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ABSTRACT

With the proliferation of electronic equipment on the market, this study was conducted to determine the feasibility of training calibration technicians at the college level in the region served by the North-Central Association of Colleges and Secondary Schools. Questionnaires were mailed to 378 supervisors of technical personnel, representing industries in 19 states to determine what they felt employees must know about instruments. Of the 378 questionnaires, 164 were returned in usable form. The second phase of the study was to determine student interest in an electronics calibration program. Fifty-one usable forms, of 158 sent to departmental chairmen in 19 states, were returned and the results tabulated. Findings indicate that there will be an increase of 52.43 percent of electronics calibration technicians over the next 3 years, and that the need for a program on the college level in the north-central region is evident. (GEB)

FEASIBILITY STUDY FOR ESTABLISHING A TRAINING PROGRAM FOR CALIBRATION TECHNICIANS

By

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John B. Baker

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CHAPTER I

INTRODUCTION TO THE STUDY

Historically, the electronics calibration technician has been trained on-the-job by the National Bureau of Standards, the military, or by private companies that utilize the services of calibration technicians. Calibration of instruments and standards is basically a refined form of measurement. In the early days of electronics, calibration laboratories were crude in comparison to modern standards. The electronics calibration technician could be trained to an acceptable level of proficiency in a relatively short period of time; however, since the end of World War II, the proliferation of electronic equipment has been astounding. One can scarcely conceive of any facet of everyday living where electronics is not involved. Some of the newer electronic equipment, particularly in the military and space technologies, are so complex and designed to such exacting standards that the associated test and calibration instruments necessary to maintain this equipment are of a quality and sophistication never dreamed of heretofore. The rapid proliferation and sophistication of test and calibration equipment has necessitated that a much greater number of calibration technicians be made available. It has also become necessary to train these technicians to a much higher degree of competency than was previously required. From the viewpoint of the time and money involved

in training an electronics calibration technician to the level of proficiency desired, the cost of on-the-job training has become prohibitive.

This study originated when a representative from a local business firm visited the electronics facilities at Jefferson College and suggested that Dr. Walsh, Dean of Technical Education, give serious consideration to the idea of providing a training program for electronics calibration technicians.

Prior to the decision to become involved in a study of the desirability of establishing a college level electronics calibration program, it was decided to determine if existing facilities were available for training calibration technicians in any of the publi or private educational institutions in the north-central region of the United States. A careful examination of the listings in the Technician Education Yearbook for 1968-69 failed to disclose any school offering a complete training program in electronics calibration.

When it had been determined that training facilities for calibration technicians were not available in any school system in the State of Missouri, or in close proximity to this state, the staff of the electronics department at Jefferson College decided to request permission from the Missouri State Department of Education to do a study to ascertain the desirability of training calibration technicians in a college laboratory situation. The request was

submitted to Mr. B. W. Robinson, Assistant Commissioner of Education for the State of Missouri, on April 16, 1969.

Permission was granted by the State Department of Education on June 4, 1969, with the primary responsibility for conducting the study assigned to Mr. John Baker, coordinator of the Jefferson College electronics department, working under the supervision of Dr. Raymond J. Walsh, Dean of Technical Education, Jefferson College.

Purposes of the Study

The purposes of the study were to: (1) determine the desirability of training electronics calibration technicians in a college laboratory situation; (2) determine if sufficient interest on the part of prospective students warranted the establishment of an electronics calibration program at the college level; (3) determine the type of instruments around which instructional units could be developed to form an appropriate course of study for electronics calibration technicians.

More specifically, the study was made in an attempt to answer the following questions:

1. How many companies in the north-central region of the United States utilize the services of electronics calibration technicians?
2. How many electronics calibration technicians were in the work force of these companies at the time of the study?
3. What was the anticipated demand for additional electronics calibration technicians for the next three years?

4. What was the salary range for electronics calibration technicians in the work force at the time of the study?

5. How many students currently enrolled in north-central region schools (in formal training as electronics technicians) expressed an interest in the advance training necessary to become a calibration technician?

6. What type and quality of test instruments did industry use in existing calibration laboratories?

DEFINITION OF TERMS

Due to the lack of universally accepted terminology, the definitions used within this study represent composites taken from the job descriptions used in the following companies: McDonnell-Douglas of St. Louis, Missouri; Conductron-Missouri of St. Charles, Missouri; and Collins Radio of Cedar Rapids, Iowa. For purposes of the study, the following definitions are used:

DEGREE OF STANDARDS:

Absolute Standards

Absolute standards are devices designed and constructed to specifications based on international agreement. The international prototype meter maintained in Paris, France is such a device. In the United States, all standards are maintained by the National Bureau of Standards. There are similar agencies in other countries throughout the world. Representatives of these agencies meet at regular intervals to ascertain that international standards

are established and maintained. These international standards are the first basis of reference and are considered to be absolute. The term "absolute" as used here is in the sense of being independent and finite and not relative.

Reference or Derived Standards

Reference standards are derived or constructed from absolute standards and are measuring devices of the highest degree of accuracy. The major differences between absolute and derived standards is that derived standards are "used" while absolute standards are not. Derived standards are tested or calibrated by the National Bureau of Standards.

Transfer Standards

Transfer standards are designated measuring devices used as a medium for transferring basic value or reference standards to lower echelon standards or measuring and test equipment. This is normally the highest standard utilized in a company calibration laboratory.

Working Standards

Working standards are designated lower echelon standards used by technicians to perform calibration of measuring and test equipment where direct calibration from the transfer standard is not feasible.

Electronics Calibration Technician

An electronics calibration technician normally works in the category defined by the "working standard". Three

of the primary duties and responsibilities of this technician are:

1. Calibration of Test and Measuring Instruments: the process of comparing an in-service instrument with a laboratory designated measuring device of known accuracy to detect and correct deviations from required accuracy.

2. Functional Test of In-Service Instruments: the process of verifying that an item of test equipment performs in accordance with its assigned operational characteristics.

3. Maintenance of In-Service Test Equipment: the process of trouble shooting, repairing and modifying all types of commercial and special test equipment.

SOURCES OF DATA AND METHOD OF STUDY

Data for this study were collected primarily through interviews, information forms, and publications from companies and schools currently active in the field of electronics calibration.

The first phase of the study involved collecting pertinent information from selected manufacturing and service companies concerning the need for electronics calibration technicians.

The second phase of the study was concerned with collecting information in an attempt to determine if there were sufficient interest on the part of prospective students to supply the continuing enrollment necessary to support a college electronics calibration program.

Establishment of an Advisory Committee

An advisory committee made up of personnel from local businesses was organized to assist in conducting the study. The committee was comprised of four members; two were supervisors of company training departments, and two were supervisors of existing electronics calibration laboratories. Specifically, the advisory committee was charged with the following responsibilities: (1) to delineate the duties and responsibilities of an electronics calibration technician; (2) to assist in the development of the information forms to be used for the study; and (3) to assemble a basic list of electronic instruments normally used in a company calibration laboratory.

Establishment of Geographical Boundaries to be Surveyed

The original intent was to limit the study to the State of Missouri. However, it was the general consensus of the advisory committee that there would not be a sufficient number of electronics calibration laboratories nor would there be potential students in any one state to yield sufficient data upon which a determination could be made as to the need for a college level training program for calibration technicians. After careful consideration of the many factors involved, it was decided to extend the scope of the study to include the 19 states within the

geographical are served by the North Central Association of Colleges and Secondary Schools. The states included were: Missouri, Iowa, Minnesota, Arkansas, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Colorado, New Mexico, Arizona, Illinois, Indiana, Ohio, West Virginia, Michigan, and Wisconsin.

Selection of Facilities to be Visited

The advisory committee recommended that the researcher visit as many calibration facilities as possible to become more familiar with the equipment and training techniques currently being utilized in the field.

After considerable correspondence by letter[1] and telephone conversations with company officers who are involved with the day-to-day operation of established calibration facilities, the following visits were made:

1. The National Bureau of Standards
   Laboratories
   Boulder, Colorado

2. University of Colorado
   Boulder, Colorado

3. Lowry Air Force Base
   Denver, Colorado

4. Collins Radio Company
   Cedar Rapids, Iowa

5. McDonnell-Douglas Company
   St. Louis, Missouri

6. Conductron-Missouri, Inc.
   St. Charles, Missouri

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[1] Appendix "A", page 52

7. United States Navy Service School
Great Lakes, Illinois

The National Bureau of Standards, being the supreme authority in the United States for establishing and maintaining calibration standards, was designated as the first place to visit in seeking information and guidance for the study. A meeting was arranged with Mr. Eldred Wolzien, consultant in the Radio Standards Division of the National Bureau of Standards facility at Boulder, Colorado. Mr. Wolzien made many excellent recommendations and suggestions which helped establish guidelines for the study. Perhaps of equal importance, Mr. Wolzien was very pleased that the Missouri State Department of Education would concern itself with a college level program in metrology, and offered his whole-hearted support.

While in Boulder, a visit was made to the campus of the University of Colorado. The Physics Department of this school is offering a short course (three semester hours) in electronics calibration. Techniques of instruction are highly innovative in this program with much of the equipment and laboratory experiments of the "home-made" type. A great deal of insight into the methods of organization and instruction at the college level was gained from the gentlemen who conducted this very fine program.

The next stop on the travel itinerary was the highly recommended and very excellent program in metrology conducted by the United States Air Force at the Technical

Training Center, Lowry Air Force Base, Denver, Colorado. This is one of the few places in the United States where an individual may receive comprehensive training in the theory and techniques of measurement. The supervisors of this school gave an excellent over-view of the whole program. The presentations included: methods of instruction, equipment utilization, texts and laboratory manuals used, and staff training for this highly complex and very successful school.

The trip to Cedar Rapids to meet with personnel from the Collins Radio Company was made because of the company's primary involvement with the manufacture and calibration of communications equipment. It was felt that the instruments used, the training and utilization of technicians, and the operation of the calibration laboratory would be more specialized in nature than would be the case in a general laboratory. The personnel consulted at Collins were very enthusiastic about the possibility of establishing a calibration program at the college level, and they offered unstinting support for such a program.

The St. Louis Branch of the McDonnell-Douglas Company is involved with the manufacture of military aircraft and many specialized space craft for the National Aeronautic and Space Administration. This company is the largest manufacturing firm in Missouri, has a very diversified calibration laboratory, and conducts a large personnel

training program. The company has had extensive experience in the training of various grades of technical personnel.

Conductron-Missouri is representative of the various manufacturing firms utilizing from 25 to 45 electronics calibration technicians. This company is one of the few in the United States having developed a practical flight simulator for the training of commercial airline pilots. The innovations used in the development of the flight simulator brought about unique problems in calibration and in the training of electronics calibration technicians.

The Electronics School at the Navy Training Station in Great Lakes, Illinois was the final place to be visited during the study. The school was chosen because the personnel in the calibration laboratory work on any type of euqipment which may be installed in a United States war ship. This equipment cuts across the whole spectrum of electronics, and includes RADAR, communications, Sonar and Loran Systems as well as guidance and missile control systems. The test instruments used in the calibration facility are perhaps as diverse as can be found anywhere.

In many conferences with the personnel involved at the supervisory and working levels of established calibration facilities, a wealth of knowledge was gained concerning the problems involved in staffing, training, equipping, and maintaining a well-organized electronics calibration laboratory. One of the most gratifying outcomes of these

visits was the fact that, almost to a man, the company officers contacted were very praiseworthy of the efforts to establish a training program for electronics calibration technicians at the college level.

The state of the art, as it exists today in the field of electronics, requires the utilization of an overwhelming number of test instruments which are highly sophisticated and very expensive. From the many recommendations made by company personnel concerning specific laboratory instruments, it was possible to select a basic list of equipment which seemed to meet the requirements of most companies utilizing electronics calibration technicians. The list of instruments was used to design a questionnaire[2] to be used in gathering data for the study.

Determination of the Business Firms to be Contacted

After delineating the nineteen-state area to be surveyed, it became necessary to ascertain a method for contacting businesses and manufacturing firms most likely to utilize the services of electronics calibration technicians. It was decided to enlist the resources of the Chambers of Commerce from the larger cities within the selected area. Sufficient data were on hand relative to various manufacturing and service enterprises in the State of Missouri, so it was necessary only to develop a listing

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[2] Appendix "D", page 58

of major cities from the other states. A list was developed which included 72 of the larger cities from these states.

A letter[3] was drafted explaining the purposes of the study and asking for assistance and support in locating industries employing electronics technicians. The letter was forwarded to the executive secretary of each of the Chambers of Commerce in the 72 cities previously chosen. Sixty of the 72 persons contacted responded by sending complete lists of manufacturing and servicing firms in their respective cities.

From the material supplied by the Chambers of Commerce, 288 companies located outside the State of Missouri were chosen to be included in the survey. In addition to these, 90 companies from the State of Missouri were selected to be included in the study. Whenever it was possible, the companies were selected by referring to the Standard Industrial Classification Manual. The manual was developed for use in the classification of an establishment according to the activity in which it is engaged. Since, in many cases, it was difficult to determine from published material whether or not a company utilized calibration technicians in some phase of its operation, several of the largest companies were included without regard to product classification.

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[3] Appendix "B", page 54

Three hundred and seventy-eight supervisors of technical personnel were each mailed an introductory letter,[4] a statement explaining the duties and functions of an electronics calibration technician, and a questionnaire.

One hundred and forty usable forms were returned within four weeks of the initial mailing. Three forms were returned by the Post Office as undeliverable. A follow-up postcard[5] was sent to all supervisors who had not returned the forms within one week. The follow-up resulted in the return of 20 additional forms. A second follow-up card was mailed during the seventh week which resulted in the return of four more usable forms. Of the 375 deliverable forms, 164 forms, or 43.73 per cent were returned. The forms were then submitted to the Missouri State Department of Education for keypunching and tabulation.

Selection of Schools to be Contacted

While the initial phase of the study concerned itself primarily with seeking information relative to calibration requirements of manufacturing and service companies, the second phase was to determine if there would be sufficient interest on the part of prospective students to warrant the establishment of an electronics calibration laboratory at the college level.

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[4] Appendix "C", page 56

[5] Appendix "E", page 62

It was decided to limit the geographical area to be surveyed to the same 19 states included in the initial phase of the study. The schools contacted were selected from the 1968-69 issue of the Technician Education Yearbook, published by Prakken, Incorporated. A list was developed which included all schools offering any kind of program for electronics technicians. There were 158 schools in this category.

A questionnaire[6] was developed in an attempt to gather the following information: (1) the number of students currently enrolled in the second year of a formal program for electronics technicians; (2) the number of these students expressing a desire to enroll for advanced training as a calibration technician; (3) the number of students that expressed an interest in advanced training and that would be willing to take such training in the State of Missouri.

One hundred and fifty-eight chairmen of electronics departments, from the schools selected, were each mailed an introductory letter,[7] a statement explaining the duties and responsibilities of electronics calibration technicians, and a questionnaire.

Forty-two usable forms were returned within five weeks. After waiting another week, a follow-up postcard[8] was sent

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[6] Appendix "G", page 67

[7] Appendix "F", page 64

[8] Appendix "H", page 70

to all persons who had not returned the completed forms. An additional nine forms were received. Of the original 158 forms, 51 usable forms, or 33.11 per cent were returned. The forms were then submitted to the Missouri State Department of Education for keypunching and tabulation.

CHAPTER II

EMPLOYMENT OF ELECTRONICS TECHNICIANS AND ELECTRONICS CALIBRATION TECHNICIANS

Three hundred and seventy-eight forms were mailed to the supervisors of technical personnel from previously selected companies. Three forms were returned by the Post Office as undeliverable. Of the 375 deliverable forms, 164 forms were returned representing a 43.73 per cent return. During the process of compiling the list of companies to be contacted, an effort was made to select companies which were involved in some phase of manufacturing or servicing of electronic equipment. In many instances, it was difficult to determine from material supplied by the Chambers of Commerce whether or not a company utilized electronics calibration technicians in some phase of its operation. Because of this fact, several of the larger companied were included without regard to product classification.

In processing the information contained in the 164 usable forms which were returned, all companies were classified using the two-digit Standard Industrial Classification (SIC) system.

Table I identifies and lists all of the Standard Industrial Classification groupings used in the study.

TABLE I

PRODUCT OR ACTIVITY IDENTIFIED BY THE

STANDARD INDUSTRIAL CLASSIFICATION NUMBER

Standard Industrial Classification (SIC) Group	Industry
13	Oil and gas extraction
16	Heavy construction contractors
19	Ordnance and accessories
25	Furniture and fixtures
28	Chemicals and allied products
29	Petroleum and coal products
33	Primary metal industries
35	Machinery except electrical
36	Electrical machinery, equipment and supplies
37	Transportation equipment
38	Professional, scientific, and controlling instruments; photographic and optical goods, watches and clocks
39	Miscellaneous manufacturing
45	Transportation by air
48	Communications: Radio-TV, telephone, telegraph
49	Electric, gas, and sanitary services
89	Miscellaneous services

Total: 16 Classifications

Information presented in Table II reveals the number of companies, by Standard Industrial Classification groupings, that utilize electronics calibration technicians in some phase of company operation.

An examination of Table II indicates that companies classified in 11 of the 16 Standard Industrial Classification groups used in the study employed calibration technicians. These groups were: 13, 19, 25, 35, 36, 37, 38, 45, 48, 49, and 89.

As shown in Table III, a total of 5,784 electronics technicians were employed by the participating companies at the time of the survey. Of this number, 923 persons, representing 15.96 per cent of the total, were employed as calibration technicians.

The projected increase in the number of calibration technicians to be added to the work force during the next three years was 484. This number represents an increase of 52.43 per cent.

Table IV presents an analysis of the wage schedule for electronics calibration technicians employed by the 80 participating companies. Table IV indicates the wages for calibration technicians on an hourly basis and on a weekly basis. The weekly wage is stipulated for a standard forty hour work week, and does not reflect compensation for overtime work. The minimum wage is the wage paid to a beginning technician with little or no training as a calibration

technician. The minimum wage is $2.70 per hour, or $108.00 per week. The maximum wage is the wage paid to a highly trained technician who has been with a company for at least five years. The maximum paid to any technician employed by a company included in the study is $7.50 per hour, or $300.00 per week.

A further examination of Table IV reveals the fact that a technician who had been with a company for at least five years could expect to earn between $10,816 and $15,600 per year.

TABLE II

COMPANIES WITHIN STANDARD INDUSTRIAL CLASSIFICATION GROUPINGS UTILIZING ELECTRONICS CALIBRATION TECHNICIANS

SIC	Number of Companies Utilizing Calibration Technicians	Number of Companies Not Utilizing Calibration Technicians	Total
13	1	1	2
16	0	1	1
19	7	0	7
25	1	0	1
28	0	2	2
29	0	3	3
33	0	1	1
35	2	2	4
36	46	44	90
37	6	7	13
38	20	11	31
39	0	1	1
45	2	0	2
48	1	1	2
49	1	2	3
89	1	0	1
Total:	88	76	164
Per cent of Totals:	53.65%	46.35%	

TABLE III

EMPLOYMENT OF ELECTRONICS TECHNICIANS AND CALIBRATION TECHNICIANS

SIC	Number of Companies Employing Electronics Technicians	Number of Electronics Technicians Employed	Number of Calibration Technicians Employed	Per cent of Electronics Technicians Employed as Calibration Technicians	Increase in Calibration Technicians Next 3 Years	Per cent of Increase of Calibration Technicians Next 3 Years
13	1	30	0	00.00	20	
19	7	769	75	8.27	29	38.67
25	1	75	6	8.00	12	200.00
35	2	21	16	76.19	16	100.00
36	46	2497	394	15.78	189	47.97
37	6	138	54	39.13	13	24.07
38	20	773	290	37.52	188	64.82
45	2	1405	75	5.34	15	20.00
48	1	7	1	14.28	0	00.00
49	1	19	4	21.05	1	25.00
89	1	50	8	16.00	1	12.50
11 Groups	88	Total 5784	Total 923	Total % 15.96	Total 484	Total % 52.43

TABLE IV

WAGES PAID TO ELECTRONICS CALIBRATION TECHNICIANS

	Minimum for Beginning Technicians		Maximum After 5 Years		Maximum Yearly Salary
SIC	Hourly	Weekly	Hourly	Weekly	
13	$4.68	$189.20	$6.87	$274.80	
19	3.12	124.80	7.50	300.00	$15,600
25	3.75	150.00	Not Given		
35	4.00	160.00	5.30	212.00	
36	2.70	108.00	6.25	250.00	
37	3.17	126.80	5.50	220.00	
38	3.00	120.00	7.03	281.20	
45	3.65	146.00	5.83	233.20	
48	3.43	137.20	5.20	208.00	$10,816
49	3.60	144.00	Not Given		
89	4.15	166.00	6.20	248.00	
	Average $3.65	Average $146.20	Average $6.18	Average $247.46	

CHAPTER III

TEST INSTRUMENTS RECOMMENDED TO SERVE AS A BASIS FOR THE DEVELOPMENT OF A COURSE OF STUDY FOR ELECTRONICS CALIBRATION TECHNICIANS

One of the purposes of the study was to determine the types of test instruments around which instructional units could be developed to form an appropriate course of study for electronics calibration technicians.

A four member advisory committee was selected and charged with the responsibility of aiding in the development of a list of test instruments which were considered to be in wide use in calibration laboratories. Two of the committee members were supervisors of industrial training departments, and two were supervisors of calibration laboratories.

Table V lists and identifies the test equipment included in the survey form.

TABLE V

ITEMS OF EQUIPMENT LISTED ON THE INFORMATION FORMS SENT TO COMPANY REPRESENTATIVES

A. VOLTMETERS

1. Transfer Standard
2. Differential
3. RMS
4. Digital
5. Thermal

B. AMMETERS

1. Transfer Standard

C. POWER SUPPLIES

1. Constant Voltage
2. Variable Voltage
3. Constant Current
4. Variable Current

D. POWER MEASURING DEVICES

1. Peak
2. Average

E. ATTENUATORS

1. High Power RF
2. Resistive

F. WATTMETERS

1. Directional
2. Absorption

G. OHMMETERS

1. Standard
2. Low Range
3. Megger

TABLE V (Continued)

ITEMS OF EQUIPMENT LISTED ON THE INFORMATION FORMS SENT TO COMPANY REPRESENTATIVES

H. GENERATORS

1. SLF
2. Audio
3. RF
4. UHF
5. VHF
6. SHF
7. Pulse

I. OSCILLOSCOPES

1. Single Trace, Plug-in Vertical Amplifiers
2. Dual Trace, Plug-in Vertical Amplifiers
3. Special Purpose

J. BRIDGES

1. Resistance
2. Inductance
3. Capacitance
4. Impedance
5. RF Admittance

K. STANDARDS

1. Cell
2. Resistor
3. Inductor
4. Capacitor
5. Thermal Transfer

L. RECORDERS

1. Direct Writing
2. Servo

M. SPECTRUM ANALYZERS

N. DISTORTION ANALYZERS

O. CURVE TRACERS

P. SWEEP GENERATORS

TABLE V (Continued)

ITEMS OF EQUIPMENT LISTED ON THE INFORMATION FORMS SENT TO COMPANY REPRESENTATIVES

Q.	GALVANOMETERS
P.	FREQUENCY SYNTHESIZERS
S.	FREQUENCY COMPARATORS
T.	DISTRIBUTION AMPLIFIERS
U.	POTENTIOMETERS
V.	VOLTAGE STANDARDS AND CALIBRATORS
W.	VOLTAGE DIVIDERS
X.	CURRENT STANDARDS
Y.	WAVE ANALYZERS
Z.	ELECTRONIC COUNTERS

The questionnaire which was sent to each supervisor of technical personnel from previously chosen companies contained instructions for completing the form. For each item of equipment the supervisor was requested to indicate the level of knowledge required of a calibration technician within his company. The three levels of proficiency were: (1) Must Know; (2) Nice to Know; and (3) Does Not Need.

Tables VI through XVII show the response to the various items of test equipment.

TABLE VI

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF VOLTMETERS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Voltmeter	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Transfer Standard	86	59	68.60	23	26.74	4	4.65
Differential	85	66	77.65	16	18.82	3	3.53
RMS	95	78	91.76	7	8.24	0	0.00
Digital	86	66	76.74	17	19.77	3	3.49
Thermal	77	38	49.35	27	35.06	12	15.58

TABLE VII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF AMMETERS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Ammeter	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Transfer Standard	86	59	68.60	23	26.74	4	4.65

TABLE VIII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF POWER SUPPLIES REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Power Supply	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Constant Voltage	87	77	88.51	9	10.34	1	1.15
Variable Voltage	86	75	87.21	10	11.63	1	1.16
Constant Current	86	65	75.88	20	23.26	1	1.16
Variable Current	83	61	73.49	21	25.30	1	1.20

TABLE IX

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF POWER MEASUREMENT REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Power Measurement	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Peak	84	46	54.76	24	28.57	14	16.67
Average	84	57	67.86	19	22.62	8	9.52

TABLE X

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF ATTENUATORS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Attenuator	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
High Power RF	82	17	20.73	25	30.49	40	48.78
Resistive	83	51	61.45	16	19.28	16	19.28

TABLE XI

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF WATTMETERS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Wattmeter	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Directional	83	32	38.55	23	27.71	28	33.73
Absorption	83	26	31.33	30	36.14	27	32.53

TABLE XII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF OHMMETERS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Ohmmeter	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Standard	86	81	94.19	4	4.65	1	1.16
Low Range	86	65	75.58	19	22.09	2	2.33
Megger	84	55	65.48	22	26.19	7	8.33

TABLE XIII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF GENERATORS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Generator	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
SLF	77	31	40.26	25	32.47	21	27.27
Audio	86	72	83.72	9	10.07	5	5.81
RF	81	49	60.49	21	25.93	11	13.58
UHF	79	38	48.10	17	21.52	24	30.38
VHF	79	37	46.84	16	20.25	26	32.91
SHF	76	17	22.37	25	32.89	34	44.74
Pulse	82	53	64.63	22	26.81	7	8.54

TABLE XIV

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF OSCILLOSCOPES REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Oscilloscope	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Single Trace Plug-In VA	84	77	91.67	5	5.95	2	2.38
Dual Trace Plug-In VA	87	76	87.36	9	10.34	2	2.30
Special Purpose	73	43	58.90	21	28.77	9	12.33

TABLE XV

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF BRIDGES REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Bridge	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Resistance	86	80	93.02	5	5.81	1	1.16
Inductance	86	69	80.23	16	18.60	1	1.16
Capacitance	86	75	87.21	10	11.63	1	1.16
Impedance	86	64	74.42	19	22.09	3	3.49
RF Admittance	77	21	27.27	29	37.66	27	35.06

TABLE XVI

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF STANDARDS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Standard	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Resistor	86	73	84.88	9	10.47	4	4.65
Cell	86	61	70.93	20	23.26	5	5.81
Inductor	84	59	70.24	20	23.81	5	5.95
Capacitor	86	65	75.58	16	18.60	5	5.81
Thermal Transfer	82	36	43.90	29	35.37	17	20.73

TABLE XVII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF RECORDERS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Recorder	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Direct Writing	81	43	53.09	25	30.86	13	16.05
Servo	83	41	49.40	27	32.53	15	18.07

TABLE XVIII

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF INSTRUMENTS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Instrument	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Spectrum Analyzer	81	32	39.51	26	32.10	0	00.00
Distortion Analyzer	81	38	46.91	22	27.16	21	25.93
Curve Tracer	84	39	46.43	37	44.05	8	9.52
Sweep Generator	84	51	60.71	25	29.76	8	9.52
Galvanometer	83	63	75.90	16	19.28	4	4.82
Frequency Synthesizer	80	22	27.50	30	37.50	28	35.00
Frequency Comparator	80	28	35.00	31	38.75	21	26.25

TABLE XVIII (Continued)

THE RESPONSE OF COMPANY REPRESENTATIVES INDICATING THE LEVEL OF KNOWLEDGE OF INSTRUMENTS REQUIRED OF ELECTRONICS CALIBRATION TECHNICIANS

Type of Instrument	Total No. Respondents	Must Know		Nice to Know		Does Not Need	
		No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents	No. of Respondents to Item	Per cent of Respondents
Distribution Amplifier	79	23	29.11	27	34.18	29	36.71
Potentionmeter	84	71	84.52	9	10.71	4	4.76
Voltage Standards & Calibrators	85	76	89.41	6	7.06	3	3.53
Voltage Dividers	84	71	84.52	11	13.10	2	2.38
Current Standards	85	64	75.29	15	17.65	0	00.00
Wave Analyzer	81	31	38.27	28	34.57	22	27.16
Electronic Counter	84	73	86.90	9	10.71	2	2.38

CHAPTER V

STUDENT INTEREST IN ELECTRONICS CALIBRATION TRAINING

When compiling the list of schools to be contacted, the Technician Education Yearbook, 1968-69, Prakken Publications, was used to identify those schools within the north-central region offering programs in electricity-electronics.

One hundred and fifty-eight forms were mailed to the chairmen of the electronics departments listed in the yearbook. Four forms were returned by the Post Office as undeliverable. Of the 154 deliverable forms, 51 forms were returned, representing a total of 33.11 per cent.

In the process of evaluating the information contained in the 51 forms which were returned, schools were separated into the following four categories: (1) Four-year college; (2) Junior or community college; (3) Post high school, technical school; (4) Technical high school. Table XIX indicates the number of schools in each category. Of the 51 schools responding, eight were four-year colleges, 23 were junior or community colleges, 16 were post-high school technical schools, and four were technical high schools.

Table XX indicates the number of students who were enrolled in formal programs for electricity-electronics and identifies the type of school they attended.

Of the 1,050 students currently enrolled in the second year of a program of electricity-electronics, 270 students or 25.71 per cent, indicated a desire to train as electronics calibration technicians. One hundred and sixty-seven of these students, or 61.85 per cent of those desiring advanced training, indicated that they would seek such training in the State of Missouri if it were available.

TABLE XIX

NUMBER AND TYPE OF SCHOOLS

RESPONDING TO SURVEY INFORMATION FORM

Total No. of Schools Responding	Four-Year College	Junior or Community College	Post-High School Technical School	Technical High School
51	8	23	16	4

TABLE XX

STUDENTS INDICATING A DESIRE TO TRAIN AS ELECTRONICS CALIBRATION TECHNICIANS

	Number of Students Who Desire Training as Calibration Technicians	Per cent of Total Students	Number of Students Who Would Take Such Training in Missouri	Per cent of Students Who Would Take Such Training in Missouri
Students in 4-Year Programs Total: 170	18	10.58	6	33.34
Students in Junior-Community Colleges Total: 526	121	23.00	68	56.19
Students in Post-High School Technical Schools Total: 227	63	27.75	48	76.19
Students in Technical High Schools Total: 127	68	53.54	25	36.76
TOTALS: 1,050	270	25.71	167	61.85

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The study was made for the following purposes: (1) to ascertain the desirability of training electronics calibration technicians in a college laboratory situation; (2) to determine if there were sufficient interest on the part of prospective students to warrant the establishment of an electronics calibration program at the college level; and (3) to determine the type of instruments around which instructional units could be developed to form an appropriate course of study for electronics calibration technicians. Specifically, the study sought to answer the following questions:

1. How many companies in the north-central region of the United States utilize the services of electronics calibration technicians?
2. How many calibration technicians are currently in the work force of these companies?
3. What is the anticipated demand for additional calibration technicians for the next three years?
4. What is the salary range for calibration technicians currently in the work force?
5. How many students currently enrolled in north-central region schools (in formal training as electronics technicians) expressed an interest in the advance training necessary to become a calibration technician?
6. What type and quality of test instruments does industry use in existing calibration facilities?

Data relative to the study were obtained from questionnaires completed by engineering supervisors from 164 companies located in the north-central region of the United States; from personal consultations with company representatives and school personnel who are currently involved with the training of electronics calibration technicians; from periodicals and other literature disseminated by companies involved with the manufacture of test instruments which are utilized in calibration facilities; and from information forms completed by the directors of the electronics departments from schools in the north-central region which offer programs of training for electronics technicians.

Summary of Findings

Three hundred and seventy-eight forms were mailed to selected companies. One hundred and sixty-four usable information forms were returned. Of this number, 88 engineering supervisors indicated that the companies they represented utilized electronics calibration technicians in some phase of the manufacturing process. The various manufacturing firms which utilized the services of calibration technicians were classified in the following 11 Standard Industrial Classification groups: 13, 19, 25, 35, 36, 37, 38, 45, 48, 49, and 89. Companies classified in four of the 11 groups utilized the services of the greatest number of electronics calibration technicians. These four classification groups were: 19 - Ordnance and accessories;

36 - Electrical machinery, equipment, and supplies; 37 - Transportation equipment; 38 - Professional, scientific and controlling instruments, photographic and optical goods, watches, and clocks. The 88 companies participating in the study employed 5,784 electronics technicians at the time the information forms were completed. Of this number, 923 persons were classified as electronics calibration technicians, or 15.96 per cent of the electronics technician work force. Representatives from these 88 companies indicated that they would seek to employ an additional 484 calibration technicians over the next three-year period. This represents an increase of 52.43 per cent.

A beginning calibration technician could expect to earn between $108.00 and $189.20 for a forty hour week. The average weekly salary paid to a beginning calibration technician was $146.20. A technician with a minimum of five years' experience in a calibration laboratory could expect to earn between $208.00 and $300.00 per week. The average salary for an experienced calibration technician was $247.46 per week.

The extreme care exercised by the advisory committee in selecting the items of test equipment to be included in the questionnaire resulted in a list of instruments which proved to be very compatible with the needs of companies involved with the operation of an electronics calibration laboratory.

There were 1,050 students enrolled in the second year of an electronics program at 51 schools in the north-central region of the United States.

Two hundred and seventy of these students expressed a desire to continue their education in electronics to achieve the necessary level of competence required of an electronics calibration technician. This represents 25.71 per cent of the second year students currently enrolled in schools which participated in the study. One hundred and sixty-seven, or 61.85 per cent of those desiring advanced training, indicated that they would come to the State of Missouri for such training if it were available.

Conclusions

Within the limitations of the study and to the extent that the data were valid, the following conclusions appear to be warranted:

The scope of technical education in public educational institutions within the north-central region of the United States is inadequate when consideration is given to the ever-increasing need for electronics calibration technicians. This inadequacy was disclosed when it was found that no public educational institution in the north-central region offers a complete and comprehensive program in electronics calibration and measurement.

There will be an increase of 52.43 per cent in the number of electronics calibration technicians added to the

work force during the next three year period. This, together with the quite favorable reaction of students toward taking such training, if it were available, leads one to conclude that the establishment of a college level program for training electronics calibration technicians is highly desirable.

Although the study did not attempt to assess the extent of support the business community is prepared to offer any school desiring to establish a program for training electronics calibration technicians, it was evident from the many letters[9] received that such support would be forthcoming.

Recommendations

In view of the findings and conclusions of the study, the following recommendations appear to be justified:

The anticipated need for an ever-increasing demand for the services of electronics calibration technicians by various manufacturing and service companies provides an excellent opportunity for the public school system to render a valuable and much-needed service to the business community. There are numerous curricula being offered by various colleges and universities to meet certain specific needs of industry, but no school in the north-central region is currently offering a complete, comprehensive program in electronics calibration and measurement. It is, therefore,

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[9] Appendix "I", page 72

recommended that a college level program for training electronics calibration technicians be organized and instituted at the earliest possible date.

The response by company personnel to the list of equipment selected by the advisory group for the study indicates that there is very close agreement as to the type of instruments to be included in the development of a course of study for a program designed to train electronics calibration technicians. It is recommended that the equipment listed and identified in Table V be used as a nucleus in the development of such a program.

The establishment of a comprehensive program to train electronics calibration technicians would probably require separate laboratory facilities from those now existent at any school considering such a program. Since a new building, or extensive renovation of existing buildings, would probably be required, it is recommended that serious consideration be given to the establishment of comprehensive calibration facilities which could support a variety of specialized calibration programs. For example, these might include, in addition to electronics, systems of weights, air and gas measurement, hydraulics, and distance.

Facilities necessary to do a first class job of training calibration technicians would require a formidable list of sophisticated, expensive equipment. The cost of establishing such a program would, in many cases, be beyond the

ability of any one school system to support; therefore, it is recommended that any school seeking to implement a program for training technicians in the techniques of calibration and measurement request assistance and support from the Federal Government.

APPENDIX A

Letter to Established Calibration Facilities

(College Letterhead)

July 2, 1969

Supervisor of Technical Personnel
Collins Radio Company
5225 "C" Avenue NE
Cedar Rapids, Iowa 52400

Dear Sir:

I have been assigned a research project by the Missouri State Department of Education. The purpose of the study is to try to ascertain the feasibility of training electronics calibration technicians in a college laboratory situation. If possible, I would like to visit your facility and meet with one of your representatives who is cognizant of the problems involved in training and utilizing electronics calibration technicians.

If you approve of this request, I would like to make the visit in the very near future. The time and date can be arranged in further correspondence.

Sincerely,

John B. Baker, Instructor
Electronics Technology

JBB:gj

APPENDIX B

Letter to Chambers of Commerce

(College Letterhead)

June 16, 1969

Executive Secretary
Grand Island Chamber of Commerce
Grand Island, Nebraska

Dear Sir:

I have been assigned a research project by the Missouri State Department of Education to try to determine the feasibility of training electronics calibration technicians in a college electronics laboratory. A major part of my research will be to contact manufacturing and business concerns in the north-central region of the United States that utilize the services of calibration technicians.

It has been difficult for me to get a listing of the major companies I wish to contact in the metropolitan areas of the north-central region. It occurred to me that your office is in an excellent position to render valuable assistance and advice in this area.

It would be very helpful if you could send me a listing of the major companies, with addresses, in your city that utilize substantial numbers of electronics technicians. If you cannot provide such a list, I would be very appreciative of any information you can provide which will enable me to get the necessary help I need.

Thank you very much for any material or advice you may be able to send me.

Sincerely,

John B. Baker, Instructor
Electronics Technology

JBB:gj

APPENDIX C

Introductory Letter to Company Supervisors

JEFFERSON COLLEGE

HILLSBORO, MISSOURI 63050

Supervisor of Technical Personnel
Ranco, Inc.
Columbus
Ohio 43200

Dear Sir:

I have been assigned a research project by the Missouri State Department of Education to ascertain the feasibility of training electronic calibration technicians in a college laboratory situation.

One of the major areas of the study is to determine the number and type of companies in the North-Central region of the United States which can utilize the services of a calibration technician.

I have enclosed a statement which describes the level of technical services an electronic calibration technician could be expected to perform.

The state of Missouri is in the process of establishing a series of comprehensive programs at the technical level. If the junior colleges and technical schools of the state are to produce technicians that can "pull their own weight" in the fast-moving field of electronics they need all the support and guidance which the business community is prepared to offer.

I need your consideration and cooperation to make this study as meaningful as possible. Please take the time from your busy schedule to complete the survey forms which I have enclosed.

If you do not utilize electronic technicians in your business please write "None" across the face of the form and return it in the enclosed envelope.

All companies that participate in this study will receive a summary report of the findings.

Sincerely,

John Baker

John Baker, Instructor
Electronics Technology

APPENDIX D

Calibration Technician Survey Form

CALIBRATION TECHNICIAN SURVEY

1. Your name _____

2. Position _____

3. Company name _____

4. Company address _____

5. Total number of electronic technicians currently employed _____

6. How many of the above personnel are utilized as calibration technicians? _____

7. Anticipated number of calibration technicians you will hire for next 3 years _____

8. What is the average salary paid to calibration technicians by your company?
   (a) beginning _____
   (b) after 2 years experience _____
   (c) after 5 years experience _____
   (d) maximum _____

9. For each piece of equipment listed below please check the appropriate column to indicate the job requirement for a calibration technician employed by your company.

Type of Equipment		Must Know	Nice to Know	Does not Need
Voltmeter	Transfer Standard			
	Differential			
	RMS			
	Digital			
	Thermal			
	(other)			
	(other)			
Ammeter	Standard Transfer			
	(other)			
	(other)			
Power Supply	Constant Voltage			
	Variable Voltage			
	Constant Current			
	Variable Current			
	(other)			
	(other)			
Power Measuring Devices	Peak			
	Average			
	(other)			
	(other)			

Type of Equipment		Must Know	Nice to Know	Does not Need
Attenuator	High Power RF			
	Resistive			
	(other)			
	(other)			
Wattmeter	Directional			
	Absorption			
	(other)			
	(other)			
Ohmmeter	Standard			
	Low Range			
	Megger			
	(other)			
	(other)			
Generator	SLF			
	Audio			
	RF			
	UHF			
	VHF			
	SHF			
	Pulse			
	(other)			
	(other)			
Oscilloscope	Single Trace, Plug-in VA			
	Dual Trace, Plug-in VA			
	Special Purpose			
	(other)			
Bridge	Resistance			
	Inductance			
	Capacitance			
	Impedance			
	RF Admittance			
	(other)			
	(other)			
Standard	Cell			
	Resistor			
	Inductor			
	Capacitor			
	Thermal Transfer			
	(other)			
	(other)			
Recorder	Direct Writing			
	Servo			
	(other)			
	(other)			

Type of Equipment	Must Know	Nice to Know	Does not Need
Spectrum Analyzer			
Distortion Analyzer			
Curve Tracer			
Sweep Generator			
Galvanometer			
Frequency Synthesizer			
Frequency Comparator			
Distribution Amplifier			
Potentiometer			
Voltage Standards and Calibrators			
Voltage Dividers			
Current Standards			
Wave Analyzer			
Electronic Counter			

APPENDIX E

Follow-Up Postcard to Company Supervisors

Dear Sir:

I recently sent your company a survey form for electronics calibration technicians. According to my records, I have not received your response.

The cooperation of everyone is essential if this school is to satisfy its responsibilities to the students as well as to the industrial community.

Please complete and return the above mentioned survey form. Thank you for your consideration.

John B. Baker, Instructor
Electronics Technology
Jefferson College
P. O. Box 126
Hillsboro, Missouri 63050

APPENDIX F

Introductory Letter to Electronics Department Chairmen

(College Letterhead)

July 29, 1969

Head, Electronics Department
Mineral Area Junior College
Flat River, Missouri 63601

Dear Sir:

I am sure you are aware of the proliferation of electronic equipment in the past decade. Some of this equipment, particularly in the military and space technologies, require test and calibration instruments of a quality and sophistication never dreamed of heretofore. This high level of sophistication in equipment has brought about a severe shortage of trained calibration technicians.

I have been assigned a research project by the Missouri State Department of Education to ascertain the feasibility of training calibration technicians in a college laboratory situation. One phase of the study is concerned with the need for calibration technicians by companies in the geographical region encompassed by the North Central Association. This part of the study has been completed and it has pointed up the fact that there is a much greater demand for well-trained calibration technicians than had been anticipated. The time involved in on-the-job training of calibration technicians has placed a severe handicap on all personnel in the engineering-technical community.

Because of the large amount of money involved in establishing a first-class calibration laboratory, it is necessary to know if there are a sufficient number of students who are currently enrolled in electronics programs such as yours who have the desire to achieve the higher level of competence that is demanded of the calibration technician.

I would appreciate your taking ten minutes to do the following:

1. Read the fact sheet describing the duties, functions, and qualifications of calibration technicians to all second year students enrolled in electronics programs in your school.

2. Take a poll of the class and complete the form at the end of the fact sheet.

3. Return the results in the enclosed envelope.

Thank you very much for your cooperation in making this a successful endeavor.

All schools that participate in this study will receive a summary report of the findings.

Sincerely,

John B. Baker, Instructor
Electronics Technology

JBB:gj

APPENDIX G

Fact Sheet and Student Interest Survey Form

WHAT IS CALIBRATION?

Calibration is the art of testing the validity of measurements by an instrument in normal service by comparison with measurements made to primary or secondary standards.

Reference Standards: Measuring devices of the highest degree of accuracy. Used to establish a basic value and tested or calibrated by National Bureau of Standards.

Transfer Standards: Designated measuring devices used as a medium for transferring basic value or reference standards to lower echelon standards or measuring and test equipment. (This is normally the highest standard utilized in a company calibration laboratory.)

Working Standard: Designated lower echelon standards used by the calibration laboratory to perform calibration of measuring and test equipment where direct calibration from the transfer standard is not feasible.

WHAT ARE THE DUTIES OF A CALIBRATION TECHNICIAN?

The electronic calibration technician is an individual who would normally work in the category defined by the Working Standard. Three of the primary duties and responsibilities of this technician would be:

1. Calibration of Test and Measuring Instruments: the process of comparing an in-service instrument with a laboratory designated measuring device of known accuracy to detect and correct deviations from required accuracy.

2. Functional Test of In-Service Instruments: the process of verifying that an item of test equipment performs in accordance with its assigned operational characteristics.

3. Maintenance of In-Service Test Equipment: the process of trouble shooting, repairing and modifying all types of commercial and special test equipment.

JOB SECURITY:

The calibration technician has excellent job security due to the fact that the company has expended a great amount of time and money training him to a high level of performance. In the event that it becomes necessary to achieve a reduction in personnel, the calibration technician would normally be one of the last persons to be released.

TRAINING THE CALIBRATION TECHNICIAN:

Heretofore the calibration technician has been trained on the job by the National Bureau of Standards, the military, the National Space Agency, or by a company which utilizes the services of such a technician. The proliferation and complexity of electronic equipment along with the sophistication of the associated test and calibration instruments has made this type of training prohibitive from the view point of the cost and time involved in such training.

The Missouri State Department of Education is conducting a study to determine the feasibility of training electronic calibration technicians in a college laboratory situation. If such a program does prove to be feasible, the very demanding nature of the training involved would necessitate a rigorous selection procedure for the students admitted into the program. This training would be beyond or in addition to the Associate Degree level; therefore, only graduate technicians would be enrolled.

The supervisors of calibration laboratories from several well known companies in the St. Louis area are acting in an advisory capacity for this study. These gentlemen have expressed the opinion that the proposed intensive training program could produce a calibration technician of respectable ability within a nine to twelve month period.

Instructor's Name _____

Title _____

Name of School _____

Address of School _____

Number of students currently enrolled in second year electronic program _____

Number of students expressing a desire to continue training beyond the associate degree level as calibration technicians _____

Number of students expressing a willingness to attend a program for training calibration technicians in the state of Missouri _____

APPENDIX H

Follow-Up Postcard to Electronics Department Chairmen

Dear Fellow Teacher:

I recently send you a survey form designed to evaluate student interest in electronics calibration. According to my records, I have not received your response.

The cooperation of everyone is essential if our schools are to attempt to satisfy the needs of the industrial community.

Please complete and return the above mentioned survey form. Thank you for your consideration.

John B. Baker, Instructor
Electronics Technology
Jefferson College
P. O. Box 126
Hillsboro, Missouri 63050

APPENDIX I

Supporting Letters from Business Community

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
BOULDER, COLORADO 80302

August 28, 1969

IN REPLY REFER TO:

Mr. John B. Baker
Head, Electronic Department
Jefferson College
Hillsboro, Missouri 63050

Dear Mr. Baker:

I am enclosing copies of the articles I promised you when you were here.

I enjoyed our discussion and endorse your proposal to provide training in practical electronic metrology. The need for this kind of training is certainly great in not only calibration activities but also many other areas.

Please let me know if we can be of any further assistance.

Sincerely yours,

Eldred C. Wolzien, Consultant
Radio Standards Engineering Division

H. R. ELECTRONICS
BOX 196, HIGHWAY PP HIGH RIDGE, MISSOURI
AREA CODE 314 · DIAMOND 3-3813

May 19, 1970

Mr. John Baker
Electronic Department
Jefferson College
Hillsboro, Missouri 63050

John:

Regarding your letter of May 12, 1970: We feel that a course in calibration would be most worthwhile to our Company as a base for hiring qualifications.

The technicians that come to us are able to operate our test equipment, but as instrumentation design is a discipline in itself, we seldom find people with a specific talent for calibration. The area does not have any large instrumentation companies and this coupled with the demands made on the person for very high standards of accuracy tends to limit their availability. One comment, a course of this type must be kept current! Methods of measurement and accuracies improve daily and any course of this type must be reviewed for content on a yearly basis! If and when you work a cirriculum out, I would be most interested in seeing it.

As a parting shot, research rests on accuracy and people that understand and can supply accurate instruments will always be in demand.

Sincerely,

S. G. Johnson

SGJ:pc

Bendix

Kansas City Division

Mr. John Baker, Head
Electronic Department
Jefferson College
Hillsboro, Missouri 63050

June 2, 1970

Dear Mr. Baker:

Thank you for your recent letter outlining the progress of your research in the area of training electronics personnel for jobs in industry.

From the standpoint of our company's needs for qualified electronics people, I think I would agree with you when you state that the need will be increasing in the future. Also, our company is unable at this time to provide formal training other than on-the-job training for technicians due to the time and expense involved, and it is desirable to be able to hire people who have already received their training from a college or a vocational school. We would definitely be interested in seeing the final results of your efforts in this area.

Very truly yours,

R. J. Godbout
Employment Supervisor

RJG:sh

Sherwood
MEDICAL INDUSTRIES INC
7210 POLSON LANE
HAZELWOOD, MISSOURI 63042 (314) 524 8314 15-16

July 16, 1970

John Baker
Electronics Department
Jefferson College
Hillsboro, Missouri

Dear Mr. Baker,

In reply to your letter of May 12, 1970, I agree with your conclusions that a college level program for training electronic calibration technicians is indeed necessary in this area. The future holds a tremendous increase in the need for technicians.

In the past, nearly 100% of these people have come from service oriented training programs, such as the Navy and Air Force. The service training course, while very beneficial, did not satisfactorily train a man for work in industry. As the total military commitment of the United States in the world decreases, this supply of partially trained technicians will also decrease. At the same time, electronic industry will be wildly expanding in the industrial field. Electronic instruments will replace our present less efficient tools in such uses as weighing, counting, measuring, and so on.

To make a top-notch calibration technician of a service trained man, it costs approximately five thousand dollars and two years of "on the job" training. This is not only costly, but such things as man-hour utilization must be considered for the organization as a whole. Trainees take considerable time from managers, engineers, and other competent people of industry.

I believe that it would be very desirable for us to obtain a pool of college-trained specialists who would fill these responsible positions in our industry.

Very Truly Yours,

SHERWOOD MEDICAL INDUSTRIES, INC.

J. L. Wilhelmson

J. L. Wilhelmson

Chief Engineer

cc/JLW

GENERAL ELECTRIC
COMPANY

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Information Systems
Information Devices Department

July 21, 1970

Mr. John Baker
Head - Electronics Department
Jefferson College
Hillsboro, Missouri 63050

Dear Mr. Baker:

Some time ago you asked for an expression of our thoughts regarding the feasibility of a program aimed at training calibration technicians for industry.

We have given this considerable thought and have investigated the needs that we foresee in the next 5 years and have come to the following conclusions:

1. That we will definitely have a need for well trained calibration technicians during this period. In the past we have filled many of these openings with untrained electronic technicians who have had to undergo considerable training within our facility.

2. We would certainly be desirous of recruiting at least a cadre of well trained calibration technicians to supplement our current programs of recruiting electronic technicians for our firm.

There should be no question - with the continuing increase in the sophistication and complexity of electronic test equipment and instruments, it is imperative that a source of trained individuals be available in the future.

I would be interested in being informed of any advances your department might make in the development of a program for calibration technicians.

Sincerely yours,

RC Hickey

R. C. Hickey, Manager
Personnel Placement & Relations