DOCUMENT RESUME

ED 023 887 08 VT 006 916

By-Rozran, Gilbert B.

A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Automechanics. Final Report.

Systems Operation Support, Inc., King of Prussia, Pa.

Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Research.

Bureau No-BR-5-1332

Pub Date 1 Apr 68

Grant-OEG-1-6-000242-0618

Note-87p.

EDRS Price MF-$0.50 HC-$4.45

Descriptors-Auto Mechanics, Comparative Analysis, *Computer Assisted Instruction, Control Groups, *Electronics, Experimental Groups, *Experimental Programs, High Schools, Material Development, *Programed Instruction, Teaching Methods, Trade and Industrial Education

Identifiers-Smart Trainer

This project utilized computer-based instruction proven effective in military training programs, cue-response programing, "SNAP" programed texts, and programed overlays for the "SMART" trainer (a universal simulation and representation devide which can be tailored to a specific course merely by changing the students' panel and playboard programing). The objectives were to explore (1) the effectiveness of the military systems and pattern recognition approach to electronics training on high school students, (2) its impact on students with lower IQ.'s than the military group sampled, and (3) its effectiveness in other subjects, in this case auto mechanics. The sample consisted of an electronics experimental group of 53 students and control group of 36 students, and an auto mechanics experimental group of 9 students and control group of 14 students. Significant results were achieved in the electronics course for students who used computer assisted and program instruction. However, no significant difference was found in the auto mechanics students. Data for upper and lower IQ. groups in the electronics experimental group revealed no significant difference. Appendixes include the four project quarterly reports, and related documents are "Auto Mechanics: Methodology. Technical Instruction Manual" (VT 001 950), and "Practical Electronids: Technical Instruction Manual" (VT 001 961). (HC)

c1

FINAL REPORT
Project No. 5-1332
Grant No. OEG-1-6-000242-0618

A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Automechanics

April 1, 1968

[redacted]

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

FINAL REPORT

Project No. 5-1332
Grant No. OEG-1-6-000242-0618

A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Automechanics. FINAL REPORT.

Dr. Gilbert B. Rozran

Systems Operations Support, INC.
580 Shoemaker Road
King of Prussia, Pennsylvania 19406

The research reported herein was performed pursuant to a grant with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

(A) Summary of Project:

This was a pioneering project in the use of computer-assisted instruction and programmed instruction book methods for vocational education. The project began on April 1, 1966 and terminated on February 28, 1967. Materials prepared for the Electronics courses in military training under Project FORECAST were utilized as much as possible; since these had produced equally knowledgeable graduates in 40% of the time of the conventional Army courses in Electronics. New materials had to be developed for Auto-mechanics; and two "SNAP" programmed texts for these subjects were published in September 1966. (Copies are provided as an attachment to this report). The three-pronged objective of exploring (1) the effectiveness of the military systems and pattern recognition approach to maintenance training on high school students; (2) its impact on students with lower I.Q.'s than the military group sampled; and (3) its effectiveness in other subjects than electronics, auto-mechanics in this case, was met by application to a final (after attrition) sample of 112 students. Of these, 53 were Electronics experimental, 36 were Electronics, control, 9 were Auto experimental, and 14, Auto-control. In addition, a side issue was explored, the background of students, rural, urban, or suburban, by setting up the experiment in three Pennsylvania schools representing each of these socio-economic areas. All students were initially tested with the Otis, Kuder, Bennett, and Beta tests for intelligence, interest, and technical comprehension, both verbally and non-verbally.

Significant results were achieved in the Electronics course for students who used the CAI and Programmed Instruction approach. No significant difference was found in Auto-mechanics, although these results might be preliminary as only two computer presented practice systems troubleshooting patterns were prepared for Auto as opposed to five for Electronics. All three socio-economic Electronics groups (experimental) did well and about equal (see Table 1). When the data for these Electronics experimental group students was split into upper and lower I.Q. groups, there were no significant differences, which would seem to indicate that the systematic pattern-recognition or data-flow method of instruction, computer-assisted, as was the case is as effective with lower I.Q. students as with those in the upper half. The range of I.Q. as measured on the Otis in this case was from the low of 83 to a high of 131; and the Bucks County population was split at the midpoint of 114, while the Montgomery County N was divided at the midpoint of 109. It would seem, then, that the answer to Objective 2 for this project, namely does this approach have an impact on lower I.Q. students, would seem to be avery positive one with many implications motivating one to do further research and application of this technology to the underprivileged and not so "bright" youth (at least on the surface, depending on socio-economic and cultural conditions). Given additional funding, application of this same Electronics course program to another large group of students, especially in the lower socio-economic or culturally removed area should provide the stringent testing required to ascertain the full impact of these findings. Details of the procedures used, the course materials, programmed instruction books, and the computer programs are documented in the quarterly reports and in the various publications arising from the project. (Copies are provided as an attachment to this report). Figure 1 illustrates what was accomplished on the FORECAST project in maintenance training on radar (electronics) on a standardization group with AGCT (I.Q. Equiv.) scores ranging from 100 to 130. Table 1 gives the results of this project in a summarized form for both Electronics and Auto-mechanics. In the case of the Army, the FORECAST students did as well in 40% of the training time as the Control Group students. In this case, it is necessary to concentrate on the Upper Bucks County School data, as this was the one instance where all the elements of the methodology were present at one time--the programmed instruction materials, the computer, the experimental and control groups in Electronics, and a curriculum which was new enough to permit SOS to be able to help balance the course content between the control and experimental groups so that both groups were being taught technical maintenance material in Electronics which was identical in precedence as well as in actual conduct. In this case, time of exposure to such subject matter can be said to be equal, and holding such subject matter equal, it becomes evident that not only was statistical significance achieved but that the final proficiency test scores of the Experimental Group were almost 40% higher than those of the Control Group.

(B) Conclusions and Interpretation:

1. The SOS combined computer-assisted methodology works well in Electronics in every case; and where, previous electronics subject matter taught can be controlled, it is significantly better at the 2% level of confidence. Where a good deal of previous subject matter had already been taught the students, and where the SMART computer was not yet available, as was the case at Dobbins (urban) it did as well as the control group.

2. The lack of a significant difference in Auto-mechanics may be due to the fact that the rural students at Bucks do a great deal of motor and farm machinery repair from an early age, and that it was not as complete a CAI course (only two prepared programs in Auto) as could have been possible; more time and funds and application in an urban environment might produce different results.

3. In every case, the intrinsic interest in solving problems on the computer, which is much like playing a game with a pin-ball machine as the lights light, the slides with the voltage readings and wave-forms appear, and where the machine gives the student immediate reward when he localizes the correct source of the trouble by removing the malfunction indications and restoring the system to an operational or "green light" status, all these contributed to a high degree of motivation on the part of the student. Where the student is motivated, as in this case, and where the device lends itself to self-instruction, there are obvious implications for its use in study halls, for additional after-class troubleshooting practice, and for its universal use, as the range of subject matter is limited only by the ability of programmers to convert applicable educational curricula into the software required for computer output.

4. Language comprehension which in turn implies the successful full receipt of the bits of intelligence the sender is trying to convey to the listener, seems to be the source of most difficulties. In the case of this CAI-PI methodology, language was used as little as possible, insofar as charts, graphs, accurate schematic and block diagrams dynamically presented to show the relationships of various components of a system, and even cartoon-like figures and drawings in the PI books were utilized instead of words. (Especially instead of those words which were long, flowery and above the reading level of the student). The results are rather interesting in terms of the apparent ability of the lower I.Q. students to master the materials when prestructured by presumably intelligent education research personnel for them that their (the students frequency) may be tuned in on so that as the educational course materials are transmitted by computer, by programmed instruction book, or even by instructor, that they be received with a maximum degree of efficiency, e.g., that the student perceive, comprehend, retain and be able to recall the material later in the right context and from the appropriate cues. It was not without some faith in this approach, that the original research team referred to it as cue-response, that I used data-flow pattern techniques with gaming and immediate reinforcement in the USAF Atlas technician training program with many favorable responses and promising results. Now that additional data has been procured on this project to further support the systems data-flow pattern recognition approach to technical training (and with considerable reinforcement from the success of a current Navy project dealing with radar, computer and weapons direction equipment repair) it would seem that the next step would outdistance or take one jump of a greater magnitude by applying the methodology outside of the predominant language-cultural group to see if it is basic enough to the learning process to again produce results in technical training, which with experience and refinement, may make the technical approach tested here of wide and useful application.

Interim Data Analysis

Dobbins - Electronics

Experimental N=22

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	73.14	115.18	110.18	36.18	5.55	6.09	6.14
2.	S.D.	9.15	7.77	9.89	5.96	1.67	1.53	1.77

$R_{1.234567} = .7215$

Control N=20

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	74.20	117.30	109.70	33.05	5.50	5.70	6.20
2.	S.D.	8.85	6.81	9.82	10.24	1.72	1.58	1.72

$R_{1.234567} = .5660$

t = .3719
40 df .05 =2.021

Upper Bucks - Electronics

Experimental N=12

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	69.25	111.16	115.17	39.83	7.25	6.17	6.58
2.	S.D.	19.93	6.08	7.72	7.75	1.42	1.82	1.75

$R_{1.234567} = .9159$

Control N=16

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	51.00	115.31	113.75	43.44	7.63	6.63	8.13
2.	S.D.	17.37	4.28	5.52	7.13	1.27	1.54	.99

$R_{1.234567} = .5764$

t = 2.49
26 df .02 =2.479

$R_{1.234567} = .9159$

Control N=16

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	51.00	115.31	113.75	43.44	7.63	6.63	8.13
2.	S.D.	17.37	4.28	5.52	7.13	1.27	1.54	.99

$R_{1.234567} = .5764$

t = 2.49
26 df .02 =2.479

Upper Bucks - Auto-Mechanics

Experimental N=9

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	66.67	105.00	107.00	39.22	8.00	5.00	5.00
2.	S.D.	14.13	8.35	8.11	8.74	1.15	.94	1.70

$R_{1.234567} = .9867$

Control N=14

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	63.93	109.07	100.78	38.07	7.36	4.85	5.64
2.	S.D.	13.33	7.13	9.97	7.50	1.76	1.64	1.23

t = .0138
21 df .05 =2.080

R1234567 = .9040

Montgomery County - Electronics

Experimental N=19

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	73.11	109.95	109.79	43.84	7.47	6.37	6.668
2.	S. D.	9.57	9.31	6.61	6.23	1.60	1.18	1.45

$R_{1.234567} = .4402$

TABLE 2

Bucks County - Control

Subj. No.	Otis above 113	Subj. No.	Otis below 112
1.	60	9.	25
2.	27	10.	57
3.	51	11.	46
4.	50	12.	35
5.	72	13.	41
6.	37	14.	39
7.	54	15.	53
8.	89	16.	80
	440		376

$\bar{X} = 55.00$ $\bar{X} = 47.00$

$X_1^2 = 26820.00$ $X_2^2 = 19626.00$

$\sum x_1^2 = 26,820. - \frac{(440)^2}{8} = 2,620$

$\sum x_2^2 = 19,626. - \frac{(376)^2}{8} = 1,954$

$$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\left(\frac{2,620. + 1954.}{8 + 8 - 2}\right)\left(\frac{1}{8} + \frac{1}{8}\right)}$$

$= \sqrt{(326.7142)\ (.2500)}$

$= 9.0376$

$t = \frac{55. - 47}{9.0376}$

$t = .8851$

14 degrees freedom 2.145 not significant

Bucks County - Exp.

Subj. No.	Otis above 115	Subj. No.	Otis below 114
1.	81	8.	87
2.	90	9.	70
3.	70	10.	72
4.	84	11.	15
5.	76	12.	62
6.	78		306
7.	46		$\bar{X} = 61.20$
	525		

$\bar{X} = 75.00$

$\sum X_1^2 = 40,593.00$ $X_2^2 = 21,722.00$

$\sum x_1^2 = 40,593 - \frac{(525)^2}{7} = 1218.$

$\sum x_2^2 = 21,722. - \frac{(306)^2}{5} = 2994.80$

$$s_{\bar{x}_1-\bar{x}_2} = \sqrt{\left(\frac{1218 + 2994.8}{7 + 5 - 2}\right)\left(\frac{1}{7} + \frac{1}{5}\right)}$$

$= \sqrt{(421.28)\ (.3428)}$

$= 12.0172$

$t = \frac{75. - 61.2}{12.0172}$

$t = 1.1483$

10 degrees freedom 2.228 not significant

TABLE 3

High vs Low I.Q.

Montgomery County - Exp. for Test

Subj. No.	Otis above 109	Subj. No.	Otis below 108
1.	92	12.	73
2.	74	13.	77
3.	64	14.	80
4.	66	15.	89
5.	70	16.	55
6.	74	17.	60
7.	77	18.	63
8.	65	19.	86
9.	77		$\Sigma = 583$
10.	79		$\bar{X} = 72.87$
11.	68		
	$\Sigma = 806$		
	$\bar{X} = 73.27$		

$\Sigma x^2 = 59716$ $\Sigma x^2 = 43,569.$

$$\Sigma x_1^2 = 59,716 - \frac{(806)^2}{11} = 658.18$$

$$\Sigma x_2^2 = 43,569 - \frac{(583)^2}{8} - 1082.87$$

$$S_{x1-x2} = \sqrt{\left(\frac{658.18 + 1082.87}{11 + 8 - 2}\right)\left(\frac{1}{11} + \frac{1}{8}\right)}$$

$$= \sqrt{(102.4150)\ (.2159)} = 4.7022$$

$$t = \frac{73.27 - 72.87}{4.7022}$$

$t = .0850$

with 17 degrees freedom

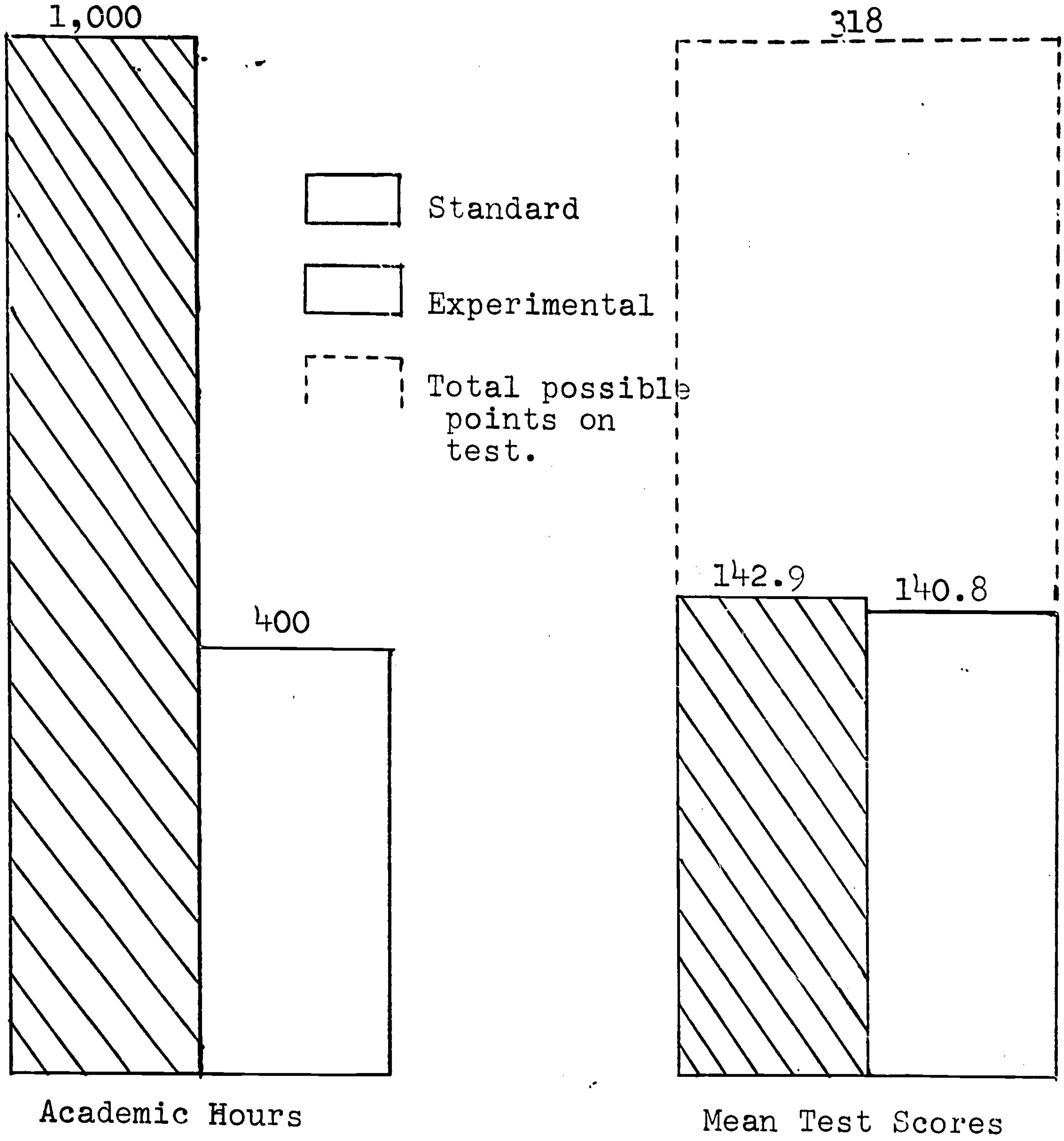
$.05 = .2110$

not significant

8.2 Figures:

FIGURE 1

Training Time and Performance Comparison, Army Cue-Response Standardization Group.



APPENDICES AND ATTACHMENTS
TO FINAL REPORT FOR
PROJECT NO. 5-1332

APPENDICES:

A--First Quarterly Report

B--Second Quarterly Report

C--Third Quarterly Report

D--Fourth Quarterly Report

ATTACHMENTS:

1. Programmed text entitled:
"Practical Electronics: Technical Instruction Manual"

2. Programmed text entitled:
"Auto Mechanics Methodology: Technical Instruction Manual"

FIRST QUARTERLY REPORT

Project US0E-51332

TITLE: A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used In Civilian High School Courses in Electronics and Auto-mechanics

TO: U. S. Department of Health, Education and Welfare
Office of Education
Division of Adult and Vocational Research

FROM: Systems Operations Support, Inc.
580 Shoemaker Road
King of Prussia, Pa.

REPORT PERIOD: 1 April 1966 -- 30 June 1966

Gilbert B. Rozran, Ph.D.
Principal Investigator

Harold I. Stalder
Administrative Grants Officer

TABLE OF CONTENTS

FIRST QUARTERLY SUMMARY

Objectives:

1. To determine the difference in performance between (a) students enrolled in a military-type computer-based instructional program in electronics and (b) students enrolled in a conventional instructional program in electronics, with both groups of students being drawn from a high school population with an I.Q. range from 100 to 130 (and higher).

2. To determine the effectiveness of the military-type computer-based instructional program in electronics when used on a lower I. Q. range (78 to 112) group of students.

3. To determine the effectiveness of the military-type computer-based instructional system when used in a different subject area: Auto-mechanics.

Procedures:

The project will utilize a computer-based instructional system which has proved to be very effective in military training programs. The system will involve the Cue-Response programming method, "SNAP" programmed texts, and programmed overlays for the "SMART" Trainer (a universal simulation and representation device which can be tailored to a specific course merely by changing the student's panel and plugboard programming.)

Course materials in two courses (Electronics and Auto-mechanics) will be programmed on the basis of the Cue-Response method resulting in the production of "SNAP" programmed texts and programmed overlays for the "SMART" Trainer. For the Electronics Course, materials previously used in military training programs will be revised, supplemented and adapted for civilian high school use. For the Auto-mechanics Course, new materials will be developed specifically for this project. Two vocational high schools (Dobbins Technical High School, Philadelphia, Penna. and the Upper Bucks County Technical High School, Perkasie, Penna. will be the locales for the experiment).

Accomplishments:

Electronics Course materials, using some content of previous military courses, are well on their way in development. After intensive analysis, five overlays for the "SMART" Trainer were defined, each capable of providing up to 25 malfunction problems. "SNAP" Programmed instruction materials have been in preparation for both courses. Two overlays were defined for the Auto-mechanics Course; and, the statistician-logician prepared the logic equations for translation to the wiring diagrams for the plugboard for the first Auto-mechanics Course overlay -- the overall block diagram. The other six overlays will have their logic equations developed as each layout is reviewed, revised and approved. Malfunction locations and their resultant system ramifications for each overlay, together with the appropriate tests and associated slides of waveforms, voltage readings, etc., are in preparation. The hardware manufacturer predicts delivery of the "SMART" Trainers on schedule.

In a meeting held with USOE, approval was obtained for minor changes in the project, resulting from the intensive analysis of course content. Numbers of overlays, plugboards, and slide packages were changed as a result of the analysis. Increased participation of the high school instructors, resulting from meetings held at the high schools, made it possible to eliminate both the second Electronics and the second Auto-mechanics "experimental" course instructors, and approval was obtained to procure 20 T.V. sets and necessary test equipment in order to assure having the tools for a standardized end-of-course proficiency examination for all electronics students. Frequent meetings, or telephone conversations, were held with the consultant in order to take full advantage of the experience with materials prepared for previous military electronics courses which used the Cue-Response method; and, the current NAVY-LORAN course facility was visited in order to take advantage of any recent innovations that may have been developed.

Plans for the next Quarter include the completion of the logic for the complete set of overlays with all malfunction problems associated with each one, the "debugging" of the programmed plugboards with associated overlays and slides on the "SMART" Trainer, the completion of the programmed instruction books, and the beginning of the courses of instruction at the respective participating high schools.

LIST OF TABLES AND FIGURES

I. Work Completed During First Quarter

The project was initiated officially on 1 April 1966. Staff members of SOS were assigned to the project group and began work immediately. Analysis of the course contents and schedules was begun for the Electronics Courses at the Dobbins Technical High School and the Upper Bucks County Technical-Vocational High School, and, for the Auto-mechanics Course at the latter school only. Meetings were held with the principals, technical education directors and instructors concerned with each of these courses, respectively.

For the Electronics Course, frequent meetings and telephone conversations were held with the Project Consultant in order to take full advantage of his experience and the Electronics Course materials from the military training applications with which he has been concerned in the past. Meeting dates are listed in Table I. SOS personnel reviewed these materials, extracted the useful content, and, with considerable expansion, are preparing experimental course materials from them.

After lengthy analysis, the overlays for the "SMART" were defined; and, work was begun on the writing of the "SNAP" programmed instruction texts. Cooperation of the electronics instructors at the two high schools was obtained in adapting their regular "control group" courses, so that course content and schedules may be the same as with the "experimental group" courses. Due to difficulties in making student assignments, it was decided to use a statistical separation of I. Q. levels, rather than a classroom separation. The numbers of students currently assigned to each of the Electronics Course classes are shown in Table 2.

Preparation of the Auto-mechanics Course materials was conducted by SOS personnel without the benefit of any military course precedent. Two block diagram overlays for troubleshooting training of auto systems on the "SMART" Trainer were prepared; and, the "SNAP" programmed instruction manuals for the Auto-mechanics Course were in preparation. Close cooperation with the Auto-mechanics instructor at the Upper Bucks County Technical-Vocational High School has enabled the preparation of two parallel scheduled course contents for the "experimental" and "control" groups, respectively. Table 3 presents the student assignments to the Auto-mechanics courses.

In the case of the Electronics Course, content analysis indicated that the "SMART-SNAP" approach could be effectively implemented by having the troubleshooting training period, with an SOS instructor using the "SMART", cover up to a four-week time block. Then, the remainder of the "experimental" course would be covered by the regular instructor, employing the "SMART" for student practice and demonstration and "SNAP" programmed texts in addition to the conventional lecture and laboratory methods. This increased participation in the teaching of the "experimental" courses by the regular high school instructors made it possible for SOS to reduce the number of special instructors required. As a result, only one SOS instructor will be assigned to the Electronics Course. Only one will be assigned to the Auto-mechanics course, since it will be conducted at just one location -- the Upper Bucks County Technical High School. The SOS Electronics instructor will divide his time during the fall term between the Upper Bucks County and Dobbins Schools according to the schedule shown in Table 4. He will, of course, be available at either school during the remainder of the school term to back up the regular instructor in the "experimental" course. In the event of an unforeseen time conflict whereby his services might be needed at both schools simultaneously, he, in turn, will be backed up by the SOS Research Scientist.

Specific details concerning the Auto-mechanics overlays are contained in Appendix A, with Figure 1 providing an illustration of the first overlay for this course. Since the first month of the Auto-mechanics Course is concerned with basic information and review of previous materials taught, the "SMART-SNAP" emphasis will begin in October and will be highlighted for approximately two months, with continued use being made of the methodology, as applicable, during the remainder of the school term. The most applicable course content areas include the ignition, fuel, carburetor and troubleshooting subject matter areas. Automobile body and brake repair, for example, are not particularly applicable areas for this methodology.

Appendix B contains a description of the overlays for the Electronics Course and the systematic troubleshooting procedure which would be used by a student in the solution of a problem. For this procedure, overlays #1 and #5 would be used, as depicted in Figures 2 and 3, respectively.

The troubleshooting procedure is based upon an analysis of the system and circuitry under consideration. The system is divided into functional groups (those components which act together to perform a specific function).

Inherent in the Cue-Response analysis is the identification and specification of the functions such groups perform. When the details of circuit functions are comprehended, the groups of parts which produce the functions are represented by a block diagram, as used on the overlays. Such a block diagram depicts the data flow from one block (group of parts) to others, and thereby makes explicit the functional relationships and dependencies existing among the blocks in the system. The technical story, based on an understanding of system operation, is written into the programmed instruction SNAP texts, and provides such detail as to convey process and purpose of the blocks. Such detail would include why the circuit is needed, which signals the circuit requires, what type of conversion is performed upon the signals and to which other circuits the outputs are directed.

Once the knowledge of circuit dependencies, functions, purposes, data paths, inputs and outputs have been developed, it is then possible to generate malfunctions in terms of the previously defined structure. A part malfunctioning in a given circuit will disrupt the normal functioning of the circuit and produce an observable sign of trouble. These signs of trouble are called symptoms. Symptoms are derivable in two distinct ways: theoretically and practically. The theoretical symptoms are derived by asking what would result if a specific part were to fail and deducing the effects. Practical symptoms are derived by actually causing the part to fail and observing the resulting effects. Both schemes are being used to develop the family of malfunction problems which will accompany each overlay. The resulting body of data then becomes the source for problems in troubleshooting practice to exercise students in logically deducing the focus of trouble. By programming these in the "SMART", the learning process can be speeded up through its design, whereby the instructor is provided with a bank of malfunction switches, so that he can insert a new problem situation for the student to solve as soon as he finishes the current one. For Electronics, where there will be five overlays available, over 100 different malfunction problems can be provided to give the student frequent and varied practice in troubleshooting, so that he can understand the variety of functions performed by electronic circuitry and the multivariant problems which can arise from the selected representative sample of malfunctions.

II. <u>Plans for the Next Quarter</u>

During the second quarter of this Project, 1 July - 30 Sept., 1966, the complicated process of programming course materials and the SMART will continue as follows:

(1) System and circuit analysis.

(2) Determination of a representative set of malfunction problems for each overlay.

(3) Practical testing of the theoretically determined symptom patterns associated with each malfunction.

(4) Identification of the appropriate test points with associated waveforms, voltages, etc.

(5) Translation of these symptom patterns into logic equations.

(6) Determination of the logic circuit interconnections required from the logic equations.

(7) Writing of the wire lists for the programmed plugboards.

(8) Testing each plugboard on the SMART to determine if all light switches are activated properly for each symptom pattern configuration (debugging the logic).

(9) Drawing of the waveforms, voltage readings, gauge levels, etc. to be used for quantitative readings at test points

(10) Photographing of the drawings for reduction and placement on the slide inserts.

(11) Retesting each malfunction switch setting for each overlay to determine if the correct slide is projected at a given test point for a given malfunction.

(12) Holepunching and silkscreening each overlay.

(13) Writing of the technical story for the subject matter including the description of the circuit functions, data flow, relationships and dependencies, inputs and outputs, malfunction sources and associated symptom patterns, periodic questions and answers.

(14) Drawing the necessary artwork to illustrate the technical story in a simple, but meaningful way.

(15) Editing of the technical story to make sure the reading level is commensurate with the level of the student body who will be using the manuals.

(16) Publication of the SNAP technical manuals and delivery of the SMART Trainers and associated equipment to the high schools.

(17) Final checkout of the hardware at the schools.

In addition to the above, it will be necessary to provide orientation sessions for the high school instructors prior to, or at the beginning, of the fall term. These will be one to two day sessions at each school in which they will be briefed on the Cue-Response methodology, use of the SMART Trainer, content of the SNAP manuals and the precise means for maintaining control over the special features of the "experimental" course materials, so that students in the "control" group do not gain access to them. The equating of course content between "experimental" and "control" groups has, of course, already been planned with the high schools; and, it will be re-iterated as a major necessity in order to maintain the proper controls for the research study.

Two half-day sessions at the beginning of the fall term for each class are being set aside at each school, so that the screening tests -- the Otis Intelligence Test, Kuder Preference Record, Owens and Bennett Mechanical Comprehension Test and the Army Beta -- may be administered to all the students who are participating in this research study.

III. Unanticipated Problems

At the present time, only 14 students each are enrolled in the "control" and "experimental" groups, respectively, of the Auto-mechanics Course at the Upper Bucks County Technical High School. This is less than the 20 students in each group promised to SOS by the school. The school principal, Mr. Ross, states, however, that a number of additional students may be expected to enroll this summer. In addition, if plans are completed before autumn to associate two more academic high schools in Upper Bucks County, including one parochial school, with the Technical School half-day program, then the student population in each group will be increased to a number well in excess of the 20 planned for in the experimental design.

To assure having a large enough population to draw from, discussions have been held with Mr. Harold B. Albright, Montgomery County (Pa.) Vocational-Technical School Director, concerning the application of the research methodology in some of his schools. If, by February 1967, it is felt that the data base is insufficient, it will be possible to move into one or two of the Montgomery County Schools for a month and pick up some additional data in either Auto-mechanics or Electronics. This will serve as backup in the event too small a sample results from unexpected attrition of the student body in any of the participating schools, and it could provide useful data for cross-validation purposes.

Due to the additional amount of logic equations which need to be written for the variety of malfunctions that are being programmed, it is evident that the additional services of a part-time logician will be required. In addition, the amount of typing required for the programmed instruction books exceeds the time availability of our one secretary assigned to this project. It will be necessary, therefore, to have a logician assisting the present statistician-logician in the preparation of the equations and to hire a part-time typist. Every effort will be made to keep the costs of the three programmers limited, so that the total costs in the personnel expenditure category may remain the same as originally predicted in the Contract.

APPENDIX

APPENDIX A

Two overlays for the SMART Trainer will be used in teaching the Auto-mechanics Course. In laying out the overlays, an attempt is being made to organize them by functional circuit. It is very difficult to isolante an automotive system into clear-cut circuits, due to the many interactions and functional relationships that must be performed during each phase of operation. For example, during the cranking sequence, thé starter/ignition switch, commonly used on most automobiles, must actuate the starter, turn on the ignition and furnish power to the various indicators and accessories. Each of these functions are connected into the storage battery for power, yet are in separate functional circuits. This makes it difficult to determine what the first sequence should be. To further complicate matters, carburetion must occur during cranking and starting. Therefore, it was necessary to assign functions in the most logical sequence. On both overlays, the sequence will be in the following order: (1) starter/ignition, (2) cranking circuit, (3) ignition circuit, (4) carburetion, (5) charging circuit and followed by (6) the normal running performance sequence.

Figure 1 is a copy of an overlay to be used as a part of the Auto-mechanics Course. This is an overall layout for the ignition, carburetion and related systems. Most of the functional components of the two systems are contained on this overlay, so it should be able to provide the necessary information for learning system functional relationships, thus supplementing the programmed text.

This particular overlay will have a total of 66 switches energized; twenty five of these switches will be for replacement, repair or adjustment of the 25 malfunctions that can be injected into the system at the direction of the instructor. Associated with these malfunctions will be a series of 33 slides containing information, either for repair or for an indication on how to proceed to the next series.

The students will be given a very brief indoctrination by the instructor on the operation of the SMART Trainer. This will be given to them as a group, thus saving considerable instructor time and will be accomplished prior to student practice on the SMART Trainer. It is currently planned that the overall layout will be phased into the course immediately after selected elements of theory and text materials have been presented to the group. This should occur about mid-semester, or just prior to the diagnostic and troubleshooting portions of the course.

Prior to student operation of the SMART, the instructor will install the proper overlay, plugboard and run a diagnostic test to insure proper trainer operation. Then the test must be set up for each individual student. In all probability the initial run through by the student will contain a minimum number of malfunctions. So, the instructor will select the malfunctions and energize the circuitry, reset the recording devices, then instruct the student to begin the test. The following is an example as to how the trainer might be used:

For the purposes of this test, all lights and indicators will be out prior to operation. Start will be initiated by depressing the <u>start-action</u> button #10. The indicator will come on "white" and remain "white" indicating the phase of operation for the test. In addition, starter/ignition switch indicator #35 is also "white" to indicate the next step in the sequence. The student will depress the starter/ignition switch button. If there is a programmed malfunction, the indicator will be "red." The student will thus need more information, so he will have to depress the button along with the test A button to the right of the overlay. Information will appear on a screen located just above the overlay. In this particular case, the slide information will direct the student to replace the defective starter/ignition switch. This will be accomplished by depressing the starter/ignition switch replace button. Indicators #25 and 35 will turn "green" to indicate the malfunction has been corrected. In addition, the cranking circuit indicator #34 will turn "white" to indicate the next sequence. Had there been no malfunction programmed into the starter/ignition switch, indicator #35 would have turned "green" and at the same time, #34 would have turned "white" to indicate the next sequence.

For illustrative purposes, let us say that a cranking motor malfunction has been programmed into the machine by the instructor. The student would depress the cranking circuit button. Indicator #34 would turn "red" to indicate a malfunction in the circuit. In addition, the indicators for the functional components in the STARTING circuit (indicators #43, 44, 53 and 54) would turn "white." However, more information is desirable so the student would depress the cranking circuit button and test A button on the right. Information would then appear on the screen. To proceed, the student would depress the battery button #43, which would turn "green." Then the battery cable button #53 will also appear green, so the student will know that there is power to the cranking motor solenoid switch. This would be depressed next (button #44) and the indicator would then turn "green." The last "white" indicator would be #54. When button #54 would be depressed, the indicator would turn "red." More information would be desired; so the student probably would then depress the cranking motor button and test button A. Information would appear on the screen, which would tell the student to replace a shorted out cranking motor. This is accomplished by depressing the cranking motor replace button #64. Indicators #54, 64 and 34 and 10 will then turn "green" to indicate that cranking action has been achieved. In order to proceed into the next phase of operation, the start-idle and ignition circuit indicators #20 and 36 will turn "white." The same type of logical sequence would follow. Thus at the end of the test, all of the phase of operation indicators (#10, 20 and 30) would be "green"; and, in addition, the remainder will either be "out," to indicate non-use for the test, or "green." At this time, the instructor will be required to document the automatically recorded data and set up the machine for the next student by depressing the appropriate buttons.

APPENDIX B

(Electronics Course)

The five overlays for the "SMART" Trainer are as follows:

Overlay #1: A block diagram depicting the complete television system.

Overlay #2: A schematic diagram describing each component in the tuner, I.F., Detector, Video, C.R.T., A.G.C. and low voltage circuitries. The function of these individual circuits are as follows: The antenna-tuner circuit selects, detects, generates and mixes different frequencies and produces an intermediate frequency called "I.F." The amplifier amplifies these frequencies. The detector extracts the intelligence from the I.F. carrier. The video amplifier amplifies the video intelligence uniformly. Next the video intelligence is changed into visual information by the C.R.T. circuitry and then reproduced on the screen. The automatic gain control, called "A.G.C." circuit, keeps the picture at a constant level. The low voltage supply changes the house (A.C.) voltage to Direct Current (D.C.) so that it can be used to energize all circuits.

Overlay #3: It shows a block diagram of the video amp., and C.R.T. The schematic diagram shows the components in the sound circuitries. The limiter purpose is to eliminate all amplitude distortion or variation in the F.M. signal. The Ratio Detector converts the frequency-modulated (F.M.) signal into equivalent sound signals. The sound amplifier amplifies the sound to a level where it can be reproduced by the sound output speaker.

Overlay #4: This shows a block diagram of video amp. and C.R.T. It displays a schematic diagram of the sync. clipper, vertical oscillator, vertical output and vertical section of the yoke. The sync clipper separates the sync pulses from the rest of the video signal and these sync pulses are used to synchronize the T.V. set to the transmitter. The vertical oscillator generates a saw-tooth voltage (and current) wave. The vertical output amplifies the saw-tooth wave and the vertical section of the yoke produces electro-magnetic deflection in step with the saw-tooth wave.

Overlay #5: It shows a Block diagram of the Video amplifier, C.R.T. and sync clipper circuitries. Also shown are a schematic diagram of the A.F.C., horizontal oscillator, horizontal output, damper, high voltage rectifier and horizontal yoke section. The Automatic Frequency Control (A.F.C.) maintains automatically the Horizontal oscillator frequency to a desired value. The Horizontal oscillator generates a saw-tooth voltage and is amplified by the Horizontal output stage which in turn is fed to the Horizontal yoke section. The damper circuit prevents any transient oscillation from being set up in the deflection coils. The high voltage (H.V.) supply supplies the voltage to the C.R.T. anode.

Example of Troubleshooting Procedure: If Overlay #1 were to be used, and a V.H.F. or U.H.F. signal were the input signal, the signal flow could be traced from the antenna block to the various other blocks. At any block, a malfunction or several malfunctions could be programmed.

Suppose the instructor inserted a programmed malfunction which was "No H.V." The first step would be to depress the ON-OFF switch. An indication that the tubes were lighting would be presented by all blocks lighting "white." This would only mean that the filaments of the tubes were lighting and not necessarily functioning. Next, if the sound for the picture is present would be determined by depressing the volume control block button. Note that all the sound blocks would turn "green," which would indicate that the sound circuitries were functioning. To determine if the picture is present, the brightness block button would be depressed and noting that nothing happens, the student would know the C.R.T. circuit is not functioning. He would probably ask himself, "Is there a video signal present?" This would be determined by depressing the contrast block button, which energizes all the blocks from the antenna through the video amplifier, indicating that video is present. By a trial and error method, eventually the bad component could be found; however, this is a long drawn out and costly job. Furthermore, our methodology teaches the student to proceed in a logical, systematical way.

Now, let us summarize the course of events to this point: It has been determined that there is no picture on the C.R.T. because of the lack of illumination of the C.R.T. So far, the signal has been traced to the C.R.T. by use of lights on the SMART Trainer. With a real T.V. set, the speaker would produce the sound after the volume was turned up, and the C.R.T. would produce no light, even after the brightness control was turned up, indicating picture trouble. As has been illustrated here, no test equipment has been used up to this point. A well-trained T.V. technician could isolate most malfunctions without the use of test equipment down to the troubled circuitry. Since the C.R.T. in this example hasn't any brightness, a volt meter can be employed for use here. By depressing the volt meter button and the C.R.T. test, it can be determined if there is proper bias on the cathode-grid of the C.R.T., or if there is proper H.V. on the

C.R.T. anode, or if there is proper screen grid voltage. The volt meter shows that the voltage on the anode is low (H.V.) This tells us that the malfunction might be in the Horizontal, Damper or H.V. Circuitry; and, this check will eliminate the need for checking the sync clipper, A.G.C. and vertical circuitries; but, it will not eliminate the fact that the trouble might be in the low voltage supply block. A quick check with the volt meter button and the low voltage check point button would reveal that the low voltage supply block was functioning. Since it would have been determined that the trouble might be in the Horizontal, Damper or H.V. circuitries, and assuming that the technician had checked all tubes first and had determined that none were bad, he would proceed by checking the Horizontal, Damper and H.V. circuits, respectively, by depressing each button relative to signal flow. When the troubled circuitry was located, it would light "red"; which, in this case, the Horizontal output circuit would do.

Now, Overlay #5, which is the Horizontal, Damper and H.V. schematic diagram drawing, would be installed in place of the Block diagram of Overlay #1. With this type of detailed Overlay, the individual components could be checked; and the student would find that the Horizontal output circuit contained the malfunction. With use of the various test equipments-- voltage, resistance or Scope, by depressing the associated test button and one of the test instrument buttons, individual components or points in the circuitry could be evaluated. With reference to Overlay #5, R 23, a 1K 2-watt resistor would be found to be opened. By depressing the volt meter and the check button that is related to the screen grid of the horizontal output tube, the student would note that no voltage is present on the screen grid of this tube. This component could be checked with an Ohmmeter to determine if it is opened, which, in this case, it would be. By depressing the replace button, the "red" lights would turn "green" telling the student that the set had been repaired and was now back in proper operation.

TABLE 1

MEETINGS HELD DURING PROJECT FIRST QUARTER

Date	Conferee	Location
April 7-8	Dr. E. L. Shriver, Consultant	Washington, D. C.
19	Messrs. Ross, Moyer, Keim	Upper Bucks Tech. H.S.
22	Messrs. Magliocco, Schecter, Johnson	Dobbins Tech. H.S.
May 3	Messrs. Ross, Moyer, Keim	Upper Bucks Tech. H.S.
17	Dr. Sidney C. High, J.J.Maimone	USOE, Washington, D. C.
18	Dr. E. L. Shriver, Consultant	Washington, D. C.
19	FORECAST-LORAN Course Instructors	USNFTA Norfolk, Va.
27	Messrs. Donovan, Magliocco, Schecter, Johnson	Dobbins Tech. H.S.
June 2	Dr. E. L. Shriver, Consultant	King of Prussia, Pa.
7	Messrs. Ross, Moyer, Keim	Upper Bucks Tech. H.S.
16	Dr. E. L. Shriver, Consultant	Washington, D. C.
23	Dr. Sidney C. High, J.J.Maimone	USOE, Washington, D. C.
24	Dr. E. L. Shriver, Consultant	Washington, D. C.

TABLE 2

STUDENT ASSIGNMENTS TO ELECTRONICS COURSE CLASSES

School	Grade	Experimental Groups		Control Groups	
		No. Students*	I.Q. Range	No. Students*	I.Q. Range
Dobbins H.S.	12	23	95-127	26	93-128
Dobbins H.S.	11(a.m.)	24	86-114	24	83-116
Dobbins H.S.	11(p.m.)	22	99-107	20	91-107
Bucks Co. H.S.	11-12	24	92-132	26	89-136
TOTALS		93	86-132	96	83-136

* Student numbers and assignments are subject to change until approximately the second week of the fall term as some students enrolled now will not be back in the fall; others will change their course objectives, etc. Overall, a sufficient number of students in the Electronics Courses can be expected to be enrolled.

TABLE 3

STUDENT ASSIGNMENTS TO AUTO-MECHANICS COURSE CLASSES

School	Grade	Experimental Groups		Control Groups	
		No. Students*	I.Q. Range **	No. Students*	I.Q. Range **
Upper Bucks Co. H. S.	11-12	14		14	

* Student numbers and assignments are subject to change until approximately the second week of the fall term as some students enrolled now will not be back in the fall; others will change their course objectives, etc. Overall, a sufficient number of students in the Electronics Courses can be expected to be enrolled. It is expected that a number of additional students will sign up for the Auto-mechanics Course, so that the total for each group will be approximately 20 students.

Note: Only the Upper Bucks County Technical High School is involved in this course.

** This information will not be available until the beginning of the fall term in September.

TABLE 4

TIME SCHEDULE FOR SOS ELECTRONICS INSTRUCTOR TO PRESENT TROUBLESHOOTING OR SERVICING INSTRUCTION BLOCK PORTION OF "EXPERIMENTAL" COURSE

		1966			1967	
School	Grade	October	November	December	January	February
Dobbins H.S.	12	----------	----------			
Bucks Co. H.S.	11-12			----------		
Dobbins H.S.	11				----------	------

FIRST HALF

MAJOR AREA	SUB-AREA	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
I. The Television Field		3	45	
	INTRODUCTION			3
	Desirable Image Characteristics			3
	Outline of Stages of T.V. Transmitters and Receivers			3
	Television Camera Tubes			3
	Electron Beam Scanning			3
	Flicker			3
	Complete Scanning Process			3
	The Image Orthicon			2
	The Image Dissector Carne Tube			2
	Blanking and Synchronizing Signal			3
	The Video Signal			3
	Negative and Positive Video Polarity			3
	Why T.V. Requires Wide Frequency Bands			3
	Effects of Low and High Video Frequencies			3
	Frequency Allocation			2
	FM for Audio Transmission			3
II. Servicing Television Receivers		4	60	
	INTRODUCTION			1
	Servicing Divisions of T.V. Receiver			3
	The Power Supplies			4
	Ripple Effects			3
	Sound vs. Filter Ripple			3
	The Cathode Ray Tube			4
	Horizontal Deflection Circuits			4
	Loss of Synchronization			4
	Interference			2
	Horizontal Linearity			3
	Horizontal Damping Circuit			3
	Vertical Deflection System			4
	Defective Clipper Action			4
	The Video Circuits			4
	Microphonic Tubes			2
	R. F. System			4
	Audio Stage Servicing			4
	Servicing Intercarrier Receivers			4

FIRST HALF

MAJOR AREA	SUB-AREA	Weeks Allocated	Hours per Major Area	Hours per Sub-Area
III. U.H.F. Waves and the T.V. Antenna		2 2/15	32	
	Requirements			2
	Radio Waves Propagation			3
	Line of Sight Distance			3
	Unwanted Signal Paths			3
	Wave Polarization			3
	Tuned Antennas			3
	Half Wave Antennas			3
	Antenna Length Computations			3
	Half Wave Dipole with Reflector			3
	Transmission Lines			3
	Antenna Installation			3
IV. Wide Band Tuning Circuits-R.F. Amp.		1 4/5	27	
	Band Width Problem			3
	Ordinary Tuning Circuits			3
	Transformer Coupling			3
	Special Tubes for Television			3
	R. F. Amplifiers			3
	Grounded Grid Amplifiers			3
	Additional R. F. Tuning Methods			3
	Internal Tube Capacities			3
	Tubes with Two Cathode Terminals			3

FIRST HALF

MAJOR AREA	SUB-AREA	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
V. The H.F. Oscillator, Mixer and I.F. Amp.		3 11/15	56	
	Converters-The Effect of High Frequencies			3
	Oscillators			3
	Modified Ultradion			3
	A.F.C. System			3
	Oscillator Frequencies			3
	Choice of Intermediate Frequencies			3
	Separation of Video and Sound Signals			3
	Video I.F. Amplifiers			3
	Transformer Coupling			3
	Trap Circuits for T. V.			3
	Placement of the Traps			3
	Types of Traps			3
	Tuning the Traps			3
	Stagger Tuned IF Systems			3
	Stagger Tuning			3
	Complex Coupling			3
	Gain per State			3
	Automatic Gain Control			3
	Contrast Control			2
VI. Diode Detectors and AGC Circuits		1 1/5	18	
	Detection of the Video Signal			4
	Positive and Negative Picture Phase			3
	Detector Filtering-Peaking			3
	AVC and AGC			4
	Keyed AGC			4

FIRST HALF

MAJOR AREA	SUB-AREA	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
VII. Video Amplifiers		2 2/15	32	
	Some Consideration for Video Amplifiers			4
	Relation Between The Eye and Detail on a Viewing Screen			4
	Low Frequency Response of Video Amplifiers			4
	Phase Distortion			4
	How Phase Distortion is Introduced			4
	Results of Phase Distortion			4
	Video Amplifiers and their Design			4
	Low Frequency Compensation			4
VIII. D-C Reinsertion		1	15	
	The Need for D-C Reinsertion into Video Signals			3
	Reinserting the D-C Components			3
	D-C Reinsertion Circuits			3
	The Brilliancy Control			3
	D-C Reinsertion with a Diode			3
	TOTAL HOURS		285	

SECOND HALF

MAJOR AREA	SUB-AREAS	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
I. Cathode Ray Tubes		4 2/5	66	
	INTRODUCTION			1
	The First Lens System			3
	The Second Lens System			3
	Electrostatic Deflection			3
	Amount of Deflecting Voltages Necessary			3
	Centering Controls			2
	Magnetic Focusing			3
	Electromagnetic Deflection			3
	Cathode Ray Tube Screens			3
	Halation			2
	Reflections Due to Curvature of Screen			2
	Reflections at Surface of Screen Face			2
	Sticking Potentials			2
	Ion Spots			2
	Adjustments of Ion Traps			2
	Special Cathode Ray Tube Elements			3
	Curvature of Television Screens			3
	Nomenclature of Cathode Ray Tubes			3
	Power Supplies in Television Sets			3
	R.F. Power Supplies			3
	The Inductive Flyback Supply			3
	Beam Relaxor Circuit			3
	Projection T.V. Systems - For RCA, Philco and Phillips			9
II. Synchronizing Circuit Fundamentals		3 4/15	49	
	Synchronizing Pulses			4
	Pulse Separation from the Rest of the Signal			4
	Diode Clippers			3
	Triode Sync Separators			3
	Pentode Sync Separators			3
	Pulses and their Form			3
	Serrated Vertical Pulses			3

SECOND HALF

MAJOR AREA	SUB-AREAS	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
II. Synchronizing Circuit Fundamentals (cont'd.)	Vertical and Horizontal Separation			4
	Vertical Pulse Filters			3
	Equalizing Pulses			3
	Synchronizing Oscillators			4
	The Blocking Oscillator			4
	Saw Tooth Waves			4
	Multi-Vibrater Synchronizing Oscillators			4
III. Deflecting Systems		2 2/5	36	
	An Electrostatic Deflection System			4
	Saw Tooth Current Waves			4
	Automatic Frequency Controls Systems			4
	An Electromagnetic Deflection Unit			5
	Horizontal AFC Systems			4
	Horizontal Discharge			3
	General Electric A.F.C. System			3
	D-C Control of Oscillator Frequency			3
	Pulse Width A.F.C. System			3
	The Philco System			3

MURRELL DOBBINS TECHNICAL HIGH SCHOOL
12th GRADE COURSE OUTLINE
ELECTRONICS

SECOND HALF

MAJOR AREA	SUB-AREAS	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
V. A Typical T. V. Receiver -- Analysis and Alignment		5 4/5	87	
	Television Receiver Cabinets			2
	Receiver Panel Control			3
	Secondary Control			3
	A Modern Television Receiver			3
	R.F. Unit			3
	The Mixer			4
	The Oscillator			4
	Video System			4
	Traps			3
	Contrast Control			3
	Video Second Detector			3
	Video Amplifiers			3
	D-C Restorer			3
	Synchronizing Amplifier and Separator			4
	Horizontal Sweep Oscillator System			4
	Horizontal Deflection and High Voltage Circuits			4
	Low Voltage Power Supply			4
	Cathode Ray Tube			3
	Alignment of the Receiver-Equipment Required:			
	(1) Oscilloscope			3
	(2) Alignment Oscillator			3
	(3) Single Signal Generators			3
	(4) Vacuum Tube Voltmeters			3
	(5) Marker Signals			3
	(6) Video I F Stages			3
	(7) Video I F Alignment			3
	(8) R.F. & Converter Circuit Adjustment			3
	(9) R.F. Oscillator Adjustment			3

MURRELL DOBBINS TECHNICAL HIGH SCHOOL
12th GRADE COURSE OUTLINE
ELECTRONICS

SECOND HALF

MAJOR AREA	SUB-AREAS	Weeks Allotted	Hrs. per Major Area	Hrs. per Sub-Area
V. Frequency Modulation		2 2/15	32	
	General Outline			3
	Transmitters			4
	F-M Receivers			4
	Limiters			3
	The Discriminator			3
	A Modified Discriminator			3
	F-M Ratio Detector			3
	Ratio Detector Modifications			3
	The Audio System in T. V. Receivers			6
VI. Intercarrier T.V. Sound System		1 1/15	16	
	Basic Principles of Intercarrier System			4
	Intercarrier Television Receivers			3
	H.F. Oscillator Frequency Changeover			3
	Advantages of the Intercarrier System			3
	Disadvantages of the Intercarrier System			3

TOTAL HOURS 285

SOS TRAINING SCHEDULE
ELECTRONICS COURSE OUTLINE
"EXPERIMENTAL" GROUP

MAJOR AREA	SUB-AREA	Weeks Allotte	Hrs. pe Major A	Hrs. pe Sub-Are
I. Operation Controls and Adjustment		2/5	6	
	Course Orientation			1
	Operations Controls and Adjustments			2
	Symptoms: Controls and Adjustment Problems			3
II. T. V. Technical Story		3/5	9	
	INTRODUCTION			1
	Technical Story--Video			5
	Technical Story -- Sound and Power			2
	Technical Story -- Test			1
III. System Troubleshooting		1 3/5	26	
	Troubleshooting Procedures			1
	T. V. Symptoms -- Orientation			1
	SMART Trainer vs. Symptoms			1
	Visual Symptoms #I- Lesson Plan			1
	SMART Troubleshooting - Practical Exercises			3
	Visual Symptoms #2 - Lesson Plan			1
	SMART and T.V. Troubleshooting -- Practical Exercises			3
	Sound and Power Symptoms			1
	SMART and T.V. TROUBESHOOTING -- Sound and Power			3
	Troubles Caused by Defective Parts			1
	SMART and T.V. Troubleshooting -- Practical Exercises			3

		Weeks Allotte	Hrs. pe Major A	Hrs. pe Sub-Are
III. System Troubleshooting (contd.)	Maintenance and Adjustments -- Yoke, Ion Trap, Ant. and Cleaning C.R.T.			1
	SMART and T.V. Troubleshooting (Adjustments).			3
	Review for Test			1
	Symptoms and Tech. Story "Knowledge" Test			1
	Troubleshooting Test using SMART and Bugged T.V.'s			1
IV. Troubleshooting		1 4/15	19	
	Chassis Troubleshooting Procedure			1
	Chassis Navigation -- Lecture-Part I			1
	Chassis Navigation -- Exercise			1
	Resistance Color Code Readings			1
	Soldering -- Lecture and Demonstration			1
	Chassis Navigation, Soldering -- Practical Exercise-SMART and T.V.			3
	T.V. Chassis Bugged -- Practical Exercise			3
	Chassis Navigation -- Part II			1
	Chassis Troubleshooting -- Hidden Parts			3
	Removing and Replacement T.V. Chassis			1
	Chassis Troubleshooting Test			2
	Review of Test			1

TOTAL HOURS 60

TABLE 7

Course Outline - Auto-Mechanics

I. The Ignition System (Time Allocation - Classroom, 5 hours)

A. Theory
1. Operation of the four cycle engine-Review
2. Functional description of the ignition system
   a. Primary circuit
   b. Secondary circuit
3. Ignition coil
   a. Description and function
   b. Ballast resistor or wire resistor
4. Ignition distributor
   a. Contact points
      (1) Cam angle
      (2) Gapping
   b. Condenser
   c. Distributor cap and rotor
   d. Automatic spark control mechanism
      (1) Centrifugal
      (2) Vacuum
      (3) Combination
      (4) Spark control curve
   e. High tension wires
   f. Spark plugs
      (1) Cleaning or replacement
      (2) Gapping
   g. Special ignition systems and devices

B. Practical (Time Allocation - Shop, 15 hours)
1. Distributor overhaul
2. Coil testing procedures
3. Spark plug servicing
4. Engine timing
5. Secondary wiring

II. Fuels and Fuel System (Time Allocation - Classroom, 15 hours)

A. Theory
1. Purpose of fuel system
2. Component part of fuel system
   a. Fuel tank
      (1) Construction
      (2) Venting
   b. Fuel gauges
      (1) Balance coil
      (2) Thermostatic
   c. Fuel filter and screens
      (1) In-line
      (2) Carburetor filter
      (3) Fuel pump

d. Fuel pump (description and purpose)
   (1) Rocker arm
   (2) Diaphram
   (3) Inlet valve
   (4) Filter and screen
   (5) Outlet
   (6) Operation
e. Carburetor (description and purpose)
   (1) Air horn
   (2) Venturi
   (3) Fuel nozzle
   (4) Throttle valve
f. Air cleaner
   (1) Purpose
   (2) Care and servicing
g. Intake manifold

3. Fuel pump operation
   a. Types
      (1) Single action
      (2) Electric
      (3) Combination-fuel and vacuum
4. Carburetor operation
   a. Purpose
      (1) Metering
      (2) Atomization
      (3) Distribution
   b. Fundamentals
      (1) Air/fuel ratio
      (2) Flow curve-air flow vs. air/fuel ratio
      (3) Flow curve-carburetor systems vs. miles per hour
   c. Principles
      (1) Vacuum
      (2) Venturi
   d. Basic systems
      (1) Float
      (2) Idle system
      (3) Main metering system
      (4) Power system
      (5) Pump system
      (6) Choke system
   e. Auxiliary system
      (1) Vacuum spark advance
5. Fuel system troubleshooting
   a. Performance analysis-carburetor
      (1) Flow curve-air flow vs. air/fuel ratio
      (2) Flow curve-curburetor systems vs. miles per hour
   b. Performance analysis-fuel pump
      (1) Pressure
      (2) Capacity
      (3) Vacuum choke
      (4) Servicing
   c. Air cleaner
      (1) Test
      (2) Servicing

B. Practical (Time Allocation - Shop, 45 hours)
   1. Tank checks and repair methods
   2. Fuel pump
      a. Test
      b. Overhaul
   3. Carburetor (Rochester)
      a. Complete overhaul
         (1) Single barrel
         (2) Two Barrel
         (3) Four barrel
         (4) Corvair model carburetor
      b. Adjustment
         (1) Choke
         (2) Idle
         (3) Pump rod
         (4) Unloader
   4. Air cleaner-test
   5. Fuel system test and diagnosis
      a. Pump pressure and capacity test
      b. Air cleaner test
      c. Combustion analyzer

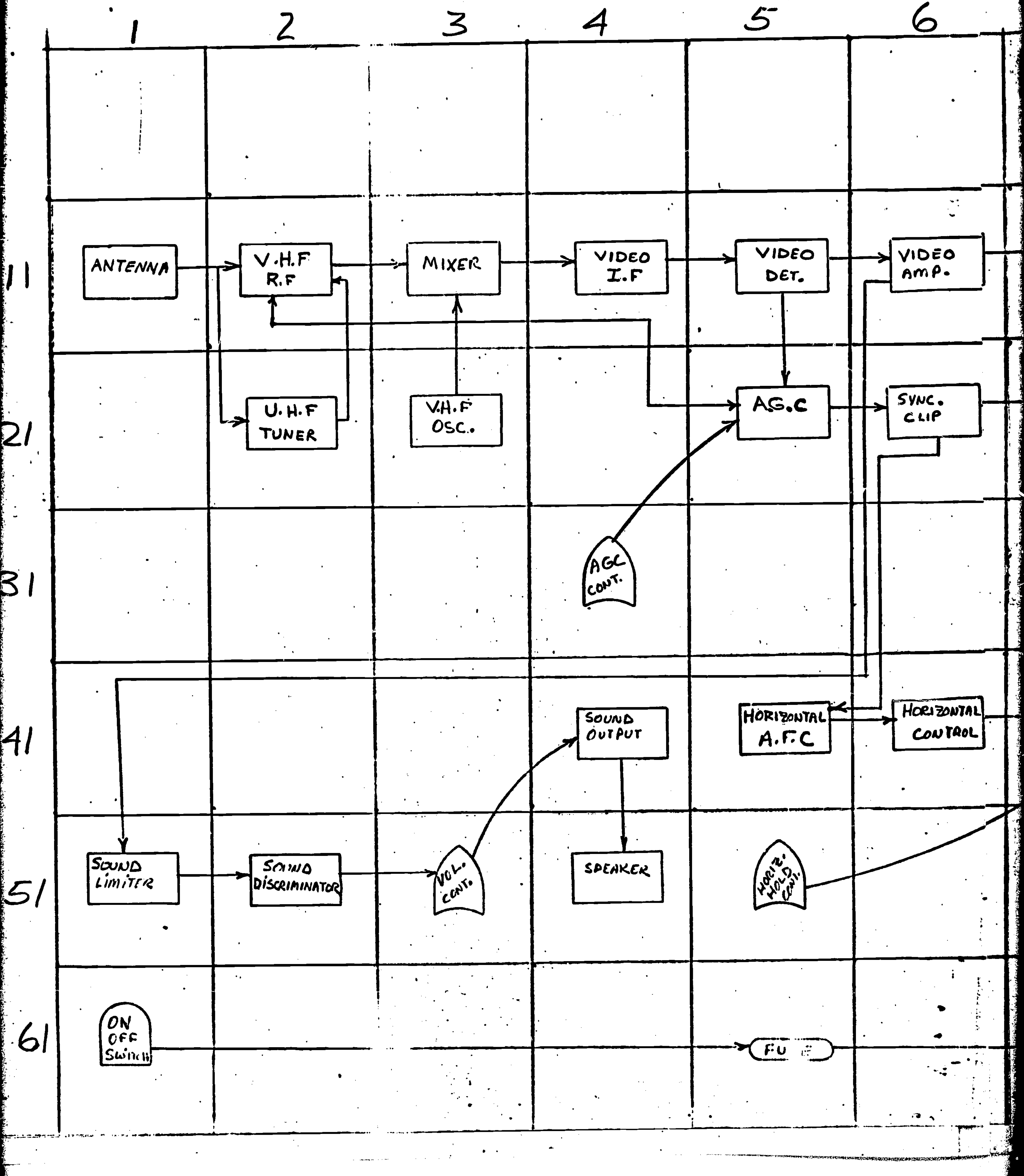
III. Engine Analysis and Tune-up (Time Allocation - Classroom & Shop 40 hours)
   A. Emergency troubleshooting
      1. Basic starting troubleshooting tests

   B. Detailed tests for hard starting
      1. Cranking system
      2. Ignition system
      3. Fuel system

   C. Tune-up procedures
      1. Types of test equipment used
         a. Compression tester
         b. Tachometer
         c. Dwell meter
         d. Exhaust analysis
         e. Vacuum gauge
         f. Voltmeter
      2. Procedures
         a. Battery and battery cable
         b. Cranking circuit
         c. Charging circuit
         d. Ignition circuit
            (1) Primary
            (2) Secondary
         e. Fuel and carburetor
         f. Compression
         g. Spark plugs
         h. Road test

FIGURE 2.

ELECTRONICS COUR



GURE 2.

NICS COURSE OVER-LAY #1

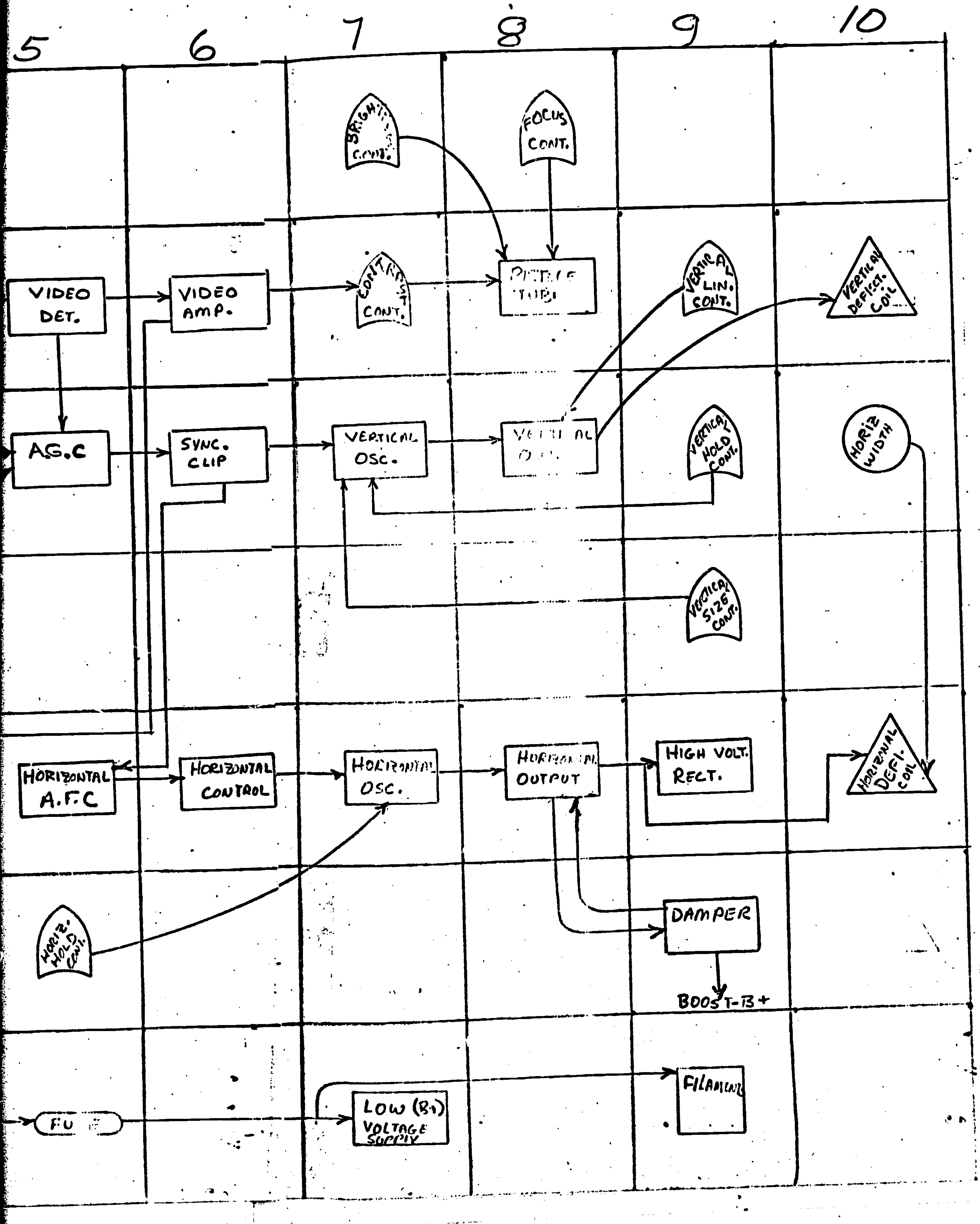
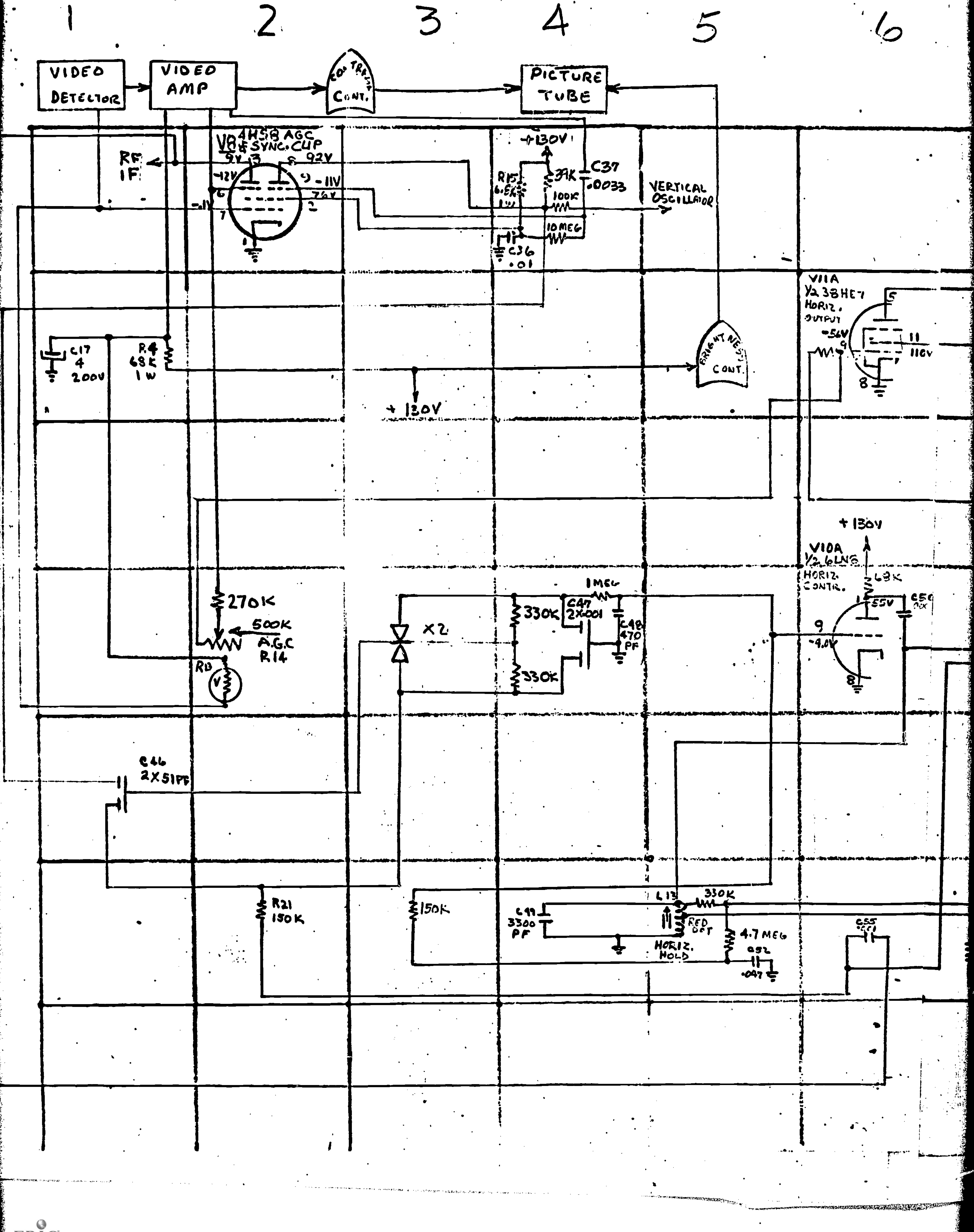
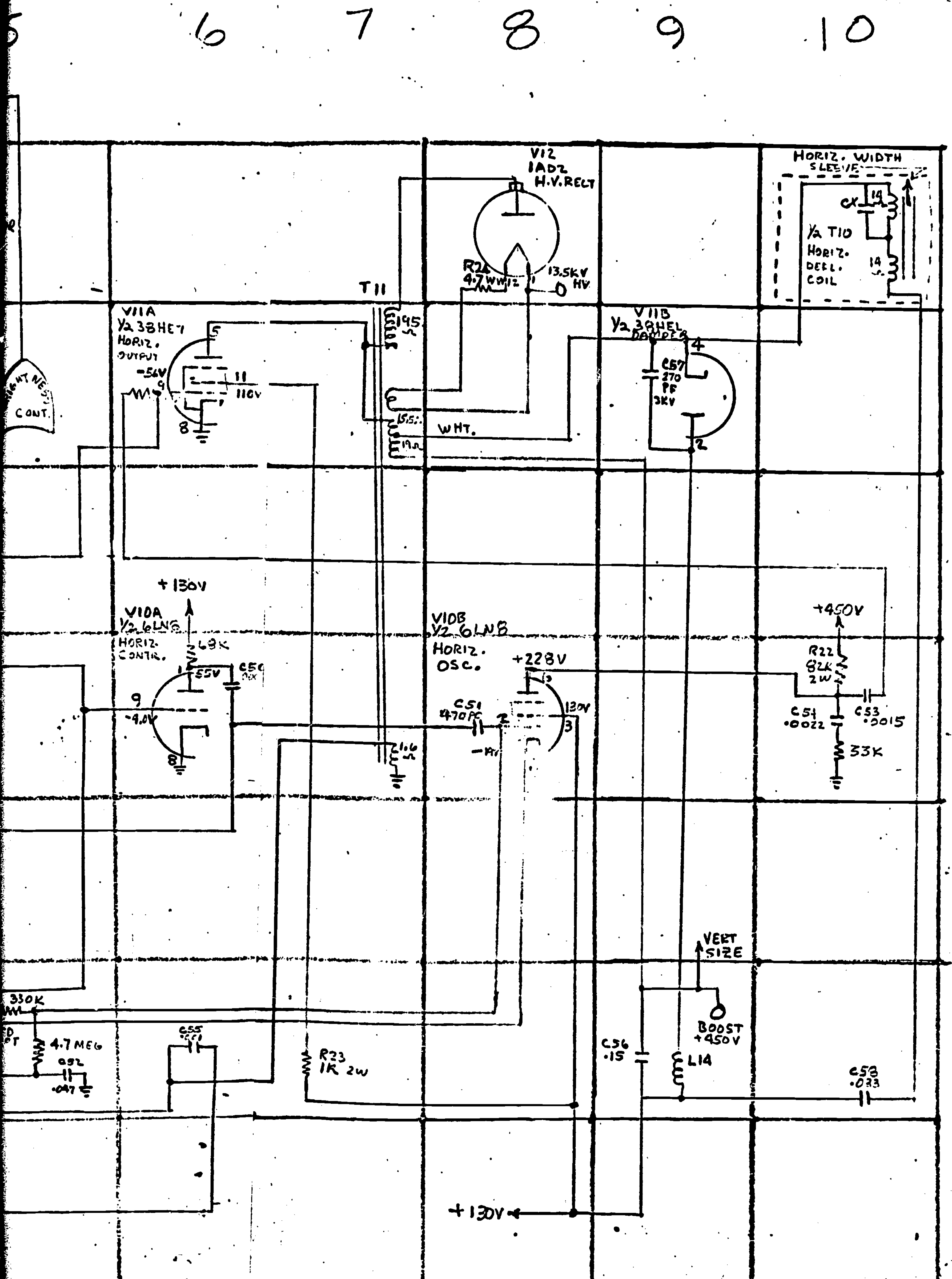


FIGURE 3.


1
2
3
4
5
6
VIDEO DETECTOR
VIDEO AMP
CONTRAST CONT.
PICTURE TUBE
RF IF
AGC & SYNC. CLIP
+130V
C37 .0033
R15 6.8K 1W
39K
100K
VERTICAL OSCILLATOR
10 MEG
C36 .01
V11A
1/2 38HE7
HORIZ. OUTPUT
BRIGHTNESS CONT.
C17 4 200V
R4 68K 1W
+130V
+130V
V10A
HORIZ. CONTR.
68K
1 MEG
C47 2X.001
C48 470 PF
330K
330K
X2
270K
500K A.G.C R14
C46 2X51PF
R21 150K
150K
C49 3300 PF
L13
330K
HORIZ. HOLD
4.7 MEG
C55

-URE 3.

OVER-LAY #5



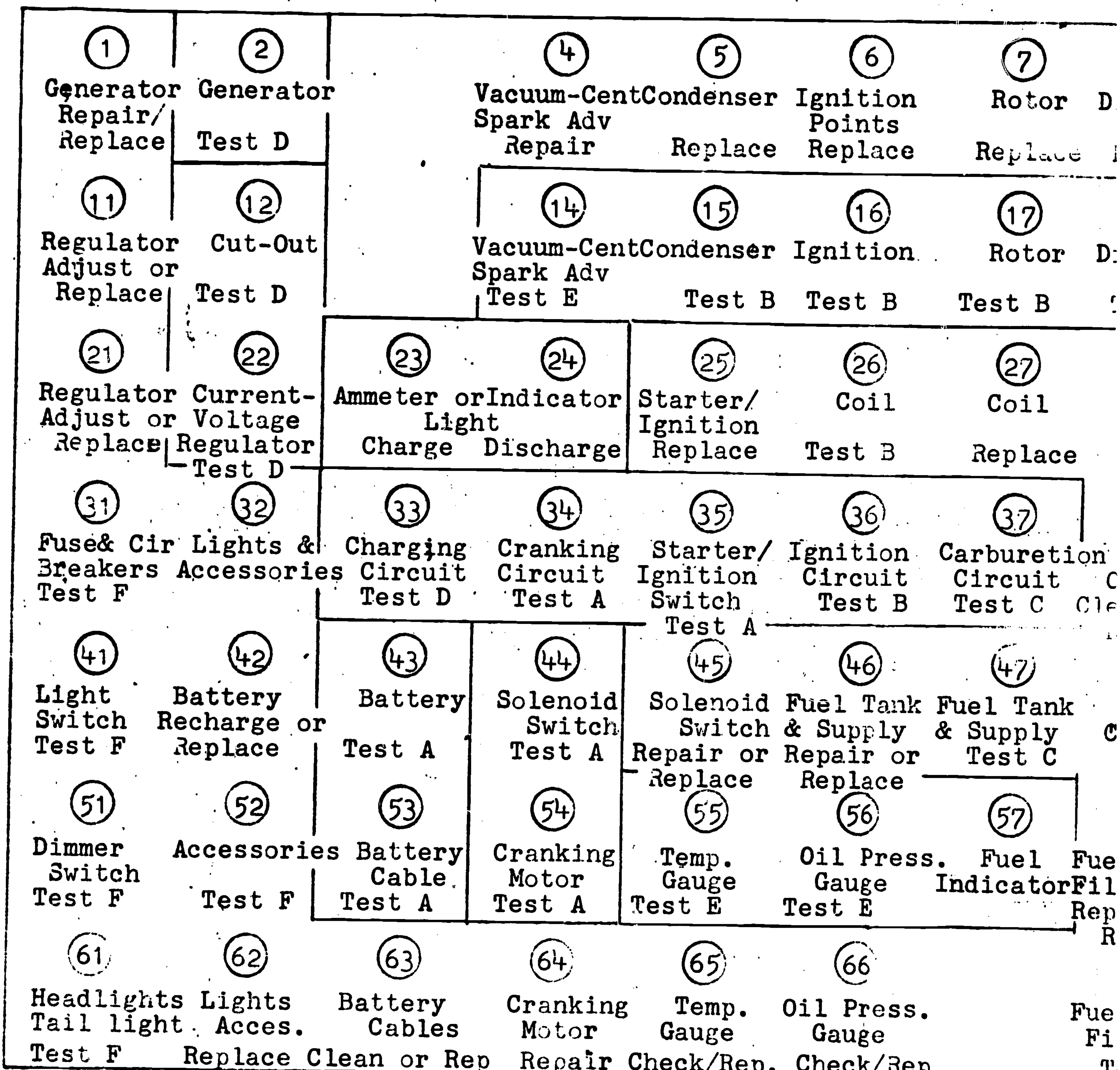


Figure 1. Automotive - Overall Block Diagram

START

(7) Rotor Replace	(8) Distributor Cap Replace	(9) Spark Plugs Replace	(10) Starter Action	○ Test A
(17) Rotor est B	(18) Distributor Cap Test B	(19) Spark Plugs Test B	(20) Start-Idle	○ Test B
(27) Coil Replace		(29) Intake Manifold	(30) Running-Normal	○ Test C
(37) rburetion Circuit est C	(38) Air Cleaner Clean or Replace	(39) High Speed Power Cir. Test E	(40) Carburetor Repair or Replace	○ Test D
(47) el Tank Supply Test C	(48) Air Cleaner Test E	(49) Automatic Choke Test C	(50) Automatic Choke Clean & Adjust	○ Test E
(57) Fuel dicator	(58) Fuel Lines Filters Repair or Replace	(59) Start-Idle Test C	(60) Carburetor Repair or Replace	○ Test F
	(68) Fuel Lines Filters Test C	(69) Fuel-Vac Pump Test C	(70) Fuel-Vac Pump Repair/Rep	

am

SECOND QUARTERLY REPORT

PROJECT USOE 5-1332

TITLE: A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Auto-mechanics

TO: U. S. Department of Health, Education and Welfare
Office of Education
Division of Adult and Vocational Research

FROM: Systems Operations Support, Inc.
580 Shoemaker Road
King of Prussia, Pa. 19406

REPORT PERIOD: 1 July 1966 -- 30 Sept. 1966

Gilbert B. Rozran, Ph.D.
Principal Investigator

Harold I. Stalder
Administrative Grants Officer

TABLE OF CONTENTS

SECOND QUARTERLY REPORT - USOE 5-1332

SUMMARY

Objectives:

1. To determine the difference in performance between (a) students enrolled in a military-type computer-based instructional program in electronics and (b) students enrolled in a conventional instructional program in electronics, with both groups of students being drawn from a high school population with an I.Q.* range from 100 to 130 (and higher).

2. To determine the effectiveness of the military-type computer-based instructional program in electronics when used on a lower I.Q. range (78 to 112) group of students.

3. To determine the effectiveness of the military-type computer-based instructional system when used in a different subject area: Auto-mechanics.

Procedures:

The project utilizes a computer-based instructional system which has proven to be very effective in military training programs. The system will involve the Cue-Response programming method, "SNAP" programmed texts and programmed overlays for the "SMART" Trainer (a universal simulation and representation device which can be tailored to a specific course merely by changing the student's panel and plugboard programming).

Course materials in two courses (Electronics and Auto-mechanics) have been programmed on the basis of the Cue-Response method resulting in the production of "SNAP" programmed texts and programmed overlays for the "SMART" Trainer. For the Electronics Course, materials previously used in military training programs were revised, supplemented and adapted for use in civilian technical high schools. For the Auto-mechanics Course, new materials were developed specifically for this project. Two vocational high schools (Dobbins Technical High School, Philadelphia, Penna. and the Upper Bucks County Technical High School, Perkasie, Penna. are the locales for the experiment).

Accomplishments:

Second quarter activity was devoted to development of the programmed instruction texts, submission of the materials to the equipment manufacturer for incorporation into the "SMART" Trainer and development of the actual course of study for each of the two experimental courses. Meetings were held with the principals, technical education directors and instructors concerned with each of the two respective courses for firming up commitments and agreements made previously.

Full day sessions for all students participating in the study at each school were devoted to administration of the Otis Intelligence Test, Kuder Preference Record, Bennett Mechanical Comprehension Test and the Army Beta. Results were tabulated and the selection of matched experimental and control groups was made for each subject matter area.

Plans for the next quarter include final acceptance of both sets of overlays (Electronics and Auto-mechanics) with all malfunction problems associated with each one, including the programmed plugboards and slides for the "SMART" Trainer. The courses of instruction at the respective participating high schools will begin this quarter.

I. Work Completed During Second Quarter:

Second quarter activity was a continuation and fulfillment of most of the work as identified during the initial planning stage. Many meetings were held with the principals, technical education directors and the instructors for the respective courses.

A. Electronics Course

For the Electronics Course, frequent meetings and telephone conversations were held with the Project Consultant in order to take full advantage of his experience and the military electronics course materials which were developed on past projects. Dates for these meetings and with the school personnel are listed in Table 1. All materials submitted by the Project Consultant have been received for content and clarity, corrected and expanded for the experimental course.

Based on this information, the text "Electronic Methodology," dated 29 September 1966, was written in conformance to some of the "SNAP" type programmed instruction methods as developed previously for various military training courses. In conformance with the principle of utilizing the optimum approach to teaching as appropriate, the matter, reading level, type of language and the format have been varied between the various sections of the text. For example, one section on troubleshooting is clearly a scrambled text. Another is very "SNAP"-like, while another section is more like an informal text. In all cases, the texts will serve as a means for introducing the student to all levels of electronics and will provide the necessary content for advancement up to and including logical and systematic troubleshooting.

B. Automobile Mechanics

Programmed information for the text "Auto Mechanics Methodology" dated 14 September 1966 was written in conformance with some of the selected criteria for the "SNAP" type programmed instruction books. This text concentrates on an area of knowledge required for the competent auto mechanic--namely, logical and systematic gathering of symptoms, analysis of these, and a logical step-by-step methodology of isolation to a system, component, removal and replacement or direct repair of the component, and then an operational check to determine that the automobile will perform satisfactorily. All superfluous information or checks which are specific to a given make or model of car have been left to the service manuals produced by their respective manufacturers.

Subject matter areas in the text include the ignition system, fuel system, engine analysis and tune-up procedures; e.g. those areas which can benefit the most from a systematic approach applicable generally to any problem which might arise. Other automotive skill areas are left to the more conventional and repetitive training methods and techniques.

C. SMART Trainer

As planned during the initial phases of the project, five overlays and associated plugboards along with the appropriate sets of slides will be utilized for the Electronics Course. For the Auto-mechanics Course, two overlays, associated plugboards and appropriate sets of slides were developed for teaching troubleshooting.

During the quarter, much of the activity was devoted to preparing the specifications for the overlays, determining the sets of malfunction problems and establishing the appropriate information for detecting these malfunctions. This was accomplished and submitted to the sub-contractor for the development and design of the seven respective overlays. In conjunction with this task, SOS personnel performed a lengthy, detailed system and circuit analysis to ensure that the machine would perform as specified.

Translation of the various symptom patterns into logic equations was accomplished during the quarter. From these equations, the logic circuit interconnections were then developed and assembled as were lists for wiring the plugboard for the respective overlays. These wire lists were then sent to the sub-contractor for plugboard wiring. Other activities included drawing and development of the various waveforms, voltage readings gauge levels and pictures of TV picture distortions, etc. to be used for quantitative reading at test points. These were completed, photographed and sent to the vendor for placement on the slide inserts. It should be noted that the photographing of malfunction indications, especially on the TV screens, was a laborious and exacting task which had to be repeated a number of times in order to produce pictures with sufficient detail for reduction to the lens caps used in the optically changed random access slide projector. Towards the end of the quarter, major work effort was being expended in preparing the "SMART" Trainer and associated equipment for phase-in for both the auto-mechanic and electronics courses. Present scheduling for the courses at both schools is shown in Table 1.

D. Psychological Testing.

A full day was spent at each school on different days for the purpose of administering a pre-selected battery of tests. The battery was made up of the following standard tests: (1) Revised Beta Examination; (2) Otis Quick-Scoring Mental Ability Test; (3) Bennett Mechanical Comprehension Test, Form AA; and (4) The Kuder Preference Record (Vocational) Form CH. All students who will participate in the research study were tested. Scoring and analysis of the test results is currently in progress. Very quick look summaries of the test results are shown in Tables 2 and 3.

Preliminary analysis of the information for the Auto-mechanics students tested on 20 September 1966 at the Upper Bucks County Technical High School produced the following results: (1) The age range of the group was 15 to 19 years; (2) the 10-12th grades were involved; (3) Otis I.Q. scores ranged from 74 to 114. As for the Upper Bucks Electronics students, the data came out as follows: (1) Chronologicla age ranged from 14 to 17 years; (2) the 10-12th grades were also involved; and (3) Otis I.Q. scores ranged from 85 to 130.

On the 27th of September 1966 the same battery of tests was administered to the Electronics students at the Dobbins Technical High. While both the 11th and 12th Grade students were tested, since the 12th Grade will be receiving the experimental course of instruction first, the results on it are available to date only and are as follow

(1) Ages 16 to 18 years, inclusive, constitute the chronological ages
(2) the Otis I.Q. scores range from 92 to 131. Experimental and control groups were selected from this population by means of pairing from a rank order of test scores. Additional data about the two grou may be found in Table 2.

II. Plans for the Next Quarter

During the third quarter of this project, from 1 October to 31 December 1966, it is planned that the majority of the data will be collected from actual administration of the experimental method, the SMART/SNAP approach, to the students in the Electronics and Auto-mechanics courses. Specific events which are planned for this period are as follows:

(1) Completion of the debugging of the SMART plugboards to see that all light switches are properly activated for each malfunction symptom pattern configuration. (debugging the logic)

(2) Completion of slide inserts and testing of locations to see that the appropriate slide shows when a given test point and test equipment switch match is made.

(3) Final acceptance tests of the SMART trainers and their delivery to the two participating high schools.

(4) Final checkout of the trainers after delivery to the schools.

(5) Initiation and completion of the course of instruction for Auto-mechanics at Upper Bucks (See Table 4)

(6) Initiation and completion of the Electronics courses at Upper Bucks and the 12th Grade at Dobbins (11th Grade will come in the final quarter in January)

(7) Continuation of the analysis of test results.

(8) Compilation of the test results. analysis and preliminary draft in preparation for the final research report. This will include tests for the significance of the difference in performance of the experimental and control groups for each course on end-of-course (experimental run) proficiency examinations.

III. Unanticipated Problems.

(1) As identified in the First Quarterly Report, the Auto-mechanics course at Upper Bucks had only 10 students in the experimental group and 14 in the control group. Unfortunately, the Bucks County School System did not increase their number by sending additional students there from other Academic High Schools as originally expected by this autumn.

(2) A number of minor budget adjustments were required as reported to you in a letter dated 21 September 1966. Concurrence by letter on th changes is still requested.

(3) Debugging of the programs has taken longer than anticipated; however, in the final analysis, delay in the delivery of the SMART Trainers after the second quarter was caused primarily by the tardine of the hardware vendors to supply vital parts such as the microswitch lights, silkscreens for the overlays, and the slide pictures mounted optically aligned, (Nevertheless, since the two SMARTs were not delivered on or before 15 October 1966, as specified in the contract, thi delay in delivery of these leased items caused SOS staff personnel to

spend many additional hours making revisions in thecurriculum schedules for both Electronics and Auto-mechanics; i.e., shifting the course content so as to allow for troubleshooting training on the SMARTs at the end of thecourses.

(4) The manufacturer sent SOS a letter on 12 September 1966 and made numerous telephone calls requesting an additional $900.00 for making up one more set of slides than originally projected for the Electronics course. This would require additional contract funds; and the matter is being referred to Area 1 Contracts and Construction Services for their consideration.

(5) Since the statistician-logician costs are now approximately 50% over the $1400.00 estimated, and final logic changes may still be made as unexpected malfunctions arise in the SMART programs, it is cle that personnel costs are at the point where there is just enough left to carry through the key personnel scheduled on the project for the remainder of the study. There has never been any slack in any other category than personnel; as a matter of fact, cost items such as Trave and Benefits, especially insurance, keep surpassing the anticipate amounts each quarter to the point that it will be difficult to meet the the estimates and not overrun in these categories before the end of the Grant.

(6) It is felt that the effectiveness of the methodology should have more time to be administered than is presently being allocated by the schools; a follow-on study to complete this work with more students, especially naive ones in the subject matter area at the 10th grade level should be made. The methodology may prove to be more effective with naive students than with those contaminated with the conventional methods of technical training in a given subject matter area.

TABLE 1

MEETINGS HELD DURING PROJECT FIRST QUARTER

Date	Conferee	Location
July 26	Mr. George Young, NAES	Sicklerville, N. J.
Aug. 10	Messrs. Bonetti, Schechter and Johnson	Dobbins Tech. H. S., Phila.
11-12	Dr. E. L. Shriver, Consultant	Washington, D. C.
19	Mr. George Young, NAES	Sicklerville, N. J.
29-31	Dr. E. L. Shriver, Consultant	Washington, D. C.
Sept. 1	Dr. E. L. Shriver, Consultant	Washington, D. C.
2-4	APA Convention	New York City
13	Testing and Conference	Upper Bucks School, Perkasie
19	Mr. George Young, NAES	Sicklerville, N. J.
20	Testing and Conference	Upper Bucks School, Perkasie
27	Testing	Dobbins Tech. H. S., Phila.
29-30	Dr. E. L. Shriver, Consultant	King of Prussia, Pa.

TABLE 2

STUDENT ASSIGNMENTS TO ELECTRONICS COURSE CLASSES

School	Grade	Experimental Groups		Control Groups	
		No. Students	I.Q. Range	No. Students	I.Q. Range
Dobbins High*	12	23	93-131	22	92-129
Dobbins High	11 (A.M.)	24	86-114	24	83-116
Dobbins High	11 (P.M.)	22	99-107	20	91-107
Bucks County High**	10-11-12	14	85-130	16	103-122
TOTALS		83	86-130	82	83-129

* I.Q. Based on the Otis Intelligence Test Administered on 27 September 1966

** I.Q. Based on the Otis Intelligence Test Administered on 20 September 1966

TABLE 3

STUDENT ASSIGNMENTS TO AUTO-MECHANICS COURSE CLASSES

School	Grade	Experimental Groups		Control Groups	
		No. Students	I.Q. Range *	No. Students	I.Q. Range *
Upper Bucks High	11-12	10	87-114	14	74-112

* I.Q. based on the Otis Intelligence Test administered on 20 September 1966

Note: Only the Upper Bucks County Technical High School is involved in this course.

TABLE 4

TIME SCHEDULE FOR SOS ELECTRONICS INSTRUCTOR TO PRESENT TROUBLESHOOTING OR SERVICING INSTRUCTION BLOCK PORTION OF "EXPERIMENTAL" COURSE

School	Grade	October 1966	November 1966	December 1966	January 1967	February 1967
Dobbins High	12	----------	----------			
Bucks County High	11-12		----------	----------		
Dobbins High	11				----------	----------

THIRD QUARTERLY REPORT

PROJECT USOE 5-1332

TITLE: A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Auto-mechanics

TO: U. S. Department of Health, Education and Welfare
Office of Education
Division of Adult and Vocational Research

FROM: Systems Operations Support, Inc.
580 Shoemaker Road
King of Prussia, Pa. 19406

REPORT PERIOD: 1 October 1966 -- 31 December 1966

DATE: 6 January 1967

Gilbert B. Rozran, Ph.D.
Principal Investigator

Harold I. Stalder
Administrative Grants Officer

TABLE OF CONTENTS

THIRD QUARTERLY REPORT

THIRD QUARTERLY REPORT - USOE 5-1332

SUMMARY

OBJECTIVES:

1. To determine the difference in performance between (a) students enrolled in a military-type computer-based instructional program in electronics and (b) students enrolled in a conventional instructional program in electronics, with both groups of students being drawn from a high school population with an I.Q. range from 100 to 130 (and higher).

2. To determine the effectiveness of the military-type computer-based instructional program in electronics when used on a lower I.Q. range (78 to 112) group of students.

3. To determine the effectiveness of the military-type computer-based instructional system when used in a different subject area: Auto-mechanics.

PROCEDURES:

The project utilizes a computer-based instructional system which has proven to be very effective in military training programs. The system will involve the Cue-Response programming method, "SNAP" programmed texts and programmed overlays for the "SMART" Trainer (a universal simulation and representation device which can be tailored to a specific course merely by changing the student's panel and plugboard programming).

Course materials in two courses (Electronics and Auto-mechanics) have been programmed on the basis of the Cue-Response method resulting in the production of "SNAP" programmed texts and programmed overlays for the "SMART" Trainer. For the Electronics Course, materials previously used in military training programs were revised, supplemented and adapted for use in civilian technical high schools. For the Auto-mechanics Course, new materials were developed specifically for this project. Two vocational high schools (Dobbins Technical High School, Philadelphia, Penna. and the Upper Bucks County Technical High School, Perkasie, Penna.) were the locales chosen for the experiment. In addition, the Electronics Course will be presented at the Montgomery County Area Vocational-Technical High School in January and February 1967.

ACCOMPLISHMENTS:

Third Quarter activity was devoted to finalizing the course material for each of the respective courses, submission of technical information to equipment manufacturer for incorporation into the "SMART" Trainer and the conduct of the instructional program in the two technical high schools.

A third school, the Montgomery County Vocational-Technical High School, has agreed to cooperate in the study for the Electronics Course for a four-week period starting in January 1967. Students participating in the study have been administered the Otis Mental Ability Test, Bennett Mechanical Comprehension Test, Kuder Preference Record and the Revised Beta Examination. Results are now being tabulated for inclusion in the final evaluation.

The "SMART" Trainer was delivered to the Upper Bucks County Technical High School for use in the Auto-mechanics Course.

Plans for the Fourth Quarter include completion of courses of instruction in the respective participating high schools, conducting the Electronics Course of instruction in the third high school (Montgomery County), tabulation and statistical evaluation of the results of the study and writing and submission of the Final Report. If time permits, the "SMART" Trainer will be sent to Dobbins Technical High School during February to collect additional data on its impact on the student population there. Due to the difficulties mentioned in the section on "Unanticipated Problems," it was not possible to use it there during October and early November.

I. <u>Work Completed During Third Quarter:</u>

Third Quarter activity was a continuation and actual fulfillment of most of the work that had been outlined during the initial planning stage. Many meetings were held with the principals, technical education directors and the instructors for the respective courses.

A. Electronics Course --

The first part of the Quarter was spent in finalizing and printing the instructional materials prior to the initial teaching phase at Dobbins Technical High School. A series of student handouts, such as a detailed description of the ohmmeter, necessary to supplement the programmed text were prepared. Another series titled TV Tips, which is a series of practice exercises to be filled out by the student during the course of instruction, was prepared. In addition, a series of lecture materials based on the information received from the Project Consultant was reviewed, corrected and reproduced for use by the instructor during the teaching phase.

The instructional phase started at Dobbins Technical High School in October and was finished on 25 November 1966. Experimental and control groups were selected from the 12th grade student body by means of pairing from a rank order of the test scores obtained from the Otis Quick-Scoring Mental Ability Test. The SOS instructor assumed the responsibility for the conduct of the experimental course during this phase. The control group was handled by the regular instructor who taught the same materials utilizing the conventional method. Unfortunately, due to a delay in hardware delivery, the "SMART" Trainer was not available for use by the students in the experimental course. Data was collected on the two groups, including a final grade and it should provide meaningful evidence for evaluation of the two distinct methods of presenting technical information, including the "SNAP" programmed instruction method but without use of the Trainer.

The instructional phase of the study for the Upper Bucks County School started on 29 November 1966. It was still in progress at the end of the Quarter. Data is being collected and tabulated for the final analysis and evaluation.

B. Automobile-Mechanics --

The first month of the Quarter was spent in development of the special training aids, instructor guides and familiarization by the instructor of the materials contained in the programmed text. A special handbook to be provided each student entitled "Diagnostic Guide and Handbook" was developed and reproduced. This information supplements the programmed text and was utilized during the Engine Analysis and Tune-up portion of the course.

The Auto-mechanics Course started on 10 October and ran until 22 December 1966. Essentially, the course was divided into three distinct areas and was taught in the following sequence: Ignition System; Carburetors and Carburetion; and Engine Analysis and Tune-up. The "SMART" Trainer was phased into the course on 1 December as planned. This was the period when Engine Analysis was being taught to the group. The control group was being exposed to similar information using the conventional teaching methods and aids at a different time period (afternoon class). At the completion of the course, a final examination was administered to both groups. This information has been tabulated and is now being evaluated.

C. SMART Trainer --

During the initial planning and preparation of course materials, two overlays and associated equipment were to be included for troubleshooting of auto systems on the "SMART" Trainer. Similarly, a series of five overlays and associated equipment were to be included in the Electronics Course. Early in the Quarter, it became apparent that the trainers were not going to be delivered by 15 October, as originally scheduled. This tardiness on the part of the manufacturer was due to late delivery of vital parts for the SMART, especially the microswitch lights and acceptable slide pictures. SOS personnel started making revisions to the basic curriculum, shifting the trainer application to the later portions of the courses. This was not enough, as unanticipated debugging problems were greater than expected. As a result, only one of the Auto-mechanics overlays was delivered to the school for use during the Quarter for use by the experimental group. As for Electronics, major difficulties in logic developed when it was discovered that the correctly-functioning components represented for training purposes were not lighting green during malfunction problems. Rectification of these errors continued to the end of the Quarter.

To assure having a large enough population for the Electronics Course, discussions were held with Mr. Harold B. Albright, Montgomery County, Pa. Vocation-Technical School Director, concerning the application of the research methodology in one of his schools. As a result of these discussions, confirmation was received on 2 December 1966 from Mr. Harry P. Reddig, the principal of the Montgomery County Area III Technical High School expressing an interest in the study and agreeing to permit SOS to conduct the study for the afternoon Electronics class. The experimental course will be given to this group starting about the first week in January. This group will be utilized to collect the data needed for the complete evaluation of the SMART/SNAP Methodology in Electronics training. Furthermore, depending upon the outcome of the request to USOE for additional funds to cover the unanticipated problem cost areas, an attempt will be made to return with the Trainer to the Dobbins Technical High School during February 1967 to complete the data collection there.

D. Psychological Testing --

Two half days were spent at the Montgomery County Vocational-Technical High School for administering the pre-selected battery of tests to the afternoon Electronics class (experimental group). The battery consisted of the following standard tests: (1) Revised Beta Examination; (2) Otis Quick-Scoring Mental Ability Test; (3) Bennett Mechanical Comprehension Test, Form AA; and (4) the Kuder Preference Record (Vocational) Form CH. Results of the tests are now being analyzed. Preliminary results are as follows: (1) the age range of the group of 20 students is 15 to 19 years; (2) the 10th to 12th grades were involved; (3) Otis I.Q. scores ranged from 95 to 122. The remaining information is not available at this time, as it is still being processed.

II. Plans For The Fourth Quarter:

A major portion of the experimental data was collected during the Third Quarter. Specific events planned for the Fourth Quarter are as follows:

A. Completion of the Electronics Course at the Upper Bucks Technical High School.

B. Initiation and completion of the Electronics Course at the Montgomery County Vocational-Technical High School.

C. Possible return to Dobbins with the "SMART" Trainer and all the Electronics overlays to complete the collection of data there.

D. Continuation of the analysis of test results.

E. Compilation, statistical analysis, and interpretation of test results.

F. Write-up, publication and submission of the Final Report for the study on or before 31 March 1967.

G. Possible curtailment of the activities of all personnel assigned to this project during February 1967, except for the Principal Investigator and the Secretary, due to the impact of the increased costs as stated in letters to USOE on 21 November 1966 and 9 December 1966, respectively.

III. <u>Unanticipated Problems</u>:

The major difficulties experienced during this Quarter concerned the impact of delays in the preparation of trainer materials such as slides and the logic development which held up the delivery of useable overlays and plugboards with accompanying slides for the Electronics Course through most of this period. The lengthy debugging process which uncovered the fact that properly functioning components were not lighting green during the malfunction problems necessitated a major redoing of the logic and a corresponding rewiring of the plugboards. This caused considerable expense which resulted in the subcontractor writing a letter to SOS on 15 December 1966 in response to our letter to them on 6 December 1966 in which North American Electronic Systems, Inc. requested another $7,650 even though SOS had asked them to cooperate in achieving a worthwhile program in this research effort and to try to absorb the costs they had verbally estimated to SOS about 1 December 1966. Meanwhile, on 9 December 1966, SOS sent USOE a letter stating the technical and cost problem areas, including insurance coverage for the equipment, added personnel costs for the additional logic work, and the fact that another set of slides would be required if the Electronics Courses were to be continued in two schools simultaneously. These problems could not be anticipated beforehand, and, as a result, the request was made to USOE for additional funds to carry out the full intent of the research objectives in spite of the obstacles cited. The end result, happily, is that the SMART Trainer in use at the Montgomery County Technical High School for the Electronics Course is working very well to capacity; and the students are taking to it with a high degree of motivation, with the learning process being expedited. On the other hand, SOS personnel will need to be taken off the project on or before 1 March 1967 because of the shortage of funds, and, unless USOE provides additional funds as stated by the subcontractor, it can be anticipated that there will be some major financial difficulties to be resolved. SOS cannot, without your approval and appropriation of these funds, take any further action in this regard.

Interim Data Analysis

Dobbins - Electronics

Experimental N=22

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	73.14	115.18	110.18	36.18	5.55	6.09	6.14
2.	S.D.	9.15	7.77	9.89	5.96	1.67	1.53	1.77

$R_{1.234567} = .7215$

Control N=20

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	74.20	117.30	109.70	33.05	5.50	5.70	6.20
2.	S.D.	8.85	6.81	9.82	10.24	1.72	1.58	1.72

$R_{1.234567} = .5660$

t = .3719
40 df .05 =2.021

Upper Bucks - Electronics

Experimental N=12

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	69.25	111.16	115.17	39.83	7.25	6.17	6.58
2.	S.D.	19.93	6.08	7.72	7.75	1.42	1.82	1.75

$R_{1.234567} = .9159$

Control N=16

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	51.00	115.31	113.75	43.44	7.63	6.63	8.13
2.	S.D.	17.37	4.28	5.52	7.13	1.27	1.54	.99

$R_{1.234567} = .5764$

t = 2.49
26 df .02 =2.479

Upper Bucks - Auto-Mechanics

Experimental N=9

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	66.67	105.00	107.00	39.22	8.00	5.00	5.00
2.	S.D.	14.13	8.35	8.11	8.74	1.15	.94	1.70

$R_{1.234567} = .9737$

Control N=14

		Final	Beta	Otis	Bennett	Kuder(M)	Kuder(C)	Kuder(S)
1.	Mean	63.93	109.07	100.78	38.07	7.36	4.85	5.64
2.	S.D.	13.33	7.13	9.97	7.50	1.76	1.64	1.23

t = .0138
21 df .05 =2.080

R1234567 = .9040

FOURTH QUARTERLY REPORT

PROJECT USOE 5-1332

TITLE: A Study of the Effectiveness of a Military-Type Computer-Based Instructional System When Used in Civilian High School Courses in Electronics and Auto-mechanics

TO: U. S. Department of Health, Education and Welfare
Office of Education
Division of Adult and Vocational Research

FROM: Systems Operations Support, Inc.
580 Shoemaker Road
King of Prussia, Pennsylvania 19406

REPORT PERIOD: January 1, 1967 to March 31, 1967

DATE: April 1, 1967

SUBMITTED BY: Gilbert B. Rozran, Ph.D.
Principal Investigator

FOURTH QUARTERLY REPORT

PROJECT USOE 5-1332

SUMMARY

The last research week at Upper Bucks Technical High School coincided with the first week of 1967 as final proficiency examinations were administered to all electronics course students. The Auto-mechanics course had been completed just prior to Christmas vacation. The Trainer was moved from Upper Bucks to the Montgomery County Technical High School, Area 3; and the computer-based programmed instruction in electronics was administered to these students (a suburban population) from 9 January to 3 March 1967. On 24 February 1967 the USOE Project Director, Dr. Sidney C. High, visited the Montgomery County Technical High School and observed a demonstration of the Methodology in the Electronics course there. The Dobbins School had requested that the project return there in February, so their students in Electronics could have use of the trainer. While a second trainer was leased, there was no second set of electronic course slides as they had not been funded by USOE; as a result, it was not possible to run two courses in parallel. Scores on the Upper Buck Electronics course Final Tests (Experimental Mean= 69.25, Control Mean= 51.00) were found to be significantly different at the 2% level of confidence (t-tst). T-tests between high and low I.Q. group students in Electronics were not significant, indicating that the Methodology might be effective across the Otis I.Q. Range of students from 83-131 (this population). Depletion of funds terminated project activities the week of February 28, 1967.