentially identical in both forms, were presented in a different order in form T2 than in T1.

Although a given item may appear identical in both forms, a covert adjustment made in advance by the experimenter resulted in a different signal input or other condition, making for a different correct answer.

The tests used the "assist" method of administration and scoring. In this method, the subject attempts to perform the test item, but if he is unable to do so, he signals the experimenter. The experimenter then provides certain assistance to the subject, and records an "assist". The subject then has a specified number of points subtracted from his score for each "assist" requested by him and given by the experimenter.

Although this method has obvious disadvantages, its advantages outweigh them in some situations. In such tasks as operating an oscilloscope, later steps in the operation cannot be performed until earlier steps are completed. If the subject is unable to complete an earlier step, no data is obtained on his ability to perform the later step.

In the present study, many of the subjects who took the pretest were unfamiliar with the oscilloscope, and would have been almost completely unable to do any of the test items. The "assist" method gave a much more sensitive measure of their performance.

The tests are described in greater detail, and the rationales given, in the Administrator's Manual (Appendix V).

Apparatus

Training and testing were done in two identical booths having three walls about 6-feet high. The subject was seated at a table in the booth. On the table were:

- An oscilloscope
- A signal generator
- Necessary probes and leads
- The Graflex audio-visual device or the programmed book for training sessions
- An electric clock
- Test sheets for testing sessions; response sheets for training sessions
- A switch with which the subject could signal the proctor if he needed assistance

Figure 1 shows a subject seated in a booth before the major equipment items.

Subjects

Ninety-two trainees enrolled in the Intercept System Technician (AZK 30474) course at the 6940 Security Wing (USAFSS), Goodfellow Air Force Base, Texas, served as subjects. Most of these trainees were experienced maintenance men who were entering this particular school to receive training on a group of systems with which they were unfamiliar. Most of these subjects had high electronic aptitudes as indicated by their personnel records. Of the total of 92 subjects, 35 had an electronic aptitude at the 85th percentile or better, 47 ranged from 70th to 80th percentile, and only 7 were known to be below the 70th percentile. No scores were available on three of the subjects.

Subjects were selected only by the criterion of being available when they were needed. All trainees of the AZK 30474 course were scheduled into this experiment during the period of data collection.

Experimental Design

The design consisted of three major groups each representing one state of the chief variable "mode of presentation". Group I was trained with the audio-visual program. Group II was trained with the programmed book. Group III received the present mode of instruction in the laboratory phase of their regular training in the Intercept Technicians' Course. The present mode of instruction, as reported by the instructors, consisted mainly of coaching the students on the use of the 545A to the extent necessary for the laboratory phase of the course. Use of the oscilloscope was not a separate instructional unit, but was an adjunct to the main objective.

Main Variable	Pretest Schedule		
	Early Pretest	Late Pretest	No Pretest
I. Audio Visual	AV EPT	AV LPT	AV NPT
II. Programmed Book	PB EPT	PB LPT	PB NPT
III. Present Mode	PMI EPT	PMI LPT	PMI NPT

Figure 3. Experimental Design
(cells contain group designations)

Contrails

All groups received a posttest within one week after completion of either experimental training or the present mode of instruction (PMI).

The early pretesting of part of the experimental groups was to provide a picture of the abilities of the input population on operation of the scope before they had any significant exposure to the school environment. The early pretest of the PMI group was delayed so that the interval between early pretest and the posttest would be approximately equal to that interval for the experimental subjects.

The late pretest, which took place immediately before training, was to provide a measure of the subjects' ability to operate the scope just before training began. It was thought this might be different from their ability at the beginning of the course.

The No Pretest group was included so that the effects of the three modes of presentation of training on operation of the scope could be determined on subjects who had not been sensitized by any pretest.

Scheduling of Data Collection

Data collection had to be fitted in with the ongoing requirements of the school. These requirements, therefore, had to be considered in the design.

At the time this study was done, the AZK 30474 course consisted of 28 academic weeks. The laboratory phase, in which all experimental subjects would receive the normal instruction in use of the AF 1807 oscilloscope, occurred in the 23rd through 28th weeks. It was therefore necessary to schedule all experimental training prior to that phase of training for each subject.

The schedule shown in Figure 4 was used.

Group	0	6	8	20	21	22	TRAINING WEEK 23 to 28	28+
I								
AV EPT	T ₁				Tng	T ₂	PMI	
AV LPT				T ₁	Tng	T ₂	PMI	
AV NPT					Tng	T ₁	PMI	
II								
PB EPT	T ₁				Tng	T ₂	PMI	
PB LPT				T ₁	Tng	T ₂	PMI	
PB NPT					Tng	T ₁	PMI	
III								
PMI EPT			T ₁				PMI	T ₂
PMI LPT						T ₁	PMI	T ₂
PMI NPT							PMI	T ₂

Figure 4. Scheduling of Training and Testing

SECTION IV

EXPERIMENTAL PROCEDURE

Two identical booths were set up for testing and experimental training. Subjects reported for training or testing as directed by the Security Service School and in accordance with the experimental design and schedule.

Upon his arrival, the subject was shown to one of the booths with the setup as previously shown in Figure 1. The audio-visual machines were removed from the booth for the Programmed Book groups and for testing.

After the subject was seated, an experimenter administered either an instructional program or a test, whichever was called for, in accordance with the appropriate manual. The manual for administration of the test, already referred to, is in Appendix V. The administrator's manual for both instructional programs is in Appendix VI.

The research team had no control over the "present mode of instruction" in the laboratory because of security restrictions. All testing of subjects in this group, however, was done at the experimental site in accordance with the test administration manual.

The experimental programs were administered in two sessions of about 3 hours each. The second session was always scheduled to take place no later than the third day after the first session.

SECTION V

RESULTS AND DISCUSSION

General

Data were obtained on 92 subjects. Variations in subject flow rate, coupled with scheduling restrictions, resulted in uneven allocation of subjects to the various treatments in the design. Two of the treatments had to be dropped because subjects could not be scheduled for them. Table II shows the number of subjects in each treatment subgroup, and for the major groups (AV, PB, and PMI), the mean Electronic Aptitude, Pretest score, and Posttest score.

TABLE II

NUMBER OF SUBJECTS IN EACH SUBGROUP,
AND MEAN ELECTRONIC APTITUDE,
MEAN PRETEST SCORE, AND MEAN POSTTEST
SCORE FOR THE MAJOR TREATMENT GROUPS

	<u>No. of Subjects</u>	<u>Mean Electronic Aptitude</u>	<u>Mean Scores</u>	
			<u>Pretest</u>	<u>Posttest</u>
AV EPT	12	81	319	498
AV LPT	10			
AV NPT	5			
PB EPT	Dropped	82	374	528
PB LPT	14			
PB NPT	7			
PMI EPT	8	79	379	403
PMI LPT	Dropped			
PMI NPT	36			

Mode of Presentation

Posttest Scores: Subjects trained with either the audio-visual or book programs performed significantly better on the posttest than subjects receiving the normal laboratory training. No significant difference was found between the two program-instructed groups.

Table III shows the results of the analysis of variance and "t" test for these comparisons.

TABLE III

ANALYSIS OF VARIANCE AND "t"
TESTS FOR POSTTEST SCORE

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>MS</u>	<u>F</u>
Mode of Presentation	2	280,675	140,337	6.47**
Within Groups	89	1,928,822	21,672	
<hr/>				
Total	91	2,209,497		

t's

AV-PB 46 df .705
AV-PMI 69 df 2.815**
PB-PMI 63 df 3.050**

**p < .01

Pretest to Posttest Gain: As with posttest scores, the experimentally-trained groups outperformed the group trained by the usual laboratory method on the gain in score from pretest to posttest. The experimental groups achieved a significantly greater gain than the PMI group, but there was no significant difference between the two experimental groups in the gain from pretest to posttest.

The analysis of variance and "t" tests for these comparisons are shown in Table IV.

TABLE IV

ANALYSIS OF VARIANCE AND "t" TESTS
FOR PRETEST-TO-POSTTEST GAIN IN SCORE

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>MS</u>	<u>F</u>
Mode of Presentation	2	196,192	98,081	3.762*
Within Groups	41	1,069,039	26,074	
<hr/>				
Total	43	1,265,231		
<hr/>				
	<u>t's</u>	<u>df</u>	<u>t</u>	
	AV-PB	34	.391	
	AV-PMI	28	2.668*	
	PB-PMI	20	2.295*	

*p .05

The present study confirms the results in a similar study by Folley, Bouck, and Foley (1964)^c with regard to the lack of difference between the two modes of presenting the instructional programs. Both studies show no difference between these two modes.

This finding suggests that the added elaborateness of the audio-visual mode of presentation appears not to be justified for this kind of training situation. Relevant factors to consider in generalizing this result are two:

1. Type and Complexity of Task.

Both studies used tasks requiring considerable manipulative and discriminative behavior. The earlier study with the carbine was almost exclusively a mechanical manipulation task requiring no computations and very little conceptual thinking. The study reported here required less manipulative skill, but sensitive discrimination, the following of rather lengthy procedures, and computation.

It would appear, then, that audio-visual and programmed book modes could be expected to be about equally effective for a fairly wide range of procedural-manipulative tasks.

2. Integration of Job Performance Practice as Part of the Instructional Program.

In both studies, practice of criterion behaviors, using the actual equipment normally used in job performance, was an integral part of the instructional programs. In the earlier study, trainees assembled and

disassembled actual carbines under the tutelage of the instructional program. In the present study, subjects worked with an actual AF1807 oscilloscope, taking required measurements under the guidance of the program. The extent to which the relative effectiveness of the audio-visual or book forms of a program would be reduced if this feature of the training were eliminated was not tested. Conservative generalization of the equal effectiveness of audio-visual and book modes of presentation would, therefore, require that this restriction be imposed on the character of the program.

Time data taken on a 20% subsample of subjects reveals a mean program running time of 4 hours 53 minutes for the programmed book ($n = 5$), and 5 hours 28 minutes for the audio-visual program ($n = 13$). There is considerable variability within groups, with a range of 3 hours 30 minutes to 7 hours 35 minutes for the audio-visual group. The difference between the two mean times of these samples is not significant ($t = .962$ with 16 df).

Effectiveness of Programs vs. PMI: The comparison between programmed instruction and the present mode of instruction (PMI) in the earlier carbine study revealed no differences in effectiveness. In that study, however, the attempt was made to equate objectives and content of the PMI training and the programmed instruction modes. It seemed apparent to the experimenter in that case that the communication of the objectives of the training to the instructors who presented the modified (PMI) training considerably enhanced the quality of their teaching.

In the present study, the experimental training modes proved superior. In this study, however, no attempt was made to influence the objectives or content of the existing school laboratory course, not even to determine what they were. The superiority of the instructional programs over the existing training may, therefore, be attributable to a difference in objectives or content rather than to any superiority of methods. There is anecdotal evidence to indicate that, in the existing laboratory training, trainees are taught to use this oscilloscope mainly as a go/no-go indicator of the presence or absence of a signal, rather than learning how to make the more sophisticated measurements included in the program and on the criterion test. This could indicate that the go/no-go level is the extent of the instructor's or field maintenance man's capability in the use of this test equipment. The desired field situation may require the more sophisticated measures if operating systems are to function at the level of sensitivity for which they were designed. Maintenance people may be just "getting by" but not performing at a desirable level.

Whether the instructional programs would have resulted in superior performance on the criterion test if uniform objectives and content had been established is problematical. If this had been done, the question of enhancement of the quality of the PMI (which then is no longer really the "present mode of instruction") would remain.

If the present instruction is "adequate" from the standpoint of job performance requirements, however, then the program significantly exceeded the training requirement for use of this oscilloscope. If, however, maintenance performance, or the learning of other parts of the training program, would be enhanced by more complete instruction on use of this oscilloscope, then this program can clearly provide the instruction.

Correlation Between Criterion Test Performance and Electronic Aptitude.

Electronic aptitude, as obtained from each subject's personnel record, was correlated with pretest score, posttest score, and pretest-to-posttest gain. The obtained correlations are given in Table V.

TABLE V
CORRELATIONS BETWEEN ELECTRONIC APTITUDE
AND CRITERION TEST PERFORMANCE

Subgroup ¹	Criterion Test Scores		
	Pretest	Posttest	Gain
Audio Visual Subjects	-.26 (21) ²	.14 (26)	.37 (21)
Programmed Book Subjects	.18 (14)	.31 (21)	.04 (14)
PMI Subjects	.22 (8)	.54* (42)	.41 (8)
All Subjects	-.01 (43)	.38* (89)	.25 (43)

*p .01

Notes for Table V.

1. The correlations with posttest scores include all subjects in each mode of presentation. Pretest and Gain, of course, contain only those subjects who took the pretest.
2. The numbers in parentheses are the number of subjects in each correlation.

Table V shows that significant correlations between electronic aptitude and posttest scores were obtained for PMI subjects and for all subjects together. The PMI subjects, who comprise almost half of the "all subjects" in this correlation, are responsible for the significant correlation obtained with the "all subjects" group.

Although these correlations suffer from some restriction in range and from small n's, these results suggest that, for a task of this kind, the effect of aptitude level on learning is less pronounced when instruction is given on the specific behaviors, a characteristic of programmed instruction, than when the subject is "on his own" to learn, as is more nearly the case in the laboratory situation.

SECTION VI

CONCLUSIONS

Three conclusions can be drawn from this study.

1. The audio-visual or the book mode of presentation may be used with equal effectiveness for this kind of material when the programming includes performance of actual job operations. Programs of this kind may, therefore, be designed to take advantage of whatever facilities are available for program presentation.
2. The analysis of variance of criterion test scores indicated that both the audio-visual and book programmed modes of presentation were significantly superior to the laboratory mode of instruction used at Goodfellow Air Force Base, Texas at the time of this study.
3. When aptitude level of trainees is a factor in determining training characteristics, the use of programming techniques will help to reduce the effects of aptitude differences on training effectiveness.

APPENDIX I

SUMMARY OF TASKS IN OPERATION OF THE AF 1807 OSCILLOSCOPE

Block 1: Preset and Calibration of the Scope

Tasks: 1.1. Preset controls

- 1.1.1 Turn 545A "ON"
- 1.1.2 Set E/CM
- 1.1.3 Set Amplitude Calibrator
- 1.1.4 POLARITY to NORMAL
- 1.1.5 Set 4 display controls mid-range
- 1.1.6 Set TRIGGERING MODE on AUTOMATIC
- 1.1.7 TRIGGER SLOPE to INT. +
- 1.1.8 TIME/CM VARIABLE until light off
- 1.1.9 Set AC-DC switch to DC
- 1.1.10 TIME/CM to 12 o'clock
- 1.1.11 VOLTS/CM VARIABLE until light off
- 1.1.12 Set Channel A MODE "A" ONLY
- 1.1.13 5X MAGNIFIER off
- 1.1.14 HORIZONTAL DISPLAY "A" position

1.2 Position and focus display

- 1.2.1 Center trace on vertical dimension
- 1.2.2 Center trace on horizontal dimension
- 1.2.3 Adjust FOCUS and ASTIGMATISM for sharp clear picture
- 1.2.4 Set INTENSITY and SCALE ILLUMINATION to comfortable eye level

1.3 Evaluate Amplitude, Waveshape, Frequency

- 1.3.1 Connect probe to channel _____ and insert in CALIBRATION OUT jack.
- 1.3.2 Set VOLTS/CM to obtain maximum size wave on grid
- 1.3.3 Adjust probe compensation
- 1.3.5 Adjust GAIN ADJUST if necessary
- 1.3.6 Evaluate waveshape

Block 2: Voltage Measurement

Tasks: 2.1 Define measurement problem

- 2.1.1 Determine correct values (refer to TO's Manuals, schematics, experience)
- 2.1.2 Determine effect of test on circuit to be tested (refer to schematics and scope manual for loading characteristics)
- 2.1.3 Select for installation equipment needed.
 - a. Plug-in unit
 - b. Auxiliary equipment
 - c. Probe, cables, fittings

2.2 Obtain display

- 2.2.1 Set VOLTS/CM at greatest value
- 2.2.2 Connect probe to channel _____
- 2.2.3 Position and focus display (see 1.2)
- 2.2.4 For AC Branch follow 1.3.2 through 1.3.4
- 2.2.5 Attend to scope display while connecting probe to test point
- 2.2.6 If trace moves up, place on bottom of grid and do 1.3.2
- 2.2.7 If trace moves down, put on top of grid and do 1.3.2

2.3 Evaluate display

- 2.3.1 Convert scale to volts
- 2.3.2 Compare to desired (2.3.1, 2.3.2)

Block 3: Frequency Measurement

- 3.1 Combine 1.1, 1.2, 1.3, and 2.1
- 3.2 Obtain Display
 - 3.2.1 Check VARIABLE ... See 1.1.11
 - 3.2.2 Connect probe to test point: See 1.3.1
 - 3.2.3 Do 1.2.
 - 3.2.4 Adjust TIME/CM setting until waveform displays maximum within grid.
- 3.3 Evaluate Display
 - 3.3.1 Count CM from end to end of wave.
 - 3.3.2 Multiply by TIME/CM setting to find Period.
 - 3.3.3 Solve for F by $1/P$ (or T).
 - 3.3.4 Compare to desired or standard.

Block 4: Comparison of Waveshape to Waveshape Standard

- 4.1 Combine 2.1 and 3.2
- 4.2 Evaluate Waveform
 - 4.2.1 Identify wave-shape display type.
 - 4.2.2 Compare type with desired type (Presumes 2.1).
 - 4.2.3 Discriminate between clean and distorted.
 - 4.2.4 If distorted wave then do 2.3 and 3.3 for tolerance check.

Block 5: High Accuracy Time Base Measurements and Comparisons

- 5.1 Display Selected Portions of Wave Form Using Both Time Bases
 - 5.1.1 Place HORIZONTAL DISPLAY on "B"
 - 5.1.2 Place TRIGGERING MODE on Time Base "B" to selected position.
 - 5.1.3 Place TRIGGER SLOPE on Time Base "B" on INT. + or -

- 5.1.4 Turn TRIGGER LEVEL on Time Base "B" fully CCW.
 - 5.1.5 Turn STABILITY CONTROL on Time Base "B" fully CW and return CCW until trace disappears.
 - 5.1.6 Adjust TRIGGERING LEVEL on Time Base "B" for stable trace
 - 5.1.7 Adjust TIME/CM on Time Base "B" for desired pattern.
 - 5.1.8 Set TIME/CM on Time Base "A" to a time faster than TIME/CM on "B".
 - 5.1.9 Turn TRIGGERING LEVEL and STABILITY controls of Time Base "A" fully CW.
 - 5.1.10 Turn HORIZONTAL DISPLAY to B INTENSIFIED BY A.
 - 5.1.11 Reduce intensity until intensified portion is visibly superimposed on rest of wave.
 - 5.1.12 Adjust width of intensified portion by changing TIME/CM on Time Base "A" until desired width is obtained.
 - 5.1.13 Move DELAY TIME MULTIPLIER until intensified portion is on portion of display to be viewed.
 - 5.1.14 Calculate display time of intensified portion: Multiply Time Base "B" TIME/CM setting by setting on DELAY TIME MULT.
- 5.2 Amplitude Comparison of Two Wave Forms Using Dual Trace Display
- 5.2.1 Place MODE on CA Unit in ALTERNATE or CHOPPED position. When CHOPPED is used assure that switch on rear of scope case is in CHOPPED BLANKING position. CHOPPED is for phase comparison.

- 5.2.2 Using Channel A VERTICAL POSITION control, center channel A trace one CM above center line on grid. Using channel B VERTICAL POSITION control, center this trace one CM below centerline on grid. NO SIGNAL INPUT.
- 5.2.3 Attach X 10 probes to channels.
- 5.2.4 Insert probe leads to signals selected for comparison.
- 5.2.5 Adjust amplitude of each trace through the corresponding VOLTS/CM control until each is less than (its) half the scale deflection. (Insure VARIABLE of each VOLTS/CM control is in calibrated position).
- 5.2.6 Select TRIGGER MODE and TRIGGER SLOPE on Time Base A to correspond with input signal characteristics.
- 5.2.7 See 5.1.4
- 5.2.8 See 5.1.5
- 5.2.9 See 5.1.6
- 5.2.10 Adjust TIME/CM on Time Base A until desired pattern is obtained. For best stability Ext. Trig. Input on A form signal input; TRIGGERING SLOPE on A to Ext. + or -.
- 5.2.11 Compare the amplitude of the two traces. Compute voltage of each trace and compare results.
- 5.2.12 Use vertical position on either channel to superimpose traces.
- 5.3 Time base comparison of two wave forms using dual trace display.
 - 5.3.1 see 5.2.1
thru thru
 - 5.3.10 5.2.10

5.3.11 To make time base comparison, superimpose the presentations. If amplitude changes are occurring at the same time, the waves will coincide.

5.3.12 If POLARITY on one or the other channels is reversed and the MODE switch is turned to ADDED ALGEBRAICALLY and only if the waves are identical, the result will be a straight line.

5.4 Frequency comparison of dual trace waves

5.4.1 see 5.2.1
thru thru
5.4.10 5.2.10

5.4.11 Compute frequency of each channel.

APPENDIX II

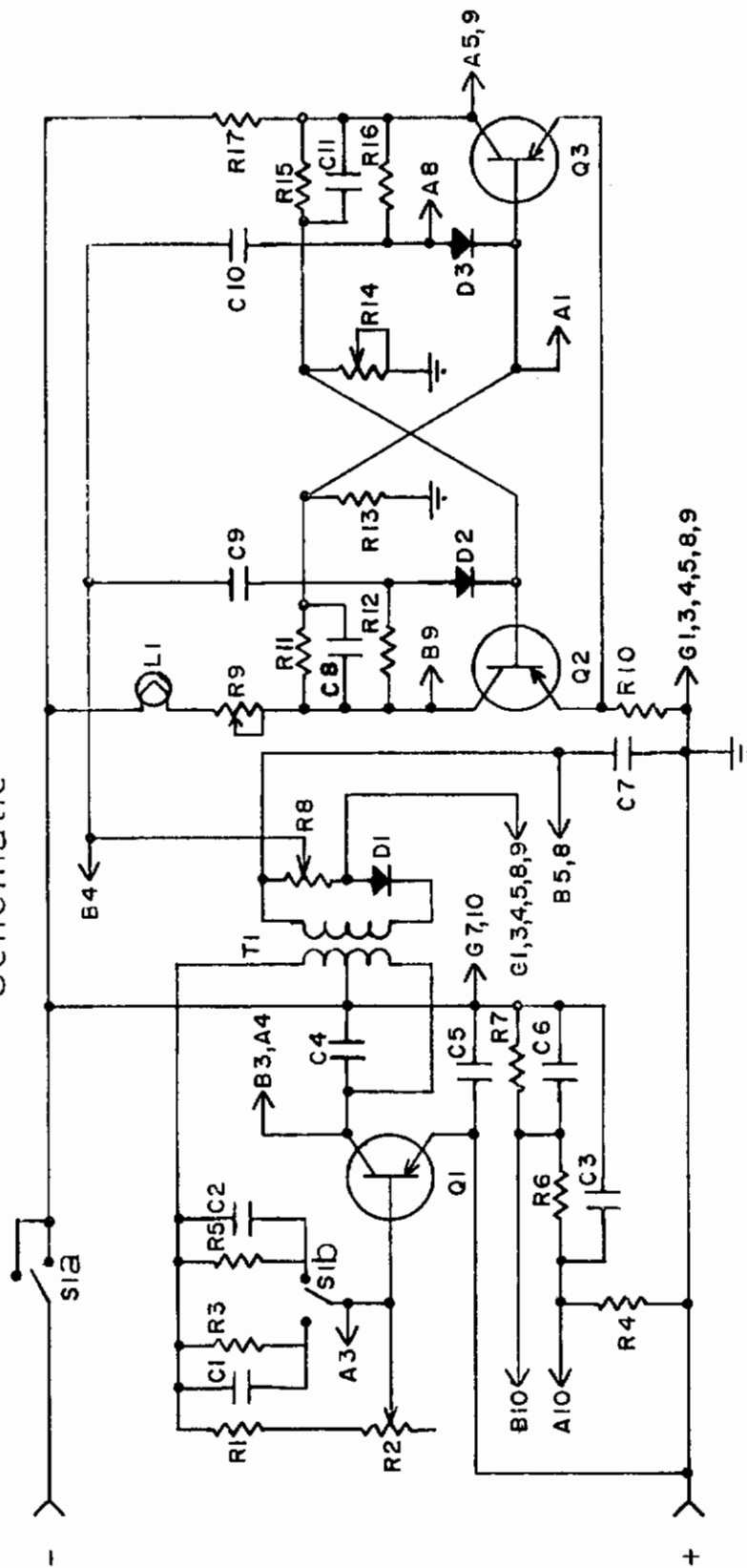
TECHNICAL INFORMATION
ON THE
TSG-1 SIGNAL GENERATOR
FOR USE WITH THE
INSTRUCTIONAL PROGRAM ON OPERATION
OF THE
TEKTRONIX 545A OSCILLOSCOPE

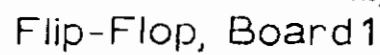
INTRODUCTION

The TSG-1 is a small, special-purpose signal generator. It was designed specifically as an accessory to an instructional program on the Tektronix 545A oscilloscope, and is not intended for any other use.

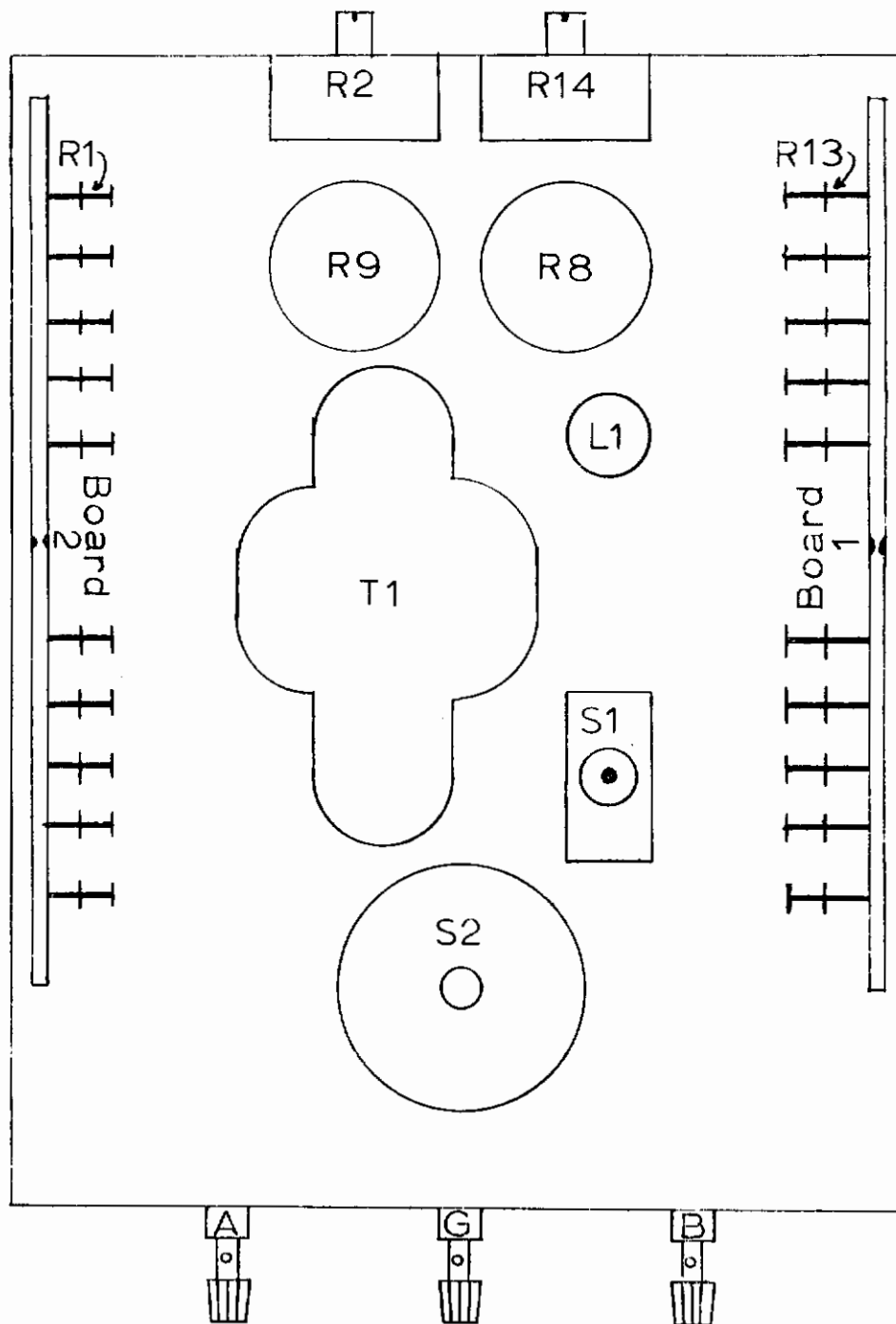
The following pages give complete instructions for construction and alignment of this device.

TSG-1'
Signal Generator
Schematic





TSG-1
Chassis Layout
(top view)



TSG-1

Connection Tables

In the tables below the terminal board containing the components for the flip-flop circuitry is called "Board 1", and the terminal board containing the components for the oscillator circuitry is called "Board 2".

R2 connections

Wiper	to common at S1B
Terminal 1	to R1 (Board 2)
Terminal 2	to no connection

R8 connections

Wiper	to C9, C10, B4 of S2
Terminal 1	to B8 of S2
Terminal 2	to G9 of S2

R9 connections

Wiper	to Terminal 1 of R9
Terminal 1	to R12 (Board 1)
Terminal 2	to Terminal 2 of L1

R14 connections

Wiper	to Terminal 1 of R14
Terminal 1	to R13 (Board 1)
Terminal 2	to R15 (Board 1)

L1 connections

Terminal 1	to R17 from Board 1, Terminal 1 S1A
Terminal 2	to Terminal 2 R9 (see above)

T1 connections

Primary

- 1 yellow wire to R5 (Board 2)
- 1 yellow wire to Q1 collector (Board 2)
- 1 red wire to C4 (Board 2)

Secondary

- 1 black wire to Terminal 1 R8
- 1 black wire to D1 -

D1 connections

D1 -	to T1 black wire
D1 +	to G5 of S2

TSG-1 CONSTRUCTION NOTES

The TSG-1 is assembled in the case using the removable cover as the bottom plate. The terminal boards are attached to the sides of the case. R2 and R14 are mounted on the rear of the case and R9, R8, L1 socket, T1, S1, and S2 are attached to the top of the case. The black banana jack, G, is mounted in the center of the front of the case and the two red jacks, A and B, are mounted one to the left, and one to the right of center. The chassis layout diagram is drawn actual size and can be used to help determine parts placement.

Construction of the TSG-1 should follow as closely as possible these steps:

1. Lay out parts placement on case.
2. Drill all necessary holes.
3. Mount all parts on terminal boards using only lower half of each terminal where possible.
4. Mount all components and terminal boards in case except S2.
5. Prewire S2 connecting jumpers and components as follows:

<u>Connection</u>	<u>S2 Position</u>
Jumper	A5 to A9
Jumper between	G1, 3, 4, 5, 8, and 9 (do not solder)
Jumper	G7 to G10
Jumper	B3 to A4
Jumper	B5 to B8
+ of D1	to G5
C7 between	B8 G8

6. Make connections between terminal boards and all components except S2 (see connection table).
7. Mount S2 in case.
8. Make connections between terminal boards and components, and S2 (see connection table).
9. Solder all connections not previously soldered.
10. Mount battery clip on bottom plate so that it is positioned below R8 and R9 when bottom plate is attached.
11. Attach battery snap contact to battery terminals and fasten bottom plate.

TSG-1 PARTS LIST

B ₁	9 volt battery	R9	500 POT IRC Type RQ
C _{1, 9, 10}	.05	R10	75
C ₂	5	R12, 16	100K
C _{3, 6}	.005	R13	6.2K
C ₄	.0005	R14	7.5K POT IRC Type RQ
C ₅	160	R17	670 ohms
C ₇	.001	S ₁	DpDt, center off
C _{8, 11}	220 pt		
D ₁	1N442B		
D _{2, 3}	1N91	S ₂	3 Pole 10 pos wafer switch, Centralab 1009
L ₁	344 (T-1 3/4 Midget flanged 10v. .015 amps)	T ₁ *	Stancor P-6134 or equiv.
Q ₁	2N270	Miscellaneous	
Q _{2, 3}	2N1098	1. Light socket DIALCO #162-8430-937	
R ₁	1K	2. Construction boards USECO terminal boards	
R ₂	100K POT IRC Type RQ	Litton Industries	
R _{3, 5, 11, 15}	10K	3. Case H. H. Smith Meter case	
R ₄	1 MEG	2257 medium size 6-13/16 x 5-9/32 x 2-5/16	
R ₆	470 K	2260 cover	
R ₇	560 K	4. 3 banana jacks-2 red, 1 black	
R ₈	50 K POT IRC Type RQ	5. Battery clip Battery snap contacts	

*Resistors are in ohms and capacitors are in mfd unless otherwise stated. Changing T₁ may change the frequency of the oscillator slightly.

TSG-1

S1 connections

A. (closest to Board 1)

Common	to Battery -
Terminal 1	to Terminal 1 L1, Terminal 2 S1A
Terminal 2	to Terminal 1 S1A

B. (closest to T1)

Common	to Q1 Base Board 2, Wiper R2 (see R2 above), A3 of S2
Terminal 1*	to C1 (Board 2)
Terminal 2	to C2 (Board 2)

S2 connections

Wafer A

Position

Common

1	
2	not used
3	
4	
5	
6	not used
7	not used
8	
9	
10	

to Jack A (Left most when viewed from top)
to R13 (Board 1)
to Common of S1B
to C4 (Board 2)
to A9 of S2
to D3 (Board 1)
to C11 (Board 1)
to R4 (Board 2)

Wafer G

Position

Common

1	
2	not used
3	
4	
5	
6	not used
7	
8	
9	
10	

to Jack G (center jack, black)
to R13 (Board 1)
to O1 emitter (Board 2)
to Battery +
to D 1+
to C5 (Board 2)
to C7
to R8 Terminal 2 (See R8 above)
to G7 of S2 (jumper)

*This is the terminal which is in the circuit when the switch lever is in the position away from the front of the case or away from jacks A, G, and B.

TSG-1

Wafer B

Position
Common

1	not used
2	not used
3	
4	
5	
6	not used
7	not used
8	
9	
10	

to Jack B (right red jack when
viewed from top)

to A4 of S2 (jumper)
to Wiper R8 (see R8 above)
to B8 of S2 (jumper), Terminal
1 R8 (see R8 above)

to C7 (Switch S2)
to C8 Board 1
to R7 Board 2

Labeling the Controls and Jacks

Components

R2

R8

R9

R14

S1*

S2

Jacks

A

G

B

Label

Frequency Vernier

Trigger Level

Trimmer

Balance

HI OFF LOW

FS1

A

G

B

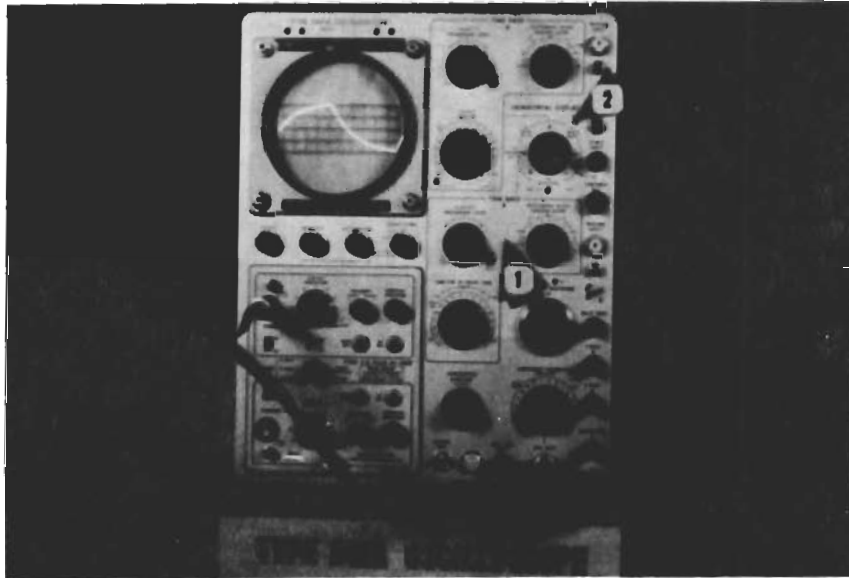
*The HI position is furthest from the
front of the case.

TSG-1 ALIGNMENT

Transistors Q-2 and Q-3 are the active elements of the flip-flop circuitry. To assure correct operation of the circuit the voltage drop across R17 when Q3 is on should be equal to the voltage drop across L1 and R9 when Q2 is on. To begin with set R14 so that its resistance is equal to R13. Next set FS1 (S2) to position 9, a VOM (20,000 ohms/volt) may be used to measure the collector voltage of Q3 (Jack A and G) and the collector voltage of Q2 (Jack B and G) with the switch in position 9. By turning R8, the trigger can be reduced to a level which will not operate the flip-flop, but permit leaving either Q2 or Q3 in the ON state. Now put S1 in the "low" position and set R8 to a position at which L1 flashes on and off. Next turn R8 until L1 stops flashing and remains off, transistor Q3 is now in the ON state, so measure the negative DC voltage between Jack A and G. Turn R8 until L1 begins flashing again and then turn it back until L1 stops flashing and remains ON; Q2 is now in the ON state. Measure the negative DC voltage between B and G and adjust R9 until this voltage is the same as the voltage between A and G when Q3 was in the ON state. This completes the preliminary alignment procedure so set R8 to a position at which L1 begins flashing again. Other adjustments are to be made following the instructions accompanying the oscilloscope program.

APPENDIX III

SAMPLE OF SCRIPT WITH BLACK-AND-WHITE SLIDES

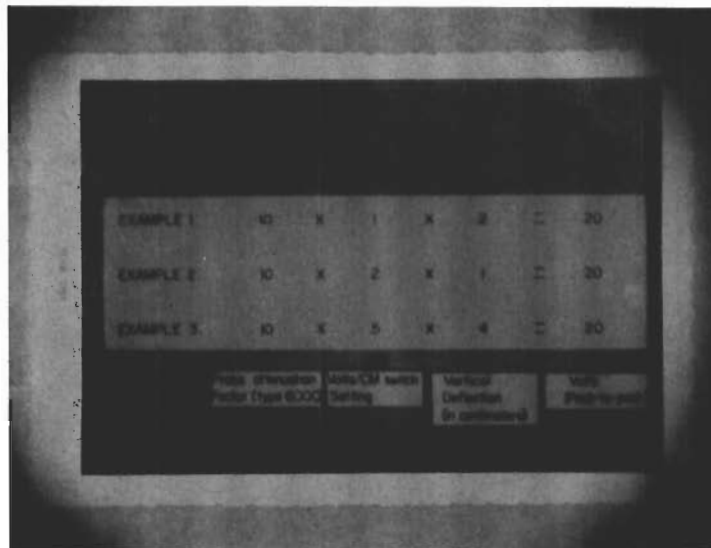


Slide #67

If you turned the horizontal display switch to A and the time per centimeter switch on, time base A is on the .1 millisecond position and if the waveform is stabilized, you will obtain the waveform on your oscilloscope that you see displayed on the slide. Reposition any controls you may have to if you do not have this waveform on your oscilloscope.....

_____TONE AND TAPE STOP _____

Turn the horizontal display switch to the A single sweep position.....
If you turned the horizontal display switch to the A single sweep position the waveform will have disappeared from the cathode ray tube.....
Now remove the probe from the integrator circuit.....



Slide #73

This is example number one on the slide if you hadn't already guessed.... The type 6000 probe has an attenuation factor of ten. The volts per centimeter switch on channel A is set to one volt per centimeter, and the vertical deflection is two centimeters. Multiply these together and you will obtain the peak-to-peak voltage value of the input waveform. Incidentally, the attenuation factor is printed on the second ring of the type 6000 probe. Turn the volts per centimeter switch on channel A to the 2 volts per centimeter position....

Now calculate the voltage of the input waveform. It will probably benefit you most to figure this on a sheet of paper.....

TONE AND TAPE STOP

This is example number two on the slide. You set the volts per centimeter switch on channel A to two volts per centimeter and found you then had one centimeter of deflection, and you multiplied this by ten, the probe attenuation factor, and found the input voltage of twenty volts peak-to-peak.... Turn the volts per centimeter switch on channel A to .5 and calculate the input voltage.

RESPONSE SHEET (Audio-Visual)

1.

2.

3.

4.

5.

6.

7.

8. 1. _____
2. Assemble _____.
3. _____ and _____.

9.

10. 1.
2.
3.
4.
5.

11.

12. You could select CHANNEL B by placing the _____
switch in the _____ position.

13. a. _____ Intensity d. _____ Scale Illum g. _____ AC-DC switch
b. _____ Volts/CM e. _____ Gain Adjust h. _____ Focus
c. _____ Astigmatism f. _____ Position i. _____ Stability
Indicator Control

14. Each time base has _____ control clusters. The two
time bases are TIME BASE _____ and TIME BASE _____.

15.

16.

17.

SAMPLE OF BOOK PROGRAM

<p>4 centimeters 4 milliseconds</p>	<p>2.37</p> <p>Look again at Example 1, Figure 12. This example should exactly match the setting which you have on your instrument. The length of one cycle is <u>***</u>. The setting of the TIME/CM controls is <u>***</u>. The length of time for one cycle is the number of centimeters multiplied by the setting of the TIME/CM control. The length of time for one cycle in this instance is <u>***</u>.</p>
---	--

<p>4 centimeters 1 millisecond 4 milliseconds</p>	<p>2.38</p> <p>Frequency is the number of times a cycle occurs in one second. It takes 4 milliseconds in this case for one cycle to occur. Four milliseconds divided into 1 second would then equal the frequency or cycles per second. Divide this now and see if you arrive at the frequency of 250 cycles per second. Your complete formula for computing frequency is:</p> <p>Frequency = $\frac{1}{\text{Number of CM X TIME/CM setting}}$</p>
---	--

	<p>2.39</p> <p>Move the TIME/CM control to the 2 MILLI SEC position. The sweep is faster now. One complete cycle now covers only <u>***</u> centimeters. Look at Example 2 on the same figure. This is the setting you now have on your oscilloscope. Follow through this example carefully. See how it fits the formula:</p> <p>Cycles per second = $\frac{1}{\text{Number of CM X TIME/CM setting}}$</p>
--	---

<p>2</p>	<p>2.40</p> <p>Work out Examples 3, 4 and 5 in Figure 12. Record your computations in the place provided on the Response Sheet. <u>Note:</u> Do not use the scope in this procedure as these examples are for computation practice only and will not match your display at all.</p>
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R E S P O N S E S H E E T

(Programmed Book)

The response sheet is provided as a convenience to you for recording your responses or "answers". Space is provided here for any mathematical calculations or "figuring" necessary. After you have completed your response you may confirm its correctness by referring to the confirmation section at the next frame in the program. Your response should be entered by the number on the response sheet corresponding to the frame in the program.

Frame 1.2

Frame 1.4

Frame 1.5

Frame 1.6

Frame 1.7

Frame 1.8

* * * * *

Frame 1.19

Frame 1.21	a. ___ INTENSITY	d. ___ SCALE ILLUM.	g. ___ AC-DC Switch
	b. ___ VOLTS/CM	e. ___ GAIN ADJUST	h. ___ FOCUS
	c. ___ ASTIGMATISM	f. ___ Position Indicators	i. ___ STABILITY Control

Frame 1.22

APPENDIX V

ADMINISTRATOR'S MANUAL FOR ADMINISTRATION OF TEST

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST

Part 1: INSTRUCTIONS TO THE OBSERVER

I. General:

A. There are six parts to this examination as follows:

1. Part 1: INSTRUCTIONS TO THE OBSERVER
2. Part 2: OBSERVER'S CHECK LIST
3. Part 3: INSTRUCTIONS TO THE STUDENT
4. Part 4: STUDENT QUESTION/ANSWER SHEET: FORM _____
5. Part 5: OBSERVERS KEY: FORM _____
6. Part 6: SIGNAL GENERATOR INFORMATION

There are two forms, T1 and T2, for Parts 4 and 5. Insure you have one or more of each as necessary.

- B. Most of the questions on this test are of the 'Time-Correct Answer-Assists' type. This means that you will help those being tested at their request and will record the number of times assistance is given and what is done for the student.
- C. Testing booths are equipped with switches which turn on numbered indicator lights outside the booth area. Locate these lights and after testing has begun keep close watch on them.
- D. Normally the persons being tested will need help only in obtaining or stabilizing a display. In other instances interpretation of a question may be necessary. You are NOT to calculate a voltage or frequency for anyone being assisted. If an individual cannot calculate either of these two values instruct him to proceed with the test and do what he can as well as he can. Any other assistance, including probe attenuation adjustment, is appropriate.
- E. While each person keeps track of his own time for each question, it is necessary to verify total time in testing. For this reason each individual being tested must be timed. If a group is being tested, all should start at the same time and individual finish times can be recorded as the student summons you for the last time. Otherwise, a record must be kept for each individual of his starting and finishing times.

II. Use of the Check List:

- A. For each question there are six assistance blanks where the type of assistance rendered can be recorded. Minimally the number of assists must be indicated. In addition there are also rating scales and guidelines for those questions which require rating of a behavior, and other indications, such as "YES" "NO", one of which may be circled.

- B. You are advised to compare Part 4: STUDENT QUESTION/ANSWER SHEET with your CHECK LIST, question by question, until you are sure you understand what the student is to be doing and what your own responsibilities are regarding each question.

III. Booth Preparation:

- A. The following items should be available at each test position before the students are assigned:
 - 1. Oscilloscope
 - 2. Signal generator
 - 3. Booth indicator
 - 4. Two type P6000 probes
 - 5. Red ground lead
 - 6. 1 BNC/Banana adaptor
 - 7. 1 clock
- B. Before assigning an individual to a testing position check all switch positions and jacks of the signal generator.
- C. NOTE: Exact voltage and frequency values to which signal must be set are listed on another part of this examination, Part 5: OBSERVER KEY FORM _____. Since there are two forms of this performance test, it is important that each booth be set up properly for the form of the test which is being taken by the individual at that booth. All booths are equipped with a test form indicator in the form of a sign on which numbers will be changed. Set these to agree with the settings you make on the signal generator. Part 6: SIGNAL GENERATOR INFORMATION of this examination supplies additional information for checking and setting the generator.

IV. Starting the Student:

- A. When the booths are checked out, students should then be assigned to those where they will be tested. They should be assigned according to the testing schedule and with reference to the booth test form indicator. Next each individual being tested should be given a copy of Part 3: INSTRUCTIONS TO THE STUDENT, and told to read it carefully. The booth indicator switch should be pointed out to each student and he should be told how to signal for the Observer. Lastly, a copy of Part 4: STUDENT QUESTION/ANSWER SHEET should be left at the positions and the student cautioned not to proceed until they are sure they understand Part 3.
- B. It is important that the students be encouraged as much as is feasible and that assistance be given in a friendly, good-natured way. Some students will never have seen the Model 545A and may be somewhat discouraged. Part 3 indicates that it is important to know what they can do even if it is nothing or very little. This is the attitude that should prevail. The observer should not come in the booth area after the student has started the test unless he is summoned by the student.

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST
Part 2: OBSERVER'S CHECK LIST (Sample)

FORM _____

OBSERVER

STUDENT

BOOTH #

TIME START

SIG. GEN. SERIAL NUMBER

TIME FINISHED

1. Focus and Astigmatism:

1 2 3 4 5

Intensity:

1 2 3 4 5

Calibration:

Yes No

ASSISTS:

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

Maximum Points: 15

Points Earned: _____

2. ASSISTS

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

Maximum Points: 10

Points Earned: _____

3. ASSISTS:

- | | |
|----------|----------|
| 1. _____ | 4. _____ |
| 2. _____ | 5. _____ |
| 3. _____ | 6. _____ |

Maximum Points: 15

Points Earned: _____

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST

Part 3: INSTRUCTIONS TO THE STUDENT

I General: At the booth to which you are assigned you will find:

1. 1 Model 545A Oscilloscope
2. 1 Signal generator
3. 1 Toggle switch labeled BOOTH INDICATOR
4. 2 Probes with BNC connectors and shielded cable attached
5. 1 lead which can be used for grounding
6. 1 BNC/Banana adaptor
7. 1 clock

Some of these items may be in the table drawer. Locate all items and inform an Observer if something is missing or obviously damaged. The "Graflex" is not to be used. Carefully push it back out of your way if you think it might interfere with your performance.

- II. This test is a test of your ability to use a Model 545A Oscilloscope efficiently. You may never have seen one, or you may recently have received special training in its use. It is assumed only that you know about 'scopes' in general. The testers are interested in how you do. An Observer is standing by at all times to assist you when you need help. This is what the BOOTH INDICATOR switch is for. Turning the indicator switch to ON will summon an Observer. Do your best, but don't hesitate to request help when you really need it. Most people will need some help. Be sure you understand each question as you go along.
- III. Notice the clock at your booth again. For each question you are to record the TIME START and TIME FINISH. Do NOT forget to record these values for each question. Your Observer is keeping track of your total time for a check, but your record will be a more accurate indication of the time you take since it takes into consideration the time you might have to wait for an Observer after you switch on the BOOTH INDICATOR.
- IV. You may find that the Oscilloscope is plugged in. If it is, proceed with the test. If the instrument is not plugged in, select a power cord and plug it in.
- V. Unless you have questions, you should be ready to begin the test. If you do have questions, signal an Observer; otherwise, proceed with Part 4: STUDENT QUESTION/ANSWER SHEET. You will write on Part 4 ONLY. Do NOT write on this sheet, Part 3. There are scratch sheets affixed to Part 4. If you need more before you finish the test, obtain them from an Observer.
- VI. NOTE: Always read the WHOLE question before you try to answer it.

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST

Part 4: STUDENT QUESTION/ANSWER SHEET: FORM T1

NAME _____

Booth Number _____

1. START TIME _____

Obtain a 10-volt signal from the "CAL. OUT" jack on the oscilloscope. When you are satisfied with your display, indicate whether or not the oscilloscope is calibrated for voltage and waveform measurement. If your instrument is not calibrated, indicate below what you judge to be out of adjustment. Next record your finish time, then, leaving your display exactly as it is, signal an Observer.

Instrument calibrated, Yes No. (Circle one)

Out of adjustment? _____ (name a part or control if you feel it is out of adjustment)

FINISH TIME _____

2. START TIME _____

Turn the signal generator function switch, FS 1, to Position 1. Measure the peak-to-peak voltage of the waveform at Jack A. Measure also the pulse frequency of this waveform, carry your calculations out to one decimal place, and record your answer below. Figure 1 represents the type of pulse you should obtain as a display.

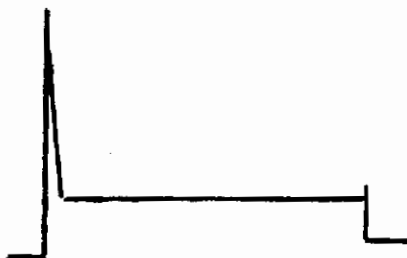


Figure 1

Voltage Jack A _____ Frequency Jack A _____

FINISH TIME _____

3. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 8:

- (a) At Jack B measure the peak-to-peak voltage of the waveform.
- (b) Measure the frequency of the waveform.
- (c) For what period of time is the positive waveform in excess of 100 volts?

Voltage _____ Frequency _____ Time spike is in excess of 100 volts _____

FINISH TIME _____

4. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 3.
Display the signals at Jacks A and B simultaneously. Compare the two waveforms:

- (a) Which peak-to-peak voltage is greater, Jack A Jack B Neither
(Circle one)
- (b) Are both waveforms at the same frequency? Yes No (Circle one)

FINISH TIME _____

5. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 9.
Display the signals at Jacks A and B simultaneously. Compare the waveforms:

- (a) Are the signals in phase? Yes No (Circle one)
- (b) Are the signals of the same peak-to-peak voltage? Yes No

FINISH TIME _____

6. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 5.
Display the signals at Jacks A and B simultaneously. The signal at B is a trigger. The signal at A is from a triggered multivibrator. How much time elapses between Peak Trigger and 100% rise of the square wave from the multivibrator?

Time: Trigger Peak to 100% Square Wave rise: _____

FINISH TIME _____

7. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 5.
Using the "B INTENSIFIED BY A" function of the oscilloscope, accurately measure the "rise time", from beginning to peak, of the square wave at Jack A. When you have measured this value record it, do not change any settings on the scope, and signal an Observer.

Rise time _____

FINISH TIME _____

8. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 2.
Measure the peak negative voltage at Jack B.

Peak neg. voltage at Jack B _____

FINISH TIME _____

9. START TIME _____

A complex waveform has different frequencies of amplitude change in one cycle. Turn the Signal Generator function switch, FS 1, to Position 1. Determine if the waveform at Jack A is simple or complex.

Waveform: Simple Complex (Circle one)

FINISH TIME _____

10. START TIME _____

Turn the Signal Generator function switch, FS 1, to Position 10. Measure the DC level at Jack A. If a signal is imposed on the DC, disregard it.

Voltage at Jack A _____ Polarity of E at Jack A _____

FINISH TIME _____

WHEN YOU HAVE FINISHED, SIGNAL AN OBSERVER.

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST

Part 5: OBSERVER KEY

I. The questions:

T1# T2#

- 1 1 The first test question is designed to allow evaluation of the quality of the display of a square wave and to detect knowledge of oscilloscope calibration procedures. Focus and astigmatism adjustments are to be rated on a 5 point scale. On this scale 1 is very poor and 5 is excellent. The same type of scale is used to specify the quality of the intensity setting. The following table illustrates the general characteristics of "good" and "bad" displays.

<u>Evaluated</u>	<u>POOR (1)</u>	<u>GOOD (5)</u>
Focus/Astig.	Fuzzy "fat" trace line.	Sharp thin trace line.
Intensity	Very bright with 'halo' effect around trace.	Just bright enough to see the trace line clearly.

As for calibration, the subject should recognize that the probe is not properly compensated or that it is causing distortion of the square wave which is obtained at the Cal Out jack of the oscilloscope or that the Gain Adjust is not set properly. (The malfunction is inserted depending on the test form.) Since the word "calibration" is somewhat ambiguous in this testing context, the Observer, after marking the two scales should ascertain what has been written by the S on his question/answer sheet. It may well be, if the malfunction inserted was misadjustment of the probe, that the S will have written that the oscilloscope is "calibrated"; but will also list the probe as being out of adjustment. Specific use of this word is of no consequence...it need only be ascertained that S recognizes waveform distortion caused by the probe. This may be done verbally if the Observer has reason to believe this knowledge exists. The observer should 'de-bug' the oscilloscope after rating the subject on this question. Be sure to indicate on Observe Check List whether said instrument was calibrated or uncalibrated.

2 3

This question is designed to detect ability to measure voltage and frequency. The terms "peak-to-peak" and

"pulse frequency" are not critical and may need to be interpreted to S. There should be no credit loss for this interpretation.

peak-to-peak



1 cycle or full pulse

T1#	T2#
3	2

This three-part question covers voltage, frequency, and time base measurement. Again frequency and peak-to-peak may be interpreted without credit loss. Help on and interpretation of the 'c' part of this question is somewhat more difficult. It must first be ascertained that the S does recognize the voltage spike to be in excess of 100 volts. If not, this should be noted and the error pointed out. Once it is established that S recognizes the spike to be in excess of 100 volts, he may be told:

"you have written down that the spike is ____ volts. (Observer looks at S's answer) This means that as the spike rises it goes past a line which is the 100 volt line as you have set up the oscilloscope now. This also means that it stays above 100 volts for some time and then falls down past the 100 volt line. The question is, "How long does it stay above 100 volts?" No more help should be offered other than to reiterate what is recorded above. If S does not understand at this point he should be told to skip the question and proceed.

4	6
---	---

The S's ability to use the dual-trace function of the oscilloscope is tested by this question. Superimposing the two waveforms will quickly give an answer to the simple questions. S may need help in stabilizing the waveforms and this should be recorded as an "assist".

5	5
---	---

Questions 4 and 5 on T1 and 5 and 6 on T2 are all much alike existing as a reliability check on dual-trace

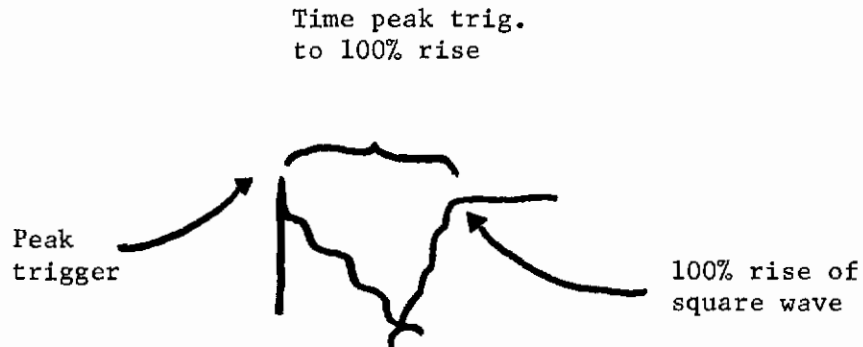
function use by S. This differs from the last only in that it is necessary that the MODE switch be set at "CHOPPED" for phase comparisons. If this is corrected by the Observer, it should be recorded as an "assist". The term "in phase" may be interpreted without credit loss:

"'In phase' means that positive-going and negative going parts of both waves are happening at the same time and that they are going in the same direction."

T1# T2#

6 4

This question should detect ability to make finer time-base measurements. The information in the following diagram may be communicated to the S without credit loss:



Other "assists" should be recorded.

7 9

The "B INTENSIFIED BY A" function of the oscilloscope permits extraordinarily accurate time-base measurement. This question tests S's ability to use this function. If S requests help and the Observer ascertains that S has not used this function before, the S should be told to skip the question and proceed. Otherwise the Observer should be well enough rehearsed in this procedure to give assistance which will then be recorded in detail as an "assist".

Some checkpoints for setting up the function:

- A. TIME BASE A Stability and Trig. controls in "free-running" position.
- B. Horiz. Dis. control at "B INTENSIFIED BY A".
- C. TIME BASE A TIME/CM control set at small value less than TIME BASE B TIME/CM setting.
- D. TIME BASE B Stability control in detent.
- E. TIME BASE B Trigger Level turned to obtain display.

On the five point scale the "Display" is rated on:

- A. Adequate intensity to show whole wave and a discriminable intensified portion.
- B. Size appropriate to close observation of the moving intensification dot.

The "Intensified portion" is rated on its size. It should be a just-detectable dot. Larger intensified portions are rated down accordingly.

T1# T2#

- | | | |
|----|----|---|
| 8 | 8 | Question 8 requires a simple voltage measurement which in turn requires the establishment of a zero reference by removing the probe from the test jack to see where the unmodified trace rests, adjustment with the VERTICAL POSITION control until the trace rests where it makes the measurement of negative voltage easy. "Assists" should be recorded. |
| 9 | 7 | This question simply requires that the S expand the wave form enough to see the irregularities imposed on the major form. If assistance of any sort is given beyond a definition of "simple" (see below), no credit should be given for the item.

"A simple waveform is a waveform like a square wave with a clean rise and fall, and no "hash" or irregularities on it, one just like a picture of a good square wave." |
| 10 | 10 | The last item is designed to detect the ability of S to measure a D.C. voltage and to determine polarity. Assistance may be given and recorded. The Observer should make sure S interprets the question properly. There is "hash" riding on the D.C. voltage. It is this "hash" the S should disregard--not the question. |

II. Answers to T1 questions:

<u>Question #</u>	<u>Answer</u>
1	Instrument <u>not</u> calibrated (No) Gain adjust is not adjusted
2	0.8 to 1.2 <u>Volts</u> acceptable 39-41 <u>CPS</u> acceptable

Contrails

- 3 200 to 210 Volts acceptable
 79 to 81 CPS acceptable
 (Time) 138 to 142 Microseconds
- 4 (a) Jack B
 (b) Yes
- 5 (a) No
 (b) No
- 6 .14 to .18 Millisecond acceptable
- 7 18 to .22 Millisecond acceptable
- 8 110 Volts peak negative
- 9 Complex
- 10 3 Volts
 Positive

III. Answers to T2 questions:

<u>Question #</u>	<u>Answer</u>
1	Instrument is <u>not</u> calibrated (No) Probe is not properly compensated
2	135 to 145 <u>Volts</u> acceptable 795 to 805 <u>CPS</u> acceptable (Time) 27 to 31 <u>Microseconds</u> acceptable
3	6 <u>Volts</u> 400 <u>CPS</u>
4	.03 to .05 <u>Millisecond</u> acceptable
5	(a) No (b) Yes
6	(a) Jack A (b) Yes
7	Complex
8	0 <u>Volts</u> negative
9	.055 to .075 <u>Milliseconds</u> acceptable
10	Positive 1.5 <u>Volts</u>

IV. Presetting the Signal Generators and Oscilloscopes

A. Test T1 Generator:

1. Set the RANGE switch of the generator at LOW.
2. Turn FS1 (Function switch) to position 8 and set the spike waveform found at jack B at 200 volts as exactly as possible. This adjustment is made using the LEVEL control of the generator.
3. Set the oscilloscope TIME/CM control at 5 Milliseconds and adjust the generator VERNIER control until three spikes appear in the first five CM of the CRT, that is, until there are three spikes in the left half of the grid. This should give a frequency of 80 CPS. Check this setting by turning the function switch of the generator to position 9 and ascertaining that 1 square wave fills half the grid at the TIME/CM setting listed above. The square wave frequency should read 40 CPS.
4. Turn FS1 to position 3 and by making very slight adjustments on the generator LEVEL control make sure that the voltage at jack B is greater than that at jack A. This will best be done using dual trace. The major waveforms have high, fast-rising spikes associated with them. When making this last setting make sure the INTENSITY control on the oscilloscope is set high enough to detect these spikes and accurately compare the two waveforms.
5. Run quickly through the values again to make sure the last adjustment did not radically change other parameters.

B. Test T2 Generator:

1. Following the general procedure outlined above make the following settings:
 - a. Generator Range...High.
 - b. Generator Position 8, jack B.....140 volts.
 - c. 'scope TIME/CM .5 Millisec., three spikes in first 5 CM. This gives a frequency of 800 CPS.
 - d. Generator Position 9, jack b...square wave fills 1/2 grid. This gives a frequency of 400 CPS.
 - e. Generator Position 3...jack A voltage should be greater.

C. Test T1 Oscilloscope:

1. When the generator has been set, the GAIN ADJUST on both CHANNEL A and B should be set completely CW.
2. The red ground lead should be plugged into an oscilloscope ground with its other end set in jack G of the generator.

3. The controls on the instrument should be set as indicated on the appended diagram of the 'scope face'. Here blue dots indicate white dots on the oscilloscope, and red dots indicate dots on red controls. Where there are words, numbers, or symbols, a particular setting of a control is thereby indicated.

D. Test T2 Oscilloscope:

1. The settings of everything are the same as for T1 except instead of GAIN ADJUST maladjustment, a misadjustment of the probes is made. The probes should be over-compensated. (See Tektronix manual)

MODEL 545A OSCILLOSCOPE PERFORMANCE TEST

Part 6: SIGNAL GENERATOR INFORMATION

I. General:

The signal generator is composed of a free running oscillator TRIGGER and a bi-stable multivibrator or FLIP-FLOP. The trigger frequency is controlled by RC time constant with two ranges and a variable resistance or VERNIER control for the fine adjustment. The output level of the trigger is controlled by a potentiometer (LEVEL control) and ranges from 0-300 volts P-T-P. The FLIP-FLOP utilizes power transistors which drive indicator lights directly. With a capacitive input the FLIP-FLOP is triggered over a parallel net.

The voltage supply for the circuit is a six volt car battery which is trickle-charged between generator use sessions. In addition a 60 CPS sine wave is taken from the charger and run over a capacitor to the generator for display from its jacks.

SCORING OF T1 and T2

Question #	Time Allowed	Number of Possible Points
------------	--------------	---------------------------

T1	T2
----	----

1	1	5 Min.	15 x 10 = 150
---	---	--------	---------------

2	3	5 Min.	10 x 10 = 100
---	---	--------	---------------

3	2	10 Min.	15 x 10 = 150
---	---	---------	---------------

4	6	5 Min.	10 x 10 = 100
---	---	--------	---------------

5	5	5 Min.	10 x 10 = 100
---	---	--------	---------------

6	4	5 Min.	10 x 10 = 100
---	---	--------	---------------

7	9	3 Min.	10 x 10 = 100
---	---	--------	---------------

8	8	3 Min.	10 x 10 = 100
---	---	--------	---------------

9	7	10 Min.	15 x 10 = 150
---	---	---------	---------------

10	10	3 Min	10 x 10 = 100
----	----	-------	---------------

1. Total possible score is 1150.
2. 1 point is deducted for each minute over allotted time.
3. 10 points deducted for each "assist".
4. No score below zero on any question.

APPENDIX VI

ADMINISTRATOR'S MANUAL FOR BOTH INSTRUCTIONAL PROGRAMS

ADMINISTRATION OF THE TEKTRONIX PROGRAMMED BOOK

1. General. It is necessary that the strictest of policies be observed in the administration of the A.S.A., Inc., Tektronix Programmed Book to the Goodfellow test population. These notes outline these policies. Both the program and the method of instruction are being evaluated. In order that this section of Study 1414 II may be effective, administrator influence must be minimized...especially where this influence may be inconsistent from one individual subject or group of subjects to another.

2. Help to Subjects. The only type of help which an administrator may give a trainee, if that trainee is to be kept as a subject, is to read properly a misspelled or unclearly printed word to him. If the subject does not understand any portion of the program the administrator should take note of this, and at all times maintain a cumulative file of these notes for all training sessions for which he is responsible. When a trainee indicates such a lack of understanding he should be advised exactly as follows:

"If the book does not make sense to you, go ahead to another problem and try it. I have been instructed to give you no help at all with the program. It should explain itself, but where it doesn't do this we keep track of this and later we will change it so that no one has trouble at that spot."

The administrator should be familiar enough with the program to know what questions are answered by the program text. Often a subject will ask a question which will be answered at a later point in the program. When this happens the administrator should say:

"Please go ahead with the program...I think you will find the answer later on. If you do not and this causes trouble, call me again and we will list this as a program discrepancy."

If such a discrepancy occurs the administrator should record it and advise the subject to continue as best he can. If the subject cannot continue, the administrator should render whatever help is necessary, record in complete detail what help is given, and note on records that the records of this and previous S's have been contaminated. The program will then be amended or corrected on the basis of the discrepancy noticed. The administrator should be cautioned to carefully discriminate generator variability from program discrepancy. If the question asked is due to some malfunction of variability of the signal generator, the generator should be adjusted (See generator settings below.)

3. Instructions to the Subject. When a trainee has been greeted and shown to a training/testing booth, the administrator will read the following instructions:

"I know it sounds funny to read these directions to you, but it is very important that the same thing is said to everyone. This is a scientific evaluation of a self-instructional program. Actually the program you are about to learn from has been tried out on other Air Force persons and has been corrected. Now it must be given to many persons in the same way to find out if it works to teach as well as we think it will. There may be some little errors but you should be able to get along alright if you read very carefully. If you do not agree with an answer in the program, note this fact in red pencil on your Response Sheet and then continue with the program. Feel free to ask questions..but be prepared if I have to read the answer to you. This is all part of being careful that no one gets help that everyone doesn't get. (Pause) Please write your name on the top of the Response Sheet. (point out to S) Do not go beyond Section III in the program today. Now go ahead and read the introduction to the book. Call me if you are missing any equipment by flipping the toggle switch at the back of the Signal Generator." (The administrator should point out the switch at this time.)

This should be sufficient, if the booth has been set up properly, to get the subject underway. The instructions above should be rehearsed by the administrator prior to program administration.

4. Booth Equipment.

- A. 2 probes (P-6006)
- B. 1 Ground cord
- C. 1 Response sheet
- D. 1 Program
- E. 2 pencils--one with regular lead the other with red.
- F. 1 oscilloscope
- G. 1 Signal Generator

5. Instructions to Administrator

- A. After setting up the oscilloscope and generator (see settings below) the probes should be disconnected from the oscilloscope, the power switch should be turned off, and the power line should be unplugged from the wall socket. The grounding wire (red) and probes should be coiled within easy reach of the S.

5. Continued

- B. Be sure to put down start and finish times for program on both first and second days.

6. Generator and Oscilloscope Settings

- A. FS on generator to Pos. 5.
- B. Range switch to High.
- C. Test Jack A
 - 1. Square wave--4 CM per cycle on oscilloscope. Time/CM at 1 Millisecond. 250 CPS.
- D. Test Jack B
 - 1. 2 CM per cycle on oscilloscope. Time/CM at 1 Millisecond. 500 CPS.
 - 2. Voltage level at 240 volts. NOTE: If voltage is not 240, adjust level then refine frequency adjustment.
- E. FS to Pos. 1, Test Jack A--Measure P-T-P of Square wave to 2 Volts. Adjust level to obtain 2 Volts.
- F. Recheck D 2 above. If more than 3% out of requirement call maintenance.
- G. See Figure 1 for Oscilloscope settings after the generator has been set.

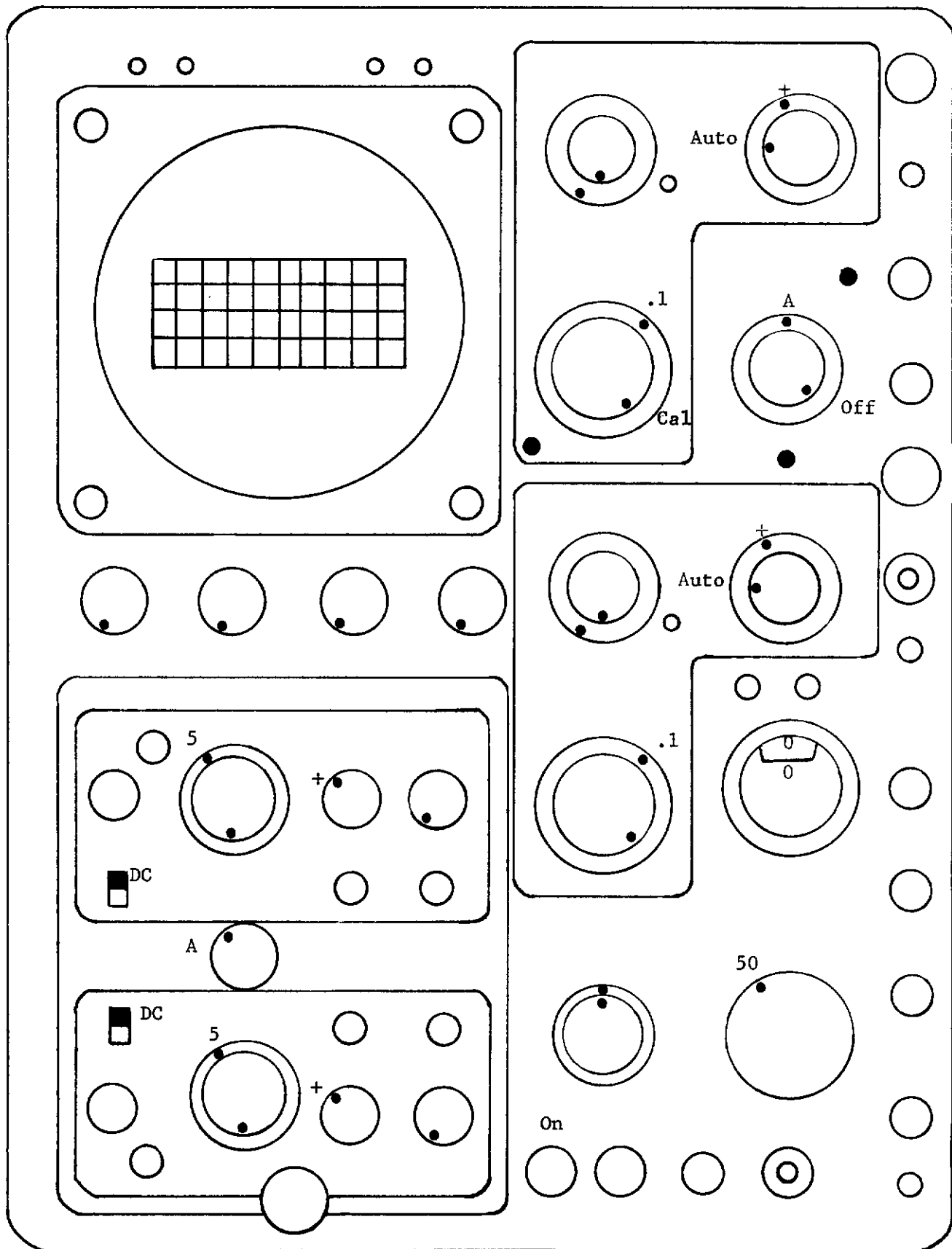


Figure 5. Oscilloscope Settings At Beginning of Program

ADMINISTRATION OF THE TEKTRONIX AUDIO VISUAL PROGRAM

1. General. It is necessary that the strictest of policies be observed in administration of the A.S.A., Inc., Tektronix Audio-Visual Program to the Goodfellow test population. These notes outline these policies. Both the program and method of instruction are being evaluated. In order that this section of Study 1414 II may be effective, administrator influence must be minimized, especially where this influence may be inconsistent from one individual subject or group of subjects to another.

2. Help to Subjects. The only type of help which an administrator may give a trainee is to correctly state an incorrectly pronounced word or phrase. If the subject does not understand any portion of the program, the administrator should take note of this, and at all times maintain a cumulative file of these notes for all training sessions for which he is responsible. When a trainee indicates such lack of understanding he should be advised exactly as follows:

"If this section of the program does not make sense to you, go ahead to another problem and try it. I have been instructed to give you no help at all with the program. It should explain itself, but where it doesn't do this, we keep track of this and later we will change it so that no one has trouble at that spot."

The administrator should be familiar enough with the program to know what questions are answered by the program text. Often a subject will ask a question which will be answered at a later point in the program. When this happens, the administrator should say:

"Please go ahead with the program. I think you will find the answer later on. If you do not and this causes trouble, call me again and we will list this as a program discrepancy."

If such a discrepancy occurs, the administrator should record it and advise the subject to continue as best he can. If the subject cannot continue, the administrator should render whatever help is necessary, record in complete detail what help is given, and note on records that the record of this S, and that of all previous subjects, has been contaminated. The program will then be amended or corrected on the basis of the discrepancy noticed. The administrator should be cautioned to carefully discriminate generator variability from the program discrepancy. If the question asked is due to some malfunction of variability of the signal generator, the generator should be adjusted. (See generator settings.)

3. Instructions to the Subject. When a trainee has been greeted and shown to a training booth, the administrator will read the following instructions:

"I know it sounds funny to read these instructions to you, but it is very important that the same thing is said to everyone. This is a scientific evaluation of a self-instructional program. Actually the program you are about to learn from has been tried out on other Air Force persons and has been corrected. Now it must be given to many persons in the same way to find out if it works to teach as well as we think it will. There may be some little errors but you should be able to get along all right if you listen carefully. If you do not agree with an answer in the program, note this fact in red pencil on your Response Sheet and then continue with the program. Feel free to ask questions, but be prepared if I have to read the answer to you. This is all part of being very careful that no one gets help that everyone doesn't get. Now go ahead and press the start button on the Graflex (point out start button) when you are ready to start. Call me if you find that you are missing any equipment or that the slides are out of synchronization by flipping the toggle switch at the back of the signal generator." (The administrator should point out the toggle switch at this point.)

This should be sufficient, if the booth has been set up properly, to get the subject underway. The instructions above should be rehearsed by the administrator prior to program administration.

4. Booth Equipment

A. First half of program:

1. 545A Oscilloscope
2. 2 probes (P-6006)
3. 1 ground cord
4. Signal generator
5. 1 Response Sheet (Mark STOP below #48)
6. 2 pencils--one with regular lead, the other with red
7. Program tapes (1 through 4)
8. Graflex
9. Slide magazine #1
10. Headset

B. Second half of program:

1. Items 1 through 6 above
2. Graflex
3. Headset
4. Program tapes (4 through 7)
5. Slide magazine #2

Contrails

5. Instructions to Administrator. (First and second half identical except where noted)

- A. Oscilloscope (prepare after using scope to check generator)
 - 1. Power switch in "off" position.
 - 2. Maladjust probes; one over, one undercompensated. (Note: on second half of program, do not maladjust probes.)
 - 3. Calibration of vertical amplifier checked and adjusted.
 - 4. Set controls as shown in Appendix I attached.
- B. Signal Generator
 - 1. Function switch on generator to position 5.
 - 2. Range switch to "High" position.
 - 3. Test Jack A--obtain square wave 4 CM per cycle on scope. Time/CM on scope set at 1 Millisecond (250 CPS).
 - 4. Test Jack B--adjust voltage level on generator to 240 volts. Refine frequency adjustment after voltage adjustment to 2 CM per cycle on scope. (500 CPS)
 - 5. Function switch at position 1--Test Jack A: Measure P-T-P of square wave to 2 volts. Adjust level to obtain 2 volts.
 - 6. Recheck 4 above. If more than 3% out of adjustment call maintenance.
- C. Graflex Audio Visual Machine (First half of program)
 - 1. Insert wall plug into power outlet.
 - 2. Power control switch on front of Graflex to "Lamp" position.
 - 3. Insert tape #1, insure that it is wound on the left reel.
 - 4. Insert slide magazine #1. Push it fully to rear of Graflex.
 - 5. Position the slide plunger over slide #1 (numbers on slide index on side of magazine) Leave the plunger in the "up" position.
 - 6. Turn volume control fully counter clockwise.
 - 7. Insert headset plug into jack on front left of Graflex.
 - 8. Place Play-Record switch on left side of Graflex to "Play".
 - 9. Place Normal-Delay switch on rear of Graflex to "Normal".
 - 10. Place headset in listening position and depress green foot pedal.
 - 11. Adjust volume to comfortable listening level.
 - 12. Depress red foot pedal until tape is completely rewound to beginning of tape.
 - 13. If called by a student to make slide synchronization, lift slide plunger, reposition slide magazine to correct slide position, and push slide plunger down. Use of slide synchronization chart will assist you to determine the correct slide which should be presented.
 - 14. Place foot pedal assembly in convenient position for student use.
- D. Graflex Audio Visual Machine (Second half of program)
 - 1. Follow 1, 2, 6, 7, 10, and 11 in C above.
 - 2. Insert tape #4. Insure that it is wound on the left reel.
 - 3. Set footage counter to zero.
 - 4. Depress "forward" button on top front of Graflex and advance tape to 100 foot on counter. Depress stop button on top front of Graflex to stop tape at the 100 foot count.
 - 5. Depress green foot pedal to start the tape, then adjust the volume to a comfortable listening level. Depress red foot pedal to stop tape immediately after instructions on the tape referring to slide cartridge change.

SLIDE SYNCHRONIZATION CHART (Sample)

This chart is used to determine the correct slide for presentation when slide synchronization with the tape control pulse has been lost.

By referring to the Response Number and/or the Tape Reel and footage number the student has reached, the slide number which should be presented may be determined.

<u>Response Number</u>	<u>Tape Reel Number</u>	<u>Footage at Which Slide Appears</u>	<u>Slide Number</u>
1	1	16	1
2-10	1	45	2
10	1	192	3
11-13	1	198	4
14-15	1	249	5
16-17	1	288	6
18	1	346	7
19	1	377	8
20-23	2	7	9
23	2	110	10

Security Classification

DOCUMENT CONTROL DATA - R&D		
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1. ORIGINATING ACTIVITY (Corporate author) Applied Science* **Aerospace Med. Res. Labs. Associates, Inc. & AMD, AFSC Valencia, Pennsylvania Wright-Patterson AFB, O.		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED
		2b. GROUP N/A
3. REPORT TITLE COMPARISON OF THREE MODES OF INSTRUCTION FOR THE OPERATION OF A COMPLEX OSCILLOSCOPE		
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13. ABSTRACT A field experiment was conducted to compare the effectiveness of three modes of instruction in the use of the AF 1807 oscilloscope (Tektronix 545A). Skilled electronic technicians of the U.S. Air Force Security Service served as subjects. One group was trained with an audio-visual instructional program, and a second group with a book form of the same program. The program combined verbal instruction and responses with practice on an oscilloscope. A third group was trained in the manner normally used at the school where the study was conducted. Analysis of variance on test scores indicated superiority of both forms of the program over the conventional instructions with no difference in effectiveness between programs. Electronic aptitude, as measured by the Airman Qualifying Examination, correlated significantly with test scores for the conventionally trained group and for all subjects together.		

DD FORM 1473
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Security Classification

Security Classification

14.	KEY WORDS	LINK A		LINK B		LINK C	
		ROLE	WT	ROLE	WT	ROLE	WT
	Training Military Training Education Instructions Training Devices						

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