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Knowledge and skill requirements of consumer electronics service technicians with implications for curriculum development

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KNOWLEDGE AND SKILL REQUIREMENTS OF CONSUMER ELECTRONICS SERVICE TECHNICIANS WITH IMPLICATIONS FOR CURRICULUM DEVELOPMENT

by

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
Consumer Electronics Industry	1
Need for Consumer Electronics Service Technicians	2
Implications for Education	3
Need for This Study	4
Purpose of This Study	5
Delimitations	6
Assumptions of the Study	6
Definitions	7
REVIEW OF LITERATURE	9
METHOD OF PROCEDURE	23
Introduction	23
Population	23
Instrument	24
Conducting the Interviews	26
Selecting Advisory Committee	27
Advisory Committee Members	27
Analysis of the Data	28
FINDINGS	30
General Findings Concerning Service Technicians	31
Information Related to Knowledge and Skill Requirement Needs of Service Technicians	47
Service Information	88
DISCUSSION	104

	Page
SUMMARY	110
General Findings Concerning Service Technicians	111
Knowledge and Skill Requirements of Service Technicians	113
Service Information	116
BIBLIOGRAPHY	118
APPENDIX A: LETTERS	122
APPENDIX B: INVENTORY FORM	125

LIST OF TABLES

		Page
Table 1.	Ages of service technicians	31
Table 2.	Years of full-time work experience of service technicians	32
Table 3.	Educational level attained by service technicians	33
Table 4.	Source of training of service technicians	35
Table 5.	License or certificates held by service technicians	36
Table 6.	Hours worked per day by service technicians	37
Table 7.	Hours worked per week by service technicians	37
Table 8.	Percentage of time service technicians spend working in the service shop and in the customer's homes	38
Table 9.	Salary received by service technicians	39
Table 10.	Distribution of service technicians that received a commission plus regular salary	40
Table 11.	Number of service technicians servicing consumer electronic products by type (N = 132)	41
Table 12.	Percentage of all consumer electronic products serviced involving B&W television (N = 132)	42
Table 13.	Percentage of all consumer electronic products serviced involving color television (N = 132)	44
Table 14.	Percentage of all consumer electronic products serviced involving tape recorders, tape players, phonographs, audio amplifier systems (N = 132)	45
Table 15.	Percentage of all consumer electronic products serviced involving radio (AM, FM, FM multiplex) (N = 132)	46
Table 16.	Percentage of all consumer electronic products serviced involving antenna installation (N = 132)	48
Table 17.	Degree of competency needed in ability to use mathematics, as reported by bench service technicians (N = 84)	50

Page

Table 18. Degree of competency needed in ability to use mathematics, as reported by home service technicians (N = 48) 51

Table 19. Degree of competency needed in ability to use mathematics, as reported by total number of service technicians 52

Table 20. Degree of competency needed in ability to organize and administer, as reported by bench service technicians (N = 84) 53

Table 21. Degree of competency needed in ability to organize and administer, as reported by home service technicians (N = 48) 54

Table 22. Degree of competency needed in ability to organize and administer, as reported by total number of service technicians 55

Table 23. Degree of competency needed in understanding of legal responsibilities, as reported by service technicians 57

Table 24. Degree of competency needed in understanding of electricity, as reported by bench service technicians (N = 84) 58

Table 25. Degree of competency needed in understanding of electricity, as reported by home service technicians (N = 48) 59

Table 26. Degree of competency needed in understanding of electricity, as reported by total number of service technicians 60

Table 27. Degree of competency needed in understanding of color fundamentals, principles of color mixing, and colorimetry, as reported by service technicians 62

Table 28. Degree of competency needed in familiarization of consumer electronic products, as reported by bench service technicians (N = 84) 63

Table 29. Degree of competency needed in familiarization of consumer electronic products, as reported by home service technicians (N = 48) 64

Page

Table 30. Degree of competency needed in familiarization of consumer electronic products, as reported by total number of service technicians 65

Table 31. Degree of competency needed in understanding of electronic stages, as reported by bench service technicians (N = 84) 66

Table 32. Degree of competency needed in understanding of electronic stages, as reported by home service technicians (N = 48) 67

Table 33. Degree of competency needed in understanding of electronic stages, as reported by total number of service technicians 68

Table 34. Degree of competency needed in understanding of circuit operation, as reported by total number of service technicians 69

Table 35. Degree of competency needed in understanding of component characteristics and applications, as reported by bench service technicians (N = 84) 70

Table 36. Degree of competency needed in understanding of component characteristics and applications, as reported by home service technicians (N = 48) 71

Table 37. Degree of competency needed in understanding of component characteristics and applications, as reported by total number of service technicians 72

Table 38. Frequency of performance and degree of competency needed, as reported by bench service technicians (N = 84) 74

Table 39. Frequency of performance and degree of competency needed, as reported by home service technicians (N = 48) 78

Table 40. Frequency of performance and degree of competency needed (mean ratings), as reported by total number of service technicians 82

Table 41. Frequency distribution of last three consumer electronic products serviced by each service technician 90

Page

Table 42. Electronic test equipment used in servicing each of last three consumer electronic products, as reported by service technicians 92

Table 43. Distribution of electronic test equipment used by service technicians based upon the last three consumer electronic products serviced 94

Table 44. Distribution of defective stages and special circuits repaired based on the last three consumer electronic products serviced by each service technician 97

Table 45. Distribution of defective electronic components replaced in the last three consumer electronic products serviced by each service technician 99

Table 46. Distribution of adjustments performed on the last three consumer electronic products serviced by each service technician 102

INTRODUCTION

Consumer Electronics Industry

Consumer electronics is classified as both the oldest and the newest of the complex of industries known as "electronics". It is as old as the crystal radio and as new as the color video recorder-player and the cassette tape recorder. The industry has advanced from what was known as the "radio industry" through the "home entertainment industry" to what is presently known as the "consumer electronics industry". The development of the portable, carry-with-you consumer electronic products such as automobile radio, transistor radio, cassette tape recorder, and the phonograph have freed these products from the home electrical outlet and the category of "home entertainment products" (6, p. 8).

The Electronic Industries Association (6) has stated that the term "entertainment" does not completely describe the industry, although entertainment may be the primary use of consumer electronic products. One of the recent surveys showed that television has become America's primary source of news, replacing the newspaper. The expanding new generation of consumer electronic products has broadened the nonentertainment area by branching into other areas such as two-way communications, consumer medical electronics, and electrical safety devices.

Consumer electronics (9) entertains and educates us through the media of radio, television, and recordings. In the last two decades, Americans have purchased over 315 million radios, 140 million television receivers, 83 million phonographs, and 33 million tape recorders. In 1969 (6), consumer electronic products accounted for 19.5 percent of the complete elec-

tronic industry's total sales while government products accounted for 49.1 percent, industrial products were 29 percent, and replacement components made up 2.8 percent.

Need for Consumer Electronics Service Technicians

One of the major problems facing the consumer electronics industry is providing enough competent consumer electronic service technicians to install new consumer electronic products and service those products presently in existence.

According to the revision to be made in the 1970-71 Occupational Outlook Handbook published by the United States Department of Labor (44), there were 126,000 consumer electronics service technicians employed in the United States in early 1969. About one-third of those service technicians were self-employed. Almost three-fourths of all consumer electronics service technicians worked in service shops or in stores that sold and serviced consumer electronic products. Most of the remaining consumer electronics service technicians were employed by the government agencies and manufacturing firms that operate their own service branches.

The Electronic Industries Association has stated in a career guidance brochure that there is a critical shortage of consumer electronics service technicians (9, p. 2):

> Current estimates indicate that there is an immediate need for 30,000 additional service technicians. The United States Department of Labor estimates that the number of service technicians is increasing by two percent per year, while the number of consumer electronic products is increasing at an average rate of 25 percent per year. A service technician shortage becomes immediately apparent from these figures, and where there is a shortage, there is opportunity.

Dukes' (7) study of the needs for radio-television service technicians indicated that there was an immediate shortage of service technicians in Iowa. His data revealed a need for 115 service technicians to fill existing vacancies in 1969 and predicted a need for 197 more consumer electronics service technicians for replacement purpose over the years 1970-1973.

Implications for Education

The sophistication and technological developments taking place in consumer electronic products have brought on a demand for constant updating of curriculum content in vocational-technical programs for training consumer electronics service technicians. Change appears to be the key word in the interpretation of the needs of the consumer electronic service industry. Vocational-technical educators must work hand in hand with the consumer electronic service industry to establish adequate educational programs geared to the changing technological scene.

Rapid strides in technology have created definite needs in training and retraining of consumer electronics service technicians. In 1946, the servicing of frequency modulated receivers (FM) presented a real challenge to the competent service technician. Soon an even greater challenge appeared -- television. Most service technicians, even those who were old timers in the service trade, had to participate in some type of television training program, whether this training was obtained in a vocational school, through self-study, or through home study courses.

In recent years, developments in transistors have made it possible to eliminate from electronic products the electronic component known as the

vacuum tube. Again the consumer electronics service technician was required to go back to school and reeducate himself.

Next came the color television receiver, the most complicated of all electronic products found in the home. This brought on even a greater demand for highly skilled service technicians.

Consumer electronics is an industry of innovation and constant change. New principles and devices constantly create new products and revolutionize older ones. According to the Electronic Industries Association, the outline of the future in consumer electronics is becoming clear. The Association made the following statement (6, p. 12):

> The integrated circuit -- which can combine the functions of many individual components on an almost microscopic chip of semiconductor material -- is showing up in consumer electronic products. Among its advantages are extremely small size, low power drain, ultra-reliability, and, eventually, very low cost in mass-production.
>
> New devices and technologies, such as the integrated circuit, will continue to make possible new versions of existing products and pave the way for entire new generations of devices to become part of the everchanging consumer electronics industry...

Need for This Study

As a result of technological changes and public demand for consumer electronic products, the consumer electronics industry has emerged as one of the most rapidly growing industries in the nation. The industry has growing faster than competent consumer electronics service technicians can be trained to install new consumer electronic products and service those presently in existence. It was incredible to discover that very little research has been conducted in the vocational-technical education field to assist in meeting the increasing demands of an industry of this nature.

The nature of this industry indicated employment needs will continue to increase.

Purpose of This Study

The purpose of this study was to gather data that would be of assistance in developing a program, in Iowa, for training consumer electronics service technicians and to gather data that could be used for guidance purposes. The technical data collected could also be used for developing a program for training consumer electronics service technicians who want to specialize in "in-home servicing" or "bench servicing" in the service shop.

The specific objectives of this study were to:

1. Gather background information concerning the Iowa consumer electronics service technicians such as: age, number of years of experience in servicing consumer electronic products, salary, hours worked, educational background, types of consumer electronic products serviced, and as to whether he worked in the service shop or the customer's home the majority of the time.
2. Gather technical data that would be of assistance in developing a program for training consumer electronics service technicians by determining:
   A. Essential knowledge required of the consumer electronics service technician in order to competently do his job.
   B. Essential skills required of the consumer electronics service technician in doing a competent job in home servicing.
   C. Essential skills required of the consumer electronics service technician in doing a competent job in bench servicing.

D. Test equipment used by consumer electronics service technicians in servicing consumer electronic products in the home or service shop.

Delimitations

The data for this study were collected by the personal interview method. Consumer electronics service technicians within 40 consumer electronic service firms located in the State of Iowa were interviewed. Therefore, it was limited to the service technicians employed within 40 consumer electronic service firms random sampled from the entire population of all consumer electronic service firms employing three or more full-time consumer electronics service technicians. The study was further limited to only service technicians who service consumer electronic products such as television receivers, radios, phonographs, tape recorders and players, audio components, and similar products. No attempt was made to include service firms that service industrial communication products.

Assumptions of the Study

The researcher assumed that the curriculum content in vocational-technical programs in Iowa needs to be constantly updated to meet the needs of modern day consumer electronics service technicians. Also, more programs need to be installed in the Iowa area vocational-technical schools. It was further assumed that these consumer electronics service technicians would be the best source for providing data that could be used in developing a program for training competent consumer electronics service technicians.

Definitions

The following definitions are made to clarify the meanings of various terms used and to make possible a more complete understanding of the material within this study.

Consumer electronic products -- Those electronic products used in the home for entertainment or education. These electronic products include television receivers, radios, phonographs, tape recorders and players, audio components, and similar products.

Consumer electronic service firms -- Those firms employing consumer electronic service technicians for maintenance and repair of consumer electronic products defined above.

Electronic technician -- A person working on an electronic technical level between the skilled tradesman and the professional scientist or electrical engineer.

Consumer electronics service technician -- A person who has the technical knowledge and skill necessary to repair and service the modern day consumer electronic products. This term will be shortened to "service technician" throughout the rest of this study.

Home service technician -- A consumer electronic service technician who spends the majority of his time servicing consumer electronic products in the customer's home.

Bench service technician -- A consumer electronic service technician who spends the majority of his time servicing consumer electronic products in the service shop.

Advisory committee -- A group of persons selected from the consumer electronic service occupation and the educational profession for the purpose of offering advice and counsel to the researcher conducting this research project.

Electronic Industries Association (EIA) -- The national trade association of the United States electronic manufacturers.

REVIEW OF LITERATURE

One of the major concerns today in vocational-technical education is revising and updating the occupational curriculums as the need arises. This is especially true in the consumer electronics service technician training curriculum. The content in these programs should be based upon sound and up-to-date research.

In reviewing the literature, the author found several studies conducted dealing with the needs of electronic technicians, appliance technicians, electricians, and radio-television service technicians. However, studies that could actually be used in developing curriculums in the electronic servicing occupations are very limited. The author has attempted to review several studies at different levels of relatedness to this study and also to reveal different types of methodology used.

Turner (40) conducted a study concerning the duties and requirements of personnel who work with electronic devices in manufacturing industries. The personal interview technique was used to gather data from 81 manufacturing firms in the St. Louis metropolitan area. The firms contacted used electronic devices and employed personnel to work with these devices.

In the 81 forms contacted, there were 1269 employees who worked in one or more of the following electronic categories: diagnosing trouble, adjusting, servicing, assembling, making repairs, installing, and maintenance of electronic devices. Professional workers, as defined in the Dictionary of Occupational Titles, were not included.

The data revealed that the most often used test equipment consisted of the multimeter, tube tester, oscilloscope, watt meter, RF signal generator, audio signal generator, field-strength meter, and function generator.

All of the employees whose major responsibility was in the area of electronics were required to possess knowledge of basic electrical circuits and basic electronic circuits. At least 86 percent of the employees were expected to know something pertaining to each of the following electronic circuits: high voltage power supply, regulation, control circuit oscillators, voltage discrimination, modulation and demodulation, impedance and network matching, triggering circuits, wide band amplifiers, linear and log amplifiers, and function generators. Eighty percent indicated it was essential to have an understanding of electronic units of measurement, dry disc rectifiers, solenoids and relays, cathode ray tubes, input and output devices, transistors, synchros and control transformers, and crystal diodes. A good understanding of principles of operation of AC and DC motors and generators, rate generators, and servomotors was considered necessary by 90 percent of the employees.

Turner's data also revealed that use of electrical measuring equipment, use of basic hand tools, and basic sheet metal techniques were necessary by 90 percent or more of the employees.

Jelden (18) conducted a study to compare the basic informational content of textbooks and other instructional materials used in electrical courses offered in teacher-education institutions with the basic electrical knowledge required of persons who work with electronic devices in industry. His study attempted to answer the following questions (18, p. 1):

1. What units or topics of basic electrical knowledge are contained in textbooks and other instructional materials used in providing electrical instruction for industrial education majors in teacher-education institutions?

2. What units or topics of basic electrical knowledge are required of persons who work with electronic devices in industry?

3. What similarities and differences exist between the basic units or topics of electrical knowledge contained in textbooks and instructional materials used in electrical instruction provided by teacher-education institutions for industrial education majors and those required by personnel who work with electronic devices in industry?

4. What are the implications of the findings of this study for programs of industrial teacher-education?

Jelden sent information forms to 163 teacher-education institutions to determine what courses were taught in electricity-electronics and the names of the textbooks used in the courses. A questionnaire was developed by listing 628 electrical topics taken from the various textbooks used in teacher-education classes. The questionnaires were then sent to 22 selected electronic manufacturing industries to be rated as "required knowledge", "preferred knowledge", and "necessary knowledge" as they pertained to electronic technicians.

Electronic topics rated as "required knowledge" for electronic technicians in which all industries were in unanimous agreement were: Lenz's Law for opposing fields; electromagnets; voltage, current, and resistance in series, parallel, and series-parallel circuits; Ohm's Law for AC and DC circuits; voltmeter and ohmmeter operation; characteristics and use of transformers; what capacitance is and what it does; operating theory of vacuum tubes; function of plate in vacuum tube; diode as a rectifier; and common tubes in power supplies. Four hundred four of the 628 topics were

marked "required knowledge" by the industries, 126 were marked "preferred knowledge", and 26 were marked "unnecessary knowledge". Topics such as semiconductors and transistor circuits, FM receivers and transmitters, discriminators, and thermistors were rarely included in instructional material used in teacher-education but were rated as "required knowledge" by the industries.

Mills (29) conducted a study to identify specific knowledges and clusters of knowledges most widely used in major types of work done by electronic technicians. His sample was a stratified sample of 222 electronic technicians in 64 establishments. They were asked to respond to a check list of 643 knowledges, selected from course of study and curriculum guides and textbooks, indicating which were essential for doing their job. Each person was asked to identify one of eight major task descriptions that most nearly described his job. These task descriptions were selected from publications discussing work done by electronic technicians and from discussions with the technicians employed in industry. The major tasks for electronic technicians used in this study were (1) diagnosing trouble in systems, (2) adjusting and/or operating, (3) servicing, (4) assembling, (5) installing, (6) designing and computing, (7) application, distribution, and electronic sales, and (8) quality control and testing.

Usable results were obtained from 154 out of 222 electronic technicians included in the sample. The data were reported by relating specified knowledges to major tasks. Knowledge items were defined as necessary for performance of a major task if 60 percent of the respondents indicated them to be needed in their job. Eighty-four of the 643 knowledges were found to be associated with the performance of six or more of the eight tasks. One

hundred fifty-four knowledges were found to be associated with three to five tasks.

Mills indicated that introductory courses in electronics should be designed to help students acquire the 84 important knowledges. The advanced courses should be designed to enable the student to acquire the additional useful knowledges considered in the study.

In 1966, Hoerner (17) studied the competencies in electricity needed by Iowa farmers. The purposes of his study were: (1) to determine the electrical competencies needed by farmers, (2) to determine the degree of competencies needed and possessed by members of average and outstanding Iowa farmer groups, (3) to determine the relationship of certain factors (such as years in farming, educational attainment, and use of electricity) to the degree of competency needed and possessed by farmers, and (4) to provide information which will assist in planning future educational needs for farmers.

He selected a 12-member panel of specialists in farm machinery electricity to select 44 farm electrical competencies needed by farmers. These 44 competencies were listed on a questionnaire and mailed to a randomly selected group of farmers considered to be average and to a group of farmers considered to be outstanding. The farmers were asked to rate the competencies in terms of both degree of competence needed and degree of competence possessed by use of a five-point scale. Of the 44 competencies selected by the panel, 18 were understandings and 26 were abilities.

He had a return of 102 usable questionnaires from farmers in each group. The understandings which rated highest by both groups for competency needed were: (1) how pressure, time, and limit switches; thermostat

controls; and magnetic relays operate in controlling mechanized feeding equipment, (2) install all electrical wiring and fixtures in a building such as a farrowing house or milking parlor, (3) determine correct pulley size for motor and equipment based upon motor speed and required equipment speed, and (4) install the wiring to a silo unloader or other major large size piece of equipment on the farm.

In three cases, some farmers indicated that they possessed more competencies than needed in individual competencies. The three competencies were: (1) understanding of why one should not operate light switches or any other electrical device while in the bathtub, (2) ability to replace fuses, and (3) ability to replace the attachment plug on the end of an appliance cord.

Hoerner's data showed the following differences between the two groups of farmers: (1) average farmers had greater differences between competence needed and competence possessed scores, (2) competence possessed scores decreased as years in farming increased with both groups, (3) outstanding farmers used almost four times as much KWH of electricity in one selected month than the average group, and (4) outstanding farmers had twice as many electrical appliances on their farm as did the average farmer.

Perkins (33) conducted a study of the training of electricians in the Tennessee Valley region in 1967. Data were gathered by utilizing an instrument which contained 122 items of possible course content and was constructed in a checklist type of format with four categories of importance for each item. The four groups of participants, consultant engineers, electrical contractors, electrical inspectors, and electrical workers, were instructed to rate each item as to its importance. A weighted mean proce-

dure was used to rank the items in order of importance. The Friedman's two-way analysis of variance by rank was used to test the relationship among recommendations made by the four groups.

Perkins' data showed that only 17 of the 122 selected items listed on the information form were designated as "essential" content in a training program for electricians by at least one of the participating groups. Five items were designated as "essential" content by all four groups. Two content items relating to requirements of National Electrical Code were among those items receiving highest ratings. Two items relating to safety instruction also received high ratings. The topics sketching, drawing, reading wiring diagrams, and building prints received high ratings.

Seventy-five items were designated by all four groups as "important" content which should be included in training programs for electricians. Activity type items which received high ratings were items relating to conduit installations and items relating to connections and splices.

Perkins drew the following conclusions from his study (33 abstract, p. 4):

1. Practicing and promoting safety habits, planning wiring installations, and making neat, reliable, non-hazardous installations should receive the highest priority as content in training programs for electricians.

2. Sketching, drawing, and reading wiring diagrams and building prints, principles of single phase current circuits and general requirements of the National Electric Code for single and multi-family dwellings and commercial buildings should receive high priority in training programs for electricians.

3. Content relating to common installations, finishing installations, conduit installations, operations with hand and power tools, splices, and connections should be included in training programs for electricians.

4. General requirements of the National Electric Code for installations in industries and hazardous locations should be included in training programs for electricians.

5. Content relating to direct current circuit principles, alternating current power distribution systems, principles and sources of electrical space heatings, and principles and applications of electric lighting should be included in training programs for electricians.

6. Content relating to special installations, working with metals, filling out information forms and assembling with fastening devices should be included in training programs for electricians only if time permits.

7. Content relating to mechanical and electronic control devices and utilization of electrical energy should be included in training programs for electricians only if time permits.

Barlow and Schill (2) conducted a study concerning the role of physical sciences in electrical-electronic technology for the State of California. In this study, 93 technicians, 65 instructors of electronics, a jury of experts consisting of 11 persons with a background of electronic work above the technician level were used to indicate the importance of 240 physical science topics in an electrical-electronic technology curriculum. The opinions of the three groups were compared, and a rank order of the importance of physical science topics was derived. The topics most closely related to electricity and electronics were considered the most important, as might be expected.

Belt's study (3) revealed that there was an acute shortage of competent consumer electronics service technicians for servicing transistorized electronic equipment such as the radio receiver, hi-fi, and television receiver. He also indicated that color television receivers have grown in numbers faster than men can be hired to install them and keep them in working order.

His study revealed that "home service technicians" had at least two years of training and two to five years of experience. Consumer electronics service technicians with more than five years of experience were in the "bench service" category.

Weede (46) conducted a study to determine personnel and training needs for electronic technicians in Iowa industries. He gathered data to fulfill the following objectives (46, p. 9):

1. To determine the number of industries in Iowa which employ electronic technicians or may do so in the future
2. To determine the skills and knowledge which the industries desired these electronic technicians to possess
3. To determine the number of electronic technicians needed to meet the present and future needs of Iowa industries
4. To determine the present source of electronic technicians being hired by Iowa industries.

There were 115 industries which employed 99,045 people and required electronically trained personnel. These industries, which provided data for the study, reported that 205 electronic technicians would be needed by 1968 and 544 more would be needed by 1972. The engineering supervisors or plant managers, who completed the majority of the questionnaires, were hesitant about projecting employment needs in the future.

The data gathered by the questionnaire technique showed that the main source of electronic technicians was from in-company training programs and from technical schools. In determining training needs for electronic technicians, Weede's questionnaire listed training needs in nine basic categories. The categories are: mathematics, basic principles of physics, shop operations and related information, technical drawing, AC and DC circuits and machines, electronic components and circuits, use and repair of test

equipment, TV circuits, and data processing. There were from two to 26 topics listed under the major categories. Each topic was rated as to importance on a five-point scale.

The highest rated topics were: soldering, blueprint reading, electronic symbols, series and parallel circuits, combination circuits, circuit laws, AC and DC power supplies, power supply regulation, algebra, and trigonometry. Television circuits and data processing categories were rated very low. The most important test equipment used by the electronic technicians was: AC and DC voltmeter, AC and DC ammeter, ohmmeter, wattmeter, vacuum tube voltmeter, and oscilloscope.

Weede drew the following conclusions (46, p. 99):

1. The manufacturing industries of Iowa have a definite need for well trained persons in the field of electronics
2. The training needs vary with the size of the industry, product manufactures, and geographical location
3. It is very difficult for industries to predict the number of additional employees needed beyond one year
4. The main source of technically trained electrical personnel is in-company training programs
5. There is a lack of agreement as to terminology used to describe technically trained electrical personnel in manufacturing industries.

Stephens (39) conducted a study of major household appliance service technician training needs in the State of Iowa in 1969. His population consisted of 181 appliance servicing firms located in Iowa cities with a population of 2,500 or more people. At the time the study was conducted, there were 85 positions open for appliance service technicians. It was anticipated there would be a need for 128 replacements for the years 1969 through 1971.

The median wage paid to major household appliance service technicians was $3.16 per hour with a range of $2.89 to $3.52 per hour. The most common source for training for these technicians through factory schools and experience on the job.

In the area of knowledge and skill requirements, the study shows that ability to talk to customer, show interest in customer, ability to estimate repair costs prior to work, and ability to handle service policies and warranties were rated highly desirable. In the categories, electrical information, electrical safety, and reading wiring diagrams were rated most important.

In the categories of instruments and skills, leak detectors and ohmmeters were considered most important while the psychrometric slide rule was regarded as the least important instrument. Soldering was thought to be the most important skill needed by these service technicians.

Stephens drew the following conclusions about his study (39, p. 111):

1. There is a shortage of appliance service technicians in the state of Iowa. However, the shortage is not critical enough to warrant a crash program to train major household appliance service technicians.

2. There is need in the state of Iowa for one or two full-time training programs for appliance service technicians.

3. There is a need for part-time, up-dating programs in the area of appliance service. These programs should be so located within the state as to make them available to the largest number of appliance service technicians.

4. If a training program is to be established to prepare technicians more specifically trained on a particular appliance group, this appliance group should be "refrigeration."

In 1969, Dukes (7) conducted a study of radio and television service technicians to determine the need for radio and television service techni-

cians in Iowa. Two questionnaires were used. The first questionnaire was mailed to 575 radio and television service firms in cities with a population of 2,500 people or more to determine the present employment needs. Three hundred fifty-five firms returned usable questionnaires. The firms represented in the study employed 807 radio-television service technicians. Forty-seven percent of these firms were categorized as the owner-operator size of firm.

The study showed that 115 radio-television service technicians were needed to fill existing vacancies, and there was a predictive need for 197 service technicians for replacement over the next three years.

The owner or service manager of the firms estimated that 54 percent of the 807 radio-television technicians had need for some type of in-service up-grading classes. The firms in Area X reported the largest number (51) of radio-television service technicians that were expected to attend these classes if available.

A second questionnaire was mailed to 275 firms that consented to supply additional information if contacted by means of another questionnaire. The 213 returned usable questionnaires were designed to determine the technical knowledge and skills felt important for radio-television service technicians as rated by the firm owner or business manager. The rating was based on a five-point scale with (1) being very little importance, (2) background knowledge only, (3) desirable, (4) highly desirable, and (5) essential.

In the category of business practices, the items ability to talk to customers and ability to make house calls were rated as "essential". Knowl-

edge of accounting procedures and knowledge of marketing procedures were rated as "desirable".

All items under English skills were rated as "desirable" while arithmetic and algebra were the only two mathematics skills with an average rating of "desirable" or higher.

AC and DC power supplies, oscillator circuits, audio frequency amplifiers, radio frequency amplifiers, and transistor analysis were the items that received the "most essential" rating.

The majority of the items listed under AC and DC circuits and machines were listed as "desirable" or higher. Series and parallel circuits, combination circuits, Ohm's Law, and inductive reactance, capacity reactance, resonance, etc. were rated as "highly desirable".

The oscilloscope, multimeter, color bar generator, tube testers, transistor testers, RF signal generator, sweep/marker generator, audio generator, and television analyst were rated as "highly desirable". Soldering skills were rated as "essential" while printed circuit techniques and desoldering skills were rated above "highly desirable".

Dukes proposed that new training programs for service technicians:

> . . . be highly practical. The initial training courses should basically consist of electronics theory and components and emphasis should be placed on the direct application to the different electronic devices. These curriculums should include some core courses, such as a certain degree of communication skills and mathematics. . . . business skills should have greater emphasis than presently being presented (7, p. 109).

In summary it can be said that research that would be beneficial in developing curriculum content in the electronic servicing occupations is very limited. The majority of the studies reviewed dealt primarily with number of service technicians needed at the present time as well as in the

future. Dukes' study showed that there was a definite need for more radio-television service technicians in Iowa. His study indicated there was a present need for 115 technicians to fill present vacancies, and there was a predictive need for 197 more technicians over the next three years.

The lack of research, that could be used for developing curriculum content in the electronic service occupations on the national, state, and local level, points out the need for future study.

METHOD OF PROCEDURE

Introduction

The primary purpose of this research project was to gather data that would be of assistance in developing a program for training consumer electronics service technicians by determining essential knowledge and skills required of the service technician in doing a competent job. The data would also be useful for developing a special program for training service technicians who would like to specialize in "home servicing" or "bench servicing" in the service shop. A secondary goal was to gather data on service technicians such as age, number of years of experience in servicing consumer electronic products, salary, hours worked, educational background, types of consumer electronic products serviced, and as to whether they worked in the service shop or in the customer's home the majority of the time. These data could be used for guidance purposes.

This chapter describes the procedures used in the collection and analysis of the data necessary to fulfill the objectives of the study.

Population

The sample for this study consisted of service technicians who were employed in 40 consumer electronic service firms in the State of Iowa. The 40 consumer electronic service firms were selected by random sample from entire population of all consumer electronic service firms, in the State of Iowa, that employed three or more full-time consumer electronic service technicians.

The list of consumer electronic service firms was compiled by using the telephone directories of cities that had a population of 10,000 or more

people. These telephone directories also listed the consumer electronic service firms in the surrounding communities. Electronic distributors that serve the various communities were asked to indicate the number of full-time consumer electronic service technicians employed by each firm. During this process, some firms not listed in the telephone directory were added to the list. In an effort to insure that all firms with three or more full-time consumer electronic service technicians were included in the population, officers of the Television Service Association of Iowa (TSA Iowa) and National Alliance of Television and Electronic Service Associations (NATESA) were asked to check the list of firms.

By limiting the study to those firms which employed three or more full-time service technicians, the one-man, owner-operator type of form would be eliminated. By using larger firms, service technicians that are more specialized in servicing specific consumer electronic products, or work in the customer's home, or in the service shop the majority of the time could be studied.

Instrument

The use of an inventory form was determined to be the most economical method of recording data during personal interviews. The inventory form was designed so that all data could be recorded on one form. It consisted of three major divisions. The divisions were: (1) general findings concerning service technicians, (2) knowledge and skill requirements of service technicians, and (3) service information.

The service technicians were asked to furnish general information concerning their age, number of years of experience in consumer electronic

servicing, types of electronic training programs attended, hourly salary rate, hours worked, types of certificates or license obtained, and types of consumer products they service. It was hoped that the answers to the foregoing questions would provide occupational information that would be beneficial in recruiting more people to enter the consumer electronics field as an occupation.

In an attempt to define the competencies needed by service technicians, technicians were asked to respond on a five-point scale to 139 items related to knowledge and skill. The major groupings of items were ability to use mathematics, ability to organize and administer, understanding of legal responsibilities, understanding of electricity, understanding of electronic theory, ability to repair and/or install consumer electronics products, and ability to use electronic test equipment. Understanding of electronic theory was subdivided into five subdivisions listing from one to 15 specific items. Ability to repair and/or install consumer electronic products was subdivided into four subdivisions with specific items listed under each heading. The technicians were asked to indicate the frequency of performance and degree of competency needed on a five-point scale. Ability to use shop techniques and ability to use test equipment categories were subdivided into from seven to 31 specific items respectively. The service technicians were also asked to indicate the frequency of performance and degree of competency needed on a five-point scale.

In an attempt to determine the types of consumer electronic products serviced and the service required, the service technicians were asked to list the last three items serviced explaining test equipment used, defective stage and components and adjustments required for completing the task.

It was felt that this information would show an indication of the types of problems encountered in servicing consumer electronic products.

Since service technicians working for firms selected in this population can specialize in working in the shop or in the home the majority of the time, they were asked to answer the responses as they apply to the position in which they work the majority of the time. Knowledge and skill requirements can be determined for the home service technician as well as the bench service technician.

The inventory form was designed from information obtained from various consumer electronics service training programs and their courses of study. It was then examined by the advisory committee selected for this study and then tested by interviewing technicians within two consumer electronic service firms in Ames.

A copy of the inventory form is included in Appendix B.

Conducting the Interviews

Before the interviews, letters written by the executive secretary of the Television Service Association of Iowa (Appendix A) and the author explaining the purpose of the study were mailed to consumer electronics service firms selected to participate.

The interviews lasted from one to two and one-half hours each. The service technicians were asked to complete the inventory form answering each item as it specifically applied to the type of work in which he was involved. Assistance was given in clarifying any items of misunderstanding or lack of clarity.

Some of the inventory forms were requested to be completed and mailed at a later date because of technicians being sick, on vacation, on home service call, or time was not to be used during work hours completing the form.

One hundred thirty-two service technicians within 38 of the initial 40 consumer electronic service firms participated in the study. One firm did not desire to participate. The other firm promised to cooperate by having their service technicians complete the inventory form and mail to researchers, but forms were never returned after two telephone calls were made to encourage their response. The number of service technicians per service firm that participated ranged from one to 12 service technicians.

Of the 132 service technicians who participated, 48 indicated they worked in the customer's home the majority of the time, while 84 indicated they worked in the service shop.

Selecting Advisory Committee

An advisory committee, consisting of four members, was selected for the purpose of offering advice and counsel to the researcher conducting this study. Two members were chosen from the educational profession while two members were chosen from the consumer electronic service trade. These committee members were asked to offer recommendations for determining the data to be collected on the inventory form and also to help to evaluate the data that were collected.

Advisory Committee Members

Mr. Ronald Crow is currently Instructor-Supervisor in the Electronics and Technical Education section of Engineering Extension Service at Iowa

State University. He is the holder of a Certified Electronics Technician Certificate and is serving on the national committee for Apprenticeship Training of consumer electronics service technicians.

Mr. Tom Dunsmore is in charge of electronic technology at Des Moines Area Community College, Ankeny, Iowa. He has considerable experience in servicing various types of electronic equipment.

Mr. Clark Pohl is a co-owner of Don's Television in Perry, Iowa. He served as president of the Television Service Association of Iowa during the year 1969.

Mr. William Gulliver is the owner of Gulliver's Television in Ames, Iowa. He is the holder of a Certified Electronics Technician Certificate and has served as president of the Television Service Assocation of Iowa during the year 1970.

Analysis of the Data

When the interviews were completed, the data obtained from the inventory forms were reviewed, coded, and recorded on 80-column coding forms. The data were then key punched on 80-column IBM business machine cards.

Frequency counts and totals were tabulated for all of the possible responses concerned with the age of consumer electronics service technicians, years of consumer electronic service experience, salary, consumer electronics products serviced, etc.

Frequency counts, totals, and means were calculated for each item answered by a response on the rating scale for the degree of competency needed. The means were calculated by assigning to the rating scale a value of four for the category "very much competency needed", three for the cate-

gory "much competency needed", two for the category "some competency needed", one for the category "little competency needed", and zero for the category "no competency needed". The means are represented by a number from zero to four indicating the relative importance of each item as it was viewed by the service technician.

Frequency counts, totals, and means were calculated for each item answered by a response on the rating scale for the frequency of performance. The means were calculated by assigning to the rating scale a value of four for the category "daily", three for the category "weekly", two for the category "monthly", one for the category "sometimes", and zero for the category "not used or performed". The means are represented by a number from zero to four indicating the frequency of performance or use as it was viewed by the service technician.

FINDINGS

The purpose of this study was to gather data that would be of assistance in developing a program in Iowa for training consumer electronics service technicians and to gather data that could be used for guidance purposes.

The findings were presented in three major divisions to fulfill the objectives of the study. The divisions were: (1) general findings concerning service technicians, (2) knowledge and skill requirements of service technicians, and (3) service information. The findings were also presented by the area in which the service technicians worked the majority of the time, "bench servicing" or "home servicing".

The data for this study were collected from 132 service technicians employed within 38 consumer electronic service firms in Iowa.

Forty consumer electronic service firms were selected by random sampling from the entire population of all consumer electronic service firms in the State of Iowa that employed three or more full-time service technicians. Two of the firms did not wish to participate in the study.

The number of Iowa service technicians per service firm that participated in the study ranged from one to 12 service technicians. Of the 132 service technicians that participated, 48 indicated they worked in the customer's home the majority of the time, while 84 indicated they worked in the service shop the majority of the time.

General Findings Concerning Service Technicians

Information concerning ages of service technicians

The median age of the bench service technicians reported in Table 1 was 37.9 years. Twenty-four bench service technicians were reported to be from 20 to 29 years of age. Twenty-six were in the category of 40 to 49 years of age.

Table 1. Ages of service technicians

Age (years)	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
Under 20	2	2.4			2	1.5
20-29	24	28.6	25	52.1	49	37.1
30-39	19	22.6	7	14.6	26	19.7
40-49	26	30.9	12	25.0	38	28.7
50-59	11	13.1	4	8.3	15	11.4
60-65	1	1.2			1	.8
Over 65	1	1.2			1	.8
Total	84	100.0	48	100.0	132	100.0
Median age	37.9		29.1		35.2	

The median age of home service technicians was 29.1 years. Twenty-five home service technicians were in the age category of 20 to 29 years. Twelve were in the category of 40 to 49 years of age.

The median age of both groups of service technicians was 35.2 years. Forty-nine service technicians reported to be between 20 and 29 years of age. Twenty-six were in the 30 to 39 years of age category. Thirty-eight were in the category 40 to 49, and two were listed as being over 64.

Information concerning years of work experience as service technicians

Of the 84 bench service technicians reported in Table 2, ten had less than one year of work experience in servicing consumer electronic products. Seventeen were in the one to three years of experience category. In the 16 to 20 years of experience category, there were 19 bench service technicians.

Table 2. Years of full-time work experience of service technicians

Experience (years)	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
Less than one year	10	12.0	4	8.3	14	10.6
1-3	17	20.4	10	20.9	27	20.5
4-6	4	4.7	8	16.6	12	9.1
7-9	7	8.3	4	8.3	11	8.3
10-12	4	4.7	3	6.4	7	5.3
13-15	4	4.7	4	8.3	8	6.1
16-20	19	22.6	9	18.8	28	21.2
21-25	11	13.1	4	8.3	15	11.4
26 or more	8	9.5	2	4.1	10	7.5
Total	84	100.0	48	100.0	132	100.0

Ten home service technicians had one to three years of experience. Nine were in the 16 to 20 years of experience category.

According to Table 2, 31 percent of the total number of service technicians had three or fewer years of consumer electronic service experience. Approximately 40 percent of the service technicians had over 15 years of experience.

Educational background of service technicians

Table 3 lists the highest educational level attained by service technicians. Fifty-five bench service technicians had completed the highest grade level of the 12th grade. Eight had not completed high school. Six bench service technicians had completed one year of college. Eleven had completed two years of college while one had completed four years of college.

Table 3. Educational level attained by service technicians

Highest grade completed	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
7	1	1.2	1	2.1	2	1.5
8	4	4.7	1	2.1	5	3.7
9	1	1.2			1	.8
10			1	2.1	1	.8
11	2	2.4			2	1.5
12	55	65.5	34	70.9	89	67.3
13	6	7.1	8	16.6	14	10.6
14	11	13.1	2	4.1	13	9.7
15	3	3.6	1	2.1	4	3.3
16	1	1.2			1	.8
Total	84	100.0	48	100.0	132	100.0

The highest grade level completed by 34 home service technicians was the 12th grade. Eight had completed one year of college while two had completed two years of college.

The highest grade level completed by 89 service technicians was the 12th grade. Fourteen of the total number of service technicians had completed one year of college. Thirteen had completed two years of college.

Four had completed three years of college while one technician had completed four years of college.

Source of training of service technicians

In order to determine how the service technicians acquired their consumer electronic servicing background, they were asked to check the program or programs in which they had participated. The programs listed were: (1) cooperative high school programs, (2) other high school programs, (3) trade school programs, (4) area vocational-technical schools, (5) colleges, (6) home study, (7) military schools, (8) factory schools, and (9) apprenticeships. Many service technicians checked more than one program. These data were recorded in Table 4.

Of the 132 service technicians interviewed in the study, 51 participated in a home study program. Forty-two service technicians attended trade schools. Forty-one attended military schools. Thirty-one had attended factory schools. Twenty-two had attended area vocational-technical schools while 18 had attended an apprenticeship program.

License or certificate obtained by service technicians

With the emphasis in the direction of certification or licensing of service technicians, the author wanted to find out how many service technicians had obtained consumer electronic license or certificates of some type. Table 5 summarized the license or certificates obtained by service technicians. Some service technicians obtained more than one license or certificate.

Eighteen of the 132 service technicians interviewed had obtained the Certified Electronic Technician Certificate (CET). Eight had attained the

Table 4. Source of training of service technicians

	Cooperative high school programs	Other high school programs	Trade schools	Area vocational-technical schools	Colleges	Home study	Military schools	Factory schools	Apprenticeships
Bench service technicians	2	5	26	11	8	33	24	21	13
Home service technicians	4	3	16	11	4	18	17	10	5
Total number of service technicians	6	8	42	22	12	51	41	31	18

Table 5. License or certificates held by service technicians

Topic item	Service Technicians		
	Bench	Home	Total
Certified Electronic Technician Certificate (CET)	11	7	18
First Class Commerical Radio Telephone License	8		8
Second Class Commercial Radio Telephone License	4	3	7
Amateur Radio License	2		2
Electronic Technician Union	2		2
Total	27	10	37

First Class Commercial Radio Telephone License while seven had obtained the Second Class Commercial Radio Telephone License.

Hours worked by service technicians

Table 6 summarized the number of hours worked per day, and Table 7 summarized the number of hours worked per week by service technicians. According to Table 6, 79 service technicians worked eight hours per day. Forty-six of the service technicians were bench service technicians, and 33 were home service technicians. Thirty-one service technicians worked nine hours per day, and ten worked ten hours per day. Only eight worked over ten hours per day.

According to Table 7, 43 service technicians worked 40 hours per week. Forty service technicians were in the 41 to 45 hours per week category. In the 46 to 50 hours per week category there were 17. Sixteen indicated they

Table 6. Hours worked per day by service technicians

Hours	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
Under 8	4	4.7			4	3.3
8	46	54.9	33	68.9	79	59.6
9	22	26.2	9	18.7	31	23.4
10	6	7.1	4	8.3	10	7.6
Over 10	6	7.1	2	4.1	8	6.1
Total	84	100.0	48	100.0	132	100.0

Table 7. Hours worked per week by service technicians

Hours	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
Under 40	4	4.7			4	3.3
40	24	28.6	19	39.6	43	32.6
41-45	25	29.7	15	31.3	40	30.3
46-50	13	15.6	4	8.3	17	12.6
51-55	9	10.7	7	14.6	16	12.1
Over 55	9	10.7	3	6.2	12	9.1
Total	84	100.0	48	100.0	132	100.0

worked between 51 and 55 hours per week. Twelve indicated they worked over 55 hours per week.

The data in Table 8 summarized the percentage of time service technicians spend in working in the service shop and in the customers' homes. Ten service technicians reported they did not work in the capacity of bench servicing, while 46 indicated they did not do home servicing. Thirty-eight worked in the capacity of bench servicing 100 percent of the time, and 10 worked as home service technicians 100 percent of the time. Forty-eight reported they worked the majority of the time in home servicing, and 84 indicated they worked the majority of the time in bench servicing. Fifteen indicated they had a responsibility other than servicing consumer electronic products. Some of the other responsibilities were: selling consumer electronic products, management, inventory, and requisitioning of parts.

Table 8. Percentage of time service technicians spend working in the service shop and in the customers' homes

Time (percent)	Bench servicing		Home servicing		Other	
	N	%	N	%	N	%
None	10	7.6	46	34.7	117	88.6
1-10	14	10.6	22	16.6	2	1.5
11-20	5	3.8	5	3.8	2	1.5
21-30	10	7.6	6	4.5	3	2.4
31-40	6	4.5	2	1.5	2	1.5
41-50	14	10.6	10	7.6	6	4.5
51-60	5	3.8	3	2.4		
61-70	2	1.5	3	2.4		
71-80	7	5.3	10	7.6		
81-90	16	12.1	7	5.3		
91-99	5	3.8	8	6.0		
100	38	28.8	10	7.6		
Total	132	100.0	132	100.0	132	100.0

Salary received by service technicians

Table 9 indicated that the median salary of the total number of service technicians was $3.33 per hour. The median salary for bench service technicians was $3.25 per hour, and the home service technicians median salary was $3.44. There were 33 service technicians in the $3.00 to $3.49 per hour category and 24 in each of the categories of $2.00 to $2.49 and $3.50 to $3.99 per hour. Eleven service technicians reported earnings of $5.00 or more per hour. Three service technicians did not report their salary. Five service technicians reported earnings of $5.00 or more per hour and were owners or co-owners of the service firm. They were not represented in Table 9.

Table 10 presented data indicating the number of service technicians earning a commission plus the regular hourly salary. There was a total of

Table 9. Salary received by service technicians

Hourly rate (dollars)	Service Technicians					
	Bench		Home		Total	
	N	%	N	%	N	%
2.00-2.49	18	23.3	6	13.0	24	19.4
2.50-2.99	11	14.3	5	10.6	16	12.9
3.00-3.49	19	24.7	14	29.7	33	26.6
3.50-3.99	12	15.6	12	25.5	24	19.4
4.00-4.49	1	1.3	2	4.2	3	2.4
4.50-4.99	9	11.7	4	8.5	13	10.5
5.00 or more	7	9.1	4	8.5	11	8.8
Total	77	100.0	47	100.0	124	100.0
Median salary	$3.25		$3.44		$3.33	

Table 10. Distribution of service technicians that received a commission plus regular salary

	Service Technicians		
	Bench	Home	Total
Yes	5	7	12
No	79	41	120
Total	84	48	132

12 service technicians earning a commission. Seven of the 12 were home service technicians, and five were bench service technicians.

Consumer electronic products serviced by service technicians

The service technicians that were involved in this research project were asked to indicate the percentage of consumer electronic products serviced in each category. The researcher discovered that the majority of the service technicians serviced more than one type of consumer electronic product.

The data in Table 11 summarized the various consumer electronic products serviced by the 132 service technicians that participated in the research project. One hundred fifteen service technicians serviced B&W televisions, 71 were bench service technicians and 44 were home service technicians. The color television receiver was serviced by 108 service technicians, 65 being bench service technicians and 43 were home service technicians. Tape recorders, tape players, phonographs, and audio amplifier systems were serviced by 92 service technicians. Fifty-eight were bench service technicians, and 34 were home service technicians. Radio

Table 11. Number of service technicians servicing consumer electronic products by type (N = 132)

Topic item	Service Technicians		
	Bench	Home	Total
B&W television	71	44	115
Color television	65	43	108
Tape recorders, tape players, phonographs, audio amplifier systems	58	34	92
Radio (AM, FM, FM multiplex)	61	28	89
Antenna installation	15	26	41
Other	4	2	6

(AM, FM, and FM multiplex) was serviced by 89 service technicians. Forty-one service technicians did some type of antenna installation. Fifteen of the service technicians were bench service technicians, and 26 were home service technicians. Other electronic products serviced by six service technicians not listed in Table 11 were: video TV cameras, video tape recorders, overhead projectors, and movie projectors.

The data in Tables 12, 13, 14, 15, and 16 summarized the percentage of consumer electronic products serviced involving all consumer electronic products. In Table 12, it was found that 17 service technicians did not service B&W television. Two bench service technicians serviced only B&W televisions. The B&W television made up one to ten percent of all consumer electronic products serviced by 45 service technicians.

Table 12. Percentage of all consumer electronic products serviced involving B&W television (N = 132)

Service technicians	Percentage											
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90-99	100
Bench	13	21	17	10	4	9	1	2	3	1	1	2
Percentage	15.4	25.0	20.2	11.9	4.8	10.7	1.2	2.4	3.6	1.2	1.2	2.4
Home	4	24	9	7	2			1		1		
Percentage	8.3	50.0	18.7	14.6	4.2			2.1		2.1		
Total number	17	45	26	17	6	9	1	3	3	2	1	2
Percentage of total number	12.9	34.1	19.7	12.9	4.4	6.8	.8	2.3	2.3	1.5	.8	1.5

According to Table 13, 25 service technicians did not service color televisions. Nineteen of those technicians were bench service technicians, and five were home service technicians. One bench service technician serviced only color televisions. For 22 service technicians (15 home service technicians and 7 bench service technicians), the color television made up 71 to 80 percent of the products serviced. Fifteen service technicians indicated the color television made up 81 to 90 percent of the products they serviced. Three service technicians indicated 90 to 99 percent of the products they serviced were color televisions.

The data in Table 14 summarized the percentage of consumer electronic products serviced by service technicians involving tape recorders, tape players, phonographs, and audio systems. Forty of the service technicians interviewed designated that they did not service any of the products listed above. Two service technicians indicated tape recorders, tape players, phonographs, and audio systems were the only items they serviced. Fifty-seven service technicians (29 bench service technicians and 28 home service technicians) indicated tape recorders, tape players, phonographs, and audio systems make up one to ten percent of the consumer electronic products they serviced.

Table 15 presented the percentage of radios (AM, FM, and FM multiplex) serviced by the 132 service technicians. Forty-two indicated they did not service radios. Radios made up one to ten percent of the consumer electronic products serviced by 53 service technicians. Thirty of those service technicians were bench service technicians, and 23 were home service technicians. Radios made up 11 to 20 percent of the products serviced by 15 service technicians.

Table 13. Percentage of all consumer electronic products serviced involving color television (N = 132)

Service technicians	Percentage											
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90-99	100
Bench	19	9	4	6	9	7	8	6	7	7	1	1
Percentage	22.7	10.7	4.8	7.1	10.7	8.3	9.6	7.1	8.3	8.3	1.2	1.2
Home	5	1		4	2	3	3	5	15	8	2	
Percentage	10.4	2.1		8.3	4.2	6.3	6.3	10.4	31.2	16.6	4.2	
Total number	24	10	4	10	11	10	11	11	22	15	3	1
Percentage of total number	18.2	8.0	3.0	8.0	8.3	8.0	8.3	8.3	15.2	11.6	2.3	.8

Table 14. Percentage of all consumer electronic products serviced involving tape recorders, tape players, phonographs, audio amplifier systems (N = 132)

Service technicians	Percentage											
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90-99	100
Bench	26	29	7	6	7	1	1	2	1	2		2
Percentage	31.0	34.5	8.3	7.1	8.3	1.2	1.2	2.4	1.2	2.4		2.4
Home	14	28	1	1	1	1	1			1		
Percentage	29.1	58.3	2.1	2.1	2.1	2.1	2.1			2.1		
Total number	40	57	8	7	8	2	2	2	1	3		2
Percentage of total Number	30.0	43.1	6.0	5.8	6.0	1.5	1.5	1.5	.8	2.3		1.5

Table 15. Percentage of all consumer electronic products serviced involving radio (AM, FM, FM multiplex) (N = 132)

Service technicians	Percentage											
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-99	100
Bench	23	30	13	6	5	3	2	2				
Percentage	27.4	35.7	15.5	7.1	5.9	3.6	2.4	2.4				
Home	19	23	2	2						1	1	
Percentage	39.5	47.9	4.2	4.2						2.1	2.1	
Total number	42	53	15	8	5	3	2	2		1	1	
Percentage of total number	31.7	40.0	11.6	6.0	3.8	2.3	1.5	1.5		.8	.8	

According to the data presented in Table 16, 69 bench service technicians were not involved in antenna installation of any type. Thirty-three service technicians (21 home service technicians and 12 bench service technicians) indicated antennas made up one to ten percent of the products they serviced or installed. Two service technicians indicated antenna servicing or installation made up 41 to 50 percent of the products they were involved with. Antennas did not make up more than 50 percent of the consumer electronic products in which service technicians were involved.

Information Related to Knowledge and Skill Requirement Needs of Service Technicians

This section described the findings concerning various items of knowledge and skill and the degree of competency needed by consumer electronics service technicians. The items were divided into six major catagories. They were: (1) ability to use mathematics, (2) ability to organize and administer, (3) understanding of legal responsibilities, (4) understanding of electricity, (5) understanding of electronic theory, and (6) frequency of performance and degree of competency needed by service technicians in servicing consumer products, using shop techniques and using electronic test equipment.

The data presented in Tables 17 through 37 reported the ratings assigned to each item by the 132 service technicians that participated in the research project. The number of service technicians that assigned ratings were presented along with the mean rating for each item. The ratings were based on a five-point scale. The scale was as follows: (0) no competency needed, (1) little competency needed, (2) some competency needed, (3) much competency needed, and (4) very much competency needed.

Table 16. Percentage of all consumer electronic products serviced involving antenna installation (N = 132)

Service technicians	Percentage											
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-99	100
Bench	69	12	1		1	1						
Percentage	82.0	14.4	1.2		1.2	1.2						
Home	22	21	3		1	1						
Percentage	45.8	43.7	6.3		2.1	2.1						
Total number	91	33	4		2	2						
Percentage of total number	69.0	25.0	3.0		1.5	1.5						

The items in each table were presented in order of descending importance as determined by the mean rating.

Ability to use mathematics

Tables 17, 18, and 19 provided data concerning the degree of competency needed in ability to use mathematics, as reported by service technicians. "Arithmetic--addition, subtraction, and division of decimals and common fractions" rated the highest with a mean rating 2.77 for bench service technicians (Table 17) and 2.90 for home service technicians (Table 18). The overall mean rating was 2.82. "Use of the slide rule" received the lowest rating with a mean of .76 for the bench service technician and .63 for home service technician.

Ability to organize and administer

Tables 20, 21, and 22 provided data concerning the degree of competency needed in ability to organize and administer as reported by service technicians. Table 20 reported the topics "follow instructions, policies, and procedures accurately", "accept responsibilities", "communicate effectively--verbally and in writing", "public relations--handling of customers, proper wearing apparel, and proper manners", and being able to "explain bills and work done on customer items" had average ratings of "much competency needed" by bench service technicians. Ability to "use general accounting procedures" had the lowest rating by bench service technicians.

In Table 21, the topics "public relations--handling of customers, proper wearing apparel, and proper manners", "communicate effectively--verbally and in writing", "accept responsibility", "follow instructions, policies, practices, and procedures accurately", "explain bills and work done on cus-

Table 17. Degree of competency needed in ability to use mathematics, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Arithmetic--addition, subtraction, multiplication, and division of decimals and common fractions	1	8	24	<u>27</u>	24	2.77
Algebra--addition, subtraction, multiplication, and division of algebraic funcations. Formula manipulation such as E=IR, I=?	5	11	<u>31</u>	27	10	2.31
Trigonometry--function of angles (sin, Cos, and Tan)	<u>30</u>	<u>30</u>	14	4	4	1.07
Use of slide rule	<u>43</u>	25	11	3	2	.76

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

tomer items", "estimate repair costs", "stocking of service truck and tube caddy", and "plan work and travel effectively" had average ratings of "much competency needed" by home service technicians. "Use of general accounting procedures" had the lowest average rating of 2.29.

<u>Understanding of legal responsibilities</u>

The data in Table 23 summarized the degree of competency needed in understanding of legal responsibilities by service technicians. The two topics "insurance and liability responsibilities" and "State and Federal

Table 18. Degree of competency needed in ability to use mathematics, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Arithmetic--addition, subtraction, multiplication, and division of decimals and common fractions	1	4	12	13	<u>18</u>	2.90
Algebra--addition, subtraction, multiplication, and division of algebraic functions. Formula manipulation such as E=IR, I=?	4	5	<u>17</u>	15	7	2.33
Trigonometry--function of angles (Sin, Cos, and Tan)	<u>23</u>	14	9	1	1	.81
Use of slide rule	<u>27</u>	15	3	3		.63

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

laws related to business" rated approximately the same for both groups of service technicians. They both had average ratings of "some competency needed".

Understanding of electricity

All topic items listed in the category of understanding of electricity had average ratings of "some competency needed" by both groups of service technicians except for the topic "DC and AC circuit analysis using Thevenin's Law". The bench service technicians rated that topic "little

Table 19. Degree of competency needed in ability to use mathematics, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Arithmetic--addition, subtraction, multiplication, and division of decimals and common fractions	2	12	36	40	<u>42</u>	2.82	2.77	2.90
Algebra--addition, subtraction, multiplication, and division of algebraic functions. Formula manipulation such as E=IR, I=?	9	16	<u>48</u>	42	17	2.32	2.31	2.33
Trigonometry--function of angles (Sin, Cos, and Tan)	<u>53</u>	44	25	5	5	.98	1.07	.81
Use of slide rule	<u>70</u>	40	14	6	2	.71	.76	.63
						N = 132	N = 84	N = 48

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored

Table 20. Degree of competency needed in ability to organize and administer, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Follow instructions, policies, and procedures accurately		3	7	27	<u>47</u>	3.40
Accept responsibility	2	3	6	33	<u>40</u>	3.26
Communicate effectively--verbally and in writing	2	1	11	34	<u>36</u>	3.20
Public relations--handling of customers, proper wearing apparel, and proper manners	7		9	23	<u>45</u>	3.18
Explain bills and work done on customer items	3	3	12	32	<u>34</u>	3.08
Estimate repair costs	1	3	24	27	<u>29</u>	2.95
Handle warranties		5	29	24	<u>26</u>	2.84
Order parts	1	10	23	<u>26</u>	24	2.74
Prepare trouble reports or work order		9	26	<u>30</u>	19	2.70
Keep inventory of parts	1	4	<u>32</u>	29	18	2.70
Help train others	3	5	<u>28</u>	26	22	2.70
Plan work and travel efficiently	3	9	24	<u>29</u>	19	2.62
Sell consumer electronic products	4	14	24	<u>26</u>	16	2.43
Stocking of service trucks and tube caddy	6	10	26	<u>30</u>	12	2.38
Interpret and analyze financial and operational statements	5	14	<u>28</u>	21	16	2.34
Use general accounting procedures	7	21	<u>27</u>	17	12	2.07

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 21. Degree of competency needed in ability to organize and administer, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Public relations--handling of customers, proper wearing apparel, and proper manners		1		10	<u>37</u>	3.73
Communicate effectively--verbally and in writing		1	1	18	<u>28</u>	3.52
Accept responsibility	2	1		16	<u>29</u>	3.44
Follow instructions, policies, and procedures accurately	1	3	2	12	<u>30</u>	3.40
Explain bills and work done on customer items		2	4	17	<u>25</u>	3.35
Estimate repair costs		1	8	15	<u>24</u>	3.29
Stocking of service trucks and tube caddy	1	1	10	10	<u>26</u>	3.23
Plan work and travel efficiently		4	5	15	<u>24</u>	3.23
Sell consumer electronic products	2	2	9	<u>18</u>	17	2.96
Prepare trouble reports or work order		8	11	11	<u>18</u>	2.81
Order parts	2	4	12	14	<u>16</u>	2.79
Help train others		2	17	<u>18</u>	11	2.79
Keep inventory of parts	1	3	<u>18</u>	9	17	2.79
Interpret and analyze financial and operational statements	1	6	13	<u>17</u>	11	2.65
Handle warranties	2	7	10	<u>16</u>	13	2.65
Use general accounting procedures		11	<u>20</u>	9	8	2.29

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 22. Degree of competency needed in ability to organize and administer, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Follow instructions, policies, and procedures accurately	1	6	9	39	77	3.40	3.40	3.40
Public relations--handling of customers, proper wearing apparel, and proper manners	7	1	9	33	82	3.38	3.18	3.73
Accept responsibility	4	4	6	49	69	3.33	3.26	3.44
Communicate effectively--verbally and in writing	2	2	12	52	64	3.32	3.20	3.52
Explain bill and work done on customer items	3	5	16	49	59	3.18	3.08	3.35
Estimate repair costs	1	4	32	42	53	3.08	2.95	3.29
Plan work and travel efficiently	3	13	29	44	43	2.84	2.62	3.23
Handle warranties	2	12	39	40	39	2.77	2.84	2.65
Order parts	3	14	35	40	40	2.76	2.74	2.79
Prepare trouble reports or work order		17	37	41	37	2.74	2.70	2.81
Help train others	3	7	45	44	33	2.73	2.70	2.79
Keep inventory of parts	2	7	50	38	35	2.73	2.70	2.79
Stocking of service trucks and tube caddy	7	11	36	40	38	2.69	2.38	3.23
Sell consumer electronic products	6	16	33	44	33	2.62	2.43	2.96
Interpret and analyze financial and operational statements	6	20	41	38	27	2.45	2.34	2.65
Use general accounting procedures	7	32	47	26	20	2.15	2.07	2.29
						N = 132	N = 84	N = 48

Table 22. (Continued)

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored

Table 23. Degree of competency needed in understanding of legal responsibilities, as reported by service technicians

Topic item	Rating 0	1	2	3	4	Mean	Total
Bench service technicians							
State and Federal laws related to business	3	14	<u>38</u>	18	11	2.24	84
Insurance and liability responsibilities	5	14	<u>36</u>	20	9	2.17	84
Home service technicians							
Insurance and liability responsibilities	2	5	<u>22</u>	11	8	2.38	48
State and Federal laws related to business		10	<u>21</u>	10	7	2.29	48
Total number of technicians							
State and Federal laws related to business	3	24	<u>59</u>	28	18	2.26	132
Insurance and liability responsibilities	7	19	<u>58</u>	31	17	2.24	132

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

competency needed". "Unit of measurement of voltage, current, and resistance", "color code of electronic components", and "DC and AC series, parallel and complex circuit analysis using Ohm's Law" received average ratings of "much competency needed" by both groups of service technicians. Inductance and capacitance in DC and AC circuits also received average ratings of "much competency needed" by the home service technicians. See Tables 24, 25, and 26.

Table 24. Degree of competency needed in understanding of electricity, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Unit of measurement of voltage, current, and resistance	2	3	3	14	62	3.56
Color code of electronic components	4	5	5	23	47	3.24
DC and AC series, parallel and complex circuit analysis using Ohm's Law	2	3	13	21	45	3.24
Inductance and capacitance in DC and AC circuits	4	6	18	29	27	2.82
Transformer operation	2	5	24	30	23	2.80
Amplitude, frequency, and phase relationship of current and voltage in an AC circuit	2	9	18	30	25	2.80
Series and parallel resonance, Q and bandwidth	1	9	26	25	23	2.71
Peak, effective, and average values of the AC sine-wave	3	7	25	32	17	2.63
Resistivity and conductivity of conductors and insulators	2	16	20	23	23	2.58
Time constants	2	14	28	24	16	2.45
Motors and controls used in consumer electronic products	3	12	36	18	15	2.36
Magnetic laws and properties	2	17	32	19	14	2.31
DC and AC circuit analysis using Kirchhoff's Law	9	10	27	23	15	2.30
Wire sizes in regard to current carrying capabilities	2	18	31	21	12	2.27
Characteristics and applications of dry cells, mercury cells, nickel-cadmium cells, and alkaline cells	5	20	30	23	6	2.06
DC and AC circuit analysis using Thevenin's Law	15	12	28	18	11	1.98

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 25. Degree of competency needed in understanding of electricity, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Unit of measurement of voltage, current, and resistance	1		2	9	<u>36</u>	3.65
Color code of electronic components	1	1	3	6	<u>37</u>	3.60
DC and AC series, parallel and complex circuit analysis using Ohm's Law		1	13	6	<u>28</u>	3.27
Inductance and capacitance in DC and AC circuits	1	2	11	10	<u>24</u>	3.13
Transformer operation	2	3	7	13	<u>23</u>	3.08
Resistivity and conductivity of conductors and insulators	1	4	11	<u>17</u>	15	2.85
Series and parallel resonance, Q and bandwidth	2	3	15	9	<u>19</u>	2.83
Amplitude, frequency, and phase relationship of current and voltage in an AC circuit	1	4	15	13	<u>15</u>	2.77
Motors and controls used in consumer electronic products		6	13	<u>19</u>	10	2.69
Peak, effective, and average values of the AC sine-wave	2	4	<u>15</u>	14	13	2.67
Magnetic laws and properties	1	7	<u>15</u>	11	14	2.63
DC and AC circuit analysis using Kirchhoff's Law	3	3	20	8	14	2.56
Wire sizes in regard to current carrying capabilities	2	4	16	<u>17</u>	9	2.56
Characteristics and applications of dry cells, mercury cells, nickel-cadmium cells, and alkaline cells	2	8	<u>19</u>	10	9	2.33
Time constants	2	12	<u>14</u>	11	9	2.27
DC and AC circuit analysis using Thevenin's Law	9	4	<u>20</u>	7	8	2.02

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 26. Degree of competency needed in understanding of electricity, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Unit of measurement of voltage, current, and resistance	3	3	5	23	98	3.59	3.56	3.65
Color code of electronic components	5	6	8	29	84	3.37	3.24	3.60
DC and AC series, parallel and complex circuit analysis using Ohm's Law	2	4	26	27	73	3.25	3.24	3.27
Inductance and capacitance in DC and AC circuits	5	8	29	39	51	2.93	2.82	3.13
Transformer operation	4	8	31	43	46	2.90	2.80	3.08
Amplitude, frequency, and phase relationship of current and voltage in an AC circuit	3	13	33	43	40	2.79	2.80	2.77
Series and parallel resonance, Q and bandwidth	3	12	41	34	42	2.76	2.71	2.83
Resistivity and conductivity of conductors and insulators	3	20	31	40	38	2.68	2.58	2.85
Peak, effective, and average values of the AC sine-wave	5	11	40	46	30	2.64	2.63	2.67
Motors and controls used in consumer electronic products	3	18	49	37	25	2.48	2.36	2.69
Magnetic laws and properties	3	24	47	30	28	2.42	2.31	2.63
Time constants	4	26	42	35	25	2.39	2.45	2.27
DC and AC circuit analysis using Kirchhoff's Law	12	13	47	31	29	2.39	2.30	2.56
Wire sizes in regard to current carrying capabilities	4	22	47	38	21	2.38	2.27	2.56
Characteristics and applications of dry cells, mercury cells, nickel-cadmium cells, and alkaline cells	7	28	49	33	15	2.16	2.06	2.33

Table 26. (Continued)

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
DC and AC circuit analysis using Thevenin's Law	24	16	<u>48</u>	25	19	1.99	1.98	2.02
						N = 132	N = 84	N = 48

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often used is underscored

Understanding of electronic theory

Principles of color mixing and colorimetry The service technicians were asked to indicate the degree of competency needed in understanding of color fundamentals, principles of color mixing, and colorimetry. That data was summarized in Table 27. The mean ratings were 2.88 and 2.98 by the bench service technicians and home service technicians, respectively.

Table 27. Degree of competency needed in understanding of color fundamentals, principles of color mixing, and colorimetry, as reported by service technicians

Service technicians	Rating					Mean	Total
	0	1	2	3	4		
Bench	5	9	12	23	<u>35</u>	2.88	84
Home	2	5	7	12	<u>22</u>	2.98	48
Total number	7	14	19	35	<u>57</u>	2.92	132

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Consumer electronic product The items that rated the highest by both groups of service technicians were familiarization of "color television", "B&W television", and "AM, FM radios, stereo, and hi fi", "various types of record players and record players and changes" rated high by the home service technicians. "Garage door opener units, headlight dimmers,

automatic mirror control, and signal seeker units" were rated the lowest by both groups of service technicians (see Tables 28, 29, and 30).

Table 28. Degree of competency needed in familiarization of consumer electronic products, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Color television	2	4	7	36	<u>45</u>	3.29
B&W television	3	5	7	31	<u>38</u>	3.14
AM, FM radios, stereo, and hi fi	3	4	12	<u>47</u>	24	2.94
Various types of record players and record changers	3	6	17	<u>38</u>	20	2.79
Antennas and antenna systems	1	11	18	32	22	2.75
Various types of tape recorders	3	5	<u>30</u>	28	18	2.63
Various types of speakers and speaker systems	1	10	<u>30</u>	23	20	2.61
Various types of multi-track tape units used in home and automobile	2	10	<u>30</u>	23	19	2.56
Garage door opener units, headlight dimmers, automatic mirror control, and signal seeker units	10	21	24	<u>30</u>	9	1.96

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Electronic stages Tables 31, 32, and 33 summarized the degree of competency needed in understanding of electronic stages, as reported by service technicians. All eight items listed required approximately the same degree of competency by both groups of service technicians. All items

Table 29. Degree of competency needed in familiarization of consumer electronic products, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Color television	1		3	11	<u>33</u>	3.56
B&W television	1		7	11	<u>29</u>	3.40
Antennas and antenna systems	1		7	18	<u>22</u>	3.25
AM, FM radios, stereo, and hi fi	1		5	<u>23</u>	19	3.23
Various types of record players and record changers		3	9	<u>19</u>	17	3.04
Various types of speakers and speaker systems	2	4	12	14	<u>16</u>	2.79
Various types of tape recorders		5	15	<u>16</u>	12	2.73
Various types of multi-track tape units used in home and automobile	1	6	12	<u>15</u>	14	2.73
Garage door opener units, headlight dimmers, automatic mirror control, and signal seeker units	5	9	<u>13</u>	11	10	2.25

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

had a mean rating between 3.21 and 3.44. The "oscillator stages" and "RF amplifier stages" were rated the highest by home service technicians and "demodulator stages" and "oscillator stages" were rated the highest by bench service technicians. "Multivibrator stages" were rated the lowest by both groups of technicians.

<u>Circuit operation</u> Table 34 provides data concerning degree of competency needed, by service technicians, in understanding of three classes

Table 30. Degree of competency needed in familiarization of consumer electronic products, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Color television	3	4	10	37	<u>78</u>	3.39	3.29	3.56
B&W television	4	5	14	42	<u>67</u>	3.23	3.14	3.40
AM, FM radios, stereo, and hi fi	4	4	17	<u>64</u>	43	3.04	2.94	3.23
Antennas and antenna systems	2	11	25	<u>50</u>	44	2.93	2.75	3.25
Various types of record players and record changers	3	9	26	<u>57</u>	37	2.88	2.79	3.04
Various types of tape recorders	3	10	<u>45</u>	44	30	2.67	2.63	2.73
Various types of speakers and speaker systems	3	14	<u>42</u>	37	36	2.67	2.61	2.79
Various types of multi-track tape units used in home and automobile	3	16	<u>42</u>	38	33	2.62	2.56	2.73
Garage door opener units, headlight dimmers, automatic mirror control, and signal seeker units	15	30	<u>37</u>	31	19	2.07	1.96	2.25
						N = 132	N = 84	N = 48

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 31. Degree of competency needed in understanding of electronic stages, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Demodulator stages		3	11	23	<u>47</u>	3.36
Oscillator stages	2	3	6	26	<u>47</u>	3.34
IF amplifier stages	1	4	9	23	<u>47</u>	3.32
RF amplifier stages	1	4	8	26	<u>45</u>	3.31
Amplifier stages	2	3	9	23	<u>47</u>	3.31
Convertor stages		5	10	25	<u>44</u>	3.29
Detector stages	1	4	11	22	<u>46</u>	3.29
Power supplies	2	5	7	23	<u>47</u>	3.29
Deflection stages		6	10	22	<u>46</u>	3.29
Multivibrator stages	1	4	12	22	<u>45</u>	3.26

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

of circuit operation. All three items were rated rather close together. "Class A operation" was rated highest by bench service technicians, and "Class B operation" was rated highest by home service technicians. "Class C operation" was rated lowest by both groups.

<u>Component characteristics and applications</u> The data in Table 35 reported that "transistors", "semiconductor diodes", "FET transistors", "integrated circuits", "unijunction transistors", "zener diodes", "diode and triode vacuum tubes", and "thermistors" rated the highest, by bench service technicians, with an average rating of "much competency needed". "Transistors", "integrated circuits", "diode and triode vacuum tubes",

Table 32. Degree of competency needed in understanding of electronic stages, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Oscillator stages			7	13	28	3.44
RF amplifier stages		1	7	13	27	3.38
IF amplifier stages		2	6	14	26	3.33
Demodulator stages		1	6	17	24	3.33
Convertor stages		3	5	15	25	3.29
Power supplies		2	8	12	26	3.29
Deflection stages		2	8	12	26	3.29
Detector stages		2	9	12	25	3.25
Amplifier stages		2	10	11	25	3.23
Multivibrator stages	1	1	9	13	24	3.21

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

"semiconductor diodes", "FET transistors", and "unijunction transistors" were rated the highest, by home service technicians, with an average rating of "much competency needed" (see Table 36). The items "photoconductive devices (photocells)" and "photovoltaic devices (solar cells)" were rated the lowest by both groups of service technicians with an average rating of "some competency needed" (see Table 37).

Frequency of performance and degree of competency needed by service technicians in servicing consumer products, using shop techniques and using electronic test equipment

The researcher felt that in order to gather data that would be helpful in developing a program for training consumer electronics service techni-

Table 33. Degree of competency needed in understanding of electronic stages, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Oscillator stages	2	3	13	39	<u>75</u>	3.38	3.34	3.44
Demodulator stages		4	17	40	<u>71</u>	3.35	3.36	3.33
RF amplifier stages	1	5	15	39	<u>72</u>	3.33	3.31	3.38
IF amplifier stages	1	6	15	37	<u>73</u>	3.33	3.32	3.33
Convertor stages		8	15	40	<u>69</u>	3.29	3.29	3.29
Power supplies	2	7	15	35	<u>73</u>	3.29	3.29	3.29
Deflection stages		8	18	34	<u>72</u>	3.29	3.29	3.29
Amplifier stages	2	5	19	34	<u>72</u>	3.28	3.31	3.23
Detector stages	1	6	20	34	<u>71</u>	3.27	3.29	3.25
Multivibrator stages	2	5	21	35	<u>69</u>	3.24	3.26	3.21
						N = 132	N = 84	N = 48

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

Table 34. Degree of competency needed in understanding of circuit operation, as reported by total number of service technicians

Topic item	Rating 0	1	2	3	4	Mean	Total
Bench service technicians							
Class A operation		6	19	<u>32</u>	27	2.95	84
Class B operation		7	22	<u>31</u>	24	2.86	84
Class C operation		8	21	<u>31</u>	24	2.84	84
Home service technicians							
Class B operation	3	1	14	<u>16</u>	14	2.77	48
Class A operation	3	1	<u>16</u>	14	14	2.73	48
Class C operation	3	1	<u>17</u>	13	14	2.71	48
Total number of service technicians							
Class A operation	3	7	35	<u>46</u>	41	2.87	132
Class B operation	3	8	36	<u>47</u>	38	2.83	132
Class C operation	3	9	38	<u>44</u>	38	2.79	132

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

cians, data concerning the frequency of performance of tasks or jobs performed by the service technician should be undertaken. The frequency of performance would report what the service technicians do and how often the tasks or jobs are performed. By using the data, the consumer electronics servicing training program could be developed around what the service technicians actually do.

This section of the study consisted of six major topics with several items listed under each topic. The major topics were: (1) ability to

Table 35. Degree of competency needed in understanding of component characteristics and applications, as reported by bench service technicians (N = 84)

Topic item	Rating 0	1	2	3	4	Mean
Transistor		3	10	21	50	3.40
Semiconductor diode		4	11	30	39	3.24
FET transistor		7	10	28	39	3.18
Integrated circuit		5	14	27	38	3.17
Unijunction transistor	1	4	16	25	38	3.13
Zener diode	1	3	15	31	34	3.12
Diode and triode vacuum tubes		9	11	29	35	3.07
Thermistor		4	23	26	31	3.00
Silicon controlled rectifier (SCR)	1	7	15	30	31	2.99
(VDR) voltage dependent resistor	2	4	19	28	31	2.98
Varactor	2	6	19	32	25	2.86
Tunnel diode	1	5	24	35	19	2.79
Photoemissive devices (photomultiplier tubes)	7	19	31	18	9	2.04
Photoconductive devices (photocells)	7	18	33	18	8	2.02
Photovoltaic devices (solar cells)	9	20	30	20	5	1.90

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

repair televisions, radios, and stereos, (2) ability to repair tape recorders and players and record changers and players, (3) ability to repair automotive radio, automotive stereo units, and automotive reverberation units, (4) installation of indoor and outdoor antennas, (5) ability to use shop techniques, and (6) ability to use electronic test equipment.

Table 36. Degree of competency needed in understanding of component characteristics and applications, as reported by home service technicians (N = 48)

Topic item	Rating 0	1	2	3	4	Mean
Transistor	3		7	13	<u>25</u>	3.19
Integrated circuit	3	2	6	17	<u>20</u>	3.02
Diode and triode vacuum tubes	3	1	11	10	<u>23</u>	3.02
Semiconductor diode	3	4	5	14	<u>22</u>	3.00
FET transistor	2	3	6	<u>19</u>	18	3.00
Unijunction transistor	2	2	8	<u>18</u>	<u>18</u>	3.00
Silicon controlled rectifier (SCR)	3	1	13	12	<u>19</u>	2.90
Thermistor	3	1	12	15	<u>17</u>	2.88
(VDR) voltage dependent resistor	3	1	11	<u>18</u>	15	2.85
Zener diode	3	1	13	<u>17</u>	14	2.79
Varactor	2	4	<u>15</u>	13	14	2.69
Tunnel diode	2	5	14	12	<u>15</u>	2.69
Photoemissive devices (photomultiplier tubes)	4	10	<u>19</u>	6	9	2.13
Photoconductive devices (photocells)	4	10	<u>22</u>	6	6	2.00
Photovoltaic devices (solar cells)	4	14	<u>17</u>	7	6	1.94

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

The service technicians were asked to rate each item as to the frequency he performed each item listed on a five-point scale. He was also asked to rate each item as to the degree of competency needed in performing each item listed on a five-point scale. The rating scale for frequency of performance was: (0) not used or performed, (1) sometimes, (2) monthly,

Table 37. Degree of competency needed in understanding of component characteristics and applications, as reported by total number of service technicians

Topic item	Rating					Service Technicians		
	0	1	2	3	4	Grand mean	Bench (mean)	Home (mean)
Transistor	3	3	17	34	<u>75</u>	3.33	3.40	3.19
Semiconductor diodes	3	8	16	44	<u>61</u>	3.15	3.24	3.00
FET transistor	2	10	16	47	<u>57</u>	3.11	3.18	3.00
Integrated circuit	3	7	20	44	<u>58</u>	3.11	3.17	3.02
Unijunction transistor	3	6	24	43	<u>56</u>	3.08	3.13	3.00
Diode and triode vacuum tubes	3	10	22	39	<u>59</u>	3.05	3.07	3.02
Zener diodes	4	4	28	<u>48</u>	<u>48</u>	3.00	3.12	2.79
Thermistor	3	5	35	<u>41</u>	<u>48</u>	2.95	3.00	2.88
Silicon controlled rectifier (SCR)	4	8	28	42	<u>50</u>	2.95	2.99	2.90
(VDR) voltage dependent resistor	5	5	30	<u>46</u>	<u>46</u>	2.93	2.98	2.85
Varactor	4	10	34	<u>45</u>	39	2.79	2.86	2.69
Tunnel diodes	3	10	38	<u>47</u>	34	2.75	2.79	2.69
Photoemissive devices (photomultiplier tubes)	11	29	<u>50</u>	24	18	2.07	2.04	2.13
Photoconductive devices (photocells)	11	28	<u>55</u>	24	14	2.01	2.02	2.00
Photovoltaic devices (solar cells)	13	34	<u>47</u>	27	11	1.92	1.90	1.94
						N = 132	N = 84	N = 48

Rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

(3) weekly, and (4) daily. The rating scale for degree of competency needed was: (0) no competency needed, (1) little competency needed, (2) some competency needed, (3) much competency needed, and (4) very much competency needed.

Tables 38, 39, and 40 summarized the data concerning the frequency of performance and degree of competency needed by service technicians in performing tasks or jobs. Tables 38 and 39 reported frequency of performance ratings assigned to each item by the bench and home service technician, respectively. The frequency of performance and degree of competency needed (mean ratings) were also presented with each item. Table 40 combined the data in Tables 38 and 39 to form the total number of service technicians. Only frequency of performance and degree of competency needed (mean ratings) were presented in Table 40.

According to the data presented, four tasks were rated as performed "weekly", by the bench service technicians, in servicing radios, televisions, and stereos. The tasks were: "removal and reassembly of radio, television, and stereo chassis of various sets", "replacement of defective components", "lubrication of various controls", and "adjustment of purity, static convergence, and dynamic convergence of color televisions". The task "replacement of various defective components" was performed more frequently by bench service technicians than by home service technicians.

The task that required the highest degree of competency by bench service technicians was "alignment of B&W and color televisions". "Adjustment of purity, static convergence, and dynamic convergence of color televisions" required the highest degree of competency by home service technicians.

Table 38. Frequency of performance and degree of competency needed, as reported by bench service technicians (N = 84)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Ability to repair televisions, radios, and stereos							
Removal and reassembly of radio, television, and stereo chassis of various sets	1	1		1	81	3.90	3.05
Replacement of various defective components in radios, televisions, and stereos	1	2	2	5	74	3.77	3.34
Lubrication and adjustment of various controls		4	3	7	70	3.70	2.94
Cleaning of safety glass, cabinets, and chassis	1	3	7	19	54	3.45	2.54
Adjustment of purity, static convergence, and dynamic convergence of color television sets	9	4	3	13	55	3.20	3.33
Replacement and adjustment of color CRT	12	9	11	33	19	2.45	3.27
Replacement and adjustment of B&W CRT	6	18	17	27	16	2.34	2.95
Servicing and adjustment of remote control systems in television sets	10	24	16	22	12	2.02	3.19
Alignment of B&W and color TV IF stages	12	34	11	17	10	1.75	3.46
Alignment of B&W and color TV tuners	22	33	9	10	10	1.44	3.15
Ability to repair tape players, recorders, record players, and changers							
Diagnosis, repairing, and replacement of defective parts in tape recorder and record changer units	4	14	8	27	31	2.80	3.14
Cleaning, lubrication, and adjustment of tape recorder units and record changer units	4	17	6	30	27	2.70	2.98

Table 38. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Removal and reinstallation from cabinet or case of tape recorder units and record changer units	3	23	7	25	26	2.57	2.81
Use of strob-o-scope to check proper speed on record player and changer units	6	17	9	30	22	2.54	2.33
Use of test tape to check head alignment and frequency response on tape players and recorders	13	26	11	16	18	2.00	2.45
Repair of automotive radio, auto stereo units, and auto reverberation units							
Diagnosis and replacement of defective parts in auto radio, stereo, and reverb units	22	22	9	13	18	1.80	2.54
Diagnosis and repair of auto tape players	28	25	9	11	11	1.43	2.48
Removal, reinstallation, and adjustment of various makes of auto radios, auto stereos, and reverberation	34	23	6	12	9	1.27	1.99
Auto antenna repair, replacement, and new installation	42	22	5	11	4	0.96	1.61
Diagnosis and repair of garage door control units, headlight dimmers, and signal seeking units	48	16	7	7	6	0.89	1.75
Diagnosis, repair, and alignment of auto multiplex units	46	22	4	9	3	0.82	2.08
Installation of indoor and outdoor antennas							
Installation of television and FM outdoor antennas	37	17	4	18	8	1.32	2.05

Table 38. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Installation of television and FM antennas in attic and other indoor locations	38	22	8	11	5	1.08	1.92
Installation and maintenance of multiple antenna and multiple outlet systems	42	23	8	8	3	0.89	2.24
Ability to use shop techniques							
Read block and schematic diagrams	2	2	0	1	79	3.87	3.35
Using small hand tools		1	2	5	76	3.86	2.84
Testing of tubes and transistors	1	2		3	78	3.84	3.12
Unsoldering and soldering of components in the circuit	3		1	2	78	3.81	3.09
Apply first aid procedures	28	36	5	6	9	1.19	2.17
Sheet metal fabrication	41	26	12	2	3	0.81	1.18
Layout and etching of printed circuit boards	57	12	4	3	8	0.73	1.13
Ability to use electronic test equipment							
Vacuum tube voltmeter (VTVM)	2	2	1	2	77	3.79	3.37
Vacuum tube tester	2	6	1	7	68	3.58	2.96
Volt-ohm-milliampere meter (VOM)	3	7		4	70	3.56	3.37
Transistor tester	1	5	4	14	60	3.51	3.21
Cathode ray tube tester	4	8	9	19	44	3.08	3.07
Transistor voltmeter (TRVM)	17	4	1	12	50	2.88	3.08
Color bar/dot/cross hatch generator	11	9	5	13	46	2.88	3.01
Signal tracer	4	14	6	26	34	2.86	2.82
Signal injector	6	13	9	26	30	2.73	2.83
Color CRT test jig	12	17	5	16	34	2.51	2.75
AF signal generator	6	18	13	23	24	2.49	2.90
RF signal generator	5	20	14	23	22	2.44	2.94
B&W CRT test jig	16	15	12	17	24	2.21	2.62
Bias power supply	7	30	12	20	15	2.07	2.73
Capacitor tester	18	22	6	16	22	2.02	2.31
Capacitor substitution box	22	18	6	16	22	1.98	2.19

Table 38. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Resistor substitution box	25	21	4	12	22	1.82	2.15
Sweep and marker generator	13	28	19	15	9	1.75	3.14
TV analyst (B&K)	31	11	8	17	17	1.74	2.52
Field strength meter	30	19	11	9	15	1.52	2.24
Transistor radio analyst	33	18	9	5	19	1.51	2.27
Multiplex generator	31	27	11	6	9	1.23	2.49
Impedance bridge	43	19	7	4	11	1.06	1.96
Grind dip oscillator	53	17	7	3	4	0.67	1.81
Oscilloscopes							
AC coupled	8	17	7	15	37	2.67	2.94
Direct coupled	12	20	5	15	32	2.42	2.87
Vector	26	19	10	15	14	1.67	2.76
Triggered sweep	33	21	5	13	12	1.40	2.37
Oscilloscope probes							
Direct	5	22	6	14	37	2.67	2.93
X10 (low capacitance)	8	21	6	14	35	2.56	2.90
Crystal demodulation	19	22	9	18	16	1.88	2.73
Isolation	27	22	6	18	11	1.57	2.29

Frequency of performance rating scale:
0 - Not used or performed
1 - Sometimes
2 - Monthly
3 - Weekly
4 - Daily

Degree of competency needed rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

All tasks listed in the category of "ability to repair tape players, recorders, record players, and changers", were performed on the average of "monthly" by bench service technicians and were given lower frequency ratings by the home service technicians. The task given the highest competency needed rating by both groups of service technicians was "diagnosis,

Table 39. Frequency of performance and degree of competency needed, as reported by home service technicians (N = 48)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Ability to repair televisions, radios, and stereos							
Removal and reassembly of radio, television, and stereo chassis of various sets		2		1	45	3.85	3.40
Lubrication and adjustment of various controls	1			6	41	3.79	3.08
Replacement of various defective components in radios, televisions, and stereos		3	1	5	39	3.67	3.52
Adjustment of purity, static convergence, and dynamic convergence of color television sets	2	1		11	34	3.54	3.56
Cleaning of safety glass, cabinets, and chassis		9	2	14	23	3.06	2.75
Replacement and adjustment of color CRT	2	13	10	18	5	2.23	3.54
Servicing and adjustment of remote control systems in television sets	2	15	11	18	2	2.06	3.33
Replacement and adjustment of B&W CRT	3	14	10	20	1	2.04	3.13
Alignment of B&W and color TV tuners	20	15	5	4	4	1.10	2.73
Alignment of B&W and color TV IF stages	14	24	6	2	2	1.04	3.13
Ability to repair tape players, recorders, record players, and changers							
Removal and reinstallation from cabinet or case of tape recorder units and record changer units	3	7	14	16	8	2.40	3.04
Cleaning, lubrication, and adjustment of tape recorder units and record changer units	3	10	12	18	5	2.25	2.98

Table 39. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Diagnosis, repairing, and replacement of defective parts in tape recorder and record changer units	4	10	13	16	5	2.17	3.08
Use of strob-o-scope to check proper speed on record player and changer units	9	15	4	17	3	1.79	2.58
Use of test tape to check head alignment and frequency response on tape players and recorders	17	16	7	8		1.13	2.38
Repair of automotive radio, auto stereo units, and auto reverberation units							
Diagnosis and replacement of defective parts in auto radio, stereo, and reverb units	17	17	4	5	5	1.25	2.29
Removal, reinstallation, and adjustment of various makes of auto radios, auto stereos, and reverberation units	22	14	3	6	3	1.04	2.08
Diagnosis and repair of garage door control units, headlight dimmers, and signal seeking units	18	17	8	5		1.00	2.02
Diagnosis and repair of auto tape players	21	15	6	4	2	0.98	2.21
Auto antenna repair, replacement, and new installation	28	11	5	2	2	0.73	1.52
Diagnosis, repair, and alignment of auto multiplex units	28	15	2	3		0.58	1.81
Installation of indoor and outdoor antennas							
Installation of television and FM outdoor antennas	11	14	7	13	3	1.65	2.58

Table 39. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Installation and maintenance of multiple antenna and multiple outlet systems	11	15	9	9	4	1.58	2.96
Installation of television and FM antennas in attic and other indoor locations	14	19	9	5	1	1.17	2.40
Ability to use shop techniques							
Using small hand tools	1	2		3	42	3.73	3.10
Unsoldering and soldering of components in the circuit	3		1	2	78	3.54	3.19
Testing of tubes and transistors	2	1	4	6	35	3.48	3.10
Read block and schematic diagrams	6	3	1	4	35	3.27	3.35
Apply first aid procedures	11	26	2	4	5	1.29	2.31
Layout and etching of printed circuit boards	33	7	1	1	6	0.75	1.46
Sheet metal fabrication	24	19	3		2	0.69	1.46
Ability to use electronic test equipment							
Vacuum tube tester	1	3	2	6	36	3.52	3.10
Volt-ohm-milliampere meter (VOM)	5	2	1	4	36	3.50	3.23
Vacuum tube voltmeter (VTVM)	5	3	2	3	35	3.25	3.17
Color bar/dot/cross hatch generator	10		1	11	26	2.90	3.17
Cathode ray tube tester	7	8	4	16	13	2.42	2.94
Transistor voltmeter (TRVM)	11	8	5	3	21	2.31	3.02
Transistor tester	7	13	4	10	14	2.23	2.94
Field strength meter	12	12	4	13	7	1.81	2.60
Signal injector	13	16	4	7	8	1.60	2.48
Capacitor substitution box	16	11	6	7	8	1.58	2.29
Signal tracer	15	15	2	10	6	1.52	2.50
Capacitor tester	15	13	7	7	6	1.50	2.42
Resistor substitution box	17	11	7	5	8	1.50	2.29
RF signal generator	15	20	4	4	5	1.25	2.48
AF signal generator	17	18	3	6	4	1.21	2.44
Bias power supply	15	20	5	7	1	1.15	2.60
Color CRT test jig	34	6		4	4	.71	2.58

Table 39. (Continued)

Topic item	Frequency of performance Rating 0	1	2	3	4	Mean	Degree of competency needed Mean
Impedance bridge	27	14	2	4	1	.71	2.13
B&W CRT test jig	32	10	1	4	1	.58	2.31
Multiplex generator	33	9	2	4		.52	2.46
TV analyst (B&K)	33	9	3	3		.50	2.25
Sweep and marker generator	31	12	4	1		.48	2.79
Transistor radio analyst (B&K)	36	9		2	1	.40	1.90
Grid dip oscillator	35	11		2		.35	1.50
Oscilloscopes							
AC coupled	32	11	2	1	2	.54	2.46
Direct coupled	34	9	1	2	2	.52	2.56
Vector	37	6	4	1		.35	2.33
Triggered sweep	39	6	1	2		.29	2.35
Oscilloscope probes							
X10 (low capacitance)	32	6	4	4	2	.71	2.48
Direct probe	34	7	3	1	3	.58	2.35
Isolation	37	7	1	2	1	.40	2.04
Crystal demodulation	35	10	2		1	.38	2.10

Frequency of performance rating scale:
0 - Not used or performed
1 - Sometimes
2 - Monthly
3 - Weekly
4 - Daily

Degree of competency needed rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

Rating most often listed is underscored.

repairing, and replacement of defective components in tape recorder and record changer units".

The three items listed under "installation of indoor and outdoor antennas" were performed on the average of "sometimes" and required a degree of competency level of "some competency needed".

Table 40. Frequency of performance and degree of competency needed (mean ratings), as reported by total number of service technicians

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Ability to repair televisions, radios, and stereos						
Removal and reassembly of radio, television, and stereo chassis of various sets	3.90	3.05	3.85	3.40	3.89	3.17
Replacement of various defective components in radios, televisions, and stereos	3.37	3.34	3.67	3.52	3.73	3.41
Lubrication and adjustment of various controls	3.70	2.94	3.79	3.08	3.73	2.99
Adjustment of purity, static convergence, and dynamic convergence of color television sets	3.20	3.33	3.54	3.56	3.33	3.42
Replacement and adjustment of color CRT	2.45	3.27	2.23	3.54	2.37	3.37
Replacement and adjustment of B&W CRT	2.34	2.95	2.04	3.13	2.23	3.01
Servicing and adjustment of remote control systems in television sets	2.02	3.19	2.06	3.33	2.04	3.24
Alignment of B&W and color TV IF stages	1.75	3.46	1.04	3.13	1.49	3.34

Table 40. (Continued)

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Alignment of B&W and color TV tuners	1.44	3.15	1.10	2.73	1.32	3.00
Ability to repair tape players, recorders, record players, and changers						
Diagnosis, repairing, and replacement of defective parts in tape recorder and record changer units	2.80	3.14	2.17	3.08	2.57	3.12
Cleaning, lubrication, and adjustment of tape recorder units and record changer units	2.70	2.98	2.25	2.98	2.54	2.98
Removal and reinstallation from cabinet or case of tape recorder units and record changer units	2.57	2.81	2.40	3.04	2.51	2.89
Use of strob-o-scope to check proper speed on record player and changer units	2.54	2.33	1.79	2.58	2.26	2.42
Use of test tape to check head alignment and frequency response on tape players and recorders	2.00	2.45	1.13	2.38	1.68	2.42

Table 40. (Continued)

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Repair of automotive radio, auto stereo units, and auto reverberation units						
Diagnosis and replacement of defective parts in auto radio, stereo, and reverb units	1.80	2.54	1.25	2.29	1.60	2.45
Diagnosis and repair of auto tape players	1.43	2.48	.98	2.21	1.26	2.38
Removal, reinstallation, and adjustment of various makes of auto radios, auto stereos, and reverberation units	1.27	1.99	1.04	2.08	1.19	2.02
Diagnosis and repair of garage door control units, headlight dimmers, and signal seeking units	.89	1.75	1.00	2.02	.93	1.85
Auto antenna repair, replacement, and new installation	.96	1.61	.73	1.52	.88	1.58
Diagnosis, repair, and alignment of auto multiplex units	.82	2.08	.58	1.81	.73	1.98

Table 40. (Continued)

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Installation of indoor and outdoor antennas						
Installation of television and FM outdoor antennas	1.32	2.05	1.65	2.58	1.44	2.24
Installation and maintenance of multiple antenna and multiple outlet systems	.89	2.24	1.58	2.96	1.14	2.50
Installation of television and FM antennas in attic and other indoor locations	1.08	1.92	1.17	2.40	1.11	2.09
Ability to use shop techniques						
Using small hand tools	3.86	2.84	3.73	3.10	3.81	2.94
Testing of tubes and transistors	3.84	3.12	3.48	3.10	3.71	3.11
Unsoldering and soldering of components in the circuit	3.81	3.09	3.54	3.19	3.71	3.13
Read block and schematic diagrams	3.87	3.35	3.27	3.35	3.65	3.35
Apply first aid procedures	1.19	2.17	1.29	2.31	1.23	2.22
Sheet metal fabrication	.81	1.18	.69	1.46	.76	1.28
Layout and etching of printed circuit boards	.73	1.13	.75	1.46	.73	1.25

Table 40. (Continued)

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Ability to use electronic test equipment						
Vacuum tube voltmeter (VTVM)	3.79	3.37	3.25	3.17	3.59	3.29
Vacuum tube tester	3.58	2.96	3.52	3.10	3.54	3.01
Volt-ohm-milliampere meter (VOM)	3.56	3.37	3.50	3.23	3.54	3.32
Transistor tester	3.51	3.21	2.23	2.94	3.04	3.11
Color bar/dot/cross hatch generator	2.88	3.01	2.90	3.17	2.89	3.07
Cathode ray tube tester	3.08	3.07	2.42	2.94	2.84	3.02
Transistor voltmeter (TRVM)	2.88	3.08	2.31	3.02	2.67	3.06
Signal tracer	2.86	2.82	1.52	2.50	2.37	2.70
Signal injector	2.73	2.83	1.60	2.48	2.32	2.70
AF signal generator	2.49	2.90	1.21	2.44	2.02	2.73
RF signal generator	2.44	2.94	1.25	2.48	2.01	2.77
Color CRT test jig	2.51	2.75	.71	2.58	1.86	2.69
Capacitor tester	2.02	2.31	1.50	2.42	1.83	2.35
Capacitor substitution box	1.98	2.19	1.58	2.29	1.83	2.23
Bias power supply	2.07	2.73	1.15	2.60	1.73	2.68
Resistor substitution box	1.82	2.15	1.50	2.29	1.70	2.20
Field strength meter	1.52	2.24	1.81	2.60	1.63	2.37
B&W CRT test jig	2.21	2.62	.58	2.31	1.62	2.51
Sweep and marker generator	1.75	3.14	.48	2.79	1.29	3.01
TV analyst	1.74	2.52	.50	2.25	1.29	2.42
Transistor radio analyst	1.51	2.27	.40	1.90	1.11	2.14

Table 40. (Continued)

Topic item	Bench service technicians		Home service technicians		Total number of service technicians	
	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed	Frequency of performance	Degree of competency needed
Multiplex generator	1.23	2.49	.52	2.46	.97	2.48
Impedance bridge	1.06	1.96	.71	2.13	.93	2.02
Grid dip oscillator	.67	1.81	.35	1.50	.55	1.70
Oscilloscopes						
AC coupled	2.67	2.94	.54	2.46	1.89	2.76
Direct coupled	2.42	2.87	.52	2.56	1.73	2.76
Vector	1.67	2.76	.35	2.33	1.19	2.61
Triggered sweep	1.40	2.37	.29	2.35	1.00	2.36
Oscilloscope probes						
Direct probe	2.67	2.93	.58	2.35	1.91	2.72
X10 (low capacitance)	2.56	2.90	.71	2.48	1.89	2.75
Crystal demodulation	1.88	2.73	.38	2.10	1.33	2.50
Isolation	1.57	2.29	.40	2.04	1.14	2.20

Frequency of performance rating scale:
0 - Not used or performed
1 - Sometimes
2 - Monthly
3 - Weekly
4 - Daily

Degree of competency needed rating scale:
0 - No competency needed
1 - Little competency needed
2 - Some competency needed
3 - Much competency needed
4 - Very much competency needed

In the category of "ability to use shop techniques", the items "using small hand tools", "testing of tubes and transistors", "unsoldering and soldering of components in the circuit", and "read block and schematic diagrams" were performed on the average of "weekly" by the service technicians. "Sheet metal fabrication" and "layout and etching of printed circuit boards" had the lowest frequency of performance ratings. "Read block and schematic diagrams" had the highest degree of competency needed mean rating which was 3.35.

The "vacuum tube voltmeter (VTVM)", "vacuum tube tester", "volt-ohm-milliampere meter (VOM)", and "transistor tester" were the test equipment items indicated as used "weekly". The "multiplex generator", "impedance bridge", and "grid dip oscillator" were indicated as the least frequently used test equipment items. The "vacuum tube voltmeter (VTVM)", "vacuum tube tester", "volt-ohm-milliampere meter (VOM)", "transistor tester", "color bar/dot/cross hatch generator", "cathode ray tube tester", "transistor voltmeter (TRVM)", and "sweep and marker generator" required a degree of competency level of "much competency needed".

Service Information

This section described the findings concerning the last three consumer electronic products serviced by the service technicians just before the interview. The service technicians were asked to list the last three consumer electronic products serviced, test equipment used in servicing each item, defective stage or stages, defective component or components, and adjustments performed to complete the service.

Last three consumer electronic products serviced by each service technician

The data in Table 41 summarized the consumer electronic products serviced by the service technicians when they were asked to list the last three items serviced. According to the data presented, a total of 355 consumer electronic products were listed. Of the 355 items listed, 173 were color televisions, 65 were B&W televisions, 59 were radios, 18 were tape recorders or tape players, 17 were record players or changers, 17 were in the category of audio systems, and six in the category of miscellaneous consumer electronic products. Ninety of the color televisions were serviced by bench service technicians, and 83 were serviced by home service technicians. Fifty-one of the B&W televisions were serviced by bench service technicians, and 14 were serviced by home service technicians. Only four of the radios were serviced by home service technicians. All of the tape recorders and tape players were serviced by bench service technicians. Two of the record players or changers were serviced by home service technicians. All of the items listed in the audio systems category were serviced by bench service technicians. All six items listed in the miscellaneous category were serviced by home service technicians.

Electronic test equipment

The distribution of electronic test equipment used in servicing the various consumer electronic products were presented in Table 42. The "vacum tube voltmeter (VTVM)" was the most frequently used test equipment item. It was used in servicing 141 of the 355 consumer electronic products serviced. The "oscilloscope" was ranked second and was used in servicing 71 products.

Table 41. Frequency distribution of last three consumer electronic products serviced by each service technician

Consumer electronic products	Serviced by bench service technicians	Serviced by home service technicians	Total products serviced
Color television	90	83	173
B&W television	51	14	65
Radio			
AM radio	16		16
AM-FM tuner/amplifier	14	2	16
FM receiver or tuner	6	2	8
Automotive radio	12		12
Transceiver	3		3
Garage door opener	2		2
FM communication receiver	1		1
FM transmitter	1		1
Sub total	55	4	59
Tape recorder and player			
Tape recorder	7		7
Automotive tape player	5		5
Tape deck	3		3
Stereo recorder	1		1
Stereo tape player	1		1
Video tape recorder	1		1
Sub total	18		18
Record player and changer			
Record player	7		7
Stereo record player	5		5
Record changer	4	1	5
Sub total	16	1	17
Audio systems			
Stereo amplifier	5		5
Stereo console	4		4
Audio amplifier	4		4
Intercom unit	2		2
PA system	1		1
Telephone and paging system	1		1
Sub total	17		17

Table 41. (Continued)

Consumer electronic products	Serviced by bench service technicians	Serviced by home service technicians	Total products serviced
Miscellaneous			
Multi-antenna distribution system		2	2
Antenna installation		1	1
Antenna rotor installation		1	1
Vidicon TV camera		1	1
Dollar bill changer		1	1
Sub total		6	6
Total	244	108	355

According to the data presented in Table 43, the "vacuum tube voltmeter (VTVM)" was the test equipment item most frequently used by both bench and home service technicians in servicing the following consumer electronic products: color television, B&W television, radio, tape recorders and tape players, and audio systems. No test equipment was required in servicing the majority of the record players and changers.

Defective stages and special circuits

The data in Table 44 summarized the defective stages and special circuits in the consumer electronic products serviced by service technicians. Some of the products had more than one defective stage, but this was not categorized in Table 44. According to the data presented, the horizontal output stage was found defective in 22 of the 173 color televisions serviced. The tuner was defective in 19 of the color televisions. In the B&W television, there were two stages that caused the majority of the problems.

Table 42. Electronic test equipment used in servicing each of last three consumer electronic products, as reported by service technicians

Electronic test equipment used	Consumer Electronic Products Serviced							
	Color television	B&W television	Radio	Tape recorder/ player	Record player/ changer	Audio systems	Misc.	Total
Vacuum tube voltmeter (VTVM)	61	32	22	12	2	12		141
Oscilloscope	37	14	12	3		5		71
Volt-ohm-milliampere meter (VOM)	24	8	6	1	4	3	3	49
Color bar/dot/cross hatch generator	35							35
No test equipment used	24		2	1	5	1		33
Vacuum tube tester	19	8	1		1	2		31
Degaussing coil	30							30
HV probe or HV tester	27							27
Transistor tester	3		8	1	3	4		19
Sweep and marker generator	14							14
CRT tester	7	7						14
Signal tracer	1		4	2	2	1		10
RF signal generator			10					10
TV analyst	4	4						8
Color or B&W CRT test jig	4	3						7
Signal injector		1	3	2	1			7
Capacitor checker	3	2	1					6
FM multiplex generator			6					6

Table 42. (Continued)

Electronic test equipment used	Consumer Electronic Products Serviced							
	Color television	B&W television	Radio	Tape recorder/ player	Record player/ changer	Audio systems	Misc.	Total
AF signal generator			5		1			6
Capacitor substitution box	2	1	1					4
Strob-o-scope					3			3
Frequency counter			3					3
Head alignment cartridge				3				3
Field strength meter							3	3
Demagnetizer				2				2
Watt meter			2					2
Resistor substitution box		2						2
Flyback transformer tester	1							1
FM sweep generator			1					1
Transistor radio analyst						1		1
Grid dip meter	1							1
Q meter	1							1

Table 43. Distribution of electronic test equipment used by service technicians based upon the last three consumer electronic products serviced

Topic item	Used by bench service technicians	Used by home service technicians	Used by total number of service technicians
Color television			
Vacuum tube voltmeter	42	19	61
Oscilloscope	37	2	39
Color bar/dot/cross hatch generator	20	15	35
Degaussing coil	12	18	30
HV probe or tester	12	15	27
No test equipment used	9	15	24
Volt-ohm-milliampere meter	8	16	24
Vacuum tube tester	9	10	19
Sweep and marker generator	14		14
CRT tester	4	3	7
Color test jig	4		4
TV analyst	3	1	4
Capacitor checker	2	1	3
Transistor tester	1	2	3
Capacitor substitution box	1	1	2
Signal tracer		1	1
Flyback transformer tester	1		1
Q meter	1		1
Grid dip oscillator	1		1
B&W television			
Vacuum tube voltmeter	24	8	32
Oscilloscope	14		14
Vacuum tube tester	5	3	8
Volt-ohm-milliampere meter	8		8
CRT tester	4	3	7
Sweep and marker generator	5		5
TV analyst	4		4
B&W test jig	3		3
Capacitor checker	1	1	2
Resistor substitution box	1	1	2
Signal injector	1		1
Capacitor substitution box	1		1
Radio			
Vacuum tube voltmeter	21	1	22
Oscilloscope	12		12

Table 43. (Continued)

Topic item	Used by bench service technicians	Used by home service technicians	Used by total number of service technicians
RF signal generator	10		10
Transistor tester	7	1	8
Volt-ohm-milliampere meter	6		6
Multiplex generator	6		6
AF signal generator	5		5
Signal tracer	4		4
Signal injector	3		3
Frequency counter	3		3
Watt meter	2		2
Test speaker	2		2
Battery eliminator	2		2
No test equipment used	2		2
Vacuum tube tester	1		1
Capacitor substitution box	1		1
FM sweep generator	1		1
Capacitor checker	1		1
Tape recorder and player			
Vacuum tube volt meter	11	1	12
Tape head alignment cartridge	3		3
Oscilloscope	3		3
Signal injector	2		2
Signal tracer	2		2
Demagnetizer	2		2
Volt-ohm-milliampere meter	1		1
Transistor tester	1		1
No test equipment used	1		1
Record player and changer			
No test equipment used	5		5
Volt-ohm-milliampere meter	4		4
Strob-o-scope	3		3
Transistor tester	3		3
Signal tracer	2		2
Vacuum tube voltmeter	2		2
Signal injector	1		1
AF signal generator	1		1
Vacuum tube tester	1		1

Table 43. (Continued)

Topic item	Used by bench service technicians	Used by home service technicians	Used by total number of service technicians
Audio systems			
Vacuum tube voltmeter	12		12
Oscilloscope	5		5
Transistor tester	4		4
Volt-ohm-milliampere meter	3		3
Vacuum tube tester	2		2
Transistor radio analyst	1		1
Signal tracer	1		1
No test equipment used	1		1
Miscellaneous consumer products			
Field strength meter	3		3
Volt-ohm-milliampere meter	3		3

The stages were low voltage power supply and vertical deflection circuit. The IF amplifier was defective in 15 of the 59 radios serviced. The audio amplifier was defective in 5 tape recorders or tape players. The main problems occurring in the record players and changers were cartridge and drive mechanism.

Defective electronic components

Table 45 contained data concerning the frequency of electronic components found defective in consumer electronic products. Many of the products required replacement of more than one component of the same type or of different types. Data concerning more than one item of the same type replaced in each product was not included in the table. According to the date presented, the vacuum tube was the component found defective most frequently

Table 44. Distribution of defective stages and special circuits repaired based on the last three consumer electronic products serviced by each service technician

Topic item	By bench service technicians	By home service technicians	Total stages repaired
Color television			
Horizontal output	9	13	22
Tuner	12	7	19
Low voltage power supply	10	7	17
Video IF amplifier	14		14
Cathode ray tube	9	4	13
Vertical deflection	8	5	13
High voltage power supply	5	7	12
Horizontal deflection	5	4	9
Color oscillator	4	3	7
Video detector	3	4	7
Demodulator	5	1	6
Automatic gain control	5	1	6
Audio amplifier	3	2	5
Video amplifier	3	1	4
Damper	3	1	4
Color burst amplifier	2	1	3
Focus	2	1	3
Bandpass amplifier	2	1	3
Sync	2		2
Regulator	1	1	2
Sound IF amplifier	2		2
Sound detector	1		1
Limiter	1		1
Color phase detector	1		1
B&W television			
Low voltage power supply	12	3	15
Vertical deflection	14	1	15
Tuner	9	3	12
Video IF amplifier	5	3	8
Horizontal deflection	7	1	8
Audio amplifier	5	1	6
Cathode ray tube	5		5
High voltage power supply	3	2	5
Video amplifier	4	1	5
Automatic gain control	3		3
Horizontal output		2	2
Damper	1	1	2

Table 44. (Continued)

Topic item	By bench service technicians	By home service technicians	Total stages repaired
Sound IF amplifier	1		1
Remote control unit	1		1
Radio			
IF amplifier	15		15
Audio power amplifier	10		10
RF amplifier	9		9
Oscillator	7		7
Power supply	6		6
Audio amplifier	4		4
Automatic gain control	3		3
Converter	3		3
Multiplex	2		2
Squelch	1		1
Tape recorder and player			
Audio amplifier	5		5
Tape head	4		4
Drive mechanism	3		3
Power supply	3		3
Audio power amplifier	2		2
Photoelectric shutoff		1	1
Record player and changer			
Cartridge	6		6
Drive mechanism	6		6
Audio amplifier	4		4
Power supply	2		2
Tone arm	1		1
Audio systems			
Audio amplifier	9		9
Power supply	5		5
Audio power amplifier	4		4
RF amplifier	1		1
Miscellaneous			
RF amplifier		3	3
Converter		1	1
Vidicon TV camera tube		1	1

Table 45. Distribution of defective electronic components replaced in the last three consumer electronic products serviced by each service technician

Topic item	Defective Electronic Components		
	Replaced by bench service technicians	Replaced by home service technicians	Replaced by total number of service technicians
Color television			
Tube	27	24	51
Capacitor	16	2	18
Transistor	9	4	13
Cathode ray tube	10	3	13
Resistor	8	4	12
Diode	7	2	9
Solder connection	4	3	7
Filter capacitor	4	2	6
Flyback transformer	3	1	4
Tuner replacement	3		3
Switch	1	1	2
Fuse	1	1	2
Volume control leads	2		2
Color burst coil	2		2
Circuit breaker		2	2
Power transformer	1		1
Filter choke	1		1
IF transformer	1		1
Trap coil	1		1
Quad coil		1	1
Control shaft		1	1
Focus coil	1		1
Thermistor	1		1
Bandpass amplifier coil	1		1
IF pannel		1	1
Delay coil		1	1
Dynamic convergence board		1	1
B&W television			
Tube	11	7	18
Capacitor	7	2	9
Resistor	7	1	8
Diode	2	2	4
Filter capacitor	3	1	4
Circuit breaker	3	1	4
Quad coil	3		3
Transistor	2	1	3

Table 45. (Continued)

Topic item	Defective Electronic Components		
	Replaced by bench service technicians	Replaced by home service technicians	Replaced by total number of service technicians
Solder connection	3		3
Filter choke	2		2
Flyback transformer	2		2
Tuner replacement	2		2
Volume control leads	2		2
Yoke	2		2
Speaker	1		1
Audio output transformer	1		1
Audio driver transformer	1		1
Fuse	1		1
Radio			
Transistor	23	1	24
Tubes	8	1	9
Resistor	5		5
Capacitor	3		3
Fuse	2		2
Solder connections	2		2
IF transformer	2		2
Lamp	1		1
Antenna coil	1		1
Oscillator assembly	1		1
Diode	1		1
Audio interstage transformer	1		1
Audio output transformer	1		1
Filter capacitor	1		1
Printed circuit board	1		1
Coil	1		1
Tape recorder and player			
Transistor	3		3
Capacitor	3		3
Printed circuit board	2		2
Resistor	1		1
Belt	1		1
Track change mechanism	1		1
Solder connection		1	1
Switch	1		1
Diode	1		1
Wiring	1		1

Table 45. (Continued)

Topic item	Defective Electronic Components		
	Replaced by bench service technicians	Replaced by home service technicians	Replaced by total number of service technicians
Record player and changer			
Cartridge	6		6
Drive wheel	3		3
Motor	2		2
Integrated circuit	2		2
Needle	2		2
Tube	2		2
Capacitor	1		1
Diode	1		1
Cycling cam and trip link	1		1
Tone arm	1		1
Audio systems			
Transistor	5		5
Tube	4		4
Capacitor	3		3
Solder connection	1		1
Speaker cable	1		1
Ground	1		1
Audio output transformer	1		1
Switch	1		1
Filter capacitor	1		1
Shielding	1		1
Miscellaneous			
Tube		2	2
Resistor		2	2
Capacitor		1	1
Vidicon TV camera tube		1	1
Switch		1	1

in color and B&W televisions. The transistor was the component found defective most frequently in radios, tape recorders and tape players, and products included in audio systems category. The cartridge was defective in six of the record players and changers serviced.

Adjustments performed on consumer electronic products

Some of the consumer electronic products required adjustments of some type. The data in Table 46 indicated that the complete color setup adjustments were performed on 56 of the 173 color televisions serviced. The high voltage adjustment was also performed on 32 color televisions. Thirteen of the color televisions were completely aligned. The height and vertical linearity controls were adjusted on 19 of the B&W televisions. The most frequent adjustments performed on radios was in the IF amplifier tuned circuits. The majority of the adjustments performed on tape recorders, tape players, record players, and changers were mechanical adjustments.

Table 46. Distribution of adjustments performed on the last three consumer electronic products serviced by each service technician

Topic item	Adjustments performed by bench service technicians	Adjustments performed by home service technicians	Total adjustments performed
Color television			
Complete color setup	41	15	56
High voltage	14	18	32
Fine tune	6	11	17
Black and white tracking	5	12	17
Convergence	8	8	16
Alignment (complete)	13		13
AGC	3	9	12
Efficiency coil	4	7	11
Height and vertical linearity	3	7	10
Focus	4	3	7
Horizontal oscillator	5	2	7
AFPC	5	1	6
Color oscillator	4	1	5
Trap coil	5		5
Color killer	1	3	4
Sound discriminator	2	1	3

Table 46. (Continued)

Topic item	Adjustments performed by bench service technicians	Adjustments performed by home service technicians	Total adjustments performed
B&W television			
Height and vertical linearity	17	2	19
AGC	4	2	6
Fine tune	3		3
Sound discriminator	3		3
Horizontal oscillator	3		3
Tuner oscillator	2	1	3
High voltage	2		2
Radio			
IF amplifier	17		17
RF amplifier	16		16
Oscillator	11		11
FM multiplex	5		5
Bias	3		3
Antenna	3		3
Squelch	1		1
Stereo indicator	1		1
Tape recorder and player			
Tape head	5		5
Stereo balance	2		2
Tone compensation	2		2
Speed	1		1
Bias	1		1
Record player and changer			
Tone arm	7		7
Speed	6		6
Stabilization arm	4		4
Pivot size select	3		3
Audio systems			
Bias	2		2
Input level control	1		1
Miscellaneous			
Gain		2	2
Balance		2	2
Height and vertical linearity		1	1

DISCUSSION

It was the purpose of this study to investigate data that were gathered for assistance in developing a program for training consumer electronics service technicians and to gather data that could be used for guidance purposes. The technical data could also be used for developing a program for training consumer electronics service technicians who want to specialize in "in-home servicing" or "bench servicing" in the service shop.

In the author's opinion, the mathematical topics were not given high ratings by the service technicians because a very limited amount of mathematics was actually used in diagnosing, troubleshooting, and replacing of defective components in the products serviced. If the service technicians were designing the stages in the consumer electronic products, a higher level of mathematics would be required.

The author felt the reason arithmetic was rated higher by the home service technicians was because home service technicians used arithmetic in figuring the bill in the customer's home. In the service shop, the service manager often figured the bill for the bench service technicians. The level of algebra used by the service technicians was primarily manipulation of Ohm's Law.

Some of the items pertaining to public relations and business practices were rated, by the service technicians, as requiring a higher degree of competency than many of the technical topics. The item, "public relations--handling of customers, proper wearing apparel, and proper manners", was given a mean rating 3.18 by the bench service technicians. The same topic was given a mean rating of 3.73 by the home service technicians. Therefore,

public relations was very important for the home service technicians because of being involved directly with the public. In many cases, the bench service technicians worked in the back of the service shop and were not involved with the customer. Being competent in public relations could make up for some incompetencies in the technical areas.

The investigation revealed that the majority of the service technicians were grouped into two categories of both age and years of experience. Over one-third of the service technicians were under 30 years of age and had less than four years of experience servicing consumer electronic products. Approximately another one-third were between 40 and 49 years of age and had 16 to 25 years of experience. The relative young age of the service technicians and limited number of years of experience should indicate need for future up-date courses. Also, a service technician cannot possibly learn all there is to know about servicing in four years.

In the author's opinion, the older group of service technicians probably started in the service trade servicing radios and B&W televisions. The older group went through the transition from B&W television to color television and from vacuum tubes to semiconductor devices. Many older service technicians were forced out of the service trade because of not being able to make the transition. The rapid advancing technology requires the service technicians to read service literature and attend up-date classes in order to keep up-to-date. Many of the modern diagnosing and troubleshooting techniques could be obtained better by attending classes and watching demonstrations.

The Iowa Area Vocational-Technical Schools would be the ideal location for offering up-date courses. The location of the schools would be conven-

ient for the technicians living in each area. The courses could be taught by the Iowa Area Vocational-Technical School electronic instructors, Iowa State University Engineering Extension electronic instructors, or factory field service personnel. The courses could be offered in the evening or during the day. One criticism of the evening classes was that technicians did not like to attend class at night after working in the service shop all day. The service shop would benefit by sending one or two technicians to up-date classes held during the day. The technicians would have more desire to learn knowing he was being paid to attend class.

The balance of knowledge and skill included in a training program has always been a problem to educators. The consumer electronic service technician program has been no exception. One comment often heard in regard to the graduates of the Iowa Area Vocational-Technical School service technician program was the technicians were overtrained in the theoretical aspect and undertrained in practical day-to-day money making activities. In other words, the graduates were better prepared to design circuits that diagnose and troubleshoot defective consumer electronic products. In the author's opinion, the service training programs should place more emphasis in teaching the understanding of the function of the electronic stages that make up the product and less emphasis on designing the stages. The students should spend a considerable amount of time in class diagnosing and troubleshooting defective modern day consumer electronic products. The single concept films and teaching aids developed for teaching diagnosing and servicing of consumer electronic products should be used to supplement the instructor. The single concept films could be viewed by the students while the instructor installed another group of troubles in the products of diagnosing. The

students should also get experience in using test equipment and reading block and schematic diagrams.

The author felt that the reason test equipment was not used in servicing 24 of the last three consumer electronic products serviced by each technician was because the service technicians had a good understanding of the function of the various electronic stages and could identify the stages not functioning properly by observation.

The service shops would like to employ technicians who possessed as much knowledge and skill as possible but were not always willing to offer salaries, fringe benefits, and working conditions comparable to those received in other similar types of occupations. The service trades has not been able to attract or hold the best qualified service technicians.

The starting salary for beginning service technicians discouraged many graduates from entering the service trade. Many of the graduates of the two-year service technician programs expected to start at the same salary as graduates of the two-year engineering technician program. The low starting salary caused difficulties in recruiting students into the two-year service technician programs. In the author's opinion, the length of the program should be shortened to be in line with the salary the graduates could expect to receive. The students should be in school long enough to acquire enough knowledge and skill to enter the service trade and not be expected to be an expert by the service shop owner. Up-date courses should be provided so the graduate could attend to gain more knowledge while working on the job.

In the author's opinion, the section of the study pertaining to service information provided very valuable information for up-dating service

technician training programs. The technicians were asked to list the last three products serviced prior to the interview, test equipment used in servicing each item, defective stage, defective components, and adjustment performed in completing the service.

The list of defective stages and defective components found in the products serviced would identify many of the service problems encountered in the service trade. The common problems could be emphasized in the training programs to help produce better technicians.

The service information would have been more valuable if service data had been gathered over several months instead of on the last three items serviced prior to the interview. The majority of the items serviced were color televisions, and very few other types of consumer products were listed. A greater number of problems would have occurred in a larger sample.

On the basis of the study, the following recommendations were made:

1. A committee consisting of guidance personnel, consumer electronics servicing instructors, and service technicians meet for the purpose of interpreting the data in the study that could be used for guidance purposes.
2. The Iowa Area Vocational-Technical School electronic instructors meet with the advisory committee to interpret data in the study that could be used to up-date the service technician training program.
3. The Iowa Area Vocational-Technical Schools should call on business managers of successful consumer electronic service firms to teach

the public relations and business practices in the service technician training program.

4. More emphasis be placed on reading of block and schematic diagrams and service literature provided by consumer electronic product manufacturers.
5. More emphasis should be placed on using modern day consumer electronic products in service technician training programs.
6. More emphasis be placed on career education in the secondary schools to make students aware of opportunities, working conditions, and responsibilities of the consumer electronics service technician occupation.

The following recommendations were made for future study:

1. Conduct a study of the antenna installers occupation to see if there is a need for development of a training program.
2. Collect data concerning service information over a long period of time by having service technicians record products serviced, test equipment used in servicing each product, defective functional stage, defective component, and adjustments performed. This type of information would be helpful in up-dating service technician training programs.

SUMMARY

The purpose of this study was to gather data that would be of assistance in developing a program in Iowa for training consumer electronics service technicians and to gather data that could be used for guidance purposes.

The specific objectives of this study were:

1. Gather background information concerning the consumer electronics service technicians such as: age, number of years of experience in servicing consumer electronic products, salary, hours worked, educational background, types of consumer electronic products serviced, and as to whether he worked in the service shop or the customer's home the majority of the time.
2. Gather technical data that would be of assistance in developing a program in Iowa for training consumer electronics service technicians by determining:
   A. Essential knowledge required of the consumer electronics service technician in order to competently do his job
   B. Essential skills required of the consumer electronics service technician in doing a competent job in home servicing
   C. Essential skills required of the consumer electronics service technician in doing a competent job in bench servicing
   D. Test equipment used by consumer electronics service technicians in servicing consumer electronic products in the home and in the service shop.

The study was limited to the service technicians employed within 40 consumer electronic service firms in Iowa selected by random sampling from the entire population of all consumer electronic service firms employing three or more full-time consumer electronics service technicians. The study was further limited to only service technicians who service consumer electronic products such as television receivers, radios, phonographs, tape recorders and players, audio components, and similar products.

General Findings Concerning Service Technicians

One hundred thirty-two service technicians within 38 consumer electronic service firms provided data for the study. Of the 132 service technicians that participated, 48 indicated they worked in the customer's home the majority of the time, while 84 indicated they worked in the service shop the majority of the time.

According to the data supplied by the Iowa service technicians, they were a relative young group. The median age for bench service technicians was 37.9 years, and the median age for home service technicians was 29.1 years. Eighty-seven percent of the technicians were under 50 years of age.

Thirty-one percent of the service technicians had three or fewer years of experience servicing consumer electronic products. Approximately 40 percent had over 15 years of experience.

Sixty-seven percent of the service technicians indicated that the 12th grade was the highest grade level completed in school. Nine percent indicated that they had completed two years of school above the 12th grade.

Home study programs were the most popular source of training of service technicians. Fifty-one service technicians indicated that they had

participated in home study programs. Forty-two service technicians indicated they had attended trade schools, and 41 indicated they had attended military schools in electronics.

The service technicians were asked to indicate the consumer electronic licenses or certificates attained. Thirty-seven service technicians indicated they held some type of license or certificate. Eighteen service technicians had attained the Certified Electronic Technician Certificate (CET). Eight held the First Class Commercial Radio Telephone License while seven held the Second Class Commercial Radio Telephone License.

Fifty-nine percent of the service technicians indicated they worked eight hours per day. Twenty-three percent indicated they worked nine hours per day. Thirty-two percent indicated they worked 40 hours per week, and 30.3 percent worked 41 to 45 hours per week.

The median salary for bench service technicians was $3.25 per hour, and the median salary for home service technicians was $3.44. The median salary for the total number of service technicians was $3.33 per hour. There were 33 service technicians in the $3.00 to $3.49 category and 24 in each of the categories of $2.00 to $2.49 and $3.50 to $3.99 per hour.

The B&W television was serviced by the largest number of service technicians. One hundred fifteen service technicians indicated they serviced B&W television, 108 serviced color television, 92 serviced tape recorders and players, phonographs, and audio systems. The majority of the service technicians serviced more than one type of consumer electronic product. Ten of the 132 service technicians did not service color television while one technician serviced only color television. Seventeen service technicians did not service B&W television, and two serviced B&W television 100

percent of the time. Forty service technicians indicated they did not service radios. Antenna installation did not contribute to more than 50 percent of the consumer electronic products installed or serviced by the service technicians.

Knowledge and Skill Requirements of Service Technicians

In determining knowledge and skill requirements of service technicians in doing their job, the service technicians were asked to rate various items of understanding and ability on a five-point scale. The scale was: (0) no competency needed, (1) little competency needed, (2) some competency needed, (3) much competency needed, and (4) very much competency needed.

In the category of "ability to use mathematics", "arithmetic" was given a rating, by the service technicians, of 2.82, and "algebra" had a mean rating of 2.32. Both "trigonometry" and "use of the slide rule" had overall mean ratings of less than 1.00.

Sixteen items were listed in the category of "ability to organize and administer". The overall mean ratings of the items ranged from 2.15 to 3.38. The topic "public relations--handling of customers, proper wearing apparel, and proper manners" was rated the highest by the service technicians.

"Insurance and liability responsibilities" and "State and Federal laws related to business" had ratings of "some competency needed".

Items concerning understanding of electricity had overall mean ratings ranging from 1.99 to 3.59. The item with the highest rating was "unit of measurement of voltage, current, and resistance". "DC and AC circuit analysis using Thevenin's Law" had the lowest rating.

The consumer electronic product that required the highest degree of competency in familiarization, by the service technicians, was the color television. B&W television was ranked second, and radio was third. All three items had mean ratings of "much competency needed".

There was no great differentiation noted between the ten items listed in the category of "understanding of electronic stages". All items had mean ratings of "much competency needed". "Oscillator stages" had the highest rating.

There were four items listed under the topic "understanding of component characteristics and applications" that had average ratings of "much competency needed" as indicated by the service technicians. The items were: "transistor", "semiconductor diode", "unijunction transistor", and "diode and triode tubes".

The service technicians were asked to indicate the frequency at which they performed various tasks or jobs on a five-point scale. The scale was: (0) not used or performed, (1) sometimes, (2) monthly, (3) weekly, and (4) daily. The degree of competency needed to perform the tasks or jobs were rated on the same five-point scale used previously.

In the category of "ability to repair televisions, radios, and stereos", the most frequently performed item listed was "removal and reassembly of radio, television, and stereo chassis of various sets". Next in order was "replacement of defective components in radios, televisions, and stereos". All nine items listed required a competency level of "much competency needed".

Four of the five items listed in the category of "ability to repair tape players, recorders, record players, and changers" were performed on

the average of "monthly" by the service technicians. The degree of competency needed ranged from "some competency needed" to "much competency needed".

The items in the category of "repair of automotive radio, auto stereo units, and auto reverberation units" had frequency of performance mean ratings ranging from .73 to 1.60 and degree of competency needed mean ratings ranging from 1.89 to 2.45, as indicated by total number of service technicians.

The service technicians installed indoor and outdoor antennas on the average of "sometimes". The degree of competency needed was "some competency needed".

Shop techniques performed "weekly" by the service technicians were: "using small hand tools", "testing of tubes and transistors", "unsoldering and soldering of components in the circuit", and "read block and schematic diagram". The items also had an average competency level of "much competency needed".

Test equipment items used most frequently by bench service technicians were: "vacuum tube voltmeter (VTVM)", "vacuum tube tester", "volt-ohm-milliampere meter (VOM)", and "transistor tester". Test equipment items used most frequently by home service technicians were: "vacuum tube tester", "volt-ohm-milliampere meter (VOM)", "vacuum tube voltmeter (VTVM)", and "color bar/dot/cross hatch generator". The items were listed in order of descending frequency of use.

Service Information

The service technicians were asked to list the last three consumer electronic products serviced before the interview. They were to indicate the test equipment used, defective stage, defective component, and adjustments performed in servicing each product. Data were gathered on 355 consumer electronic products serviced. Two hundred forty-four of the products were serviced by bench service technicians, and 108 were serviced by home service technicians.

One hundred seventy-three of the products serviced were color televisions. Ninety of the color televisions were serviced by bench service technicians, and 83 were serviced by home service technicians. The home service technicians serviced a very limited number of the other types of consumer electronic products.

The test equipment items used most frequently by service technicians in servicing their last three items were: "vacuum tube voltmeter (VTVM)", "oscilloscope", "volt-ohm-milliampere meter (VOM)", and "color/bar/dot/cross hatch generator". The items were listed in descending order of frequency of use. The "oscilloscope" was used primarily by bench service technicians.

The electronic stage defective most frequently in the color television was the "horizontal output stage". The "low voltage power supply" and "vertical deflection circuit" were defective most frequently in the B&W televisions. In radios, the "IF amplifier stage" was defective most frequently.

The electronic component defective most frequently in the color and B&W television was the "vacuum tube". "Transistors" were found defective most frequently in radios, tape recorders and tape players, and items in the audio systems category.

The color setup controls were adjusted in 56 of the color televisions serviced. The height and vertical linearity controls were adjusted in 19 of the B&W televisions serviced. The adjustments performed most frequently on the radios were the tuned circuits in the RF and IF amplifier stages. The majority of the adjustments performed on record players, changers, tape recorders, and tape players serviced were mechanical adjustments.

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APPENDIX A: LETTERS

Television Service Association of Iowa

P. O. BOX 215 – WATERLOO, IOWA 50704

PHONE: 319-232-6675

March 1970

To the Television Service Shop Owner:

This letter will introduce Mr. Claude Siegler of Iowa State University who is doing a research study, "Knowledge and Skill Requirements of Consumer Electronic Technicians." In order to accumulate the necessary data Mr. Siegler will be calling on various shops throughout Iowa during the next few weeks. The Television Service Association of Iowa has endorsed this program and we sincerely hope you will cooperate with Mr. Siegler when he calls at your shop.

The Association feels the results of this study will be extremely useful in establishing guidelines for apprenticeship training programs, technical school curriculum, and other facets of our business.

Again urging you to fully cooperate with Mr. Siegler when he calls I remain,

Very truly yours,

Les Buchan

Les Buchan
Executive Secretary

LB:rh

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY
Ames, Iowa 50010

COLLEGE OF EDUCATION
INDUSTRIAL EDUCATION

March, 1970

To Radio-Television Shop Owner:

An important research study is presently being conducted in the state of Iowa to determine the "Knowledge and Skill Requirements of Consumer Electronics Service Technicians." Your shop has been selected as one of the forty larger leading shops in the state to participate in this study.

The need for this research study has been brought about by the need for updating and improving the Consumer Electronics courses in the Area Technical and Vocational schools. This information will also be helpful in improving the apprenticeship program in Iowa.

This study is endorsed by TSA of Iowa and conducted under the supervision of the Industrial Education curriculum at Iowa State University. Your time, effort, and cooperation will be greatly appreciated and a summary of this study will be sent to you upon completion of the study.

Your cooperation is requested when you are contacted in the next few weeks. This information will be strickly confidential and will be used for group statistical treatment only.

Very truly yours,

Claude I. Seigler

Claude I. Seigler, Electronics Instructor
Industrial Education Building
Iowa State University
Ames, Iowa 50010

APPENDIX B: INVENTORY FORM

AN INVENTORY
of
KNOWLEDGE AND SKILL REQUIREMENTS OF CONSUMER ELECTRONICS SERVICE TECHNICIANS WITH IMPLICATIONS FOR CURRICULUM DEVELOPMENT

NOTE: All answers will be strictly confidential and used for group statistical purposes only.

PART 1. GENERAL INFORMATION (Please complete as indicated).

1. Name of Company_____
2. Location_____
   Street City
3. Name of Technician_____
4. Please check number of years of full time experience that you have in radio-television servicing.
   ___ A. Less than one year ___ D. 7-9 years ___ G. 16-20 years
   ___ B. 1-3 years ___ E. 10-12 years ___ H. 21-25 years
   ___ C. 4-6 years ___ F. 13-15 years ___ I. 26 or more years
5. Please check your approximate age.
   ___ A. Under 20 ___ D. 40 to 49 ___ G. Over 65
   ___ B. 20 to 29 ___ E. 50 to 59
   ___ C. 30 to 39 ___ F. 60 to 65
6. Please circle highest grade in school completed.
   Grades 7 8 9 10 11 12 College 1 2 3 4
7. What training specifically related to radio-television servicing have you had? Please list "months" completed in each program.
   ___ A. Cooperative Program (High School) ___ F. Home Study School
   ___ B. High School (Other) ___ G. Military School
   ___ C. Trade School ___ H. Factory School
   ___ D. Area Vocational-Technical School ___ I. Apprenticeship Program
   ___ E. College ___ Other _____
8. Please indicate percent of time that you spend in each area:
   ___ A. Bench servicing
   ___ B. Home servicing
   ___ C. Other _____
9. Please indicate your approximate hourly salary rate.
   ___ A. $2.00 to $2.49 ___ D. $3.50 to $3.99 ___ G. $5.00 or over
   ___ B. $2.50 to $2.99 ___ E. $4.00 to $4.49
   ___ C. $3.00 to $3.49 ___ F. $4.50 to $4.99
10. Indicate the number of hours you work per day, per week.
    ___ A. Hours worked per day.
    ___ B. Hours worked per week.
11. Do you work on a commission plus a regular hourly rate?
    ___ A. Yes ___ B. No
12. Are you a holder of any of the following certificates or license?
    ___ A. Certified Electronic Technician Certificate (CET)
    ___ B. First Class Commercial Radiotelephone License
    ___ C. Second Class Commercial Radiotelephone License
    ___ D. Other _____
13. Indicate the percentage that each item makes up of all items you service.
    ___% A. Antenna installation
    ___% B. B & W Television
    ___% C. Color Television
    ___% D. Radio (AM, FM, FM Multiplex)
    ___% E. Tape Recorders, Tape Players, Phonographs, Audio Amplifier Systems
    ___% Other _____

    100%

PART 2. KNOWLEDGE AND SKILL REQUIREMENTS. (Please complete as indicated.)

NOTE: Please answer all items as they apply to the position you work at the majority of the time, either home servicing or bench servicing.

Please circle your major position: (Bench servicing, Home servicing)

"Degree of Competency Needed" Column

Evaluate the degree of competency needed by an efficient consumer electronic service technician in performing his responsibilities. Use the following scale when making your analysis.

4 - Very much competency needed
3 - Much competency needed
2 - Some competency needed
1 - Little competency needed
0 - No competency needed

Place an X in the box which most accurately expresses your feelings.

	Degree of Competency Needed				
	4	3	2	1	0
COMPETENCY: Ability to Use Mathematics					
1. Arithmetic -- addition, subtraction, multiplication, and division of decimals and fractions					
2. Algebra -- Addition, subtraction, multiplication, and division of algebraic numbers. Formula manipulation such as E = IR, I = ?					
Other:					
3. Trigonometry -- function of angles (sin, Cos, and Tan)					
Other:					
4. Use of slide rule					
COMPETENCY: Ability to Organize and Administer					
5. Public relations -- handling of customers, proper wearing apparel, and proper manners.					
6. Communicate effectively -- verbally and in writing					
7. Help train others					
8. Accept responsibility					
9. Follow instructions, policies, and procedures accurately					
10. Interpret and analyze financial and operational statements					
11. Use general accounting procedures					
12. Explain bill and work done on item to customer					
13. Prepare trouble reports or work order.					
14. Estimate repair costs					
15. Keep inventory of parts					
16. Order parts					
17. Handle warranties					
18. Stocking of service trucks and tube caddy					
19. Plan work and travel efficiently					
20. Sell consumer electronic products					
Other:					
COMPETENCY: Understanding of Legal Responsibilities					
21. State and Federal laws related to business					
22. Insurance and liability responsibility					
Other:					

128

	Degree of Competency Needed					
	4	3	2	1	0	
COMPETENCY: Understanding of Electricity						
23. Unit of measurement of voltage, current, and resistance						
24. DC and AC series, parallel and complex circuit analysis using Ohm's Law.						
25. DC and AC circuit analysis using Kirchhoff's Law						
26. DC and AC circuit analysis using Thevenin's Law						
27. Resistivity and conductivity of conductors and insulators						
28. Wire sizes in regard to current carrying capabilities						
29. Characteristics and applications of dry cells, mercury cells, nickel-cadmium cells, and alkaline cells						
30. Inductance and capacitance in DC and AC circuits						
31. Motors and controls used in consumer electronic products						
32. Magnetic laws and properties						
33. Amplitude, frequency, and phase relationship of current, and voltage in an AC circuit						
34. Peak, effective, and average values of the AC sine-wave						
35. Series and parallel resonance, Q and bandwidth						
36. Time constants						
37. Transformer operation						
38. Color code of electronic components						
Other:						
COMPETENCY: Understanding of Electronic Theory						
39. Understanding of color fundamentals, principles of color mixing, colorimetry						
Familiarization of consumer electronic products						
40. Color television						
41. B & W television						
42. Antennas and antenna systems						
43. AM, FM radios, Stereo and hi fi						
44. Various types of record players and record changers						
45. Various types of tape recorders						
46. Various types of multi-track tape units used in home and automobile.						
47. Garage door opener units, headlight dimmers, automatic mirror control and signal seeker units						
48. Various types of speakers and speaker systems						
Understanding of electronic stages						
49. Convertor stages						
50. Detector stages						
51. Amplifier stages						
52. RF amplifier stages						
53. IF amplifier stages						
54. Demodulator stages						
55. Oscillator stages						
56. Multivibrator stages						
57. Power supplies						
58. Deflection stages						
Understanding of circuit operation						
59. Class A operation						
60. Class B operation						
61. Class C operation						

	Degree of Competency Needed				
	4	3	2	1	0
Understanding of component characteristics and applications					
62. Semiconductor diodes					
63. Tunnel diodes					
64. Zener diodes					
65. Varactor					
66. Silicon Controlled rectifier (SCR)					
67. Transistor					
68. Unijunction transistor					
69. FET transistor					
70. Integrated circuit					
71. Thermistor					
72. (VDR) Voltage dependent resistor					
73. Photoemissive devices (Photomultiplier tubes)					
74. Photoconductive devices (Photocells)					
75. Photovoltaic devices (Solar Cells)					
76. Diode and triode vacuum tubes					

Indicate the degree of competency needed and the frequency of task performance or test equipment use.

D - Daily
W - Weekly
M - Monthly
S - Sometimes
N - Not used

	Frequency of Performance					Degree of Competency Needed				
	D	W	M	S	N	4	3	2	1	0
COMPETENCY: Ability to repair television, radio, stereo										
77. Removal and reassembly of radio, television and stereo chassis of various sets										
78. Cleaning of safety glass, cabinets, and chassis										
79. Lubrication and adjustment of various controls										
80. Adjustment of purity, static convergence and dynamic convergence of color television sets										
81. Replacement and adjustment of B & W CRT										
82. Replacement and adjustment of color CRT										
83. Replacement of various defective components in radio, TV and stereos.										
84. Servicing and adjustment of remote control systems in television sets										
85. Alignment of B & W and color TV IF stages										
86. Alignment of B & W and color TV tuners										
Other:										
COMPETENCY: Ability to repair tape players, recorders, record players and changers										
87. Removal and reinstallation from cabinet or case of tape recorder units and record changer units										
88. Cleaning, lubrication, and adjustment of tape recorder units and record changer units										
89. Diagnosis, repairing and replacement of defective parts in tape recorder and record changer units										

130

	Frequency of Performance					Degree of Competency Needed				
	D	W	M	S	N	4	3	2	1	0
90. Use of strob-o-scope to check proper speed on record player and changer units										
91. Use of test tape to check head alignment and frequency response on tape players and recorders										
Other:										
COMPETENCY: Repair of automotive radio, auto stereo units, and auto reverberation units										
92. Removal, reinstallation and adjustment of various makes of auto radios, auto stereos, and reverberation units										
93. Diagnosis and replacement of defective parts in auto radio, stereo, and reverb units										
94. Diagnosis and repair of auto tape players										
95. Auto antenna repair, replacement and new installation										
96. Diagnosis and repair of garage door control units, headlight dimmers, and signal seeking units										
97. Diagnosis, repair, and alignment of auto multiplex units										
Other:										
COMPETENCY: Installation of indoor and outdoor antennas										
98. Installation of television and FM outdoor antennas										
99. Installation of television and FM antennas in attic and other indoor locations										
100. Installation and maintenance of multiple antenna and multiple outlet systems										
COMPETENCY: Ability to use shop techniques										
101. Testing of tubes and transistors										
102. Unsoldering and soldering of components in the circuit										
103. Sheet metal fabrication										
104. Layout and etching of printed circuit boards										
105. Using small hand tools										
106. Read block and schematic diagrams										
107. Apply first aid procedures										
COMPETENCY: Ability to use test equipment										
108. Volt-ohm-milliampere meter (VOM)										
109. Vacuum tube voltmeter (VTVM)										
110. Transistor voltmeter (TRVM)										
111. Vacuum tube tester										
112. Cathode ray tube tester										
113. Transistor tester										
114. Field strength meter										
115. Capacitor tester										
116. Impedance bridge										
117. Signal tracer										
118. Signal injector										
119. Transistor radio analyst (B&K)										
120. TV analyst (B&K)										
121. Grid dip oscillator										
122. RF signal generator										
123. AF signal generator										

131	Frequency of Performance					Degree of Competency Needed				
	D	W	M	S	N	4	3	2	1	0
124. Sweep and marker generator										
125. Bias power supply										
126. Color bar/dot/cross hatch generator										
127. Multiplex generator										
128. Resistor substitution box										
129. Capacitor substitution box										
130. Color CRT jig										
131. B&W CRT jig										
Oscilloscope										
132. AC coupled										
133. Direct coupled										
134. Triggered sweep										
135. Vector oscilloscope										
Oscilloscope probes										
136. Direct probe										
137. X10 (low capacitance) probe										
138. Crystal demodulation probe										
139. Isolation probe										
Other equipment:										

PART 3. SERVICING INFORMATION

Please list the last three items that you have serviced indicating test equipment used and service required to complete the job.

1. Name of item_____
   Test equipment used----

   Service required:
   Defective stage----
   Defective components----
   Adjustments----

2. Name of item_____
   Test equipment used----

   Service required:
   Defective stage----
   Defective components----
   Adjustments----

3. Name of item_____
   Test equipment used----

   Service required:
   Defective stage----
   Defective components----
   Adjustments----