DISCRIMINANT FACTORS INFLUENCING PARTICIPATION IN CONTINUING ENGINEERING EDUCATION

By

LEE JAMES PHILLIPS, JR.

Bachelor of Science

Texas A and M University

College Station, Texas

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DISCRIMINANT FACTORS INFLUENCING PARTICIPATION

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Thesis Approved:

Earl J. Ferguson
Thesis Adviser

Monroe W. Kriegel

Paul V. Braden

Thomas B. Auer

D. Durham
Dean of the Graduate College

PREFACE

This investigation is concerned with an analysis of certain factors believed to have an influence on determining whether or not practicing engineers will participate in one aspect of professional development--that of short courses. From the 13 variables selected, a stepwise discriminant analysis technique is used to order the importance of the variables and lead to conclusions concerning their order.

Appreciation is expressed to Dr. Earl J. Ferguson, major advisor, for his counsel which was requested so often. Appreciation is also expressed to the other members of the committee, Dr. Thomas B. Auer, Dr. Paul V. Braden, and Dr. Monroe W. Kriegel for their invaluable guidance and suggestions made during the preparation of this thesis. Special thanks goes to Dr. James E. Shamblin who met with the committee and offered valuable suggestions which were incorporated into the dissertation. Appreciation is also extended to Dr. Dwane E. Anderson, Dr. Patrick L. Odell, and Dr. Arun G. Walvekar of Texas Tech University and Dr. Richard Wiegand of the Georgia Institute of Technology for their interest in and suggestions toward the research.

Many good things occurred to the author during the time this degree was being sought--added knowledge, new philosophies, new friendships. But all of these events were overshadowed by the untimely death of Professor Wilson J. Bentley, Head of the Department of Industrial Engineering and Management, and a member of the committee.

His guidance was sincerely appreciated and is especially acknowledged.

Credit for the excellent appearance of the survey and transmittal letter used in the research belongs to Mrs. Flo Myers. Mr. James E. Archer, Jr., whose expertise with computer languages and programming techniques greatly simplified the processing of the data, is also recognized for his professional contribution both here and elsewhere in the manuscript. Thanks also goes to Mrs. Patsy Wohler who not only did an excellent job of transcribing rough notes to draft form, but also kept the office running during those times of absence made necessary by the research. All credit for the excellent appearance of the finished copy of the thesis is given to Mrs. Margaret Estes with special thanks to her for processing the thesis through proper channels in the author's absence.

In addition to the professional contributions which the author has recognized, there were personal contributions of encouragement and understanding by many people. To Robert F. Goodson, the author can only say "thank you" for constant encouragement.

The Administration at Texas Tech is acknowledged for their encouragement and support in the form of a leave of absence granted in 1970-71. Foremost of those officials is Dean of the College of Engineering at Texas Tech University--Dr. John R. Bradford. The author wishes to recognize Dean Bradford as the one individual who made it possible to pursue this work.

But the key to all efforts belongs to three people who exhibited great solidarity and spirit during the year's separation while the author was in residence. Their encouragement and understanding were a source of strength. The author can only acknowledge his pride in them and humbly thank them--his daughter, Lee Anne; his son, John Calvin; and his wonderful wife, Joanne.

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CHAPTER I

PROBLEM IDENTIFICATION

Introduction

Systems of continuing education are, in fact, formal organizations requiring an executive who is responsible for providing a system of communication, formulating purpose, and securing essential effort for the organization. Furthermore, a review of the literature in the area of continuing education as it specifically applies to practicing engineers (Chapter II) will show that much study and research have provided the executive with the first two essential elements mentioned, but more study must be done on the element of securing essential services--or, in other words, getting the practicing engineer to participate in a program of continuing professional development.

It is the overall objective of this research to determine if certain job-attitude factors can be used to discriminate between practicing engineers who participate in continuing education activities and those who do not. The general hypothesis is that practicing engineers have certain attitudes toward continuing education that determine whether or not they will participate in such activities.

Continuing Education Systems as Organizations

Since the end of World War II, there has evolved an awareness of the need for individuals--particularly professional people--to continue their education after completing a formal regimen of learning at a college or university. This awareness has led to the formation of systems of continuing education programs by industry, government, professional societies, and educational institutions. An examination of the elements involved in the operation of these systems leads one to the conclusion that these efforts to maintain professional competence are, in every sense, a formal organization as defined by Barnard: "... a formal organization (is a) system of consciously coordinated activities or forces of two or more persons."[1]

Barnard further states:

> An organization comes into being when (1) there are persons able to communicate with each other (2) who are willing to contribute action (3) to accomplish a common purpose. The elements of an organization are therefore (1) communication; (2) willingness to serve; and (3) common purpose.[2]

Fitting the definition and the required elements to a continuing education program, it is found that where such a program does exist, there are persons able to communicate with each other. They are represented as students and resource people (instructors). Furthermore, they are willing to contribute action in the form of effort to learn and effort to teach for a common purpose--the exchange of knowledge. It is apparent that for these elements to exist, two or more people must make a conscious, continuous, coordinated effort to effect this exchange of knowledge.[3] Furthermore, continuing education systems are

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[1]Chester Barnard, The Functions of the Executive (Massachusetts, 1962), p. 81.

[2]Ibid., p. 82.

[3]Dr. Earl Ferguson, teaching Industrial Management at Oklahoma State University, modifies the definition of a formal organization as

complex organizations because of the variety of means and purposes available to such organizations.

Consider the essential element "common purpose." Exchange of knowledge has been cited as a common purpose, but it is possible to further refine this element. As continuing education programs grew, there evolved concepts which enabled one to be more specific in defining the purpose of a particular education effort. For example, a learning experience might be designed to update or upgrade an individual; it might try to stretch one's competence or familiarize a person with a new body of knowledge; or it may be designed to retrain or reorient the individual. Coupled with the freedom to choose from these several purposes is the method by which information is exchanged and the means available. Knowledge can be exchanged from one person to another directly on a one-to-one basis, or a one-to-many basis. The teacher-student or teacher-class relation is an example. Knowledge can also be exchanged on a self-study basis, through correspondence courses, programmed instruction, and/or computer-assisted instruction. There is also the exchange of information between machine and man which includes computer-assisted instruction plus audio and video networks. This brings into consideration the means available for exchanging information.

The oldest means for exchanging information is the student going to the resource person. This means is presently being replaced in many

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given by Barnard: "A system of consciously <u>continuously</u> coordinated activities or forces of two or more persons." The rationale being that organization exists <u>only</u> while two or more persons consciously coordinate activities or forces. Hence, the insertion of the word <u>continuously</u> emphasizes this point.

continuing education organizations by the resource person going to the students. The future should see both resource person and students remaining "in place" and utilizing some form of electronic transportation. Means available include the Electrowriter, closed circuit television with or without talk-back facilities, educational broadcast television, audio and video tapes. Coupling these methods and means with the various purposes for which a continuing education program may be designed should support the contention that these systems represent complex, formal organizations. It is, however, the third element that is perhaps the most complex--willingness to serve.

Given that there exists various purposes for which a system of continuing education can be designed and that there also exists a multitude of means of communicating within such a system, the strategic factor appears to become the securing of a willingness to act or to serve in this type of organization. We will use Barnard's definition of a strategic factor:

> ... when we concentrate our attention upon a restricted or subsidiary system (in this case a system of continuing education) or set of circumstances, we often find, on the basis of previous experience or knowledge, that the circumstances fail to satisfy the requirements of purpose because they lack an additional element or elements, that is, elements which are known to exist in the larger environment. These are ... limiting (strategic) factors.[4]

The acts or services required include the willingness of a resource person to teach or guide, the willingness of a sponsor to provide resources, and most important, the willingness of individuals to attend such programs and gain the knowledge thought to be important. The

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[4]Barnard, p. 203.

securing of this willingness to serve is one of the three functions of the executive as outlined by Barnard:

> The coordination of efforts essential to a system of cooperation requires, as we have seen, an organization system of communication. Such a system of communication implies centers or points of interconnection and can only operate as these centers are occupied by persons who are called executives ... . The essential executive functions ... are, first, to provide the system of communication; second, to promote the securing of essential efforts; and, third, to formulate and define purpose.[5]

It is, therefore, determined that the executive of a continuing education system is responsible for formulating and defining the purpose of proposed programs, providing a system of communication, and promoting the securing of essential services. It is the third part of his responsibility--promoting the securing of essential services in the form of developing a willingness on the part of the individual to attend continuing education programs--upon which this research will focus.

Delineation of the Problem

It has been implied that continuing education programs can serve many groups. These groups may be designated as professional and non-professional. Within professional groups are found doctors, lawyers, scientists, and engineers. Continuing education for scientists and engineers has received much attention because of the highly publicized "technological explosion" which began to occur at approximately the end of World War II.

Because technological innovation and its rate of application is still of concern to the Nation at a time of changing national priorities,

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[5]Ibid., pp. 215, 217.

this research will be focused on the factor of the executive's responsibility to promote willingness to serve in a cooperative system designed to provide continuing education benefits to the practicing engineer. Specifically, the problem of trying to determine why some engineers participate in short courses designed to help them on their jobs while other engineers do not participate will be examined.

Need for the Study

In about 1946, it became apparent that the elapsed time between scientific discovery and technological innovation was beginning to decrease at a more rapid rate. This "rate of change" was causing significant change in engineering curricula as emphasized by several studies.

Tom Stelson, in 1961, then Head of the Department of Civil Engineering at Carnegie Tech, emphasized the problem when he revealed that

> Even though Carnegie Tech had a newly developed and progressive curriculum in Civil Engineering ten years ago, about twenty-five percent of the four-year curriculum has since been completely abandoned and has been replaced by more advanced course work in science, mathematics, and engineering. The evolution rate of new knowledge in the B. S. degree program is then about one year in ten, or ten percent per year.[6]

Zelikoff (37) added emphasis to this significant rate of change in a report of his comprehensive study of changes in engineering curricula in American Universities for the period 1935 through 1965. He discovered that, had no courses been deleted from the curricula during this thirty year period, the number of courses offered would have

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[6] Thomas Stelson, "Education for Oblivion?," Carnegie Alumnus (April, 1961), pp. 5-6.

doubled every 17 years. Implied in these pronouncements of change was the fact that unless the practicing engineer made a conscious, continuous, coordinated effort to keep abreast of developments in his field, he would fall behind in engineering knowledge and techniques. From this reasoning developed the much publicized phase "technical obsolescence." Seifert defined engineering obsolescence as

> The measurement at some point in time of the difference between the knowledge and skills possessed by a new graduate of a modern engineering curriculum and the knowledge and skills actually possessed by the practicing engineer who may have completed his formal education a number of years ago.[7]

Based on the rate at which new courses were being added to the engineering curriculum, Lukasiewicz (20) was able to plot the number of years to potential obsolescence against the year of graduation. From his chart, Figure 1, one estimates that the class of 1950 had a potential for becoming 100% obsolete in 20 years after graduation. The class of 1970 faced this dismal prospect in only 12 years after graduation. Extrapolating, the class of 2056 might reach 100% obsolescence in one year. The extrapolation is not realistic but does serve notice that techniques and innovations are changing and, if one is to keep up with developments, he must continue his education in some form. Industry, government, professional societies, and educational institutions recognized the problem in varying degrees and began an attack on obsolescence by offering continuing engineering education in such various forms as in-plant training, on-campus non-credit training, off-campus non-credit training, as well as all variations of college credit

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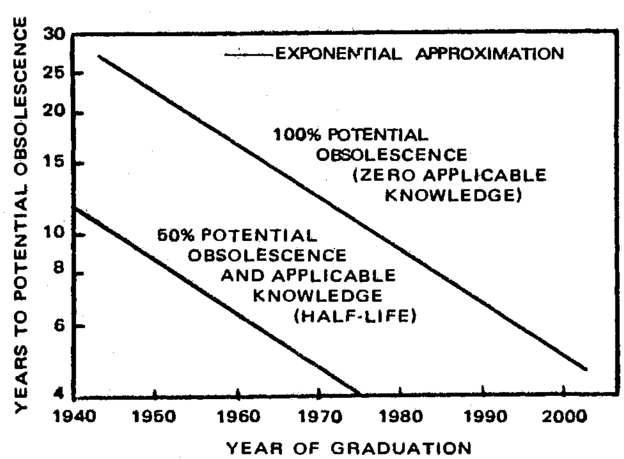
[7]William W. Seifert, "The Prevention and Cure of Obsolescence in Scientific and Technical Personnel," Research Management (November, 1964, pp. 143-149.

programs. Companies participated either by doing their own teaching or offering financial assistance to their employees or the institutions or both. Technical societies organized professional development programs and enlisted the aid of their members as teachers or sponsored classes for their members. Educational institutions developed short courses, conferences, workshops, and other forms of course work specifically for the practicing engineer. Professors accepted "overload" assignments for small stipends in order to assist in solving the problem of obsolescence. Yet in spite of all the intensive efforts to provide this continuing education, the organization often was observed to falter because of lack of participation by the people it was designed to help--the practicing engineer.



Source: J. Lukasiewicz, "The Dynamics of Science in Engineering Education", Engineering Education, 61 (1971) p. 881.

Figure 1. Decreasing Number of Years to a Given Percent of Engineer's Potential Obsolescence

That the need existed is fairly well documented by surveys (reviewed in Chapter II). That the lack of interest existed is documented by comments from executives of these continuing engineering organizations from Boston to Los Angeles. Thousands of brochures announcing continuing education efforts are mailed to practicing engineers regularly. Results of this massive mailing usually results in few replies--often not enough to justify offering the course. The Rutgers University Center for Continuing Engineering Studies recently sponsored a study to assess the current state of the art in teaching-learning research for the Continuing Engineering Studies field. The findings indicate that

> Little is known about the process of keeping up to date, the needs or wants of engineers, the best teaching methods, and how to motivate the engineer and company to collaborate on a study plan.[8]

If the value which the practicing engineer places on continuing education in the form of short courses designed to help him on his job were better understood, then the engineer and his company might be better motivated to collaborate on a plan of study.

Design of the Experiment

Objective

The objective of this experiment was to investigate the differences in certain attitudes between those engineers considered relatively "active" in attendance at short courses and those engineers considered

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[8] J. G. McNeill and R. H. Karol, "Research in CES Teaching Methods Reviewed," Engineering Education, 61 (1971), p. 878.

relatively "inactive." The attitudes of interest were certain job-attitude factors as developed by Herzberg, Mausner, and Snyderman (13).

Several approaches to the problem of participation at short courses could have been taken. However, again referring to Barnard (2), there were two factors of particular interest to this study involved in the securing of essential effort. They were (1) faith the effort would be fruitful and (2) the requirement that the benefits of participation would outweigh the burdens imposed by the organization. These factors were recognized to be interrelated and implied that the practicing engineer that was relatively active in short course methods saw greater benefits than burdens in being a part of the organization and had a faith that participation would be fruitful. The converse must be assumed for the relatively inactive engineer who apparently saw greater burdens than benefits and possibly felt that participation would really make no difference to him on his job. It became important, therefore, to try to measure this difference in attitudes. Tied in with the philosophy of this test was Herzberg's two factor theory of motivation (13).

Herzberg maintained that man exists in two primary dimensions. One dimension was represented by "animal characteristics"--his need to avoid fear, death, hunger. The other dimension was represented by "human characteristics"--his need to grow in ability, recognition, advancement. Herzberg advanced the concept that when an organization aimed assistance to the worker on the job toward animal characteristics, the results was probably a "non-dissatisfied" worker. That is, he may not have been satisfied, but he was not dissatisfied. He, in effect, was existing on the job. However, when assistance to the worker on the job was aimed at his human characteristics, the results was probably a motivated worker.

Accepting Herzberg's theory, the investigator hypothesized that the engineer who was relatively active in short course participation saw greater benefits accruing to his human characteristics than did the relatively inactive participant. If the hypothesis was true, then the active participant should have had a significantly higher opinion of this type of continuing education (short courses) as it affected his chances for recognition, advancement, achievement, greater responsibility, and increased ability on the job than did the inactive participant. Accordingly, the experiment was designed to test this hypothesis. Also included in the experiment were two job-attitude factors which Herzberg designated as "satisfiers," appealing to the animal characteristics of man. These were security and salary. For these factors it was hypothesized that there was no significant difference in attitude between relatively active participant and the relatively inactive participant since most men, by Herzberg's theory, should be "non-dissatisfied" on their job, or they would quit. In other words, it was believed that engineers that did participate in short courses designed to help them on their jobs, did so because they believed it would help them gain recognition, advancement, achievement, and greater responsibility with their company and increased ability on their job.

It was recognized at the onset that the hypothesis might not be true in its entirety. However, if such proved to be the case, it was surmised that those factors showing no significant difference might be the very strategic factors upon which the executive of the continuing education organization should concentrate in order to motivate the engineer and his company to collaborate on a plan of study.

Methodology

To accomplish the objective described above, it was decided to design an instrument capable of surveying engineers' attitudes toward short courses designed to help them on their job and to conduct the survey via the mail after pre-testing.

Of prime importance in designing the survey instrument was the consideration of statistical analysis. It was desired to receive data capable of being analyzed at the highest level possible. Research of psychometric techniques indicated that questions amenable to answers on a Lickert-type scale generated data capable of being analyzed by at least ordinal statistical tests. It was recognized that one disadvantage of this design was the necessity to repeat a question in various forms to give some dispersion to the quantification of the answers. In working with engineers, it was expected that this repetition might alienate a portion of the sample being surveyed. However, the advantage gained in level of data was thought to outweigh the possible disadvantage and the main part of the survey was so designed.

This main part consisted of a series of five questions for each of eight factors selected from Herzberg's work. The factors and the questions corresponding to the factors are shown in Table I.

Some questions were asked in the negative form to compensate for "halo effect."

It next became necessary to measure the degree of participation in short course work by the engineer responding to the questionnaire.

TABLE I

FACTORS TO BE SURVEYED FOR ATTITUDE AND THEIR CORRESPONDING QUESTION NUMBERS

Factor	Question No.				
Advancement	1	9	17	25	33
Recognition	2	10	18	26	34
Work Itself	3	11	19	27	35
Security	4	12	20	28	36
Achievement	5	13	21	29	37
Company Policy	6	14	22	30	38
Salary	7	15	23	31	39
Responsibility	8	16	24	32	40

Accordingly, a system was devised to ascertain the number of short courses attended in the past five years. A respondent indicating that he had not attended any type of short course (as defined in the survey) in the past five years was classified "none." A respondent indicating he had attended from one to five short courses in the past five years in any, or all of the categories given was classified "medial." A respondent indicating he had attended six or more short courses in the past five years was classified "active."

Additional questions were added to the instrument to determine the respondent's age, academic major, major field of work, job function, and approximate annual income, plus questions to determine his location and the number of years since graduation at the baccalaureate level. These data were used for correlational studies and as a check for "reality" since it was deemed important to see if the respondent's opinion was verified by fact.

Pretest

The survey instrument, in its original form was reviewed by selected faculty members of the College of Engineering and one faculty member from the Department of Psychology at Texas Tech University. The purpose of the review was to obtain opinions as to the clarity and validity of the questions. After several revisions, the questionnaire was printed, together with a letter from the investigator, and submitted to five groups of practicing engineers currently enrolled in off-campus programs conducted by Texas Tech. These engineers were not a part of the sample for the experiment. A review of their responses (69 questionnaires were issued and all were returned) and their comments was made and a conference was held with the research advisor. As a result of this activity, one factor was removed (there were originally nine factors proposed), eight questions were changed for clarity, and three questions of a demographic nature were added. The revised questionnaire lended itself to satisfactory analysis of data and was presented to the Dean of Engineering at Texas Tech in the final form shown in Appendix A.

Scope and Limits of the Study

The population for this study was defined as any person residing within one of the fifty United States that had received an engineering degree from Texas Tech University at the baccalaureate, master, or doctoral level, or any combination thereof. In addition, it was required that there be a known mailing address for the individual. According to the Office of Institutional Research at Texas Tech, the total number of engineering degrees awarded since 1925, the year the University was opened, was 6981. The disciplines in which degrees were awarded from 1925 to present were:

Agricultural Engineering
Architecture Engineering
Chemical Engineering
Civil Engineering
Electrical Engineering
Engineering Physics
Geological Engineering
Industrial Engineering
Mechanical Engineering

Petroleum Engineering

Textile Engineering

A computer listing, by discipline, showed 5465 engineers met the requirements for inclusion in the population.

The Sample

A sample of approximately 15% of the population was selected for the experiment. Beginning with a random selection of the first name from the first discipline, the Division of Engineering Services authorized a print-out of every fifth eligible name. From the resulting list, every other individual was selected for the experiment. However, further consideration of the type of survey being conducted resulted in the investigator deciding that a larger sample should be selected for mailing. A review of reports on results of this type of mailed survey showed that a return of 30% to 40% could be expected. Therefore, from the remaining list, every other name was again selected, resulting in a sample of 819 engineers. The actual number, by discipline, is shown in Appendix B.

The Limits

This research was primarily an investigation into differences in attitudes of engineers as concerns the value of only one aspect of continuing engineering studies--that of short courses. The design of the study, the method of investigation, and the population selected placed certain limits on the validity of the findings and should be recognized.

The design of the study incorporated the use of certain job-attitude factors as developed by Herzberg, Mausner, and Snyderman (13). Herzberg's two factor theory of motivation was accepted by the investigator and from the job-related factors were chosen those factors most often mentioned in the literature as reasons for participating in continuing engineering studies--advancement, achievement, recognition, work itself, responsibility, security, salary. Others exist, but this research considers only the above mentioned. Also, the design of the experiment incorporated the use of annual wages as a measure of success. This was recognized as not the only measure of success, but was obtainable through the use of a mailed survey. Therefore, it was recognized as a limiting factor.

Conduct of the survey through the use of the mail was itself a limiting factor since it forced the investigator to accept answers given by those choosing to reply. It also forced the assumption that the questions were understood and that the replies were correct. Had resources been available, the interview method might have been an improvement over the mail technique.

The sample for the experiment is another limiting factor since it was chosen from a population involving engineers graduated from only one institution. However, since a reliable mailing list was available, the limiting factor was accepted. Appendix C is a summary of states represented in the original mailing. Here it should be noted that approximately 72% of the 819 questionnaires were sent to addresses in Texas thereby biasing the report to this geographical factor.

Distribution

On November 21 and 22, 1971, 819 survey instruments, together with transmittal letter and return envelope, were sent via first class mail to the selected sample. A total of 11 were returned for unknown addresses or no forwarding address. On December 31, 1971, the cut-off date selected by the investigator, 336[9] questionnaires had been received, for a return of 41%. Six of the questionnaires received were unusable making the sample size for the experiment equal to 330.

Response by Stratification

To determine the extent the response represented the sample, a Chi Square analysis was performed on the stratification by academic major. A $\chi^2 = 4.27$ with nine degrees of freedom indicated that the null hypothesis (no significant difference in the number received versus the number expected) could not be rejected at the $\alpha = .05$ level. It was concluded that the response was representative of the sample and the results are given in Table II.

There was a slight over-representation in Agricultural Engineering and slight under-representation in Architectual, Geological, and Textile Engineering.

Definitions

The primary objective of the research was to test for significant differences in attitudes toward the value of short courses in an

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[9]Appendix D shows that 337 questionnaires were received. However, the number 277 was ommitted from the sequence.

TABLE II

RESPONSE BY STRATIFICATION

Major	Sample Size	No. of Questionnaires Received and Usable	No. of Questionnaires Expected
Agricultural Engineering	21	13	9.76
Architecture Engineering	6	1	2.58*
Chemical Engineering	91	38	37.05
Civil Engineering	120	51	49.11
Electrical Engineering	198	80	79.84
Engineering Physics	10	4	4.02
Geological Engineering	2	0	*
Industrial Engineering	104	41	41.64
Mechanical Engineering	166	67	66.92
Petroleum Engineering	80	30	31.59
Textile Engineering	21	5	7.47

*Architecture and Geological Engineering cells were combined to meet the requirements of the Chi-Square Test.

engineer's professional development. The engineers were to be classified as active, medial, or non-participating. The job-attitude factors against which opinions were to be measured were: advancement, recognition, work itself, security, achievement, salary, responsibility. Accordingly, the following terms are defined for purposes of this research.

Short Course

A course presented by a member(s) of the faculty of a college or university either on-campus or at an off-campus location in which instruction is scheduled for a period that may vary from two days to six weeks. It is typically either an abbreviation of a standard course in the subject, a presentation of recent research or developments in a given field, a brief review of a broad area of practical knowledge, a refresher course, or an intensive study of a narrow segment of a subject. (It may also be referred to as a conference, institute, seminar, or workshop.) It is not offered for college credit.[10]

Active Versus Medial Versus Non-Participant

The distinction as applied to engineers for this experiment was determined by the procedure described on page 14.

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[10]The definition used is a composite of definitions given for a course and a short course by *Learning Resources*, Winter 1968-1969, Vol. 1, No. 1. Published by Engineers Joint Council, New York, plus modifications as suggested by Dr. Monroe W. Kriegel, Director of Engineering Extension, Oklahoma State University.

Job-Attitude Factors[11]

Advancement. A job-attitude factor that implies a change in the respondent's status or position in the company.

Recognition. An act of recognition to the respondent from his supervisor, a member of management, management as an impersonal force, a professional colleague, or the general public. It is assumed that the act of recognition is favorable to the respondent.

Work Itself. The actual doing of the job or the tasks of the job. As used in this survey, a query into the value of short courses in providing techniques that could be used on the present job.

Security. Implies job security as reflected by objective indications such as tenure or stability. As used in this survey, the implication is that participation results in improved job security.

Achievement. Seeing the results of one's work, finding solutions to problems, successful completion of a job.

Company Policy. Primarily personnel policies as interpreted to being beneficial or harmful to a proposed program of continuing education.

Salary. An increase in salary or wage. The question to be resolved in this survey: Does participation in short course activity improve one's chances for unexpected or additional pay increases over what one would normally expect?

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[11]Definitions for the eight job-attitude factors were extracted from Herzberg, Mausner, and Snyderman's work (13).

Responsibility. An increase in responsibility for one's own work, the work of others, or a new responsibility. The assumption was that increased responsibility was desired by practicing engineers.

Summary of Objectives

1) The overall objective of the experiment was to determine if certain job-attitude factors could be used to discriminate between practicing engineers that do participate in continuing engineering education short courses designed to help them on their job and those engineers that do not participate. The general hypothesis was that practicing engineers have certain attitudes towards continuing education that determine whether or not they will participate in such activities (page 1).

2) The investigator specifically wanted to determine if certain of Herzberg's "motivators" could be used to make a discrimination between the two groups mentioned in the general objective. The hypothesis was that the engineer participating in short course activities saw greater benefits accruing to his human characteristics than did the non-participant (page 11).

3) Finally, the investigator specifically wanted to determine if certain of Herzberg's "satisfiers" could be used to make a discrimination between the two groups mentioned in the general objective. The hypothesis was that there was no significant differences in certain attitudes between

participants and non-participants so far as "satisfiers" were concerned (page 11).

CHAPTER II

REVIEW OF THE LITERATURE

Continuing education must be as old, or older, than the adage "live and learn." Continuing education in a formal sense dates back to 1891, so far as the United States is concerned, with the recognition of the need for institutions to "extend" themselves into communities where education could be used "on the job" (6). Continuing engineering education as an organization began developing in the early 1960's and a chronological review of literature pertinent to this dissertation reveals a rather logical development of the formal organization of continuing engineering education programs from 1961 to the present. The need was recognized and efforts made to measure this need--this developed the purpose. Methods and means were designed to accomplish the purpose--this developed a system of communication. Finally, consideration began to be given to who was attending and why--this developed a concern for the element of willingness to participate.

Chronological Review

1961

Dr. Thomas Stelson (32) is generally given credit for continuing engineering education receiving expanded interest in the 1960's. The empirical data he supplied (quoted on page 6) was the first measure of "change and rate of change." However, a close study of his paper revealed that Dr. Stelson was not advocating only the need for continuing education for engineers, he was advocating change in education for engineers at all levels--undergraduate, graduate, post-doctoral, and on-the-job. He expressed concern not only for the practitioner but for the professor as well and emphasized the need for a broader based, more fundamental curricula for students with the thought that specialization in the latest techniques could be developed later using these fundamental facts.

> The continual incorporation of new fundamental knowledge about physical phenomena in both graduate and undergraduate course work so that new graduates are in the best possible position for current success and continued growth is essential (32).

1962

Thus, in 1961, Dr. Stelson gave a reason--a purpose--for organizations of continuing engineering education programs to exist. In 1962, Dr. Monroe Kriegel (18), noting the "furor" started by Dr. Stelson's article, began to refine the broad purpose by specifically identifying the size of the problem of technical "obsolescence," and what, if anything, had to be done about it. From an analysis of the data available to him, Dr. Kriegel identified five factors involved in the problem of technical obsolescence: (1) an expected shortage of people entering the profession while industrial research organizations continued a steady but modest growth, implying new developments to be utilized by older professionals; (2) the growth rate of knowledge; (3) the modification of collegiate training in recent years; (4) the influence of computing machines; (5) the practices followed in industrial research of rewarding the engineer for specialization, not for keeping up basic academic training. Kriegel developed another vital point concerning the problem of technical obsolescence that might answer the often asked question: If technical obsolescence is a real problem, what has happened to those engineers who have not continued their education in near proportion to the recommended amount of ten percent of available time to keep up with new developments plus ten percent in refresher training?

> The early 50's, then, was the period of maximum utilization of the results of basic science by industrial research. Many new people were hired from colleges each year, and due to continuous expansion (emphasis mine), there were ample opportunities for the comparatively few older employees.

In other words, during times of rapid expansion, there was room for older employees, possibly in job functions other than engineering. But as costs rise, productivity becomes vital and only those capable of increasing productivity will be in demand. Coupled with his added emphasis on purpose, he had recommendations for industry and educational institutions which began to bring the element of communication into the developing environment of continuing education.

Dr. Kriegel recommended a "thorough study by each company of its expected training needs" which could then be presented to interested institutions for development into some type of course work. He admonished the institutions to emphasize the development of courses "specifically designed for the man who wants refreshing and updating." Thus, in 1962 there was a refining of purpose and the beginning of emphasis on methods and means (communication).

1964

In 1964, the literature on continuing engineering education included three noteworthy publications in which a more specific meaning was given to obsolescence, the element of cost of continuing education was noted, and a study of responsibility for providing such education was made.

William W. Seifert (28) applied a definition of obsolescence to scientific and engineering skills as noted on page 7. He further pointed out how one could recognize an organization that had, because of the large number of individuals suffering from technical obsolescence, itself become obsolescent:

> ... one observes that (1) its products continue unchanged over long periods of time, (2) its competition becomes increasingly effective in cutting into its markets, and (3) few new ideas develop.

In Seifert's publication he proceeded to list the means available to an engineer to upgrade himself--graduate work, in-house courses, and college-sponsored short courses. He also identified, to some extent, the role professional technical societies should play "... enabling engineers to keep more or less up to date rather than to catch up once having fallen behind." And Seifert made a clear distinction between the interests and needs of "overall program managers" and "key engineers ... directly concerned with carrying out the technical aspects of projects." This was the first recognition given to the need for a discriminating function in continuing engineering education programs.

Again in 1964, Torpey (33), having recognized <u>costs</u> of continuing engineering education programs as a strategic factor, reported the results of a 1963 survey of 290 employer representatives from "large, medium-sized, and small companies in most major industries employing scientists and engineers." The purpose of the survey was to determine what industry was doing to provide educational activities for their own scientist and engineers. From his survey he determined:

- the average cost to the companies surveyed of educational activities was 0.539 percent of gross sales.
- spending on such activities had increased from three times to eight times in the past ten years.
- a noticeable lack of managerial policies and principles to assure wide-spread, constructive activity in this area (of continuing education).
- the predominant single technique pursued through company funds was the tuition refund plan.
- that 55.4 percent of all scientists and engineers surveyed participated in the continuing education programs, on an individual basis, less than 11 man days per year.

But perhaps the most significant finding so far as this research is concerned was the feeling among company representatives that their companies

> ... would be willing to invest more in continuing education of this kind if scientists and engineers in the company were willing to participate voluntarily to a greater degree.

In this same year that evidence was found that the element of "willingness to serve" was becoming a strategic factor in the developing concept of continuing engineering education organizations, Donald B. Miller (22) of IBM revealed that his company, in recognizing the problem of technical obsolescence, also recognized that the problem occurred because of one of three reasons: previous disuse of the knowledge; not having really learned the material initially; or that one simply forgot. As a result of their study, IBM established new principles for guiding their continuing education program:

1) Professional growth is a part of the job responsibility.

2) Growth is a responsibility shared by the professional and the company.

3) Management must place a high priority on education.

4) Education must, in essence, be voluntary, though the environment must encourage it and management demonstrate approval.

From these principles we see that companies were, in 1964, making concessions to their technical personnel in order to encourage a "willingness to participate."

1965

In 1965, two major reports on continuing education for engineers were published. Both dealt primarily with an investigation into the needs of practicing engineers, but some thought was given to the factors involved in such a program.

The Engineering College Administrative Council (ECAC) and the Relations with Industry (RWI) Divisions of the American Society for Engineering Education formed a joint "Feedback Committee" in 1962

> ... to determine, analyze and report the needs which engineers believe they have for further training several years after they have begun their professional careers in industry.

To meet this objective, 7,185 questionnaires were mailed to engineers employed by companies who were active in the RWI Division. Of this number, 4,057 were determined to be useful. The engineers in the population received their undergraduate degree in the years 1955, 1956, 1957 since the joint committee wanted to know the needs of those engineers who had had sufficient experience to recognize what additional training or re-training they needed, yet had not been on the job long enough to be removed from engineering responsibilities.

The general finding of the survey indicated that this group of engineers needed more training (the average number of courses needed according to the survey was 24½ subjects per engineer). It was further pointed out that nine of the first fifteen subjects selected from the list of courses provided by the survey were non-technical in nature (Management Practices, Technical Writing, Public Speaking, Creative Thinking, Working with Individuals, Working with Groups, Speed Reading, Talking with People, Business Practice). The committee decided to cross-analyze the data according to the academic major of the Bachelor's Degree, advanced degree, job function, and industry grouping. The committee hypothesized that these factors might have some bearing on what the engineer said he needed. In fact, the analysis did reveal that needs were a function of these variables with the exception of the need perceived for "Probability and Statistics."

Limits recognized in this survey include the restricted population which did not consider the practitioner with ten to fifteen years experience, the fact that a list of courses was provided for the respondent thereby enabling him to check as many as he pleased, and the fact that only university-type courses were included in the survey. While the purpose of the study was to determine needs, the experiment was designed to also determine who needed what--a discriminate investigation.

In the same year (1965), Dubin and Marlow (9) reported the results of a somewhat similar survey as made by ECAC-RWI. Their survey of 2,090 engineers (proportionately stratified and having graduated at five years prior to the survey) by major industrial group and company size was conducted for the purpose of determining the continuing education needs of engineers employed in industries in Pennsylvania. Using both the mailed questionnaire and group interview technique, Dubin and Marlow set out

1) To determine the continuing educational needs of engineers who have been out of college five or more years.
2) To determine attitudes of engineers towards continuing education needs as related to their job, supervision, and company.
3) To recommend methods for providing continuing educational programs for updating engineers in Pennsylvania.

The investigators' findings so far as objective (1) was concerned was similar to the ECAC-RWI findings--eight out of ten engineers reported a critical need for strengthening their communicative skill (non-technical courses). To accomplish continuing education goals, the sample reported that so far as formalized programs were concerned, short seminars were most popular, followed by in-plant courses, evening courses, and full-time courses in that order. However, the survey likewise showed that only one-third of the engineers questioned had participated in <u>any</u> continuing education activities even though seventy-nine percent of the respondents reported that their companies had an educational assistance program. Interestingly, seventy-four percent of the respondents indicated that the availability of such assistance had <u>no effect</u> on motivating them to undertake educational work. This finding prompted Dubin and Marlow to recommend further study in motivation for continuing education. Coupled with the finding that only one-third of the engineers participated in continuing education was the finding that two-thirds of the engineers reported that their supervisors did not encourage further training.

By listing some reasons for not participating in advanced degree programs, it was found that time and space were the most strategic factors--time to go to school and geographic barriers to getting to school. The fact that the job did not require more education was of about equal importance to the first two mentioned. In fact, eighty-one percent of the engineers felt that post-collegiate work was not required for promotion or salary increase while only four percent indicated such training was necessary--the balance did not know for sure. The survey, so far as measuring attitudes was concerned, was apparently designed to see if there was a need for an advanced degree program for practicing engineers. Engineers were asked if they had an advanced degree or were working on an advanced degree. If they were not, they were asked why not and given a list of possible answers. The survey did not attempt to measure attitudes of engineers towards continuing education in general but did note that "strong personal motivation is required for an engineer to remain up to date in times of rapid technological change."

While neither of these major reports of 1965 did extensive research into factors involved in participation in continuing education, the pattern for such work was laid.

1966

The year 1966 saw four excellent articles published on the problem of continuing education for engineers. One took exception to the then popularized phase of "technical obsolescence." Another supported the research findings of ECAC-RWI and Dubin-Marlow. A third introduced the use of a psychological equation. And the fourth reported a significant amount of research at the heart of the problem--the factors involved in getting the engineer to participate in professional development.

Merritt A. Williamson (36) challenged the feeling developed in the late 50's and early 60's that "half of what a graduate knows upon graduation will become obsolete in ten years" on the premise that what was true ten years ago would be true today. His point in challenging the popular phase of technical obsolescence was to point out that what really was changing for the engineers was the evolving methods of solving problems. Williamson pointed out what he felt were three different cases of obsolescence and attempted to point the finger of blame for each case. In case one, the man was considered obsolete because the job he performed was no longer needed. He was a victim of circumstance and the company bore responsibility for giving him the opportunity to undertake a new assignment and to take refresher courses or upgrading courses. Case two, the man refused to learn new things that gradually came along--"The opportunity is present, but the intellectual curiosity is gone." In this case the fault lay entirely with the man. In case three, the man was promoted to a position where technical knowledge did not have a chance to grow. The fault, according to Williamson was hard to pin-point, but probably lay primarily with the company. His point, as was Miller's (22) in 1964, was that so called "obsolescence" was a shared responsibility with prime responsibility lying with the individual, but companies, professional societies, and educational institutions also being a part of the environment. In essence, Williamson was recognizing the problem of change and the purpose of continuing education while recommending methods of overcoming the problem (communication) and pointing out that self-motivation (willingness to serve) was of prime importance.

Robert D. Best (3) summarized general conclusions from 20 surveys (unidentified) "bearing on what engineers say is critical to their continued professional growth." Significant points which Best made were

- Although most engineers express a desire for more education, few are interested in enrolling in formal course work ...
- Most engineers, particularly the younger, want practical job-related knowledge ...
- Most companies apparently encourage their engineers to continue their education but usually along fairly narrow lines.

Best, in effect, was saying that industry, professional associations, and educators had identified a problem and developed a purpose for continuing engineering education. The practicing engineers had not fully accepted the existence of the problem--at least not to the degree expected. It reflected on the economy of incentives of the organization. As Best said,

> How management organizes the work and rewards contributions tells the engineer a great deal about what professional requirements will be needed in the future. A basic difficulty with our current notions about administering engineering organizations is that they often produce tactical groups of engineers suited to work efficiently in a stable environment ...

In addition to the contribution by Best, John C. South (31), borrowing from Vroom (34) and Herzberg (13), introduced the concept of applying human motivation models to continuing education studies.

South reviewed four generalizations regarding human motivation:

1) A hierarchy of needs exists ...

2) Internal sources of motivation are more effective than are external sources ...

3) Positive motivating agents ... are more effective than negative agents ...

4) Individuals possess levels of aspiration which they establish and revise based upon their expectancies and experiences. The individual does not strive for any event or object which is clearly beyond any real likelihood of occurrence.

Utilizing Vroom's model, $F = V \times E$, he applies these findings to the concept of continuing education for engineers. Briefly, the model is explained as follows:

F = the force or motivation to perform the act;

V = the psychological valence of the outcome, where valence is a value the individual places on an outcome, object, or accomplishment; and

E = expectancy that, if the individual takes the necessary action, the desired outcome, accomplishment, or object will be achieved.

The point of the paper was to focus attention on the need to better identify purpose (V) for the engineer to continue his professional development and to better explain or demonstrate the outcome of participation (E).

Barnard's Theory of Opportunism[1] manifested itself in this paper. South had pointed out two specific areas to be given attention by the administrator of a continuing engineering education program--two areas that, in reality, could be attacked for the purpose of increasing one's desire to participate (F) in continuing education programs. South concluded with an observation significant to this research:

> It has been noted that recognition, achievement, responsibility, and the work itself are motivators of professional engineers. Establishing a close relationship between completed studies and increased work responsibility, different work assignment, and certain forms of recognition should increase motivation.

Richard Wiegand's (35) dissertation "Factors Related to Participation in Continuing Education Among a Selected Group of Graduate Engineers" was completed in May, 1966, and made a direct attack on the growing puzzle of determining who participated in what types of continuing education programs. This significant research utilized a questionnaire mailed to a sample of 831 engineers from a population defined as "baccalaureate graduates of eight engineering curricula at the Georgia Institute of Technology." The population was further restricted to the classes of 1948 to 1963. From the original sample, 435 usable replies furnished the data for this research "primarily limited to an investigation of the extent of participation in continuing education and is only secondarily concerned with the nature of participation."

Making extensive use of the Chi-square test (312 Chi-squares were computed), Wiegand tested twenty-four independent variables ("developed after an exhaustive review of previous research and theoretical writing ...") against three major types or methods of continuing education

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[1]Chester Barnard, The Functions of the Executive (Massachusetts, 1962), pp. 200-211.

(course work, professional activities, reading, and self-directed learning). His findings are summarized in Table III where "X" denotes those instances where there was deemed to be a significant relation between independent and dependent variables.

Even though the data collected did not lend itself to correlational analysis, Wiegand did recognize that the "typical participant" in some form of continuing education activity might be described.

> An attempt can be made to give a profile of a 'typical participant'. However, the specifications would vary for the different types of continuing education activities covered by this investigation. For example, the typical participant in Course Work -- especially in Formal Credit Work -- would have had different characteristics in many ways from the participant in Professional Activities.

Recognizing the limitations of the design utilizing a restricted population, a mailed questionnaire, plus the limitation of the statistical technique available for analysis, Wiegand recommended that more research be done in "participation in continuing education among working engineers." Specifically, he saw a need for "participation scales" of measurement, a need for research into the "... working environment of the engineer," a need to "relate his (the engineer) needs for new knowledge to his job," and a need for "techniques ... that would allow future investigators to identify clusters of factors that are related to participation."

1967

Utilizing a "projective test" technique familiar to applied psychologists, Rubin and Morgan (24), in 1967, reported on attitudes toward continuing education as perceived by research and development engineers. The study was designed to test two general hypothesis:

TABLE III

SIGNIFICANT RELATIONSHIPS AMONG INDEPENDENT AND DEPENDENT VARIABLES

Continuing Education Activities		Educational Background			Job-Related Factors								Geographical Factors							Personal Factors						Total
		I-1	I-2	I-3	I-4	I-5	I-6	I-7	I-8	I-9	I-10	I-11	I-12	I-13	I-14	I-15	I-16	I-17	I-18	I-19	I-20	I-21	I-22	I-23	I-24	
A. COURSE WORK																										
1. Formal Credit Work	D-1	X	X	X		X	X	X	X			X	X		X	X				X		X	X		X	15
Formal Credit Hours	D-2	X					X					X												X		4
2. College Non-Credit Work	D-3					X																				1
College Non-Credit Hours	D-4																									0
3. Non-College Courses	D-5						X			X									X							3
Non-College Hours	D-6												X													1
B. PROFESSIONAL ACTIVITIES																										
1. Prof. Societies	D-7			X				X								X							X	X		5
Prof. Societies Number	D-8					X						X							X							3
2. Prof. Registration	D-9		X	X	X	X	X	X		X				X					X	X		X	X	X		13
C. READING AND SELF-DIRECTED LEARNING																										
1. Types of Reading	D-10		X				X		X	X	X					X						X			X	8
2. Personal Subscriptions	D-11															X							X	X		3
3. Self-Directed Learning	D-12																									0
Correspondence Courses	D-13	X	X														X									3
TOTAL		3	4	3	1	4	5	3	2	3	1	3	2	1	1	4	1	0	3	2	0	3	4	4	2	59

Key to Independent Variables:

I-1 Georgia Tech Grade Point Average
I-2 Georgia Tech Major
I-3 Georgia Tech Class
I-4 Company Size
I-5 Principal Industry Classification
I-6 Principal Job Area
I-7 Time with Company
I-8 Company Attitude toward Continuing Education
I-9 Company Practice on Continuing Education
I-10 Company Practice on Professional Societies
I-11 Company Requirements of Continuing Education for Advancement
I-12 Section of Country
I-13 Community Population (In Thousands)
I-14 College Proximity
I-15 Availability of College Work--in Field--Credit
I-16 Availability of College Work--in Field--Non-Credit
I-17 Availability of College Work--General Adult Education
I-18 Availability of Professional Society Courses
I-19 Marital Status
I-20 Educational Level of Spouse
I-21 Attitude of Spouse toward Continuing Education
I-22 Age
I-23 Annual Salary (in thousands)
I-24 Personal Views on Importance of Continuing Education

Source: Richard Wiegand, "Factors Related to Participation in Continuing Education Among a Selected Group of Graduate Engineers," (unpub. Ph.D. dissertation, Florida State University, 1966).

> First, research and development engineers regard continuing education as a means of avoiding technical obsolescence, and, second, research and development engineers regard continuing education as a method for organizational advancement.

The population for this study was the research and development engineers of one unidentified company and there were 370 individuals included in the sample. There were 312 usable replies which showed that

> ... participation in continuing education is perceived as making an engineer less obsolete. He is regarded as clearer-thinking, growing, active, and more up-to-date. Continuing education is also perceived as a mark of professionalism ... A participating engineer is also regarded as having more ambition, higher initiative, more enthusiasm, and higher management potential than a non-participating engineer.

However, the authors cite the last part of their findings "higher management potential" as a possible reason why some engineers might not participate in continuing education programs.

> It is conceivable that some engineers might not bother with continuing education because the reward of becoming a manager is not what they desire.

This reference to the economy of incentives tied in closely with Best's (3) comments quoted on page 34. It also represents another document dedicated to exploring the problem involving the third necessary element in a formal organization--the willingness to serve.

<u>1969</u>

Articles published in 1969 dwelled heavily on those factors thought to be deterrents to participation in continuing education programs by practicing engineers. In addition, definite steps were taken to develop "measures" of obsolescence and to model a system of continuing education.

Biedenbach (4), recognizing that tuition refund programs were available in most companies, estimated that only fifteen percent of the engineers in a company took advantage of such programs. He argued that the burden of having to travel many miles to a class after a full day's work plus the neglect of social responsibilities to the engineer's family, friends, and community were greater than the benefits he envisioned by enrolling in continuing education programs. Biedenbach, long an advocate of continuing education (thinking seventy-five percent a more realistic figure for participation by engineers) advocated that willingness to participate could be improved by improved methods and means of communication--the use of electronic blackboards, TV, casette tapes and other technological developments in communication.

Interestingly, Karol (15), in a survey of universities and companies who were members of the Continuing Engineering Studies Division of the American Society for Engineering Education, found that approximately twenty-five percent of the engineers employed by these companies were participating in some form of continuing education--a statistic not too different from Biedenbach's (4) estimate. Karol also found that

> None of the respondents (replies from company representatives) reported an automatic increase in status, rank or salary upon the completion of CES (Continuing Engineering Studies) programs. Several stated that data were entered in the personnel files, and two indicated that employees received a personal congratulatory letter from management. In general, however, industry feels that company recognition in terms of advancement and salary increase comes as a result of improved job performance resulting from CES.

This was another significant statement regarding the economy of incentives as employed by industry. So far as answering the questions of "Who pays for CES?" was concerned, Karol found that employers expected the employee to bear one quarter of the costs plus the donation of some of his free time, while the company was paying three-quarters of the costs and permitting partial use of working hours for CES courses. Universities were found to be making little contribution to the direct costs of CES.

Zelikoff (37) made an interesting contribution to the art of "measuring" obsolescence of engineers by carefully reviewing course descriptions from five engineering schools he deemed representative of all engineering schools: Columbia University, Cooper Union, Drexel Institute of Technology, Massachusetts Institute of Technology, and Georgia Institute of Technology. On the hypothesis that obsolescence was a difference between what an engineer would know if graduating today versus what he knew when he actually graduated, Zelikoff developed "erosion curves" which showed the "percentage of applicable knowledge" possibly possessed by a graduate engineer as a function of the year graduated. His study was based on engineering curricula on five year intervals and resulted in Zelikoff stating

> The obsolescence of a particular engineering specialization apparently is a function of the year of graduation and the number of years past graduation.

Uniquely, Zelikoff did not use his findings to advocate the organization of formal regimens of learning. He admitted that the engineer's ability to specialize would delay "advancing vocational age" and even that "continuing his studies" would help, but maintained that, if our technology was to continue to accelerate, "ever-increasing numbers of engineers must be sacrificed ..." He felt his research proved that obsolescence was inevitable.

This same year another significant article was prepared by Cohen and Dubin (8) in which they presented "A Systems Approach to Updating Professional Personnel." It was deemed significant because the chronological review of the literature to this point has documented the natural development of a formal organization of continuing education for engineers--from the recognition of the problem, the definition of the need, through the development of means and methods of communication, to the frustration of attempting to encourage a willingness on the part of practicing engineers to participate in such an organization. Through the review it was possible to see that this "willingness to serve" became the strategic factor upon which much philosophizing was done prior to attempts to quantify the problem in the hope it would be better understood by engineers. Cohen and Dubin's article then introduced an effort to mathematically model a system of updating to "take cognizance of the many psychological factors involved in updating." In fact, their model incorporated "the educational environment, psychological and motivational factors" and was represented as

$$t_o = \frac{I(WPt_{in} + t_a A)}{1 - I(G + H + P)}$$

where

t_o = updated individual,

t_{in} = individual coming into the system,

W = formal education,

P = supervision relationships,

A = management policies,

G = peer groups,

H = self-achievement,

t_a = actuation of management policies, and

I = updating practices.

Unfortunately, neither field studies nor experimentation were reported, but hypothetically, from this model one could examine the effects of a certain factor by holding the other factors constant and solving for the desired factor. Again, the article was felt significant because it introduced the concept of the interdependence of factors thought vital to the motivation of the professional to update himself.

1970

By 1970, the main emphasis seemed to be a search for support for continuing education programs. Fair (11), was advocating that companies should have been spending up to two percent of their budgets on continuing education while, at the same time, admitting that the answer to top management's question, "What is the payoff in continuing education?" was still unknown. Karol (16) was delineating the problem of financing, identifying the little-known as well as the better-known variables involved in financing and simulating continuing education systems from a cost standpoint in order to make comparisons of instruction costs for CES, CES costs per course, and costs per student.

Paul Mali (21), made a contribution to the area of continuing education for engineers by developing a measurement of obsolescence in engineering practices to be known as an obsolescence index. Working with six companies throughout the nation and utilizing 591 practicing electrical engineers from these companies, a search began for "causes and trends of obsolescence" in practicing engineers. By developing a criteria model based on technologies regarded as current, an obsolescence index (OI) was constructed and defined "as the ratio between current knowledge, as understood by the practioner, and the current knowledge in the field." The empirical expression was

$$OI = \frac{K_e}{K_f} .$$

From the research, Mali found that only 50% of the practioners met half of the model's criteria. Furthermore, it was found that production engineers had the lowest index (.140) as compared to research engineers index (.803), the highest. So far as causes for obsolescence were concerned, Mali identified four:

- Failure to keep pace with knowledge
- Low level of utilization or disuse of knowledge (Half of the participants felt their work assignments to be within the range of technician)
- Overspecialization
- Failure to plan a career life.

From his study, Mali concluded that

> ... education per se is meaningless for either the individual or his company, unless it is aimed at a specific, predetermined target and takes into account the many forces present both within and without the work environment.

1971

In 1971, continuing education "came of age" when the May-June issue of Engineering Education was dedicated to Continuing Engineering Studies. The issue had ten good articles concerning continuing education--its promises and its problems. Two of the articles were thought particularly worthy of mention because of their bearing on this research.

Katz and Grogan (17) summarized the evolving concepts in continuing education and identified the purposes and characteristics of CES, types of learning situations applicable to CES, and the motivations and rewards in CES. They maintained that CES led to

1. No formal recognition other than subsequent financial reward that accrues from increased competence and better performance on the job.
2. Exposure to challenging assignments on the job ...
3. Certificate for completion ...
4. Recognition of CES by employers as a valid element in personal professional development.

Katz and Grogan's feelings on motivation and rewards were interesting in that they possibly pointed out some of the barriers to participation by practioners. On the assumption (accepted in this dissertation) that Herzberg's (13) Theory of Motivation was valid, it was job-related factors of recognition, achievement, advancement, and responsibility, as well as work itself that motivated engineers on the job. If practicing engineers see no value in continuing education as contributing to these factors, it might be possible to explain the lack of participation that was bothering administrators in 1971.

Fred Landis (19) authored another of his hard-hitting articles in the May-June issue of Engineering Education based on interviews with engineering management and data collected from an extensive confidential questionnaire having to do with the utilization of engineers and their relations with their companies. Landis predicted that regular college courses would not play a vital role in the practicing engineer's education because the practioner was more interested in learning how to do his current job better rather than learning how to do a better job. Even in cases where college courses would succeed, Landis felt that they would be limited to management, mathematics, and computer oriented courses rather than basic science or basic engineering courses. According to Landis, universities could make a contribution if their efforts were in the form of work shops designed to improve skill training. Finally, Landis (based on his findings from the survey) had suggestions for companies:

> Companies must find the proper recognition and monetary reward level for their technical specialists ... the company must show its recognition of technical contributions in a positive fashion.

Summary

As mentioned in the beginning of the chapter, a chronological review of the literature on continuing education seemed justified because such a study revealed the rather logical development of the concept for an organization of continuing education--from Tom Stelson's effort to alert the technical society to the effects of rapid technical change on practioners, through the development of systems of communication, to the present and perplexing problem of achieving a higher percentage of participation. And each year seemed to bring further refinements and redefinitions of purpose and means and methods. It seemed interesting that at this date, when purpose and communication within such organizations had been rather well identified, that little quantitative work had been done on the now-strategic factor of participation.

Richard Wiegand's (35) work on factors significant to participation made a real contribution toward assisting the executive of a continuing education system for engineers. Again, the techniques applicable to the available data somewhat limited what could be done with the experiment even though maximum use was made of the data.

With surveys having been made which identified needs of practicing engineers, studies having been performed to develop efficient means and methods of communicating new knowledge and techniques to these engineers, and some research having been conducted into the factors involved in participation, it would appear that an investigation would be in order to determine if, _in the engineer's opinion_, continuing education is seen as of value in contributing to his ability to gain recognition, advancement, achievement, responsibility, improve his salary and/or security, or to improve his ability on the job. Furthermore, it would be of interest to attempt to discriminate between those engineers that do participate and those that don't based on their opinions plus other demographic dimensions. Accordingly, this research attempted to accomplish such a goal.

CHAPTER III

RESULTS OF THE STUDY

Analysis of the Survey

The survey instrument was designed so that the investigator could determine to what extent the respondent attended three types of short courses: college-sponsored, in-company, and professional society-sponsored. Given this information, the balance of the information pertained to variables which were thought to have some effect on whether or not an engineer attended such activities.

Some of the variables lent themselves to classification only. They were:

D-1 Academic Major

D-2 Major Field of Work

D-3 Change in Major Field of Work from Academic Major

D-4 Major Job Function

D-5 Highest Degree Held

The remaining variables were considered continuous in nature and were used as such in the statistical analysis:

C-1 Annual Income

C-2 Sum of Opinion Scores (C-3 thru C-10)

C-3 Advancement

C-4 Recognition

C-5 Work Itself

C-6 Security

C-7 Achievement

C-8 Company Policy

C-9 Salary

C-10 Responsibility

C-11 Years Since Degree

C-12 Age

C-13 Percent Company Pays for Short Courses

C-14 Percent of Short Courses Attended That Were Technical in Nature

Data Processing

As explained in Chapter I, the survey instruments were mailed on November 21 and 22, 1971. As the instruments were returned, they were sequentially numbered and dated, then checked to determine if they were usable. Six questionnaires had to be omitted because they were not completed by the respondent. Information from the remaining surveys were key punched onto data processing cards and verified.

The data were then processed through an edit program[1] capable of detecting invalid entries on the data card. A listing of this data is given in Appendix D. The messages noted in the listing were:

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[1]The edit program was the property of Mr. James E. Archer, Jr., General Manager, Caprock Computer Systems, Lubbock, Texas, and was modified for this problem by Mr. Archer.

1) "Invalid Most Important Job Type, Major Used." Where this message appeared, the assumption was made that the respondent's most important job function was the same as his major job function.

2) "Question _____ Is Invalid." Examination of every case where this message occurred showed that a question had been left blank. Therefore, the four scores from the other questions pertaining to that variable were averaged and this average was used for the question left blank.

3) "Invalid Work Engineering Field, Academic Used." Again, it was assumed that the respondent was working in the same field in which he received his degree.

4) "Invalid Academic Engineering Field, Work Used." This is the converse of "3". The assumption was that the respondent was working in the same field in which he received his degree.

With these refinements, the data then comprised the raw data file from which information was drawn for desired tests.

Tabulation of the Data

An overview of the data gathered from the 330 usable surveys is presented for a better understanding of the sample statistics.

The variable upon which all tests were designed was "extent of participation." Table IV summarizes the number of cases falling into four categories: college-sponsored, non-credit; in-company training; professional society-sponsored; all courses. The number of cases shown in the category "all courses" was derived as follows: If a respondent indicated he had not attended any type of short course listed in the past five years, he was classified "none"; if a respondent indicated he had attended from one to five short courses in the past five years--be it in one, two, or all three categories--he was classified "medial"; if the respondent indicated he had attended six or more short courses in the past five years in any category, he was classified "active".

TABLE IV

CLASSIFICATION OF RESPONDENTS BY DEGREE OF ATTENDANCE AT SHORT COURSE ACTIVITIES

Category	Sample Size	None	Medial	Active
College Sponsored	330	217	106	7
In-Company	330	109	183	38
Professional Society	330	230	90	10
All Courses	330	60	220	50

From Table IV, it was observed that the majority of respondents had attended one or more in-company short courses in the past five years, but such was not the case with the other two categories. The number of respondents indicating attendance at one or more short courses sponsored by a professional society was approximately equal to the number attending one or more college sponsored short courses.

The age distribution of the respondents is given in Figure 2. This graph indicated a rather representative distribution whose mean was approximately 37 years of age (36.91) with a standard deviation of ± 9.57 years.

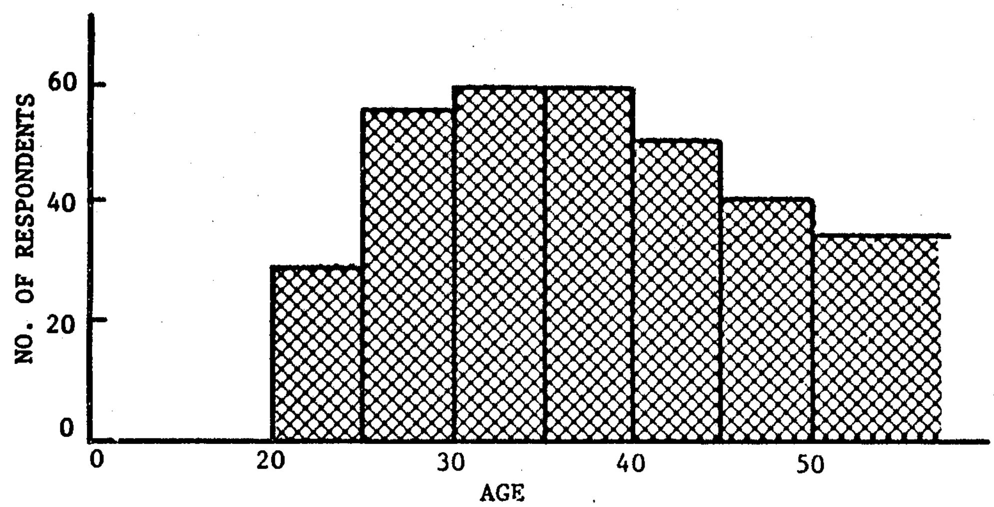


Figure 2. Age Distribution of Respondents

The educational profile of the respondents is given in Table V.

Table VI presents a picture of the tendency for respondents to this survey to remain in the field of engineering in which they received their degree. The "Academic" column represented the number of respondents originally receiving a degree in the discipline noted. The "Remain" column represented the number of those engineers from column one who had remained in that field of engineering. Column four--"new"--represented engineers coming into that particular discipline from some other engineering discipline. The row designated "Other" generally represented shifts to more specialized fields of engineering (systems,

TABLE V

EDUCATIONAL PROFILE

Highest Degree Held	No. of Respondents	Percent
Doctorate	13	3.93
Master	39	11.81
Bachelor	278	84.26

TABLE VI

NUMBER OF RESPONDENTS WORKING IN THE FIELD OF ENGINEERING IN WHICH THEY RECEIVED THEIR DEGREE

Discipline	Academic	Remain	% Remain	New
Agriculture Engineering	13	6	46	0
Architecture Engineering	1	1	100	0
Chemical Engineering	38	25	65	2
Civil Engineering	51	39	76	4
Electrical Engineering	80	66	82	3
Engineering Physics	4	2	50	0
Industrial Engineering	41	24	58	5
Mechanical Engineering	67	49	73	10
Petroleum Engineering	30	28	93	9
Textile Engineering	5	2	40	0
Other	0	0	--	55

computing, aerospace, manufacturing, electronics) while approximately one-third of those designating their major field of work as "other" were in the military service, sales, management, law, or one of the sciences (geology or physics).

In analyzing job functions of respondents the 12 functions listed on the survey were grouped into four major functions as shown in Table VII.

TABLE VII

SUMMARY OF MAJOR AND MOST IMPORTANT JOB FUNCTIONS REPORTED BY RESPONDENTS

Function	Major	Most Important
Research and Development	44	42
Research		
Development		
Supervision	103	89
Engineering Managment		
Non-Engineering Management		
Training		
Engineering	160	165
Estimating/Planning		
Production/Operations		
Quality Control		
Sales		
Systems Design		
Testing		
Other	23	34

Table VIII gives the total and average score for each of the job attitude factors tested as well as the overall score. The mid-point of the range for each factor was 15 and the overall mid-point was 120. From the table it was observed that the sample, overall, scored the value of short courses to "work itself" and "achievement" higher than average and scored "security" and "salary" lower than average.

TABLE VIII

SCORES ON JOB ATTITUDE FACTORS

Attitude	Sample Size	Total Score	Average Score
Work Itself	330	6620	20.06
Achievement	330	6322	19.16
Recognition	330	5033	15.25
Company Policy	330	4952	15.00
Advancement	330	4712	14.28
Responsibility	330	4647	14.08
Security	330	4215	12.77
Salary	330	4205	12.74
Overall	330	40706	123.35

A histogram displaying the reported salary profile of the respondents is given in Figure 3. The average salary of the sample was approximately $16,500.00 with a standard deviation of approximately $5,000.00.

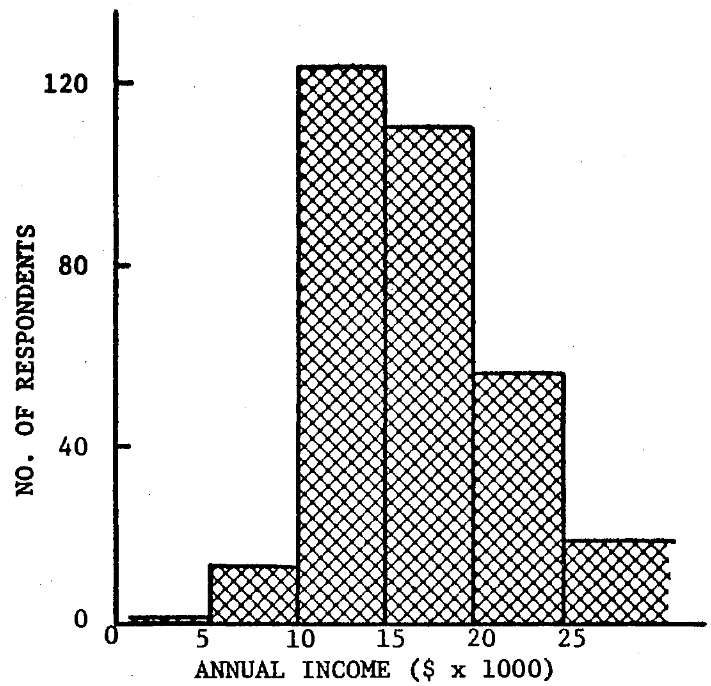
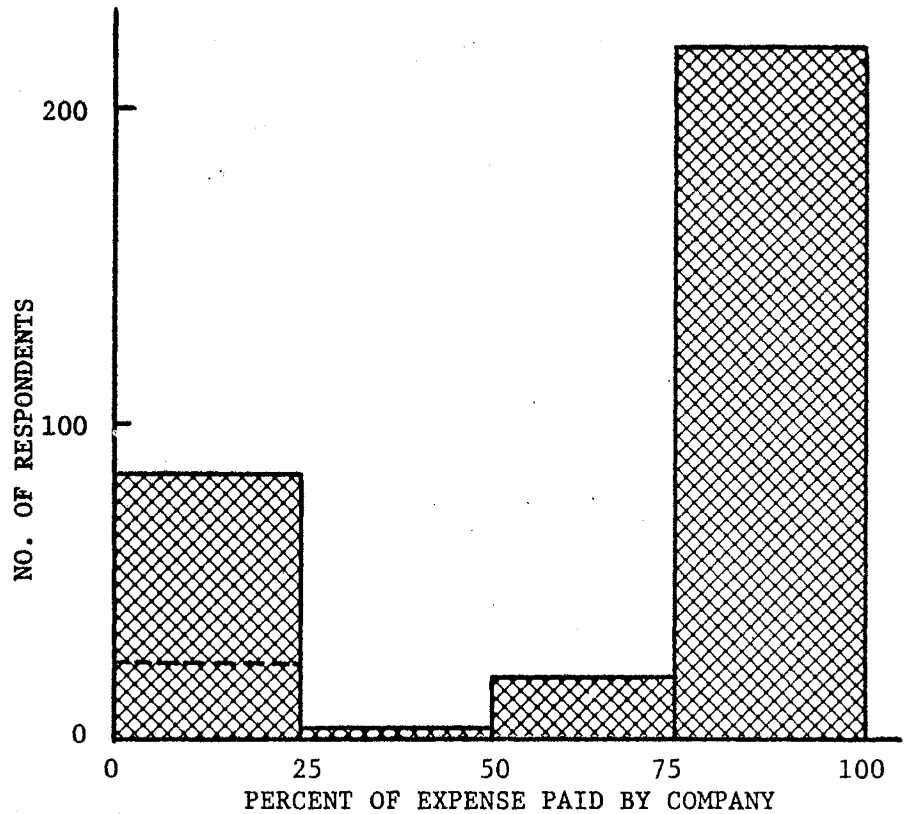


Figure 3. Salary Profile of Respondents

The final two variables considered in this survey were the amount of support the practicing engineer received from his company and the degree of technical content the participating engineer felt was in the short courses he attended. No attempt was made to define "technical content". Rather, the respondent was free to indicate his feelings. Summary results are given in Figures 4 and 5.

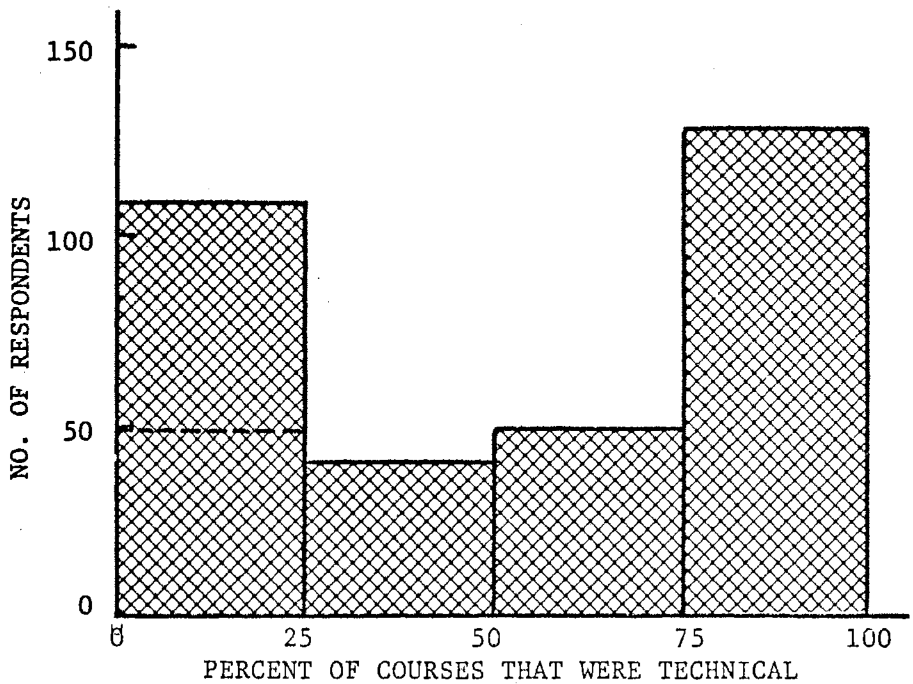
Statistical Analysis of the Data

As noted in the beginning of this chapter, the variables selected for analysis were designated as either discrete (D-1 thru D-5) or continuous (C-1 thru C-14). There were assumptions made for variables C-2 thru C-10 which are discussed later in this chapter. Basically,



Note: Of the 82 respondents reporting 0-25 % support, 60 had not attended any type of short course in the past five years. The histogram reflects this information with a dashed line.

Figure 4. Percent of Total Expense Paid by Company



Note: Of the 106 respondents reporting 0-25 % technical content, 60 had not attended any type of short course in the past five years. The histogram reflects this information with a dashed line.

Figure 5. Percent of Courses Attended That Were Technical in Nature

the discrete variables were analyzed by non-parametric methods while the continuous variables were analyzed by parametric methods.

Non-Parametric Analysis

The statistical analysis began with non-parametric tests to determine if the respondents' academic major, major field of work, change in major field of work from academic major, major job function, or highest degree held was significant in his reported attendance or non-attendance at short courses. The Chi-square test was appropriate and, as noted where necessary, classifications were collapsed to meet the requirements of the tests.

Participation Versus Academic Major

Table IX represents the appropriate cell entries for testing the null hypothesis that academic major was not a factor in attendance at short courses. In all non-parametric tests, the Type I error was set, arbitrarily, at $\alpha = .05$. The computed χ^2 (Chi-square) = 1.3523 with 6 df (degrees of freedom). The null hypothesis was not rejected and it was concluded that academic major was not a factor in participation.

Participation Versus Major Field of Work

The null hypothesis to be tested was that the major field of work was not a factor in participation in short courses. The $\chi^2 = 4.1645$ with df = 6. The null hypothesis was not rejected at $\alpha = .05$. Table X represents the appropriate data for the test. It was concluded that major field of work was not a factor in participation in short courses.

TABLE IX

ACADEMIC MAJOR AND PARTICIPATION

Major	Participants Percent	Non-Participants Percent
Chemical	78.9	21.1
Civil	80.4	19.6
Electrical	81.3	18.7
Industrial	87.8	12.2
Mechanical	82.1	17.9
Petroleum	80.0	20.0
All Others*	82.6	17.4

*All Others = Agricultural + Architecture + Engineering Physics + Textile. Collapse of these classifications was necessary for cell size to meet the requirements of the Chi-Square Test.

TABLE X

MAJOR FIELD OF WORK AND PARTICIPATION

Field of Work	Participants Percent	Non-Participants Percent
Chemical	74.1	25.9
Civil	79.1	20.9
Electrical	79.7	20.3
Industrial	79.3	20.7
Mechanical	86.4	13.6
Petroleum	83.8	16.2
All Others*	84.8	15.2

*All Others = Agricultural + Architecture + Engineering Physics + Textile. Collapse of these classifications was necessary for cell size to meet the requirements of the Chi-Square Test.

Participation Versus Change in Major

Those cases where a respondent indicated he was working in a field of engineering that was different from the field in which he received his degree were tested against participation since some need for training or familiarization was implied. Accordingly, Table XI represents the data used to test the null hypothesis that the fact an engineer was working in a field different from the field in which he received his degree had no bearing on his participation. For $\alpha = .05$, the null hypothesis was not rejected with $\chi^2 = 3.7556$, df = 1. It was concluded that the fact that an engineer was working in a field different from the field in which he received his degree was not significant in determining his participation in short course activities.

Major Job Function Versus Participation

The null hypothesis was that major job function was not a factor in participation. The data is displayed in Table XII and the $\chi^2 = 0.2551$ with df = 2. The null hypothesis was not rejected and it was concluded that the engineer's major job function was not a factor in determining participation in short course activities.

Highest Degree Held Versus Participation

The question to be resolved was, "Are engineers with a Doctorate more likely to have participated in short courses than those with a Master's or Bachelor's?" Likewise, "Are those with a Master's more likely to have participated than those with a Bachelor's?" The null hypothesis was that the highest degree held was not a factor in determining participation. Table XIII gives the appropriate data. The

TABLE XI

CHANGE AND PARTICIPATION

Status	Participants Percent	Non-Participants Percent
No Change	79.3	20.7
Change	88.6	11.4

TABLE XII

MAJOR JOB FUNCTION AND PARTICIPATION

Job Function	Participants Percent	Non-Participants Percent
Research and Development	81.8	18.2
Engineering	82.5	17.5
Supervision	84.5	15.5

TABLE XIII

HIGHEST DEGREE HELD AND PARTICIPATION

Degree	Participants Percent	Non-Participants Percent
Doctor	76.9	23.1
Master	82.0	18.0
Bachelor	82.0	18.0

computed $\chi^2 = 0.2177$ with df = 2. The null hypothesis was not rejected and it was concluded that the highest degree held was not a factor in participation in short course activities.

From the non-parametric tests performed, there was no reason to believe that any of the discrete variables selected for investigation were significantly related to participation in short course activities.

Parametric Analysis

To test the general hypothesis that practicing engineers had certain attitudes toward continuing education that determined whether or not they would participate in activities such as short courses, the technique of stepwise discriminant analysis was used. The basic idea of a discriminant function which maximized the distance between two or more groups was developed by R. A. Fisher (12) in the 1930's. However, because of the extensive calculations, it was not a practical approach until the introduction of the digital computer. In 1950, Rao (23) refined the concept of discriminant functions and in the 1960's a "Stepwise Discriminant Analysis"[2] program was developed which allowed the investigator to specify a level below which variables would not be considered as discriminators. The program furthermore allowed the investigator to specify a level below which a variable that was entered could be removed, thereby providing the best combination of discriminating variables possible in a stepwise system.

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[2]Paul Sampson, "Stepwise Discriminant Analysis," Biomedical Computer Programs. W. J. Dixon, Editor. Berkeley and Los Angeles: University of California Press, 1967, pp. 214a-214t (as modified for Texas Tech Computing Services, January 27, 1969).

Basically, the computer program calculated a linear classification function (the classification functions collapse to the discriminant function) for each group to be classified, utilizing those "p" variables accepted by the "F" numbers chosen. The functions were of the form

$$Y_1 = c_{01} + c_{11}X_1 + c_{21}X_2 + \dots + c_{p1}X_p$$

$$Y_2 = c_{02} + c_{12}X_1 + c_{22}X_2 + \dots + c_{p2}X_p$$

$$\vdots$$

$$Y_n = c_{on} + c_{1n}X_1 + c_{2n}X_2 + \dots + c_{pn}X_p$$

for "n" groups

Each case (in this experiment a case was represented as a respondent) was fitted to each classification function and placed in the group with the largest "Y" value. The rationale for such placement was explained by the expression for the posterior probability of case "k" in group "m" coming from group "ℓ"

$$P_{\ell mk} = \frac{\exp(Y_i)}{\sum_{i=1}^{n} \exp(Y_n)} .$$

From this expression it is determined that the classification function with the largest "Y_i" represents the greatest probability of case "k" in group "m" coming from group "ℓ". A summary of classification by discriminant function versus classification by posterior knowledge was then generated.

Input to the program required the designation of the variables to be considered, the number of groups to be discriminated, the number of cases in each group, the desired "F number" for each variable to enter or to be deleted from the program, and the tolerance level desired. Table XIV gives a summary of the original tests run at various values for "F", various variables included, and different groupings.

Preliminary experimentation with the program revealed that results could be noticeably affected with the selection of different input parameters. A discussion of the selection of these parameters would be appropriate.

The input parameter most affecting the number of variables accepted by the program was the "F number." The "F numbers" selected for these tests were strictly arbitrary and represented "threshold" numbers only--a point arbitrarily selected for entry. The first "F to enter" and "F to delete" values (0.010 and 0.005) were suggested by the program description and allowed most variables submitted to be entered. This provided a basis for conditional statements to be made as to their importance. The second "F" values (1.000 and 0.500) were chosen arbitrarily.

Grouping of the data requires just a note. From the data collected, respondents were classified as "none," "medial," or "active." There were three possible combinations to group these classifications into two groups: "none-medial," "none-active," and "medial-active." By combining classifications "medial" plus "active" another classification was generated, labelled "some." As might have been expected, the best discrimination resulted between the "none" and "active" groups, while the worst discrimination existed between the "medial-active" groups.

As can be interpreted from Table XIV, the major parameter being changed was the "Variables Omitted" in the tests. The variables were

TABLE XIV

TEST INPUT PARAMETERS

Test No.	F to enter / F to delete	Groups / Sample sizes	Variables Omitted: Opinion									Demographic				
			2	3	4	5	6	7	8	9	10	1	11	12	13	14
1	0.010/0.005	None-Some	X													
2		(60-270)	X												X	X
3			X						X						X	X
4			X						X			X	X	X	X	X
5		None-Medial	X													
6		(60-220)	X												X	X
7			X						X						X	X
8			X						X			X	X	X	X	X
9		None-Active	X													
10		(60-50)	X												X	X
11			X						X						X	X
12			X						X			X	X	X	X	X
13		Medial-Active	X													
14		(220-50)	X												X	X
15			X						X						X	X
16			X						X			X	X	X	X	X
17	1.000/0.500	None-Some	X													
18		(60-270)	X												X	X
19			X						X						X	X
20			X						X			X	X	X	X	X
21		None-Medial	X													
22		(60-220)	X												X	X
23			X						X						X	X
24			X						X			X	X	X	X	X
25		None-Active	X													
26		(60-50)	X												X	X
27			X						X						X	X
28			X						X			X	X	X	X	X
29		Medial-Active	X													
30		(220-50)	X												X	X
31			X						X						X	X
32			X						X			X	X	X	X	X

"X" denotes that the variable was not submitted.

designated as belonging to two groups which were labelled "Opinion Variables" and "Demographic Variables" in Table XV.

TABLE XV

VARIABLE CLASSIFICATION

	Opinion Variables		Demographic Variables
C-2	Sum of Opinion Scores	C-1	Annual Income
C-3	Advancement	C-11	Years Since Degree
C-4	Recognition	C-12	Age
C-5	Work Itself	C-13	Percent Company Pays for Short Courses
C-6	Security	C-14	Percent of Short Courses That Were Technical in Nature
C-7	Achievement		
C-8	Company Policy		
C-9	Salary		
C-10	Responsibility		

Of those labelled "Opinion Variables," note should be taken of two of them--C-2, "Sum of Opinion Scores," and C-8, "Company Policy." From preliminary "runs" with the program, it was decided that C-2, representing the sum of the eight opinion variables in the analysis, was not to be submitted to the program. It being "a sum of opinions" and since the general hypothesis of the research was based on engineers' opinions on selected job-attitude factors, it was decided to delete C-2 from all tests and leave the various opinion scores intact. Therefore, the variable C-2 does not appear in future tables. The variable "Company Policy" (C-8) was included in the first tests and deleted in later tests. Actually, the survey instrument attempted to have the respondent make statements to the effect "that by attending short courses, chances for doing a better job (Work Itself), being recognized, achieving, advancing, gaining responsibility, making more money, or achieving more security would be improved (or not be improved)." It can be seen that it was difficult to fit the variable "Company Policy" into the above statement since the survey actually resulted in a statement by the respondent about the degree to which he felt the company supported the idea of short courses. It was considered a valid opinion, but duplicate tests were run with it excluded.

Before reviewing the results of the tests, a summary of what the analysis had basically shown should be discussed. Given an arbitrarily selected threshold number designated "F to enter" and another designated "F to delete," a tolerance level which, in effect, designated the number of significant figures to be carried throughout the run, the number of groups and the number in each group for the test, plus the variables pertinent to the particular run, the program calculated linear classification functions which were functions of the maximized distance between the given clusters based on the variables available at the "F" number selected. Each case, being given as belonging to one of two groups, was evaluated using the classification functions generated. With this information, the program was able to classify each case. Therefore, it was possible to compare the number of cases in each group as determined by the discriminant function with the number of cases in each group as determined by the degree of participation indicated by each respondent. This comparison was reflected in Table XVI, Test Results, under the column entitled "Percent Accuracy." Appendix F gives an example of the computer print out of the Stepwise Discriminant Analysis Program (Test No. 1).

Results with "F to Enter" = 0.010 and "F to Delete = 0.005

By varying the "F to enter" and "F to delete" values, the number of submitted variables entered in a particular test was also varied. A low "F to enter" and "F to delete" allowed more variables to enter (when submitted) and generated an "order of importance" of the variables.

Accordingly, 16 tests were run with "F to enter" = 0.010 and "F to delete" = 0.005. Examination of Table XVI shows this set of tests ranged in accuracy from 59% to 97% with accuracy generally improving as the number of variables submitted increased.

Three of the 16 tests run using the "F" number mentioned above gave better than 90% accuracy. This accuracy was computed on the basis of the number of "correct" classifications made by the program utilizing the discriminant function generated from the input data. The design of the program required a posterior classification. This classification was based on the respondent's answers to the questions on his degree of participation at short courses. The program then selected, from the variables submitted, the strongest discriminators and calculated the coefficients of the discriminators describing the best linear function of each group. From these functions, the program then classified the respondents into one of the two given groups and

TABLE XVI

TEST RESULTS

Test No.	F_{in}/F_{delete}	Groups	Variables Submitted & Entered* 3	4	5	6	7	8	9	10	1	11	12	13	14	Percent Accuracy
1	0.010/0.005	None-Some	10	6	7	11	X	5	12	4	9	3	8	1	2	92
2			X	8	4	3	7	1	5	6	2	9	10	-	-	65
3			3	8	2	4	6	-	5	X	1	7	9	-	-	61
4			3	6	1	4	2	-	5	7	-	-	-	-	-	61
5		None-Medial	9	6	7	X	X	8	11	5	4	3	10	1	2	91
6			10	X	4	3	5	1	8	9	2	7	6	-	-	63
7			3	6	2	5	4	-	10	7	1	8	9	-	-	60
8			2	5	1	4	3	-	6	X	-	-	-	-	-	59
9		None-Active	6	12	7	8	13	4	11	5	2	10	9	1	3	97
10			10	9	11	2	6	1	4	5	3	7	8	-	-	78
11			6	X	2	3	8	-	4	7	1	9	5	-	-	68
12			4	6	1	2	7	-	3	5	-	-	-	-	-	62
13		Medial-Active	10	12	4	1	9	2	8	7	5	6	X	11	3	67
14			9	10	3	1	8	2	5	6	4	7	X	-	-	68
15			9	10	2	1	6	-	3	7	4	5	8	-	-	61
16			X	6	2	1	4	-	3	5	-	-	-	-	-	60
17	1.000/0.500	None-Some	X	X	X	X	X	5	X	4	X	3	X	1	2	92
18			X	X	4	3	X	1	X	X	2	X	X	-	-	65
19			X	X	2	X	X	-	X	X	1	X	X	-	-	61
20			X	X	1	X	X	-	X	X	-	-	-	-	-	61
21		None-Medial	X	6	X	X	X	X	X	5	4	3	X	1	2	91
22			X	X	X	X	X	1	X	X	2	X	X	-	-	62
23			3	X	2	X	X	-	X	X	1	X	X	-	-	58
24			X	X	1	X	X	-	X	X	-	-	-	-	-	60
25		None-Active	X	X	X	X	X	X	X	X	2	X	X	1	3	97
26			X	X	X	2	6	1	4	5	3	X	X	-	-	78
27			X	X	2	3	X	-	4	X	1	X	5	-	-	66
28			X	X	1	2	X	-	3	X	-	-	-	-	-	61
29		Medial-Active	X	X	4	1	X	2	X	X	5	X	X	X	3	66
30			X	X	3	1	X	2	X	X	4	X	X	-	-	66
31			X	X	2	1	X	-	3	X	4	5	X	-	-	61
32			X	X	2	1	X	-	3	X	-	-	-	-	-	60

* An "X" implies the variable was submitted but not entered
A numerical entry indicates the order in which the variables entered
A "-" implies the variable was not submitted

summarized the computations in a summary table at the end of each run (see page 72 for an example of the classification table). The resulting tables for those tests showing better than 90% accuracy are given in Table XVII.

As would be expected, the results of the three tests show that the best discrimination was performed between groups expected to be farthest apart--those who had not attended any type of short course and those who had been "active" in attendance.

Considerably less success was realized when attempts were made to classify a respondent by opinion alone. Table XVIII summarizes the four tests run at "F to enter" = 0.010 for opinions only.

The next item of interest was the degree to which submitted variables were utilized by the experiment or, put another way, given a variable was submitted, the percent of the time was it utilized. Table XIX summarizes this information.

As could be seen from this table, the majority of the variables submitted were utilized, but it was noted that all demographic variables except C-12 were utilized 100% of the time they were submitted. Five of the eight opinion variables were not that "strong."

Since all variables were used at least 83% of the time they were submitted, it was necessary to study which of the variables appeared strongest under different conditions. Table XX gives some indication of the order in which the first five variables entered a particular test for "F to enter" = 0.010.

Looking at Table XX as a whole, a fairly consistent ranking of variables occurred as the variables submitted were changed except for the last entry in each group. These tests (13, 14, 15, 16) were

TABLE XVII

SUMMARY OF CLASSIFICATION TABLES FOR TESTS HAVING 90% ACCURACY OR BETTER; "F TO ENTER" = 0.010

A. Test No. 1, all variables submitted, accuracy = 92%

		Computed Groups	
		None	Some
Given Groups	None	59	1
	Some	25	245

B. Test No. 5, all variables submitted, accuracy = 91%

		Computed Groups	
		None	Medial
Given Groups	None	59	1
	Medial	24	196

C. Test No. 9, all variables submitted, accuracy = 97%

		Computed Groups	
		None	Active
Given Groups	None	59	1
	Active	2	48

TABLE XVIII

SUMMARY OF CLASSIFICATION TABLES FOR TESTS BASED ON OPINION ONLY; "F TO ENTER" = 0.010

A. Test No. 4, accuracy = 61%

		Computed Groups None	Computed Groups Some
Given Groups	None	34	26
	Some	102	168

B. Test No. 8, accuracy = 59%

		Computed Groups None	Computed Groups Medial
Given Groups	None	30	30
	Medial	85	135

C. Test No. 12, accuracy = 62 %

		Computed Groups None	Computed Groups Active
Given Groups	None	38	22
	Active	20	30

D. Test No. 16, accuracy = 60%

		Computed Groups Medial	Computed Groups Active
Given Groups	Medial	133	87
	Active	20	30

TABLE XIX

VARIABLE UTILIZATION AT "F TO ENTER" = 0.010

Percent Utilization	Variable
100.0	C-1
100.0	C-5
100.0	C-8
100.0	C-9
100.0	C-11
100.0	C-13
100.0	C-14
93.7	C-6
87.5	C-3
87.5	C-4
87.5	C-7
87.5	C-10
83.3	C-12

TABLE XX

ORDER OF VARIABLES ENTERED UNDER DIFFERENT TEST CONDITIONS FOR "F TO ENTER" = 0.010

Condition	Test No.	Variables Entered 1st	2nd	3rd	4th	5th
A. All variables submitted	1	13	14	11	10	8
	5	13	14	11	1	10
	9	13	1	14	8	10
	13	6	8	14	5	1
B. All variables submitted except C-13, C-14	2	8	1	6	5	9
	6	8	1	6	5	7
	10	8	6	1	9	10
	14	6	8	5	1	9
C. All variables submitted except C-8, C-13, C-14	3	1	5	3	6	9
	7	1	5	3	7	6
	11	1	5	6	9	12
	15	6	5	9	1	11
D. Opinion variables less C-8 submitted	4	5	7	3	6	9
	8	5	3	7	6	4
	12	5	6	9	3	10
	16	6	5	9	7	10

attempting to discriminate between "medial" and "active" groups while the balance of the tests were discriminating between "none" and other classifications of participation.

When all variables were submitted (Group A, Table XX), the most pronounced variables were Percent Company Participation (C-13) and Percent Technical Content (C-14) as long as discrimination between "none" and some degree of participation was being performed. Responsibility (C-10) also appeared in these cases although ranking fourth or fifth in importance.

Removing C-13 and C-14 from consideration (Group B, Table XX), variables Company Policy (C-8), Annual Income (C-1), and Security (C-6) become better discriminators, with Work Itself (C-5) increasing in importance. Again, test 2, 6, 10 fit a pattern for the reason mentioned in the previous paragraph.

Referring to the first three tests in Group C, Table XX (tests 3, 7, 11) the effect of removing C-8 was noted with the emergence of Annual Salary (C-1) as the strongest discriminator followed by Work Itself (C-5).

Finally, when all demographic variables plus Company Policy were removed from consideration, Work Itself (C-5) became the best discriminator (Group D, Table XX).

An interesting chain was noted in the four groups of Table XX. The Percent the Company Paid for Short Courses was the best discriminator. If this was not considered, Company Policy became most important. But in many ways this is a similar measure of percent participation. If Company Policy was also removed from consideration, Annual Income became most important with Security becoming more important. Finally, with only the balance of the opinion variables left, the fact that short courses were seen as a means to gain information to help on the job itself became number one in importance. Salary (C-9) appeared in the first five ranks after C-13 and C-14 had been removed from consideration. Advancement (C-3) and Achievement (C-7) were noticed only after C-8, C-13, and C-14 were removed and Recognition became a factor only when there were only seven variables left from which to account for variance.

Results with "F to Enter" = 1.000 and "F to Delete" = 0.500

Tests 1-16 were replicated after increasing the "F" number selected for entry and for deletion by a multiple of 100. The result was a decrease in the number of submitted variables being entered into the experiments as can be seen in Table XVI. Variable utilization decreased to some extent as shown in Table XXI which compares variable utilization at "F to enter" = 1.000 with variable utilization at "F to enter" = 0.010. At "F to enter" = 1.000, it was noted that only three of the eight opinion variables were utilized 50% of the time or more. These variables were Work Itself, Security, and Company Policy. This table served to further order the importance of the variables under consideration in this research. Attention was given to the fact C-13 was not entered in one of the four cases to which it was submitted under "F to enter" = 1.000. Again, the conditions of the test were important. In the case where C-13 was not entered, the test was concerned with discriminating between "medially active" and "active" respondents. Reference to the histograms of Percent Company Participation for "active" and "medial" engineers (pages 138 and 139) which showed greater

TABLE XXI

COMPARISON OF VARIABLE UTILIZATION AT
"F TO ENTER" = 1.000 AND 0.010

Percent Utilization at "F to enter" = 1.000	Variable	Percent Utilization at "F to enter" = 0.010
100.0	C-14	100.0
91.7	C-1	100.0
75.0	C-8	100.0
75.0	C-13	100.0
68.8	C-5	100.0
50.0	C-6	93.7
31.3	C-9	100.0
25.0	C-11	100.0
18.8	C-10	87.5
8.3	C-12	83.3
6.3	C-3	87.5
6.3	C-4	87.5
6.3	C-7	87.5

similarity than the comparable histograms for engineers classified "none," implying this factor would not be a characteristic upon which discrimination could be based.

In order to compare the results of the order in which variables were entered with "F to enter" = 1.000 with "F to enter" = 0.010, Table XXII was generated in similar form to Table XX.

In each case, the order of the variables entering was the same as with the lower "F" number. The difference came in the number entered. Where all cells were filled in Table XX, ten of the 16 tests run at the higher "F" number did not enter five variables. Perhaps, the comparison of Tables XX and XXII could be labelled "survival of the fittest." In all cases, it was opinion variables that were not entered at the higher "F" number. There were five occasions where Security and Achievement failed to enter; four occasions where Advancement and Salary failed to enter; three cases where Responsibility failed to enter and one case each where Recognition, Work Itself, and Company Policy did not enter.

Even though not as many variables were entered in the tests run at "F to enter" = 1.000, it was interesting to note that an insignificant amount of accuracy was lost when comparing the 16 tests at the lower "F" number to the 16 tests with the higher "F" number.
Table XXIII summarizes the classification tables for those tests which gave better than 90% at "F to enter" = 1.000. It was noted to differ from Table XVII by only one case in two of the three tests.

TABLE XXII

ORDER OF VARIABLES ENTERED UNDER DIFFERENT TEST CONDITIONS FOR "F TO ENTER" = 1.000

Condition	Test No.	Variables Entered 1st	2nd	3rd	4th	5th
A. All variables submitted	17	13	14	11	10	8
	21	13	14	11	1	10
	25	13	1	14	-	-
	29	6	8	14	5	1
B. All variables submitted except C-13, C-14	18	8	1	6	5	-
	22	8	1	-	-	-
	26	8	6	1	9	10
	30	6	8	5	1	-
C. All variables submitted except C-8, C-13, C-14	19	1	5	-	-	-
	23	1	5	3	-	-
	27	1	5	6	9	12
	31	6	5	9	1	11
D. Opinion variables less C-8 submitted	20	5	-	-	-	-
	24	5	-	-	-	-
	28	5	6	9	-	-
	32	6	5	9	-	-

TABLE XXIII

SUMMARY OF CLASSIFICATION TABLES FOR TESTS HAVING 90% ACCURACY OR BETTER; "F TO ENTER" = 1.000

A. Test No. 17, all variables submitted, accuracy = 92%

		Computed Groups None	Computed Groups Some
Given Groups	None	59	1
	Some	24	246

B. Test No. 21, all variables submitted, accuracy = 91%

		Computed Groups None	Computed Groups Medial
Given Groups	None	59	1
	Medial	25	195

C. Test No.25, all variables submitted, accuracy = 97%

		Computed Groups None	Computed Groups Active
Given Groups	None	59	1
	Active	2	48

Summary of Results with Original Sample

Two sets of 16 tests each were run using the total sample of 330 respondents. Twelve of the 16 tests were attempting to discriminate between those respondents who reported they had not attended any type of short course in the past five years and those that reported varying degrees of attendance. Four of the tests in each set were attempting to discriminate between "medially active" participants and "active" participants. Given that a respondent was active to some extent in short courses, it was not expected that opinion variables or demographic variables would differ significantly between groups as participation varied. This was borne out in Table XVI where overall accuracy for Tests 13-16 and 29-32 remained below 70% regardless of the number or type of variables submitted. It was also expected that the variable Percent Company Participation would not be as useful a discriminator under "medial-active" tests as the others. This was shown to be reasonable by ranking the variables as shown in Table XXIV. For this table, a weighted average was used. Summing the number of times a variable was entered after multiplying by a weight of from one to 13 depending on when it was entered (13 for the first variable entered, 12 for the second, ...) and dividing by the number of times it was submitted gave the ranks derived in Table XXIV.

From the table, it appeared the demographic variables, Percent Company Participation, Percent of Course Technical in Nature, and Annual Income, were the best discriminators between non-participants and those participating to some degree. The next strongest group were opinion variables, Work Itself, Company Policy, and Security. Such was not the case when discriminating between degrees of participation.

TABLE XXIV

RANKING OF VARIABLES BY WEIGHTED AVERAGE

Variable	Ranking for Tests 1-12	Ranking for Tests 17-28	Ranking for Tests 13-16	Ranking for Tests 29-32
Opinion				
C-3	7	11	11	10.5*
C-4	13	12.5*	10	10.5*
C-5	5	5	3	3
C-6	6	6	1	1
C-7	11	12.5*	9	10.5*
C-8	4	4	2	2
C-9	8.5*	7	6	6
C-10	10	9	8	10.5
Demographic				
C-1	3	3	5	5
C-11	8.5*	8	7	7
C-12	12	10	13	10.5*
C-13	1	1	12	10.5*
C-14	2	2	4	4

* indicates tie

Security appeared to be the best discriminator in that situation, followed by Company Policy, Work Itself, plus the demographic variable Percent of Courses Technical in Nature.

Overall, the tests were considered successful in developing a basis for ranking the importance of the variables but it was hoped that the overall accuracy of the discriminant functions could be improved. Accordingly, two more sets of tests were run with reduced sample sizes.

Sample Size Reduced for Recent Graduates

When the input data was reviewed it became apparent that many of the respondents (26.6%) had recently graduated and had not actually had five years of practicing experience during which time they might have had the opportunity to form an opinion of short courses based on actual attendance, or the chance to refuse to attend. Therefore, recent graduates were removed from all samples on the following basis: If a respondent had a Bachelor's degree and had graduated in the past five years, he was deleted; if a respondent had a Master's degree and had graduated in the last seven years, he was deleted; if a respondent had a Doctor's degree and had graduated in the last ten years, he was deleted. Accordingly, the sample was reduced from 330 to 242 ("none" went from 60 to 34, a 43% decrease, "medial" went from 220 to 166, a 24% decrease, and "active" went from 50 to 42, a 16% decrease). The tests were run with an "F to enter" = 0.010 only, with results shown in Table XXV.

A slight decrease in accuracy occurred with all variables submitted for "none" versus some degrees of participation, but accuracy improved slightly in most of the other tests. Perhaps of more interest was the

TABLE XXV

TEST RESULTS AFTER REMOVING RECENT GRADUATES

Test No.	F_{in}/F_{delete}	Groups	Variables Submitted & Entered*													Percent
			3	4	5	6	7	8	9	10	1	11	12	13	14	Accuracy
1 R'	0.010/0.005	None-Some	9	4	6	10	12	11	X	3	5	8	7	1	2	90
2 R'		(34-208)	9	7	X	8	3	1	6	10	5	4	2	-	-	67
3 R'			2	10	9	8	3	-	6	7	4	5	1	-	-	64
4 R'			1	X	3	5	2	-	6	4	-	-	-	-	-	60
5 R'		None-Medial	6	5	9	X	11	10	12	3	4	7	8	1	2	91
6 R'		(34-166)	5	6	X	7	3	1	8	X	9	4	2	-	-	67
7 R'			2	8	X	X	3	-	7	4	6	5	1	-	-	62
8 R'			1	5	3	6	2	-	7	4	-	-	-	-	-	60
9 R'		None-Active	7	12	5	X	11	4	10	6	3	9	8	1	2	96
10 R'		(34-42)	7	9	1[illegible]	2	10	1	4	5	6	8	3	-	-	84
11 R'			2	X	6	3	8	-	5	7	4	X	1	-	-	64
12 R'			1	4	7	2	5	-	3	6	-	-	-	-	-	61
13 R'		Medial-Active	10	12	8	2	3	1	6	7	13	5	11	9	4	71
14 R'		(166-42)	10	9	11	2	3	1	5	6	8	7	4	-	-	71
15 R'			X	8	7	1	2	-	3	X	5	6	4	-	-	64
16 R'			6	5	4	1	2	-	3	7	-	-	-	-	-	63

* An "X" implies the variable was submitted but not entered
A numerical entry indicates the order in which the variables entered
A "-" implies the variable was not submitted

comparison of variables ranked for the reduced sample size, Table XXVI, against the full sample ranking.

The samples analyzed in these tests represented engineers with the opportunity to have had more experience. Tests 1-12 do not consider discriminating between "medial-active" participants. The most significant change in rank was C-12, Age--from a relatively weak variable with the full sample to number three for the reduced sample. Nevertheless, the first three variables in order of rank for these tests were still demographic variables. Four of the opinion variables made a noticeable shift in position with Advancement becoming the most important of the opinion variables, Achievement going from eleventh to seventh while Work Itself and Security dropped relatively far back. By removing recent graduates from the sample, the factor of Annual Income had ceased to be a "good" discriminator, implying that the variance of this variable between populations was not as great with the reduced sample as with the full sample. On the other hand, Advancement had become a "good discriminator" with the reduced sample, implying a greater difference in attitude toward this factor in the reduced sample.

When looking at those tests discriminating "medial-active" (Tests 13-16) it was noticed that all three of the most important discriminators by rank were now opinion variables--Company Policy ranking first, Security second, and Achievement third. The change in rank of Work Itself (C-5) indicated that in cases where respondents had been out of school five or more years, this variable was not as good a discriminator between degrees of participation as it was with the full sample. A review of the classification tables (Table XXVII) for those tests with 90% accuracy or better shows that the only significant reduction

TABLE XXVI

COMPARISON OF RANKED VARIABLES; REDUCED SAMPLE FOR RECENT GRADUATES VERSUS FULL

Variable	Ranking for Tests 1-12 Reduced	Full	Ranking for Tests 13-16 Reduced	Full
Opinion				
C-3	4	7	13	11
C-4	12	13	9.5*	10
C-5	13	5	8	3
C-6	11	6	2	1
C-7	7.5*	11	3	9
C-8	5	4	1	2
C-9	10	8.5*	5	6
C-10	7.5*	10	9.5*	8
Demographic				
C-1	6	3	11	5
C-11	9	8.5*	6	7
C-12	3	12	7	13
C-13	1	1	12	12
C-14	2	2	4	4

* indicates tie

TABLE XXVII

SUMMARY OF CLASSIFICATION TABLES FOR TESTS HAVING 90% ACCURACY OR BETTER WITH SAMPLE REDUCED FOR RECENT GRADUATES

A. Test No. 1 R', all variables submitted, accuracy = 90%

		Computed Groups	
		None	Some
Given Groups	None	33	1
	Some	22	186

B. Test No. 5 R', all variables submitted, accuracy = 91%

		Computed Groups	
		None	Medial
Given Groups	None	33	1
	Medial	17	149

C. Test No. 9 R', all variables submitted, accuracy = 96%

		Computed Groups	
		None	Active
Given Groups	None	33	1
	Active	2	40

occurred in the number of misclassifications of those respondents classified "some" and "medial." In Test 1R' the misclassifications were reduced from 25 to 22 and in Test 5R' the misclassifications were reduced from 24 to 17 (based on an "F to enter" = 0.010). This did not represent any real improvement over the original tests. There was one other logical reduction in sample size considered.

Sample Reduced to Delete Respondents Not Presently in Engineering

From a review of the input data generated from the samples which had been reduced by deleting recent graduates, it was decided to investigate those respondents indicating that they were working in some field other than those given in the survey instrument. From the reduced sample, 45 respondents had indicated "other" as their major field of work. Of the 45, 30 had indicated a more specialized field of engineering than those listed, while 15 indicated they were working outside the field of engineering. These 15 respondents were removed from the reduced sample, making the newest sample size equal to 227. Of these, 32 were classified "none" (6% reduction), 157 were classified "medial" (5% reduction), and 38 were classified "active" (9% reduction). Table XXVIII summarized the results of tests run under this further reduced sample size. Again, the overall effect appeared to be a slight reduction in accuracy for test 1R" and otherwise an overall slight improvement.

The comparison of ranked variables for this reduced sample size with the first reduction and the full sample, Table XXIX, showed little change in the rankings from the first reduction. Variables C-13 and

TABLE XXVIII

TEST RESULTS AFTER REMOVING RECENT GRADUATES AND RESPONDENTS NOT IN ENGINEERING

Test No.	F_{in}/F_{delete}	Groups	Variables Submitted & Entered* 3	4	5	6	7	8	9	10	1	11	12	13	14	Percent Accuracy
1 R"	0.010/0.005	None-Some	6	4	7	11	X	8	10	3	5	X	9	1	2	90
2 R"		(32-195)	10	3	11	9	8	1	4	6	5	2	7	-	-	70
3 R"			5	4	X	X	7	-	2	8	3	1	6	-	-	67
4 R"			1	2	5	6	4	-	3	7	-	-	-	-	-	61
5 R"		None-Medial	6	4	8	X	10	7	9	3	5	X	X	1	2	91
6 R"		(32-157)	6	5	9	10	3	1	4	X	8	2	7	-	-	69
7 R"			5	6	9	10	3	-	2	8	4	1	7	-	-	66
8 R"			1	3	5	6	2	-	4	7	-	-	-	-	-	62
9 R"		None-Active	7	X	5	10	X	4	11	6	3	9	8	1	2	97
10 R"		(32-38)	10	7	11	3	8	1	4	5	6	9	2	-	-	80
11 R"			6	7	4	5	8	-	2	9	3	10	1	-	-	59
12 R"			1	6	7	2	4	-	3	5	-	-	-	-	-	63
13 R"		Medial-Active	11	9	8	2	3	1	6	7	12	X	5	10	4	69
14 R"		(157-38)	9	7	8	2	3	1	5	6	X	10	4	-	-	70
15 R"			10	7	6	1	2	-	3	9	5	8	4	-	-	63
16 R"			5	6	4	1	2	-	3	7	-	-	-	-	-	62

* An "X" implies the variable was submitted but not entered
A numerical entry indicates the order in which the vasiables entered
A "-" implies the variable was not submitted

TABLE XXIX

COMPARISON OF RANKED VARIABLES: DOUBLE REDUCTION VERSUS SINGLE REDUCTION VERSUS FULL SAMPLE

Variable	Ranking for Tests 1-12 Reduced"	Reduced'	Full	Ranking for Tests 13-16 Reduced"	Reduced'	Full
Opinion						
C-3	6	4	7	10	13	11
C-4	7	12	13	8.5*	9.5*	10
C-5	12	13	5	7	8	3
C-6	13	11	6	2	2	1
C-7	11	7.5*	11	3	3	9
C-8	3	5	4	1	1	2
C-9	5	10	8.5*	5	5	6
C-10	8	7.5*	10	8.5*	9.5*	8
Demographic						
C-1	4	6	3	12	11	5
C-11	10	9	8.5*	13	6	7
C-12	9	3	12	6	7	13
C-13	1	1	1	11	12	12
C-14	2	2	2	4	4	4

* indicates tie

C-14 remained as rank order one and two throughout the tests when comparing no participation with some participation. Variable C-4 was noticeably stronger when compared to the full sample which indicated more of a difference in attitude toward this variable with the reduced sample.

No real improvement in overall accuracy of tests was experienced by reducing the sample for recent graduates or by further reducing it for respondents not working in the field of engineering. When Table XXX was examined, it was noted that, again, no significant decrease in misclassifications could be detected. In all classification tables summarized, it was noted that one case given as "none" was consistantly classified "some," "medial," or "active" regardless of sample size. This case was reviewed and it was noted that the respondent, an Electrical Engineer from the Class of 1958, making between $15,000 and $19,999, had written in his survey that he had attended "1-5" in-company training courses of from "8-16 weeks" duration during the past five years. This length of time exceed the definition of a short course and he was classified "none." His attitude towards short courses was favorable to them and based on the discriminators, he should have been classified "some."

Using Table XXX as a basis, the 21 misclassifications of Test 1R" (excluding the misclassification mentioned above) were also reviewed. From Table XXIX, it was observed that C-13 was the best discriminator. Accordingly, the survey review showed that 18 of the 21 cases which actually had attended short courses on a medial basis (as determined by the experiment) received no company support. Two of the remaining

TABLE XXX

SUMMARY OF CLASSIFICATION TABLES FOR TESTS HAVING 90% ACCURACY OR BETTER WITH SAMPLE REDUCED FOR RECENT GRADUATES AND RESPONDENTS NOT IN ENGINEERING

A. Test No. 1 R", all variables submitted, accuracy = 90%

		Computed Groups	
		None	Some
Given Groups	None	31	1
	Some	21	174

B. Test No. 5 R", all variables submitted, accuracy = 91%

		Computed Groups	
		None	Medial
Given Groups	None	31	1
	Medial	16	141

C. Test No. 9 R", all variables submitted, accuracy = 97%

		Computed Groups	
		None	Active
Given Groups	None	31	1
	Active	1	37

three received from 26-50% support. The remaining case indicated 100% company support.

The second best discriminator was C-14, the Percent of Courses Attended That Were Technical in Nature. Of the 21 cases, seven reported technical courses comprised 0-25% of their experience while ten reported 100%. The one case reporting 100% company support also reported 51-75% technical content. Third in importance as a discriminator was C-10, Responsibility. The one case, which to this point seemed an exception, had a raw score of ten on Responsibility which was below the reduced sample average on this variable of 13.58. Likewise on C-4, Recognition, fourth best discriminator, this case scored ten as compared to the sample average of 14.98. Yet the overall score of this case was 125, well up with the sample average of 121.42. In general, the respondent ranked the value of short courses to himself in this order: Achievement, Work Itself, Advancement, Salary, Company Policy, and tied scores for Recognition, Security, and Responsibility. The case was judged to be one of the exceptions to the method used to discriminate between populations.

As for the balance of information gleaned from the survey review, one of the 21 cases held a Master's degree--the rest held Bachelor's degrees. Civil engineers had the most representatives (7) and the Class of 1950 was the mode so far as "Year of Degree" was concerned (5). The average annual salary was approximately $15,600.00--in line with the sample average.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

The experiment was designed to generate data that would be useful in examining hypotheses concerning the effects of opinions of graduate engineers towards one aspect of continuing education--short courses. From the hypotheses it was expected that information would be gained about the practicing engineer, the concept of continuing education, and continuing education as an organization.

Conclusions

The Hypotheses

The general hypothesis of the research was

> ... that practicing engineers have certain attitudes toward continuing education that determine whether or not they will participate in such activities.

This hypothesis was concluded to be false. The conclusion was based on an analysis of those tests made utilizing only "opinion variables" (test numbers 4, 8, 12, 16, 20, 24, 28, 32, Table XVI). This group of tests had the lowest percent accuracy of any group of tests, ranging from 59% to 62%. These results implied that a "guess" at whether an engineer would attend a short course or not was almost as good as a statistical analysis if only opinions were used in the discrimination.

Two specific hypotheses were investigated in conjunction with the general hypothesis. First, it was reasoned that the more motivated engineer would be more likely to attend a short course than the less motivated engineer. Herzberg maintained that the motivation for an engineer came through recognition, responsibility, achievement, advancement, and the work itself. The rationale of the first specific hypothesis was that those attending short courses saw such activities as a means of receiving this recognition, responsibility, advancement, achievement, or knowledge to use on the job. This hypothesis was concluded to be false. Unlike the general hypothesis that focused attention on "opinion variables" only, the entire environment as described by the variables selected for this experiment had to be considered. This consideration was represented by test numbers, 1, 5, 9, 13, 17, 21, 25, 29, Table XVI. Table XX emphasized the relative importance of "demographic variables" as compared to "opinion variables" and implied that discrimination, when based on all variables considered, would focus on events rather than opinions. The important questions were: "Did the company pay for the course? Was the course technical in nature?" Answers to these questions were what determined attendance --much more so than the engineer's opinion of the value of short courses.

The second specific hypothesis was formulated on Herzberg's theory of "satisfiers" or "hygienic" factors. Herzberg maintained that there existed certain factors necessary for the engineer to realize a satisfaction on the job, but these factors did not motivate the engineer to do better work. Of several such factors identified by Herzberg, salary and security were selected to test the hypothesis that there was no difference of opinion in certain attitudes between participants and non-participants so far as satisfiers were concerned. This hypothesis was accepted. Again, as in the first specific hypothesis, the "demographic variables" were the strategic factors, and removed most "opinion variables" from the higher ranks of consideration. Test 1, Table XVI, shows salary to be the poorest discriminator entered in the program, and security to be the next poorest discriminator entered.

It was concluded, in general, that for the population represented in this experiment, there was no reason to believe that a measure of a practicing engineer's opinion toward short courses would imply a correct classification of the engineer as a participant or non-participant.

Relative Strength of the Variables

In reaching conclusions as to the hypotheses of the research, it was noted the "demographic variables" appeared to be much stronger discriminators between participating and non-participating engineers than "opinion variables." This point was emphasized by summarizing the ranking of the variables under two conditions and taking a weighted average to generate a final ranking. Four groupings were considered in the experiment: "none-some," "none-medial," "none-active," and "medial-active." If the problem was attendance or willingness to attend, the two groupings of most interest would be "none-some" and "none-medial." It was conceived that attention given to "none-some" tests were related to the overall problem of continuing education short courses for engineers while "none-medial" tests were related to a more specific problems of differences between engineers that do not attend and those that attend on what was termed a minimal basis. Table XXXI summarizes the order the variables entered in Test 1 and Test 5,

TABLE XXXI

RANKINGS OF VARIABLES FOR STRATEGIC GROUPINGS

Variable	Groupings None-Some	Groupings None-Medial	Overall Ranking
Opinion			
C-3	10	9	10
C-4	6	6	5
C-5	7	7	8
C-6	11	-	12
C-7	-	-	13
C-8	5	8	6.5*
C-9	12	11	11
C-10	4	5	4
Demographic			
C-1	9	4	6.5*
C-11	3	3	3
C-12	8	10	9
C-13	1	1	1
C-14	2	2	2

* indicates tie

Table XVI, then ranks the variables based on weighted averages for the two tests.

Based on the rankings of Table XXXI, the best discriminating factor was the obligation of the company to pay for the short course. Considering that factor, the next best discriminator was determination of the content of the course as to whether it was a technical course or not. Continuing through the rank order of variables it was found that achievement, salary, and security were the poorest discriminators. Table XXXI was considered to generate a "profile" of the characteristics of the clusters developed by the stepwise discriminant analysis of the data. It was most important to realize that the profile was based on the selected variables and had different variables been selected, a different profile would probably have been generated. This realization led to the additional conclusion that the finding that demographic variables were relatively stronger than opinion variables was more significant than the order of the variables themselves.

A Check on Reality

In Chapter I, page 14, it was stated that certain demographic variables were included in the survey to be "... used for correlational studies and as a check on 'reality' ..." The "reality" being sought was an indication that those engineers who were of the opinion that short courses were of value to them were actually realizing some benefit--in this case, a measure of annual income was used. The fact that opinions proved to be relatively poor discriminators led to the hypothesis that such data would be inconclusive. Table XXXII shows a general trend for average annual income to increase as participation increased among those engineers who had an above average opinion of the value of short courses. However, a similar trend was noted for those with a below average opinion of short courses. Furthermore, those engineers with a below average opinion consistantly had a higher income although the standard deviations of the data negated any significance.

TABLE XXXII

AVERAGE ANNUAL INCOME AS PARTICIPATION INCREASES FOR ABOVE AND BELOW AVERAGE OPINIONS

Opinion	None	Participation Medial	Active
High	\$13790 ± 4570	\$15630 ± 4300	\$17500 ± 4000
Low	\$16980 ± 6340	\$17500 ± 4880	\$17900 ± 5640

An examination of Figure 6 gave some indication of how these respondents with an opinion toward short courses that ranked below the average opinion for this sample came to have higher incomes than those with above average opinions. Whereas 64.7% of those engineers making \$10,000 or less annually had an above average opinion of the value of short courses, this percentage consistantly decreased as annual income increased. In the final category--those respondents making \$25,000 or more annually--only 15.8% had an above average opinion of the value of short courses. This information could lead to suggestions that either the potential value of short courses was perceived to decrease as respondents earned more money, or--if the theory that income increases with experience is accepted--it might suggest that experienced engineers were disenchanted with the concept of short courses. In either case, the only conclusion that could be reached from the data was that income apparently increased as participation increased, but no causal relation was implied.

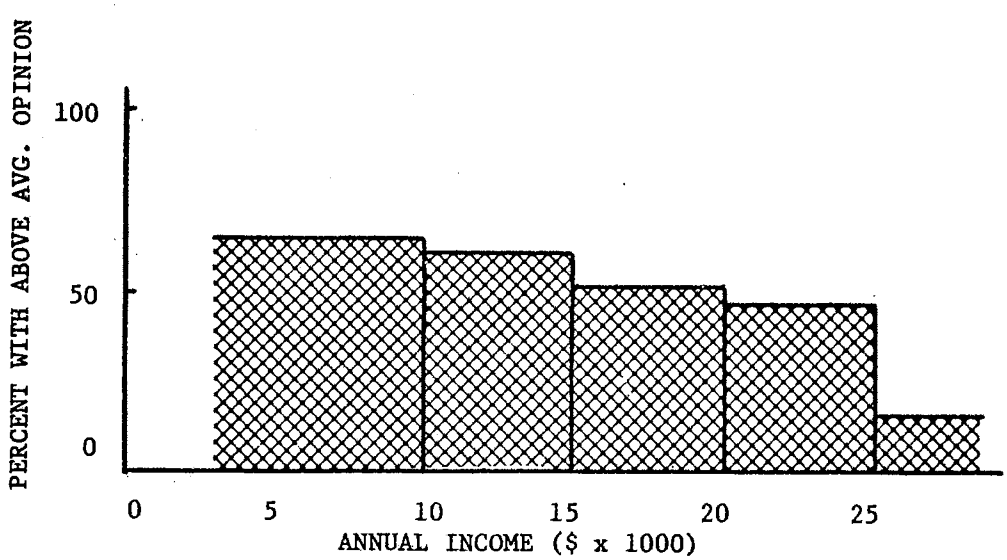

Figure 6. Opinion and Annual Income

Implications

The results of the experiment strongly implied that attendance at short courses depended mainly on company support and company support appeared to depend on the technical nature of the proposed course. If the purpose of a continuing education program was to keep the engineer up to date on developments in his field of interest then two factors appeared important. First, company-supported short courses could accomplish the purpose of a continuing education program only to the extent that the engineer's personal goals were "in phase" with the company's goals for that engineer. Second, if (as is usually the case) these goals were different to some extent, then an effective continuing education program would have to provide other means of up dating--perhaps credit work which would award the engineer by the concrete act of conferring a degree and identify an end point of effort for a phase of professional development.

Surveys by ECAC (10) and Dubin (9) found that engineers perceived their needs to lie primarily in the non-technical area. This research found an apparent contradiction in that most short courses attended were technical in content. But the factor of company participation was important. As stated above, companies paid for courses that were primarily of benefit to the company.

The means of communication are available to the continuing education organization. They must be utilized effectively. The purpose of the continuing education organization is heavily interdependent on securing essential services in the form of willingness on the part of the engineer to attend. The challenge to the executive of a continuing education organization is to become aware of industry's needs and the individual's goals to the extent that both can be integrated into a program of continuing education. It would appear that effective action for the executive would be concentrated on knowing his "market" intimately. Utilizing a system of questionnaires and/or interviews, the executive of a continuing education program must identify individual "wants" and goals. He must then make these desires known to management and attempt to establish a basis from which both industry and the individual will be satisfied.

Recommendations

This research selected one group of engineers and certain job-attitude factors identified in one theory of motivation and attempted to discriminate between engineers that do attend short courses and those that do not attend. Many additional studies should be made in this area. Perhaps the most logical extension of this work would be an attempt at discrimination of engineers based on credit course work. As suggested in the above section, successful completion of credit courses are direct recognition of the individual's efforts and might be reflected in changes in opinions and attitudes such that opinions would become better discriminators. Other variables should be considered. The variables used in this experiment were chosen from one of several theories of motivation. Other theories should be examined in conjunction with this area of research.

Also, the trend for above average opinion of short courses to decrease as income increased is an interesting phenomenon and deserves further research. Other populations might confirm this finding. If so, then opinions toward education itself might be interesting.

Engineers have been characterized as a "peculiar breed" of individuals who are wrapped up in their work and look for recognition and self-achievement as reward for effort more so than money and security. This may or may not be true, but a replication of the experiment for other professions or for those with degrees in other fields would be interesting.

Finally, of the many ideas and thoughts scanned as this research was being planned, one approach was particularly appealing--an investigation into the continuing education programs of the Armed Forces of the United States. These programs are highly successful and while one might intuitively reason their success, much could be learned from their efforts. Who is selected, how selections are made, when a course is offered, why it is offered, what the reward is for attendance, how the material is presented, how the material is updated--all are factors which, when answered, might give the continuing education executive, company management, and practicing engineers a better insight of what it takes to establish common ground for a program of professional development.

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APPENDIX A

THE SURVEY WITH ACCOMPANYING TRANSMITTAL LETTER

College of Engineering
Office of the Dean
Phone (806) 742-1211

Texas Tech University
P.O. Box 4200
Lubbock, Texas 79409

Dear Alumnus:

Alumni groups throughout the country can do many things to and for their Alma Mater. While much of such activity is generally associated with their university's athletic department, it is not often that they participate in the design of a proposed program of education. However, this is exactly what I am asking of you.

We are thinking of expanding our efforts to provide meaningful programs of continuing education for engineers. Before going into the planning stages we are sincerely soliciting opinions from our engineers that might tell us what importance the concept of "short courses" play in their professional development. Accordingly, I am asking you to take 15-20 minutes of your time to reply to the enclosed questionnaire with my assurance to you that the replies are strictly confidential and to be published only in summary form after the data are analyzed. In fact, if you would complete the survey and return it in the pre-addressed, stamped, envelope today, we would publish the results in the spring issue of *Tech Today*.

Your opinion of continuing education for engineers will make a difference! Please take a few minutes to let us know how you feel. Comments will be most welcome.

Sincerely,

John Bradford

John R. Bradford
Dean of Engineering

An ENGINEERING ALUMNI Survey on Continuing Education

This questionnaire is intended to be filled out by those who graduated from Texas Tech with a baccalaureate, master, or doctorate in engineering. All answers to this questionnaire will be considered as **strictly confidential** and no use of the data will be made that will in any way identify individual respondents.

The questionnaire is designed to take a minimum of your time – 15 to 20 minutes – yet it should be understood that supplementary notes or comments are welcomed and encouraged. Simply staple or clip such notes on the questionnaire and mail in the enclosed addressed envelope. Return postage is paid.

Part I

Please give the name and location of your company:

____
Company

____
City *State*

Please indicate the year you received your Bachelor's Degree in Engineering: ____________
Year

Please indicate (☒) all degrees received from Texas Tech:

- ☐ Bachelor
- ☐ Master
- ☐ Doctorate

Please indicate (☒) degrees received from Universities or Colleges other than Texas Tech:

- ☐ Bachelor
- ☐ Master
- ☐ Doctorate

Please indicate (√) your age bracket:

20-24 ( )
25-29 ( )
30-34 ( )
35-39 ( )
40-44 ( )
45-49 ( )
50-54 ( )
55-59 ( )
60-64 ( )
65 and over ( )

Please indicate (☒) your academic major and your major field of work in the boxes at left:

Academic Major	Major Field of Work	
☐	☐	01 Agricultural Engineering
☐	☐	02 Architectural Engineering
☐	☐	03 Chemical Engineering
☐	☐	04 Civil Engineering
☐	☐	05 Electrical Engineering
☐	☐	06 Engineering Physics
☐	☐	07 Industrial Engineering
☐	☐	08 Mechanical Engineering
☐	☐	09 Petroleum Engineering
☐	☐	10 Textile Engineering
☐	☐	11 Other ____________ *please specify*

Below is a list of general job functions. Please indicate (☒) which function takes the majority of your time. Then indicate the function you feel is most important in your job:

Major Function	Most Important Function	
☐	☐	01 Development
☐	☐	02 Engineering Management
☐	☐	03 Estimating/Planning
☐	☐	04 Non-Engineering Management
☐	☐	05 Production/Operations
☐	☐	06 Quality Control
☐	☐	07 Research
☐	☐	08 Sales
☐	☐	09 Systems Design
☐	☐	10 Testing
☐	☐	11 Training
☐	☐	12 Other ____________ *please specify*

Part II

This is the "heart" of the questionnaire and will hopefully give you a chance to express your opinion about one aspect of continuing education as it relates to your work.

We specifically want to know how you feel about attending short courses. We will define a short course as a

> **course presented by a member(s) of the faculty of a college or university either on-campus or at an off-campus location in which instruction is scheduled for a period that may vary from 2 days to 6 weeks. It is typically either an abbreviation of a standard course in the subject, a presentation of recent research or developments in a given field, a brief review of a broad area of practical knowledge, a refresher course, or an intensive study of a narrow segment of a subject. (It may also be referred to as a conference, institute, seminar, or workshop.) It is not offered for college credit.**

On the following pages you will find statements about the effect short course work might have on your job. Attendance at the course implies successful completion.

- Read each statement and decide the extent you agree or disagree.
- Keeping the statement in mind, indicate in the appropriate (☒) whether you personally strongly agree, generally agree, are undecided, generally disagree, or strongly disagree.
- Remember, keep the statement in mind when deciding how you feel about this aspect of continuing education. Please be frank. Give us your true opinion of this method of continuing education for engineers.
- Please answer every item.

On my present job, I feel that my attendance at a short course . . . .

	Strongly Agree	Generally Agree	Undecided	Generally Disagree	Strongly Disagree
1. is of no value so far as promotion is concerned	☐	☐	☐	☐	☐
2. would result in more notice of my efforts by my supervisor . .	☐	☐	☐	☐	☐
3. would provide me with problem solving methods that could be put to immediate use	☐	☐	☐	☐	☐
4. would not contribute to my job security	☐	☐	☐	☐	☐
5. would be of value to me in my work	☐	☐	☐	☐	☐
6. is an integrated part of my company's program to maintain professional competence	☐	☐	☐	☐	☐
7. would improve my chances for a pay increase	☐	☐	☐	☐	☐
8. would result in me being given increased responsibility for the work of others	☐	☐	☐	☐	☐
9. would be a waste of time so far as improving my chances of advancement is concerned	☐	☐	☐	☐	☐
10. would be highly desirable because of the recognition I would expect to receive from management	☐	☐	☐	☐	☐
	Strongly Agree	Generally Agree	Undecided	Generally Disagree	Strongly Disagree

On my present job, I feel that my attendance at a short course . . . .

		Strongly Agree	Generally Agree	Undecided	Generally Disagree	Strongly Disagree
11.	would give me insights to better ways to perform my job . . .	☐	☐	☐	☐	☐
12.	is an important way to improve my job security	☐	☐	☐	☐	☐
13.	would make me feel more satisfied with my job	☐	☐	☐	☐	☐
14.	is strongly encouraged by my immediate supervisor	☐	☐	☐	☐	☐
15.	would qualify me for a better salary than others in a comparable position	☐	☐	☐	☐	☐
16.	would not result in me being given an increase in responsibility for my own work	☐	☐	☐	☐	☐
17.	improves my chances for promotion	☐	☐	☐	☐	☐
18.	would be seen by employees of my company as a mark of recognition	☐	☐	☐	☐	☐
19.	is unnecessary because I have all the education I need to do my job	☐	☐	☐	☐	☐
20.	is directly related to increased job security	☐	☐	☐	☐	☐
21.	contributes nothing to my personal goals	☐	☐	☐	☐	☐
22.	is not seriously recognized by company policy as a means of updating or upgrading the engineer	☐	☐	☐	☐	☐
23.	might mean an unexpected wage increase	☐	☐	☐	☐	☐
24.	is an excellent way to qualify for more responsibility	☐	☐	☐	☐	☐
25.	means the difference between whether I receive a promotion or not	☐	☐	☐	☐	☐
26.	would result in my receiving recognition of the effort by my professional colleagues	☐	☐	☐	☐	☐
27.	would result in learning new methods and/or techniques that would be of help to me on my job	☐	☐	☐	☐	☐
28.	means the difference between who is kept and who is released during a "cut back"	☐	☐	☐	☐	☐
29.	is evidence of my desire to maintain professional competence .	☐	☐	☐	☐	☐
30.	is an important factor in company policy concerning promotions	☐	☐	☐	☐	☐
		Strongly Agree	Generally Agree	Undecided	Generally Disagree	Strongly Disagree

On my present job, I feel that my attendance at a short course . . . .

	Strongly Agree	Generally Agree	Undecided	Generally Disagree	Strongly Disagree
31. is one way I can qualify for a merit pay increase	☐	☐	☐	☐	☐
32. would result in the opportunity for me to make more decisions on my own	☐	☐	☐	☐	☐
33. would provide opportunities for advancement I otherwise would not have	☐	☐	☐	☐	☐
34. adds nothing in the form of recognition for my abilities in my company	☐	☐	☐	☐	☐
35. would give me ideas that I could try out on my job	☐	☐	☐	☐	☐
36. is a necessary part of maintaining my job security	☐	☐	☐	☐	☐
37. is one thing I can point to as evidence of achievement in my profession	☐	☐	☐	☐	☐
38. should be on company time	☐	☐	☐	☐	☐
39. would be well worth my time so far as financial rewards are concerned	☐	☐	☐	☐	☐
40. would reduce the amount of supervision I am presently receiving	☐	☐	☐	☐	☐

Please indicate (☒) in the appropriate boxes the number of short courses of the type described you have attended in the past five years:

	No. of courses attended in past 5 years			
	0	1-5	6-10	11+
Short Course – college sponsored, non-credit	☐	☐	☐	☐
Short Course – in-company training	☐	☐	☐	☐
Short Course – sponsored by a professional society	☐	☐	☐	☐

	Percent			
	0-25	26-50	51-75	76-100
What % of these courses were technical in nature:	☐	☐	☐	☐
What % of the total expense (registration, travel, subsistence) was paid by your company:	☐	☐	☐	☐

Please indicate (☒) your approximate annual income from wages:

- ☐ under $5,000
- ☐ $5,000 to $9,999
- ☐ $10,000 to $14,999
- ☐ $15,000 to $19,999
- ☐ $20,000 to $24,999
- ☐ $25,000 +

This concludes the survey. Please place the questionnaire in the return envelope and mail. Any comments on this survey or other functions of the College of Engineering will be appreciated. Thank you for the time you took to give us your views on this aspect of professional development.

APPENDIX B

POPULATION AND SAMPLE SIZE

BY ENGINEERING DISCIPLINE

Discipline	Population	Sample Size
Architectural Engineering	32	6
Chemical Engineering	617	91
Civil Engineering	800	120
Electrical Engineering	1318	198
Engineering Physics	69	10
Industrial Engineering	698	104
Mechanical Engineering	1104	166
Petroleum Engineering	536	80
Textile Engineering	139	21
Geological Engineering	16	2
Agricultural Engineering	136	21
	5465	819

APPENDIX C

SUMMARY OF DISTRIBUTION OF

QUESTIONNAIRES BY STATES

State	Sample Size
Alabama	4
Alaska	1
Arizona	7
Arkansas	1
California	44
Colorado	11
Connecticut	3
Delaware	1
Florida	8
Georgia	3
Hawaii	1
Illinois	11
Indiana	2
Iowa	2
Kansas	4
Kentucky	1
Louisiana	19
Maryland	10
Massachusetts	1
Minnesota	1
Mississippi	4
Missouri	1
Montana	1
Nebraska	2
Nevada	1
New Jersey	7
New Mexico	18
New York	6
North Carolina	5
Ohio	2
Oklahoma	18
Pennsylvania	3
South Carolina	4
Tennessee	3
Texas	589
Utah	1
Virginia	8
Washington	7
Wisconsin	1
Wyoming	3
	819

APPENDIX D

COMPUTER PRINT OUT OF RAW DATA INDEXED

BY SEQUENTIAL NUMBER ASSIGNED

AS SURVEYS WERE RETURNED

```
0011123TX36X        7 0808 02   2222222222222222222242222222222222222222 111       6
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.

0021123TX53X        4 0909 0404 2443443323433344431221454354444332523343 221 2 4 3

0031123TX57X        3 0909 0404 2242422222424222241212242442422422524242 111 1 1 4

0041123TX55X        4 0505 0301 41454111414122_2225115111141411111414222 111       3
QUESTION 15 IS INVALID.

0051123TX37X        7 0404 0206 2432243424444333442434332443434333424444 221 2 3 4

0061124TX53X        4 0404 0303 2442434424545444331412343354534443534433  2  1 4 4

0071124TX61X        3 0909 0202 4244442212522415211222141251511112511521 242 4 4 4

0081124TX49X        5 0404 0203 2444514222424424222212242442422244324252 221 3 1 3

0101124TX58X        3 0111 0408 2442443424444422441422442444444442444442 221 1 4 3

0111124TX71X        0 0303 0309 2344433413443324421424442443424542444333 111 1 1 3

0121124TX69X        1 0303 0405 2241422322523242241222424434224424242 42  2  1 4 3

0131124TX64X        3 0809 0505 1352552312523423222111233235253222352443 1 24  4 4 3

0141124TX61X        2 0404 0211 2452154413545442441412254452524542544444 221 4 4 3

0151124TX59XX       3 0101 0707 4454543222524234241222221452422222425432 111       3

0161124TX58X        4 0909 0502 2442424412444232421224242242424423422423 221 2 4 3

0171124TX52X        4 0511 0303 2432443324443432431422242442444322324423 111       5

0181124TX47X        5 0811 1212 51152111512111511212_1111212112152112 11 112 1 4 4
QUESTION 22 IS INVALID.

0191124TX53X        4 0909 0504 4232422242424433232222322453422422424432 222 3 4 4

0201124TX60X  X     3 0311 0909 5451552422542422121321242253532443534544 2   4 4 3

0211124TX64X   XX 2 0101 0707 1244554214524325442222222452524223522322 222 4 4 4

0221124TX36X        7 0505 0209 2444423332433224232333322232432324423422 111 1 1 5

0231129LA56X        3 0909 0101 1131544324443443341412243433434342444341 222 3 4 4

0241129LA50X        4 0404 03   5544355314252522524521421242454241422541 222 4 4 6
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.

0251129TX63X        2 0404 0403 1541545415545444441412252451522222525152 121 1 4 5

0261129C047X  X     5 0505 1111 5244511122424224124224222243422224424322   2 2 4 3

0271129TX59X        3 0108 0404 5133322232322313232323232343432333433332 121 2 4 4

0291129TX70X        0 0303 0105 4344432232323314211213221242322223422532 111       3
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0301129TX61X       2 0707 0303 24444222434241442222322224343243242243Z 121 3 4 3
0311129TX70X       1 0505 0909 524451244152512424111414244251244442441Z 111     3
0321129TX69X       1 0808 0101 424244432242233222222224224242_232322323  2  4 4 3
QUESTION 31 IS INVALID.
0331129OK50X       4 0909 0505 2245522241414225112124121141211224412311 2 2 1 4 5
0341129TX60X       3 0404 0402 5445441154414215141112111241411114414511 211 4 4 3
0351129TX67X       1 0808 0209 4423342231323224322223122243421224423323 121 1 4 3
0361129TX69X       0 0404 1212 2452424424443342451422343454534442545454 111     3
0371129TX54X       4 0808 0412 4222344221322322222222211214212233242 41 121 2 4 4
0381129TX67X       1 0505 0505 1442444424444342442421343344434442444444 222 2 4 3
0391129TX67X       1 0505 0808 2432422222422224321224222242422222422432 231 1 4 4
0401129TX51X       5 0505 0202 2542255525453525542522555225255542453435 2   4 4 4
0411129TX47X       6 0411 0303 5225211151115115111115111151511115511511 111 1 1 4
0421129TX58X       4 0505 0404 4234432222424222222222241242422442424422 221 4 4 5
0431129TX64X       2 0808 0101 4344433323443242431323442243434433444543  2  4 4 3
0441129TX71X       0 0404 0311 2453554411445542421414343343433432444544 111     3
0451129NC66XX      1 0711 0304 3424253334521424321213221231433222424122 232 2 4 4
0461129NM59X    XX 2 0101 0207 2344242222423222222222232442433333424432 121 1 4 4
0471129TX46X       6 0505 0202 2342543324544333331212242353443442433442  2  4 4 5
0481129TX61X       4 0505 0901 1434424313442_32442215242243422242424422  22 2 4 5
QUESTION 14 IS INVALID.
0491129TX48X     X 0 0505 0909 5454512242525224221244241151511124522422 122 4 1 4
0501129CO66XX      1 0109 0303 2343443212424234331212332342434432421222  4  4 4 3
0511129AR58X     X 3 0505 0909 3234332242322324233222122433422224434422 222 4 4 5
0521129TX67X     X 1 0707 0505 2434522422422424442121224244242242442 2442  22 3 3 3
0531129WA50X       6 0303 0101 4224421242424224221222222243421223424222 221 4 4 4
0541129CA58X       3 0808 0102 2424244424423343441123232442534342424332 3   1 4 5
0551129TX65X     X 1 0707 0503 4235411142423222232222313234141331441232 2 122 1 1 3
0561129TX57X       3 0707 0808 2244422222424224242222222442422222424442 122 3 3 6
0571129AL51X       4 0311 0909 5145441151412115112124111245251114414511 121 4 4 6
0581129MO59X       3 0707 0202 4234322242322224222224121232421224322311  2  3 4 5
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0591129TX34X     7 0511 0305 444244442444434244242223434434434423334443 2   2 1 4

0601129MD56X     3 04   0303 24525523245145124311122534515224225224 22 231 2 4 5
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

0611129TX70X     0 0404 0303 2441444413444442441211344444534442444444 111     3

0621129OK71X     1 0509 1109 4235422233321_3423121433232342254432352 4 121 4 4 2
QUESTION 14 IS INVALID.

0631129NA40X     7 0505 0404 5145411241411115112125211341411115414441 223 3 2 6

0641129NY67X     1 0505 0101 2453553514534542341312343442522432534543 221 4 4 3

0651129TX51X     2 0505 0509 4454522232434333342223232453534432525322  2  4 1 3

0661129TX50X     4 0808 0202 2442424412544242441412342443534441444244 2   1 4 3

0681129TX61X     2 0404 1212 4224422242324424242224222442422224424422  2  4 4 3

0691129TX62 X X X 2 0808 0909 4224222242222224244224222422422224222222 111     4

0701129TX65XX    1 0505 0101 2452543423433432432311342453533432434343 131 2 4 4

0711129WA57X     4 0101 0203 4242552321545411241312152453521524534522 121 4 1 4

0721129NM64X     2 0808 0803 2454554223544242421415221452524321524241 243 4 4 3

0731129TX68X     2 0703 0503 4443522442535422241212242351412432524224  2  4 4 3

0741129TX63X     2 0404 0101 4441442442443224221222241242422424422322 22  4 4 3

0751129TX49X     5 0909 1205 5245511141111115114141111114151111441441 1 123 2 4 6

0761129TX58X     3 0808   05 1441544414454_3244131135244242343142424 2 22  2 4 3
QUESTION 14 IS INVALID.
INVALID MAJOR JOB TYPE, MOST IMPORTANT USED.

0771129TX48XX    4 0505 0107 143252332444523424132323245253333243414_ 111 1 1 5
QUESTION 40 IS INVALID.

0781129TX69X     3 0909 0209 4244442322422224242222342451422422424442 232 4 4 6

0791129TX51X     6 0404 0203 2424442222422224222422222242421114412422 221 4 4 4

0801129TX66XX    1 0707 0404 2452454424544442441412242354432442544523 222 4 4 3

0811129TX33X     8 0504 1212 3_444444244443444423224444444444442444444 211 1 4 4
QUESTION 02 IS INVALID.

0821129CO70X     0 0807 0506 2443534314434333442411354344333343433444 111     1

0831129TX71X     0 0611 07   3333431333322323333223233332432333324323 111 1 1 1
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.

0841129IL65X     2 0303 0808 3234322232322224232244222332422233324421  2  4 4 3

0851129TX63X     2 0303 0503 2422434221422222221221142251422224422422 132 1 4 3

0861129TX63X     2 0404 0909 2244242322424433442211342242432432434344 122 4 1 4
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[illegible]		2	0808	0909	14525444143443334414122424525424441434554	121	4	4	4
0881129TX63X		5	0505	0709	13424544133333332132433224342222343243 3	112	1	1	4
0891129TK58X		3	0311	0402	51343111413121151121451113314111114412322	211	1	1	4
0901129TK51X		4	0404	0202	22425444144443424414111415544424414444443	22	3	4	4
0911129TX56X		3	0707	0404	23244333432232242232442222222222224322322	111	1	1	6
0921129TX61X	X	2	0505	0405	24245544224245224411212414424222222424442	433	2	4	4
0931129OK63X		2	0808	0303	43432443224323233222232422424224324233 23	2 2	3	4	3
0941129TX59X		3	0408	0202	42243442232242244312422222424232224224 22	121	2	4	4
0951129TX51X		4	0404	0202	21152455221114_55441421222244211121124 21	2	1	4	5

QUESTION 15 IS INVALID.

0961129WA57X		3	0804	0101	42454212425153141411114111451511223524422	242	4	3	5
0971129TX42X	XX	6	0505	0202	44444544244245424422222422424224424244 44	22	4	4	6
0981129TX66X		1	0808	0902	42524443244454323423222424515424325244 42	112	4	4	4
0991129TX70X		1	0808	0303	44534233225453334422143423445334524334 32	121	1	4	3
1001129TX50X		5	0505	0208	24415444225442424414224433445344424443 44	2	4	4	5
1011129TX64X		1	0303	0505	43243412422222252442222224224222223144 21	233	1	4	4
1021129TX64X		2	0308	0312	24414433144444323414123434434334314444 32	122	2	4	4
1031129TX50X		5	0708	0909	44224234444442223224442422424224244222 24	2	2	1	3
1041129OK50X		5	0909	0304	22424322244331342312242212314122244334 41	221	2	4	5
1051129AR60X	X	2	0808	0101	42_54222224232222222232223434222234234 32	22	4	4	5

QUESTION 03 IS INVALID.

1061129TX64XX		5	0808	0202	14525243245454524515114435535433345335 42	121	2	4	3
1071129NM37X		7	0505	0210	42344422424223242322222422414112344224 32	211	3	4	6
1081129NM56	XXX	3	0505	0707	44524422224243222342222413415112234134 32	221	4	4	4
1091129TX67X	X X	1	0808	0505	14434533224234243222112322424343334224 44	121	2	4	3
1101129TX39X		6	0909	0504	24454222324442342413243424424222424444 43	111			3
1111129TX61X		2	0311	0202	24525444224444434414224434444324324344 44	22	4	4	5
1121129TX47X		6	0308	0104	44233343233322443423324322234224244234 22	212	4	3	4
1131129TX49X		5	0809	0109	34353521413121242222542312414123244113 12	2	4	4	5
1141129TX70X		0	0505	1001	24222555154414424324124444445434514342 33	121	3	4	3
1151129TX62X		2	0811	0202	42545512115245142212111211515114345223 11	322	4	4	3

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1161129TX66X       1 0808 0303 1451544314545432451411243554544541545343 221 2 4 3
1171129TX65X       2 0808 0109 24222444322424423421121341141424332323321 122 4 1 3
1181129HA70X       0 0404 0601 15545553135545524314114422515425525335 22 222 4 1 3
1191129CA64X    X  2 0505 0909 42444242224423242114232222445322244435 42 2     1 4 4
1201129TX55X       4 0303 0205 54415324235443433414142414535224324242 44 122 3 4 4
1211129CA58X       3 0909 0405 33555322114252222211141414525114435133 42 2     4 4 5
1221129TX48X       5 0808 0502 14444222144242224412122424424222424241 42 121 3 4 4
1231129CA55X  X    4 0909 0505 44345344234343343423243324424233324243 33   2 3 4 4
1241129TX47X     X 5 0811 1212 24525553235444434213122333535322345324 53 222 4 4 4
1251129CA58   XXX  3 0711 0404 41353111413133152221251111314111154124 21 112 4 4 4
1261129NM64X       2 0505 0909 33444223434233433412123423534343325235 32 3     4 4 4
1271129CA58X       3 0909 0502 44324433334432433443323323324332233334 32 112 3 4 4
1281129TX55X       3 0811 1111 34342132333233342322231212425322344343 23 121 4 4 3
1291129TX49X       5 0404 0309 33444433234332343322222423424232244234 33 2     4 4 4
1301129TX50X       5 0511 1212 33343222423243242222242223424233344243 23 112 1 1 3
1311129TX64X       2 0404 0202 42555222225242242412142424515222225225 22 111       4
1321129TX64X    X  3 0505 0303 21545222315231342211122314545222235234 22 121 4 4 3
1331129TX68X       1 0808 0909 14515245145353344413114524524344425242 55  2  3 4 3
1341129TX52X       4 0711 0808 43253111424121141211232412413213224233 32 122 1 4 5
1351129TX69X       1 0707 0808 4324_2114232222422123222223221222222223 21  1   1   4
QUESTION 05 IS INVALID.
1361129TX55X       4 0711 1202 24434232234343324413233434434343324343 22 122 3 3 3
1371129CA58X  X    4 0505 0909 23324443234334434323113323424333324432 32 111 4 4 4
1381129TX67X       1 0505 0201 42444422424221242222222224242222224224 22 121 4 4 4
1391129FL38X       7 0404 0201 42444222424231242322224232452421224424 442 211 1 1 5
1401129TX49X    XX 4 0811 1212 15515345155544525222233521515342434232 42 111 1 1 5
1411129TX52X       4 0404 1009 24234433232244333323212422444333324342 42 221 4 3 3
1421129TX69X       1 0711 0509 42244422324242342312232224424224224242 22  4   2 4 3
1431129CA49X       6 1007 0503 24434443244344324312223424424444324344 42   2 3 4 4
1441129TX68X       2 0909 0804 14324234234242324222223423424224324234 34 2     4 4 4
1451129KS66X       1 0303 0303 24525244144422424424244424424244424444 44 221 3 4 3
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1461129CA54X       3 0411 0808 4245442242423114242114121443422422414121 111 1   6
1471129CA59X    X  2 0511 0202 2442424413524142441312241452412242524445  2  1 4 5
1481129TX58X    X  3 0505 0901 5155511111511111111111111451511415415511 111     4
1491129TX49X    XX 4 0303 0702 4232322212423324321222222142422433421432 2    4 4 5
1501129TX50X       5 0909 0203 23444323224234223212222_32_422324422_32   22 1 3 5
QUESTIONS 25,28,38 ARE INVALID.
1511130TX58X       3 0505 0209 4234341152413124122132121231411212313411 131 1 4 5
1521130TX58X       3 0909 0303 5245542221415532141112241141512442414522 123 3 4 3
1531130TX67X       1 0303 1202 4244422242423324221223222242432224422422 132 4 4 3
1541130TX67X       1 0505 1212 2451543414445441441322253452434542433544 222 2 4 3
1561130TX69X       1 0707 0505 1431425224443434341224222345532222435132 121 1 3 3
1571130TX51X       5 0808 0212 5135411151314111112125141141411211414311 111     3
1581130TX49X       5 0409 0302 5423222242322214222123131441411333424231 221 4 4 5
1591130VA61X       2 0805 0808 1541554414444541441411444444454441444353 232 2 4 3
1601130MD61X       3 0511 0808 2445422323433333331312333333333332334133 222 2 4 4
1611130TX52X       4 0505 0909 2342434322434233242322343442433342433432 111     3
1621130TX65X    X  1 0606 0405 5244442142422324122222222242422114422221 111     4
1631130TX62X       2 0505 0202 2444411121423215111215111242511415414412   2 3 3 4
1641130TX66X    X  1 0505 1010 5235421342424324241124132441521322414413  2  4 4 3
1651130TX33X       8 0202 0207 4344422143435215241315141442422214425521 111     5
1661130IL64X       2 0808 0209 4244412221422224221212232241312232423131 222 4 3 4
1671130CA51X       5 0404 0102 5442422242524222241224442452522422524244 221 1 2 5
1681130CA50X       5 1011 0911 4234442242423224222242222443422334322522  12 3 4 3
1691130TX70X       0 0303 0505 1442534314424433441313143453533331424344 111 1 1 3
1711130CA64X    XX 1 0303 0707 2433443422424422241212242442433443443443 121 4 4 4
1721130TX71X       0 0811 0808 5115111151311111111113511112151111511122 2  4 4 3
1731130TX32X       8 0807 0808 1441534424444332442423443444444442444243 111     4
1741130MD49X       5 0909 1212 5235441131434235322222141332432232334431 2 1 1 4 6
1751130TX48X       5 0505 0404 2453443322422444322232242242542334434243 121 4 4 5
1761201TX61X       2 0808 1012 4234411222423224242234221442311124423421 121 4 4 3
1771201TX50X       4 09   02   312442124242221_512234121242421224412412 111     6
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QUESTION 16 IS INVALID.
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.

1781201OK68X        1 0711 0210 4425441424424422241222242442522222424422  2   4 4 3

1791201TX63X        2 0511 0502 1322444212432342521412132243532242334332 23   3 4 4

1801201TX48X        6 0511 0203 5245421151415215134114111241411124414321 222 4 4 4

1811201TX61X        2 0303 0202 5244452242424423141221141441412233422432 222 1 4 4

1821201TX61X        3 0711 1212 2442553414534442441311443452543441424544 222 2 4 4

1831201CA69X        0 0411 0404 1321454424342311541351144424541111445331 121 4 4 3

1841201MN69XX       0 0303 0101 1541555515555555551511454555545541545254 222 3 4 3

1851201AR56X        3 0404   03 2441544413544342441412443454433442434344 212 4 1 3
INVALID MAJOR JOB TYPE, MOST IMPORTANT USED.

1861201MO62X        2 0111 0808 1442544412444432421312343353433442434444 121 1 4 3

1871201TX69X        0 0404 0505 1551555514554451541512453554544551545343 121 4 4 3

1881201TX61X        2 0505 0303 4224422242423424222224222242422224424222 111     4

1891201CA52X        4 0511 0909 2442444423444443442321342442442444242432 22   3 4 5

1901201TX60X        3 0404 0402 2442411142444414221215121441511124424411 121 1 4 4

1911201TX57X        4 0909 0606 5145421121413414121125121251411214412325 2 2 2 4 4

1921201TX58X        3 0808 0502 1452534314544333441224243441432322424422 121 4 1 4

1931201TX65X        4 0505 0202 4234322242323224223244222232322224323422 121 4 4 4

1941201MD56X    X   3 0404 0505 1441554414444443431411242342542342444543 232 4 4 4

1951201IL49X        5 07   0405 2443443323434423442323333443433432434433 222 3 4 4
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

1961201NY63X        2 0505 0202 4454442222422444222224222242422222422344 142 2 3 4

1971201UT62X        3 0305 0610 3453514424554243541414333253523242444142 22   3 3 3

1981201PA59X        4 0705 0210 4244452242524424221211341254522442424222 121 1 4 5

1991201FL69X        1 0808 0101 2435322221212144132143231241414215212421 121 2 4 3

2001201AR64X    X   4 0808 0204 1531352314343523433432142232431323332331 221 3 3 5

2011201LA70X        0 0303 0505 3333313233223232333333222332432234312532 111     3

2021201TX50X        4 0909 0403 2232243221422323212312132242422232422432 121 1 4 6

2031202OK48X        5 0404 0305 4342444323544333441314342444423242434432 231 1 3 5

2041202TX61X        3 0101 0503 1433544414545233221312243453531541525532 231 4 2 4
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2051202TX50X       5 0404 0202 4444432324434332441224242452422342413422  22 4 1 4

2061202TX69X       1 0505 0309 4543421134544142241512122243422443345523 111 1 1 3

2071202WY47X       6 0309 0512 1544445414454352442421442444444441424242 2   3 2 4

2081202TX50X       6 10   05   1551511151555151551512555555555551555555 121 1 1 3
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.

2091202MD58X       4 0505 0202 1444414214444554451451242344542242424232  22 2 4 5

2101202CA69X       0 0511 0202 343344112342331513513312113341__24422322 121 4 4 1
QUESTIONS 31,32 ARE INVALID.

2111202NY49X       5 05   0204 5111515111511142141114221241411111111122 111 1 1 6
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

2131202LA67X       1 0408 0509 4424212241442224221224222442422442422244 121 4 4 4

2141202TX69X       1 0808 0505 2442444424434443431321442442433433434344 122 3 4 3

2151202TX66X       2 0909 0503 4452454413544533221221242352422222523433 222 4 4 4

2161202TX65X       2 0505 0709 4544454222425522421212142442522422524422 222 4 4 3

2171202GA49X       5 1007 0211 2444534414544332441212443454544442544333   2 4 4 4

2181202TX70X       0 0709 0303 2543444323423432341112341342412442414433 121 4 4 3

2191202TX49X  X    5 0707 0505 4343422332445343442413344444533443424344 211 3 4 4

2201202TX34X   X   7 0511 1212 2422444224444242442422242442442442424442  2  4 4 5

2211202AR64X       2 0811 0101 422324212143122322222331_2221422223223412 121 4 4 4
QUESTION 24 IS INVALID.

2221202CA66X       1 0311 0303 5144411241413115231125111443411234414322 121 4 4 3

2231202MD68 X X    1 0707 0303 2441544514444334443311343443443432433433  2  4 3 3

2241202DE63X       2 0303 0202 4344452224432422241211131342412342424321 131 1 4 4

2251202LA70X       0 08   0308 2435423222422115332223222242422323312222 111     3
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

2261202TX71X       1 0704 1212 4552542312544322421211252454522541515444 111 1 1 3

2271202OH64X       2 0808 0202 1442544514424242441212242442424422424442 234 4 4 4

2281203TX63X       3 0707 0512 2245422212524224221222222442422442424422   2 4 1 4

2291203TX71X       0 0808 0909 1452412244445434251412231441422222422432 112 3 4 2

2301203TX50X       5 0707 0505 4244544422522442221211242252424442422242  3  4 4 3

2311203NC49X       5 1010 0505 4442454423544542541414353443533434544344 322 2 3 5

2321203NM69XX      1 0505 0102 2552551414534421331351133153535133524533 121 4 4 2
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2331203WI71X 0 0807 0303 44534444224332422213223432434444434343 121 1 4 3

2341203TX59X 3 0104 0302 34424133224443333235434244243343444533 121 3 4 4

2351203TX56X 4 0707 0505 22445242225241244222541424525222225142 2 4 4 5

2361203LA51X 4 0803 0308 22155411214143343511121515525222224141 121 4 4 4

2371203WI57X 3 0311 0502 42424222224242244212242422542222244242 222 3 4 5

2381203DC56X 4 0707 0909 42434223335442333422242424424233344344422 2 4 4 5

2391203TX60X 3 0909 0202 34515323225342342412142213424223333424533 111 5

2401203CO50X 5 0505 0202 14424544245243424314114423434423314242 32 3 4 4 4

2411203TX60X X 2 0505 0101 44424222324232443212242222424222234233332 121 4 4 4

2421203NM68X 1 0711 0404 42414411224144154221151211514412244114212 121 3 4 3

2431203TX37X 8 08 0305 15515443245444324413122424524444425444443 231 2 4 4
INVALID ACADEMIC ENGINEERING FIELD, WORK USED.

2441203TX34X 7 0404 0303 24425234224443444412222424424222223222423 111 3

2451206IN58X 3 0505 0610 24424224224444224413123424435223414242 42 22 4 4 4

2461206AL59X 4 0404 0201 42424424124244222413122423424222224224 22 222 4 4 5

2471206LA48X 6 0309 0202 24425534115434323412112513215224225444444 222 2 4 5

2481206IO59X 3 0908 0808 42244222224243343422222324424222224244 22 222 4 4 5

2491206CA70X 0 0311 1212 51151111511111151151551111111111115111111 111 2

2501206CA50X 5 0505 0303 23322433134333443412223423444343423344 32 123 4 3 4

2511206LA64X 2 0404 0108 42243222222222242222242222424222243222 22 121 1 4 4

2521206MD70XX 0 0808 0510 22414434324434323314123533545334434433 34 111 1 1 3

2531206TX62X 2 0808 0802 42414542124433524314112414545234325244 52 222 3 4 4

2541206FL68X 1 0411 0211 24445544245454224414112424535345423244 52 122 4 4 3

2551206CO55X 4 0404 0909 22424244234442444424242422434222424244 22 121 1 4 4

2561206TX60X 2 0303 0808 42244222412221241251452211112212242122 22 232 3 3 4

2571206NC68X 1 0707 0505 32245134125232343322132322435223235234 43 123 3 4 3

2581206TX59 X X 4 0505 0203 24524233245444333413114424525424425255 42 22 4 4 4

2591206TX50X 5 0404 0312 22444122325441242414153524545122244245 32 2 1 1 4

2601206OK71X 0 0303 1212 44542121224232242212132222415223544221 12 111 1 1 3

2611206CA42X 6 0303 0202 4443432242423_24242323342443431122424232 121 4 4 5
QUESTION 14 IS INVALID.

```
2621206TX63X      2 0111 0412 442444224222321513414524123131222442l521 131 2 4 2

2631206PA57X      3 0505 0601 24424433145443424314132434544333324451 43  2  4 4 3

2641206MT70X      2 0505 0405 443344233343433334232314334243322242 3432 121 4 4 2

2651206VA60 X X   2 07   0404 42243212413221141321441111415112244144 11 121 3 4 4
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

2661206FL57 XXX   3 0707 0202 52354211424132151121251111413112154144 11 111     4

2671206DC48X  XX  5 0811 0202 24444423224232243222224224242232342243 2 221 3 4 5

2681207TX64XX     1 07   0404 42224233223242424232242222312124444221 22 121 1 4 4
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

2691207IL62XX     3 0707 0504 42444122424252142111142112514122244113 31 22  4 4 4

2701207TX69X      1 0808 0112 25454244242242434322422212344324432242 22 111     3

2711207TX47X      6 0909 0505 44344222233333243221223423334223234242 32 112 2 1 3

2721207TX58X      3 0909 0503 24424433234344333323223333434333324344 33 222 4 4 4

2731207TX53X      5 0505 0502 51555111114142151111141414414144454142 11 121 4 4 3

2741207KN64X      2 0711 0301 53153411513131151313151113214113153145 31  3  4 4 3

2751207TX69X      1 0303 0506 14315545154553524415134534455334434351 51 111     3

2761207TX68X      1 0505 0903 24454142214145344251422212412124345144 12  2  4 4 3

2781207OH58X      4 0811 0808 42344333334342333312132323434322234342 32 131 4 4 4

2791208TX56XX   X 3 0808 1212 34445412134434433413113414444143424444 22 2   4 4 5

2801208TX50X      4 0411 0803 24424222244242222222224224242242242242 4 112 4 4 4

2811208TX48X      5 0511 0804 22424322224243244412122214425222324244 42 3   3 4 6

2821208AL67X      1 0303 0101 52444421424214441122441212424214242345 12 231 3 4 3

2831209NY67X      1 0505 0202 24245314224252144211121214515111125145 12 122 1 4 2

2841209NY70X      0 0711 0905 42244123224222222131434124242222442213 2 22  2 4 3

2851209GA71X      0 0505 0101 25425523245435142414111314445225224455 24 121 4 4 3

2861209DC40X      6 0505 0202 44254222424121142321231414414212234124 32  2  3 4 6

2871209TX68X      1 0608 0305 15425144155451424314154514545135525553 23 121 4 1 2

2881210TX69X      1 08   0402 44344514134245122411111413415114224255 24 121 1 4 2
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.

2891210FL56 X XX  3 0707 1212 145_1422545443244424222422524222245244 42 121 4 4 4
QUESTION 04 IS INVALID.

2901210CA67X   X  1 0505 0202 24445424145245244412122242453521432524 333 141 4 4 3
```

```
29112100K48X       4 0303 0905 424444423242242424122122244343334343242 2 221 3 4 4
2921210MP56X       4 0404 0707 244545114241341512111112124151131251351 2 321 4 4 5
2931214NJ70X       0 0808 0312 154253441544453342221223414244442242432 2 121 4 4 3
2941214TX68X       1 0808 0606 154154551444434443131134334343344143424 4 121 4 4 3
2951214TX64X       2 0101 0707 442441224222242111421122114414122224143 21 212 3 3 3
2961214TX70X       0 06   02   444455332252553244121134224242224224233 22  3  3 4 3
INVALID WORK ENGINEERING FIELD, ACADEMIC USED.
INVALID MOST IMPORTANT JOB TYPE, MAJOR USED.
2971214TX64X       3 0505 0201 345321232553432234122434334352244353444 4 111     3
2981214TX71X       2 0404 1212 454445342343333243221233234242443242332 3 111 1 1 2
2991214SC59 X X    2 0808 0202 244245331343343345132233245343344253334 3 222 2 4 4
3001215TX62X       2 0711 0504 244242432244434344141234344442434243424 3 121 2 4 3
3011215TX70X       1 0303 0503 244244423444444234142223244343332244443 3 2 2 4 4 3
3021215TX48X  X    5 0911 0112 235215432354433333221134225353332243443 4  32 4 4 5
3031216AR60X       3 0808 0101 245241424444222434212221112414422244242 42 121 4 4 5
3041216AZ70X       0 0505 0303 254443222352432223221313244353222142431 2  2  4 4 2
3051216LA52X       4 0411 0403 424141114141211522112422135141111341432 2 22  3 4 5
3061216TX59X     X 3 0505 0109 224232222324224234234222241422334422432 122 4 4 5
3071216TX69X       1 0808 0909 244344323343342424232223143142223342443 2  2  2 4 3
3081217AR71X       1 0404 1212 232233233534323331113233342432331323433 111 1 1 2
3091217CO68X       2 0505 0401 155153442444433244141434345343343254443 4 121 4 4 2
3101217ND57X       4 0909 0505 244244442244443243142224232343243242244 2 121 4 4 4
3111220TX64XX      3 0505 0109 255154441454554145141535255454444515333 44 221 4 4 4
3121220TX43X       6 0411 0909 244243332343423424232333344343333242443 2 211 4 4 5
3131220TX50X       6 0404 0202 443434224232222422434223223242222232322 2 111 1 1 5
3141220FL65X       3 0808 0502 245151542455413433112512145353345253514 3 111 1 1 3
3151220TX67X       2 0808 0909 424444224342444422221212224252222242441 1 211 4 4 3
3161220CO48X       5 0309 0303 421523224211212521314213122242122322222 2 121 3 4 6
3171221TX70X       1 0808 0505 245255231254543243141124145253255154433 2 122 4 4 3
3181231IL61X       3 0111 0408 144244441253453243131224135241342152142 4 131 1 4 4
3191231AZ59X  XX   6 0808 1212 422422224222222422424422222242222422332 2 122 4 4 4
```

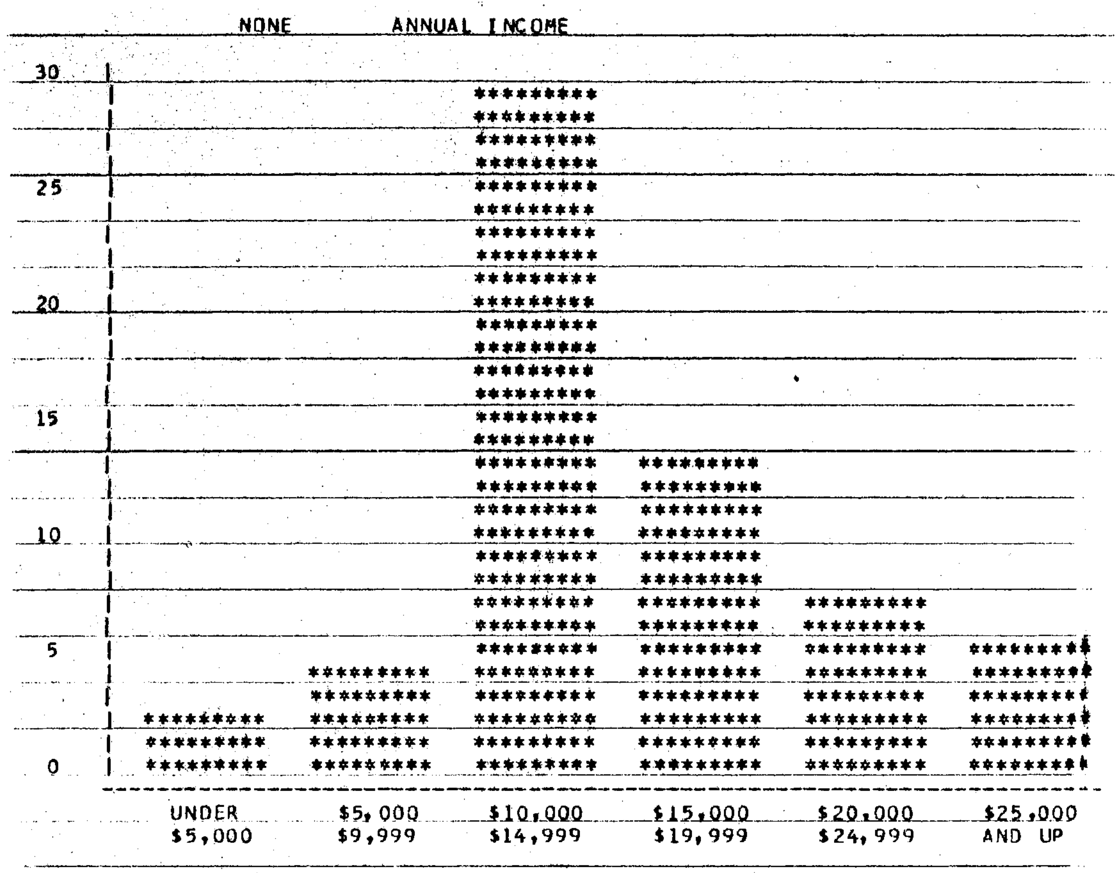
3201231FL66X		2	0808	1001	511511115111111511212511111141111531111	121	4	1	4
3211231TX63X		3	0811	1212	422232332344423233232333234443233433444 2	111	1	1	3
3221231WA54X	X	5	0303	0101	524452223232424422121534125242234442442 2	111	1	1	3
3231231TX63X		3	0808	0909	254255421454414444131124244253444142454 2	221	4	4	3
3241231CA69X		2	0505	1109	242145442444324244241124344444443244424 3	111	1	1	3
3251231MS70X		2	0505	0101	445251342454412224141555245551244252553 2	111	1	1	2
3261231IL39X	X	7	0408	0105	425255222554543245141234355554445244424 3	224	4	4	4
3271231TX70X		1	0707	0303	423422214241231422222223124242122342342 3	111	1	1	3
3281231TX57X		4	0909	0205	114241115141111511114411114151111551151 1	111	1	1	3
3291231OK61X		3	0511	0505	143455242332422222221224124142222442224 1	131	1	4	6
3301231TX53X		5	0711	0405	243544222242222422222222242222223424222	132	2	4	5
3311231MD64X		4	0404	0505	232522225422242524222422222222222222422	222	4	4	4
3321231TX56X		4	0505	0101	245242442244423333232234324343344243442 2	121	3	4	4
3331231TX61X		6	0408	0303	444531222232322423224544144142232442423 1	121	4	4	4
3341231TX60X		5	0808	0505	243241441444423244122234144142222242444 2	111	1	1	3
3351231TX43X		7	0909	0808	244242432343424244221424344242242442444 2	111	1	1	4
3361231SC58X		4	0505	0109	242252221444343224142314144242242242433 2	111	1	1	4
3371231TX57X		4	0707	0302	245154541444432253141235235453443242424 4	121	1	4	3

NUMBER OF CARDS READ = 330

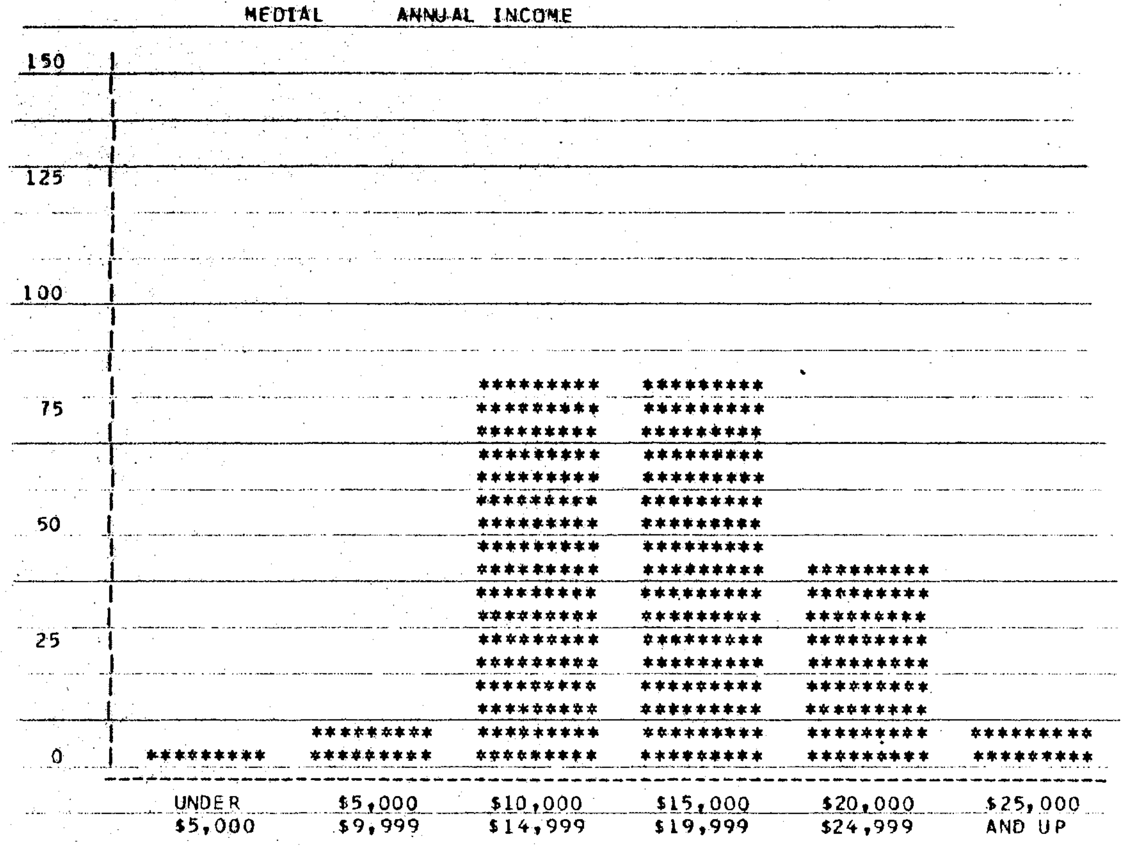
APPENDIX E

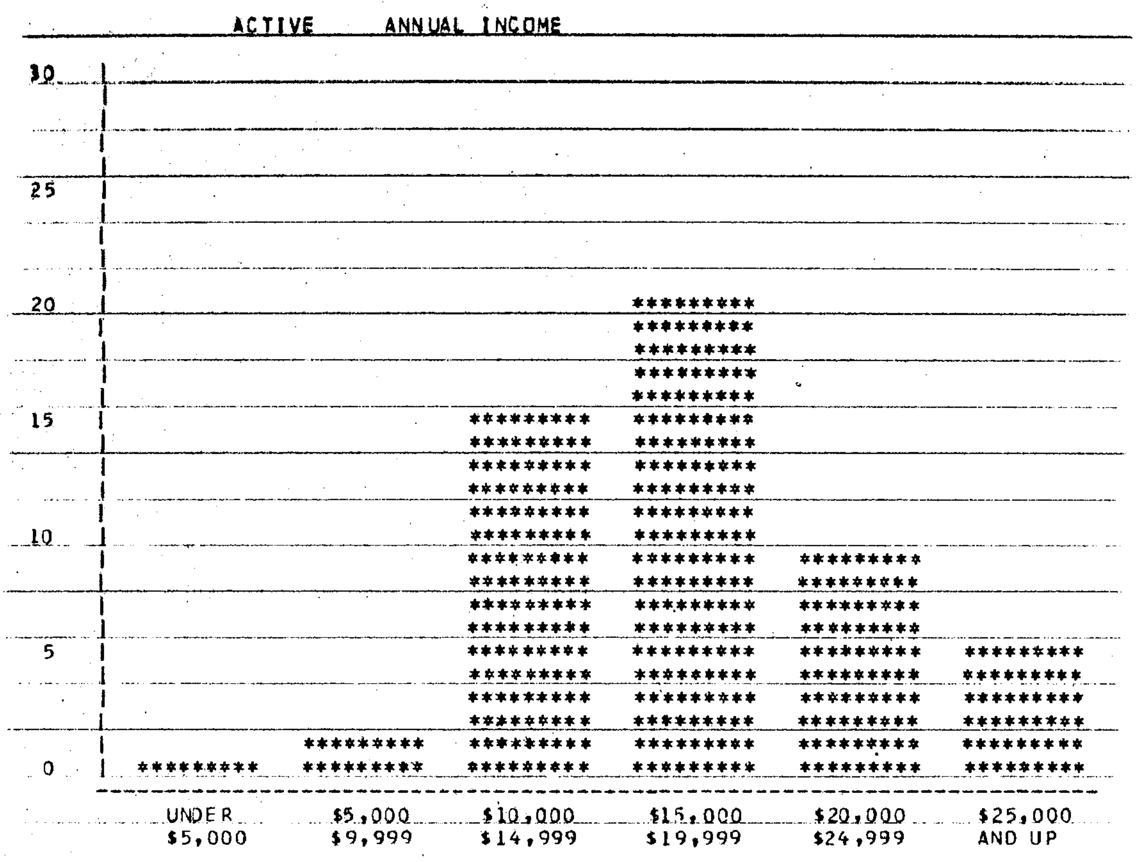
HISTOGRAMS OF VARIABLES C-01 THROUGH C-14

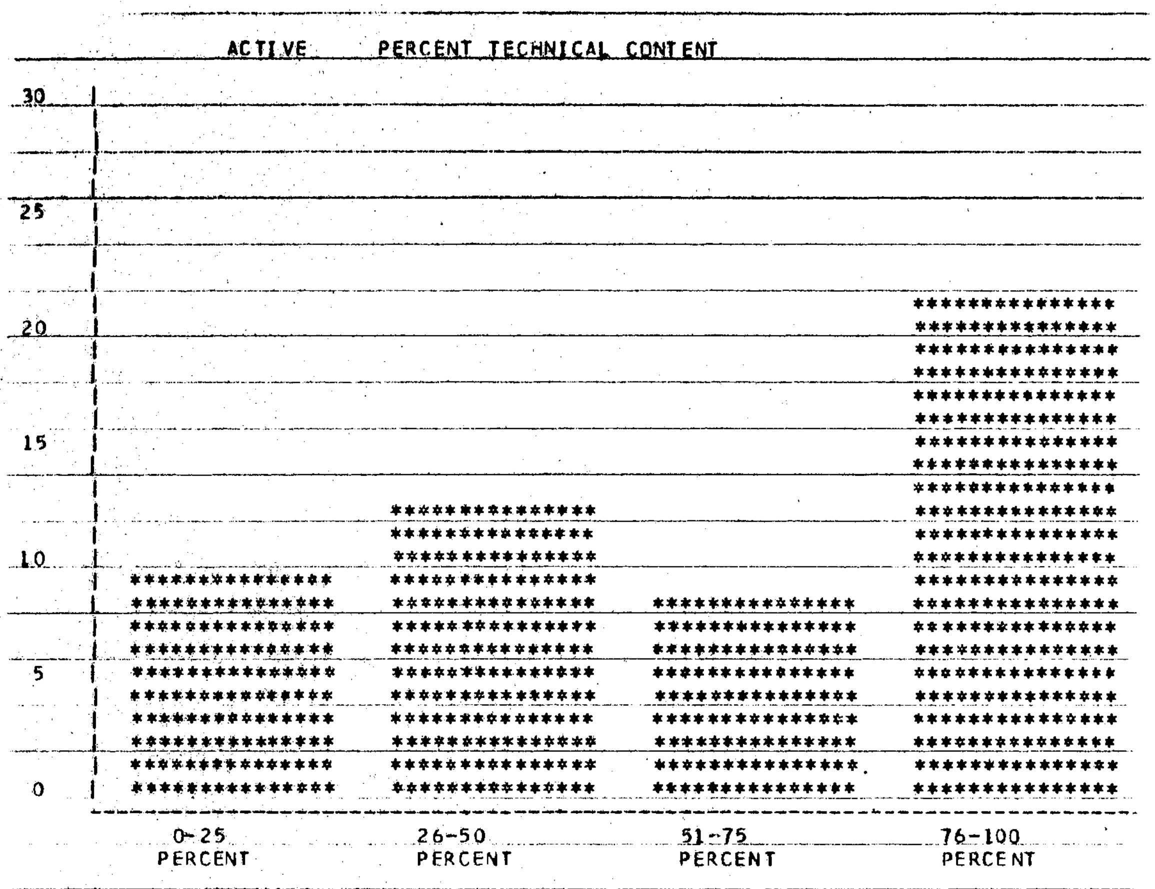
BASED ON SAMPLE SIZE OF 330

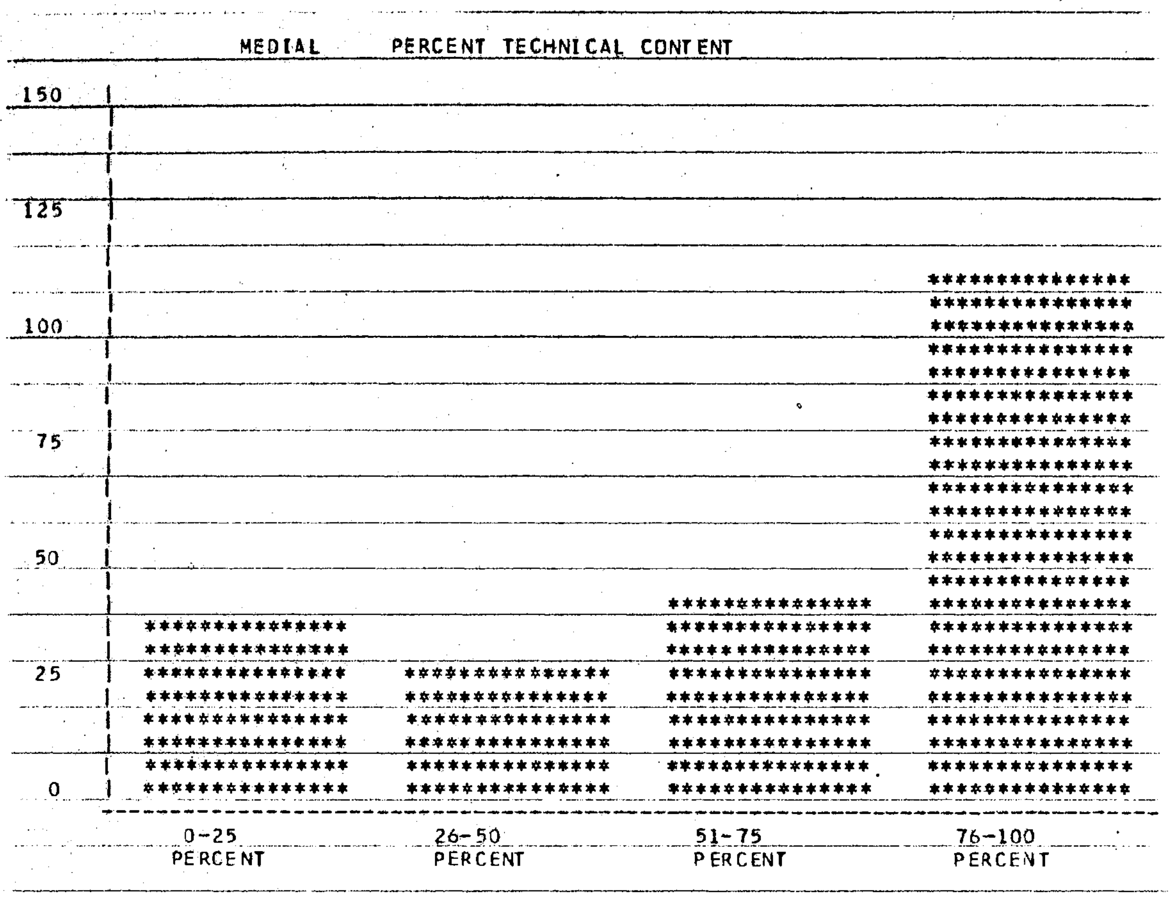

NONE
ANNUAL INCOME
30
25
20
15
10
5
0
UNDER $5,000
$5,000 $9,999
$10,000 $14,999
$15,000 $19,999
$20,000 $24,999
$25,000 AND UP

MEDIAL ANNUAL INCOME




ACTIVE ANNUAL INCOME
30
25
20
15
10
5
0
UNDER $5,000
$5,000 $9,999
$10,000 $14,999
$15,000 $19,999
$20,000 $24,999
$25,000 AND UP


ACTIVE
PERCENT TECHNICAL CONTENT
30
25
20
15
10
5
0
0-25
PERCENT
26-50
PERCENT
51-75
PERCENT
76-100
PERCENT


MEDIAL PERCENT TECHNICAL CONTENT
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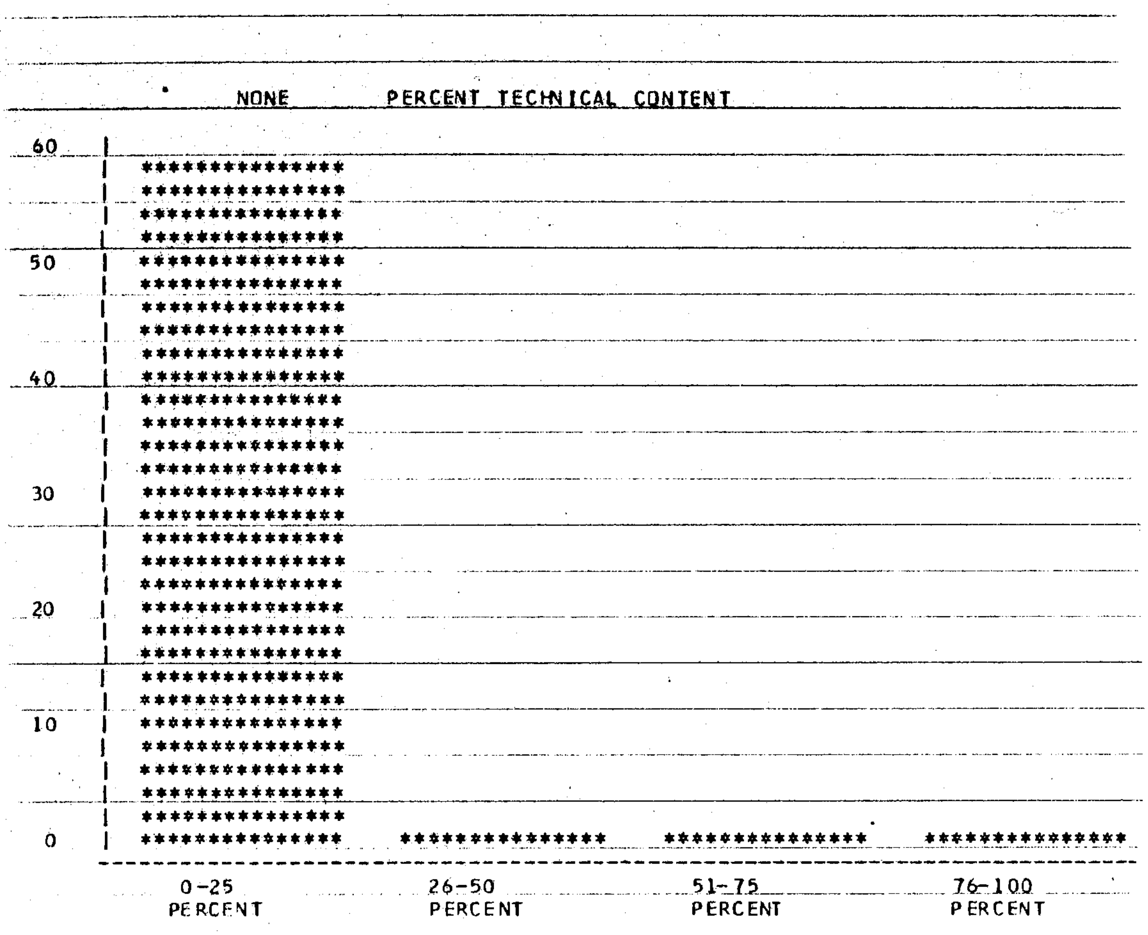
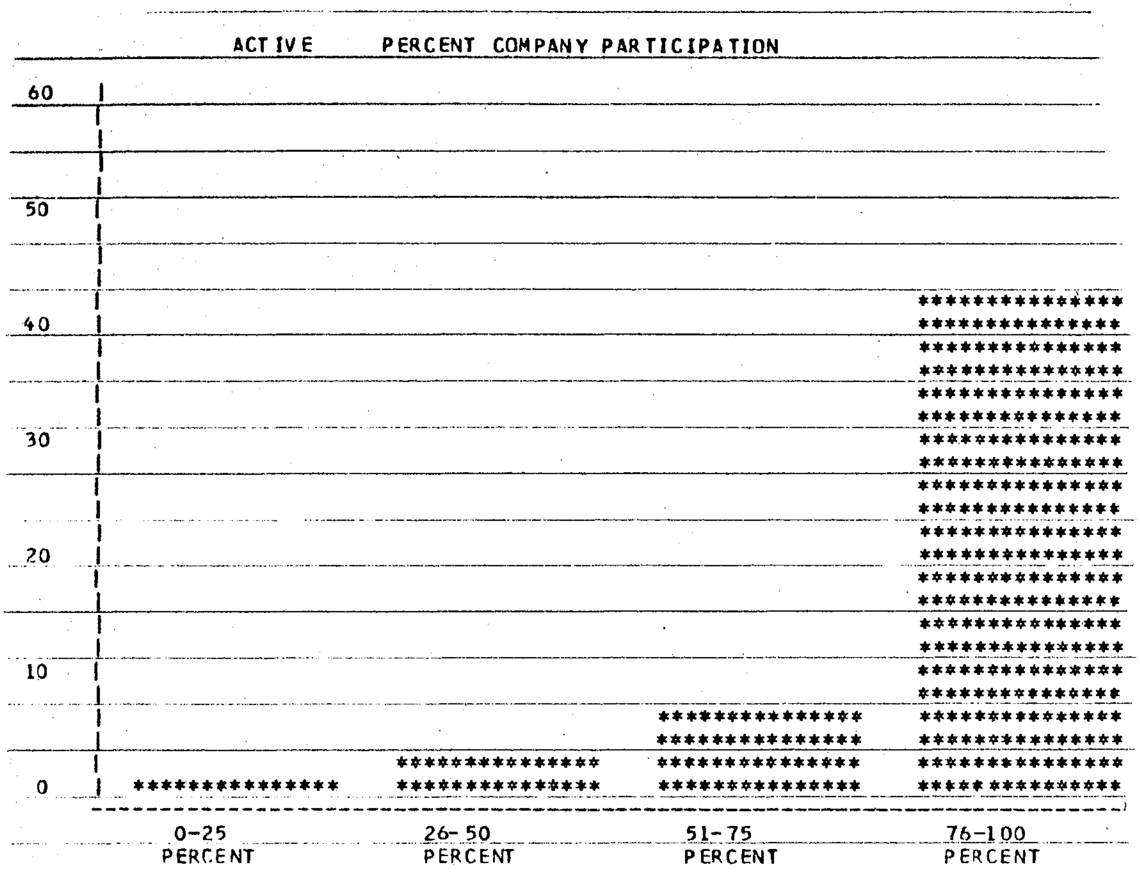
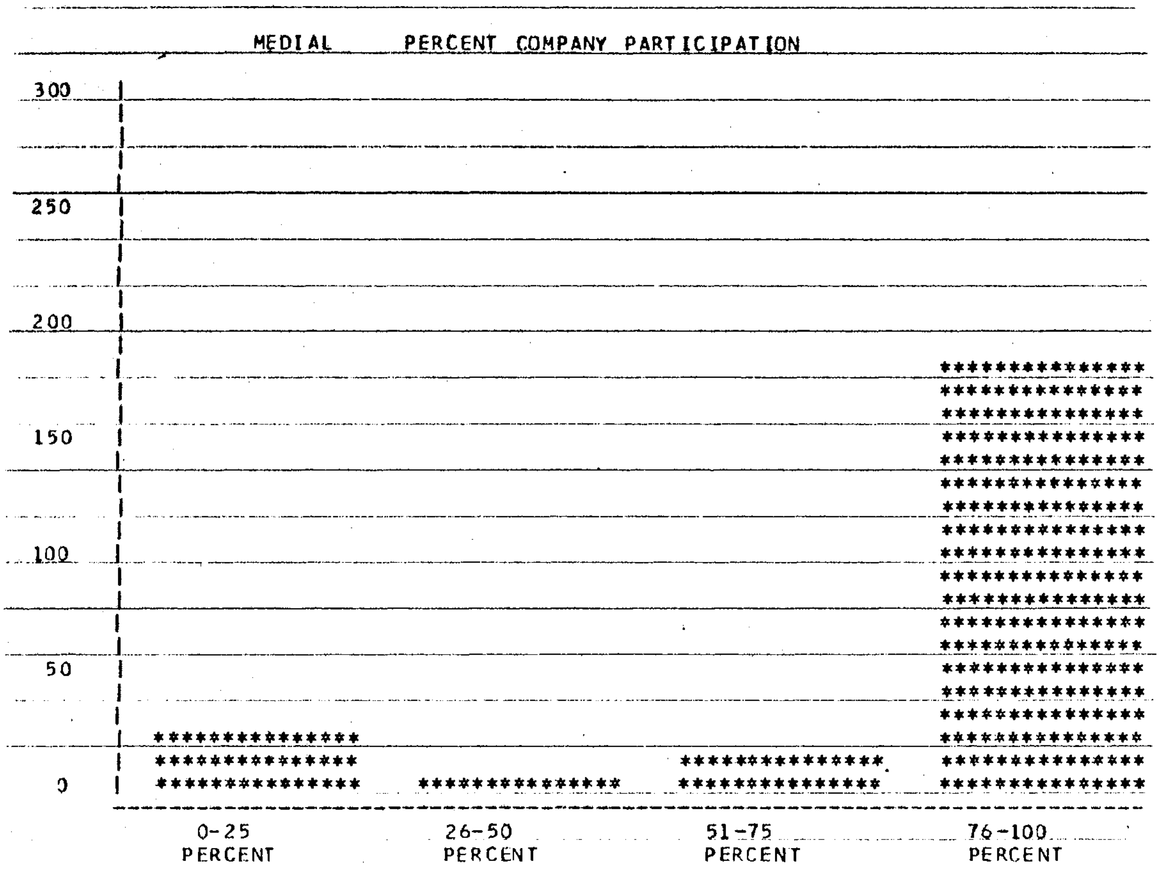
125
100
75
50
25
0
0-25 PERCENT
26-50 PERCENT
51-75 PERCENT
76-100 PERCENT


NONE
PERCENT TECHNICAL CONTENT
60
50
40
30
20
10
0
0-25 PERCENT
26-50 PERCENT
51-75 PERCENT
76-100 PERCENT



ACTIVE
PERCENT COMPANY PARTICIPATION
60
50
40
30
20
10
0
0-25 PERCENT
26-50 PERCENT
51-75 PERCENT
76-100 PERCENT


MEDIAL
PERCENT COMPANY PARTICIPATION
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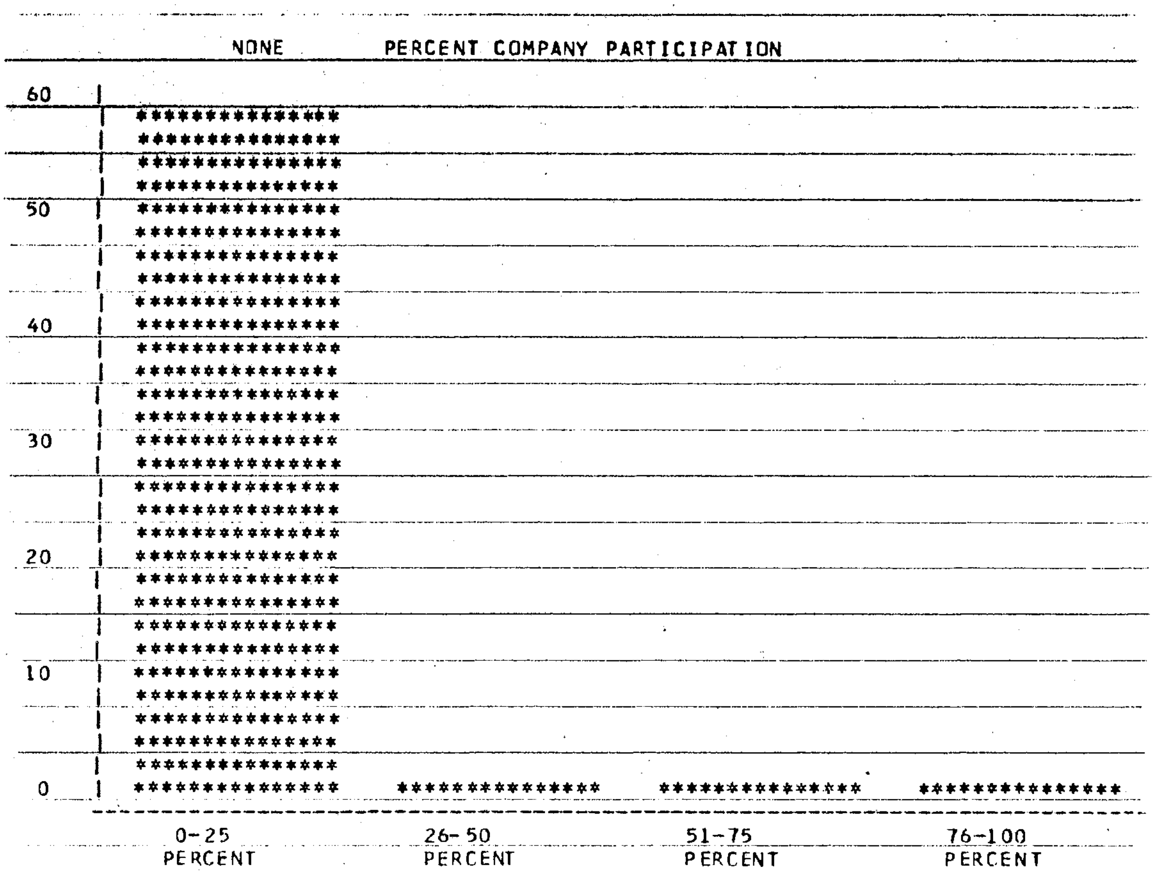
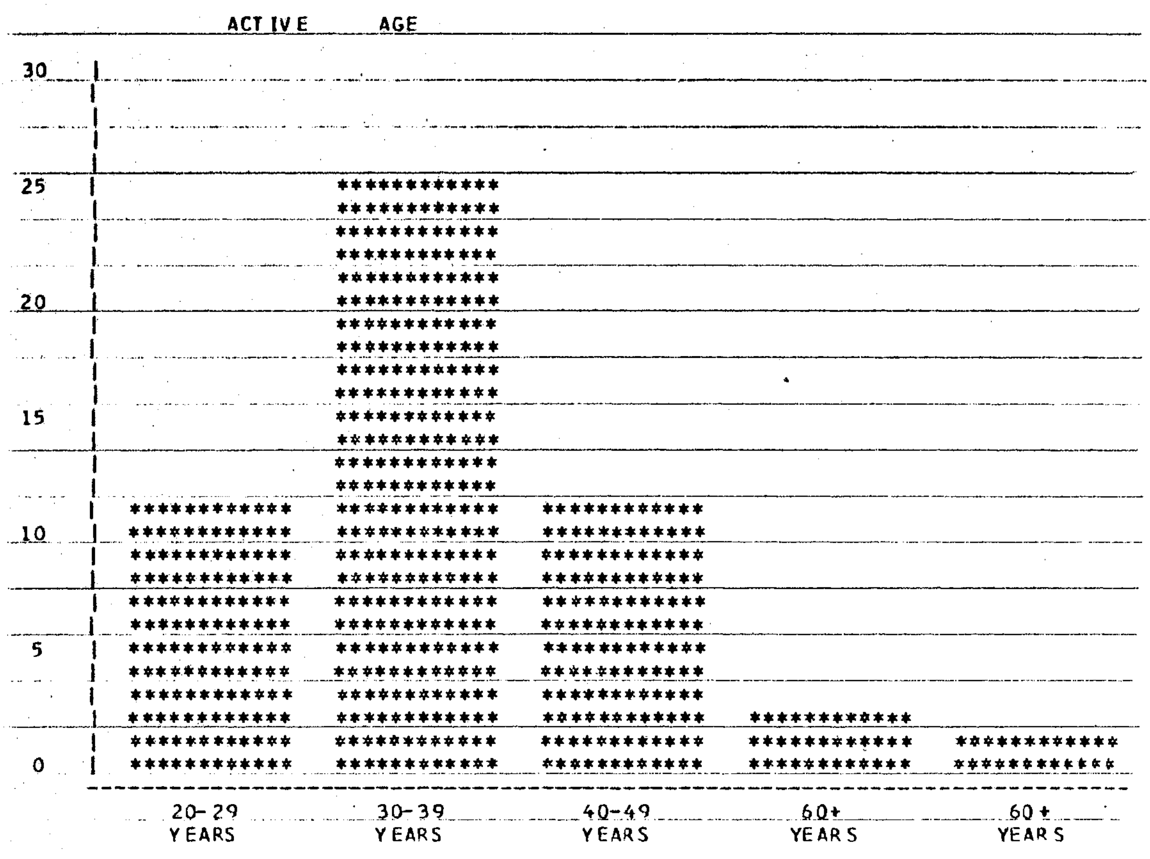
250
200
150
100
50
0
0-25 PERCENT
26-50 PERCENT
51-75 PERCENT
76-100 PERCENT


NONE
PERCENT COMPANY PARTICIPATION
60
50
40
30
20
10
0
0-25 PERCENT
26-50 PERCENT
51-75 PERCENT
76-100 PERCENT


ACTIVE AGE
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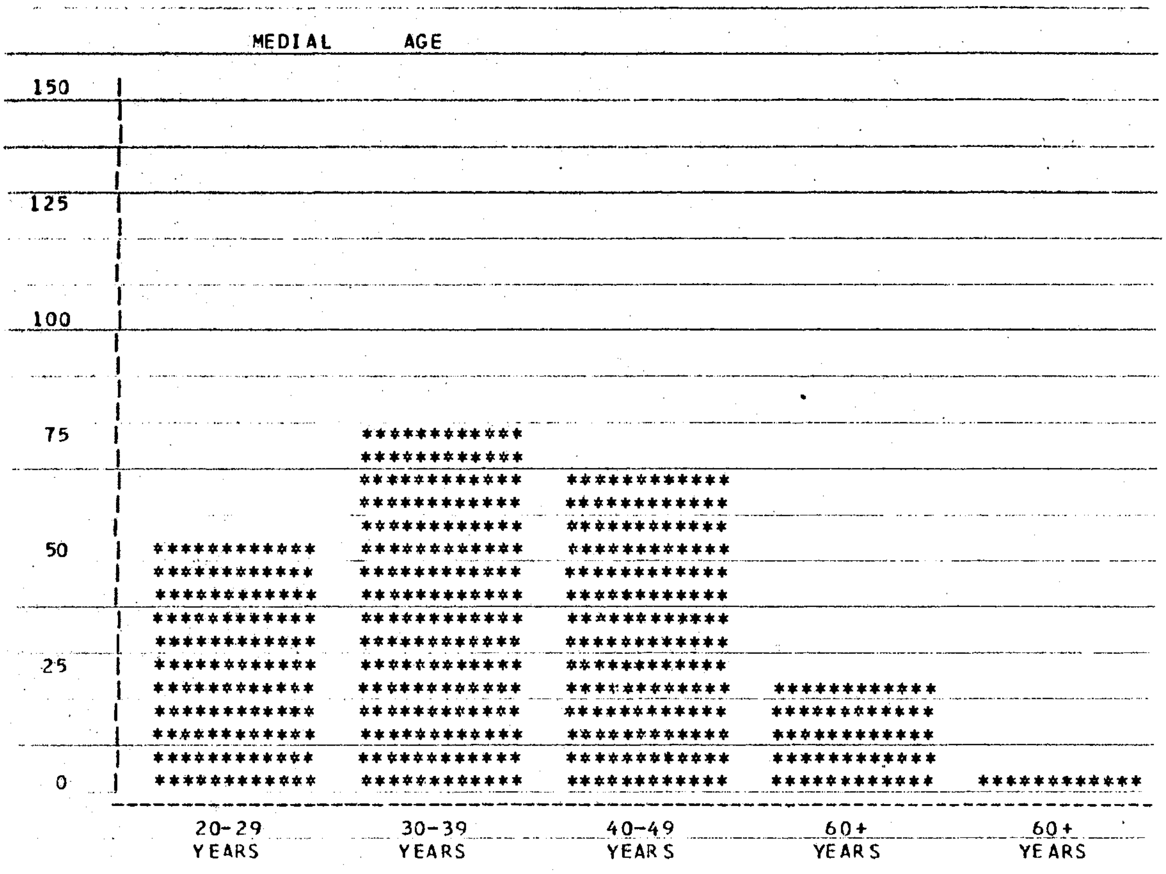
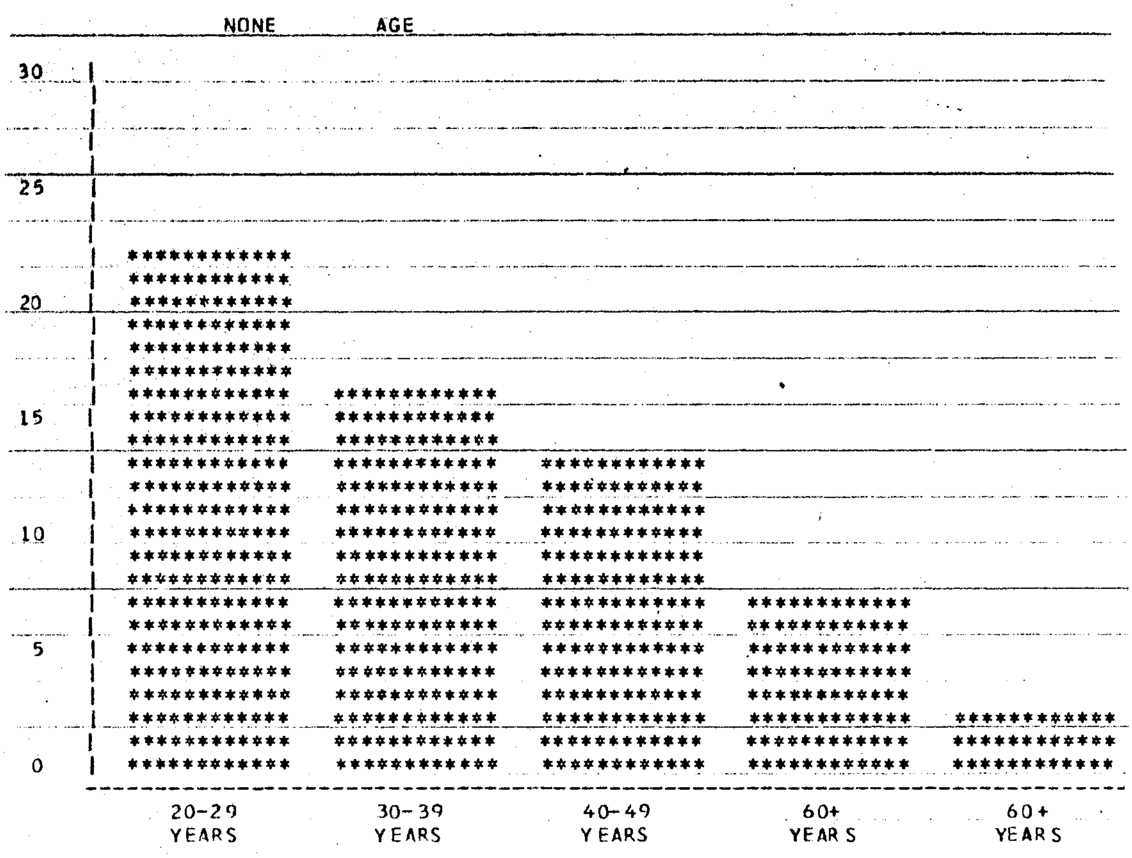
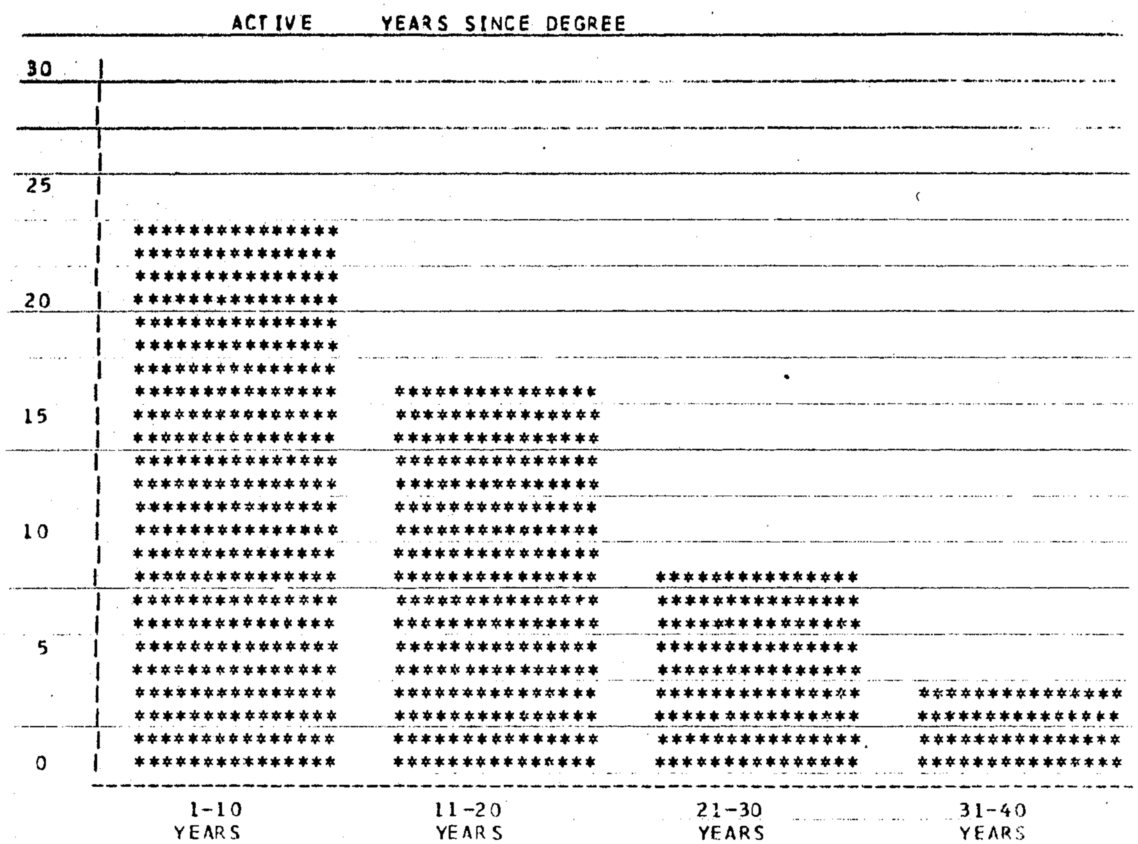
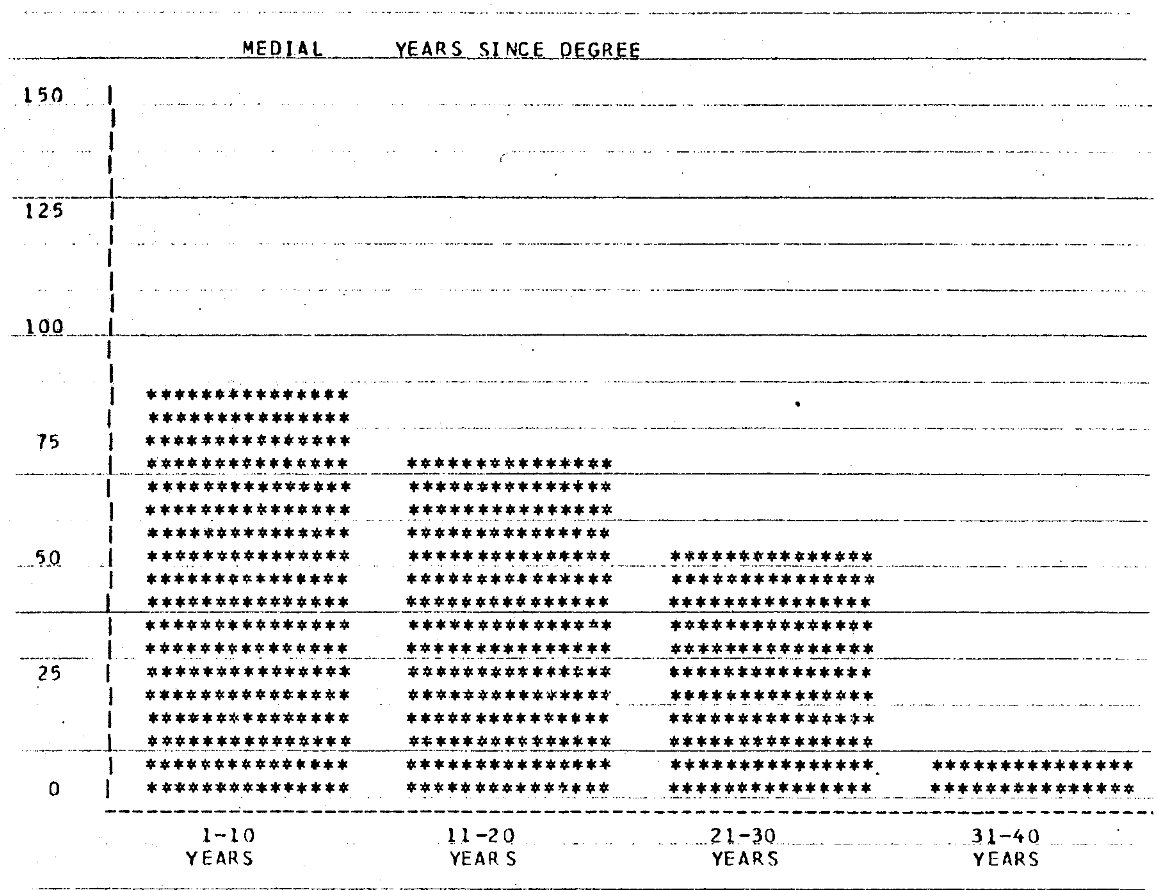
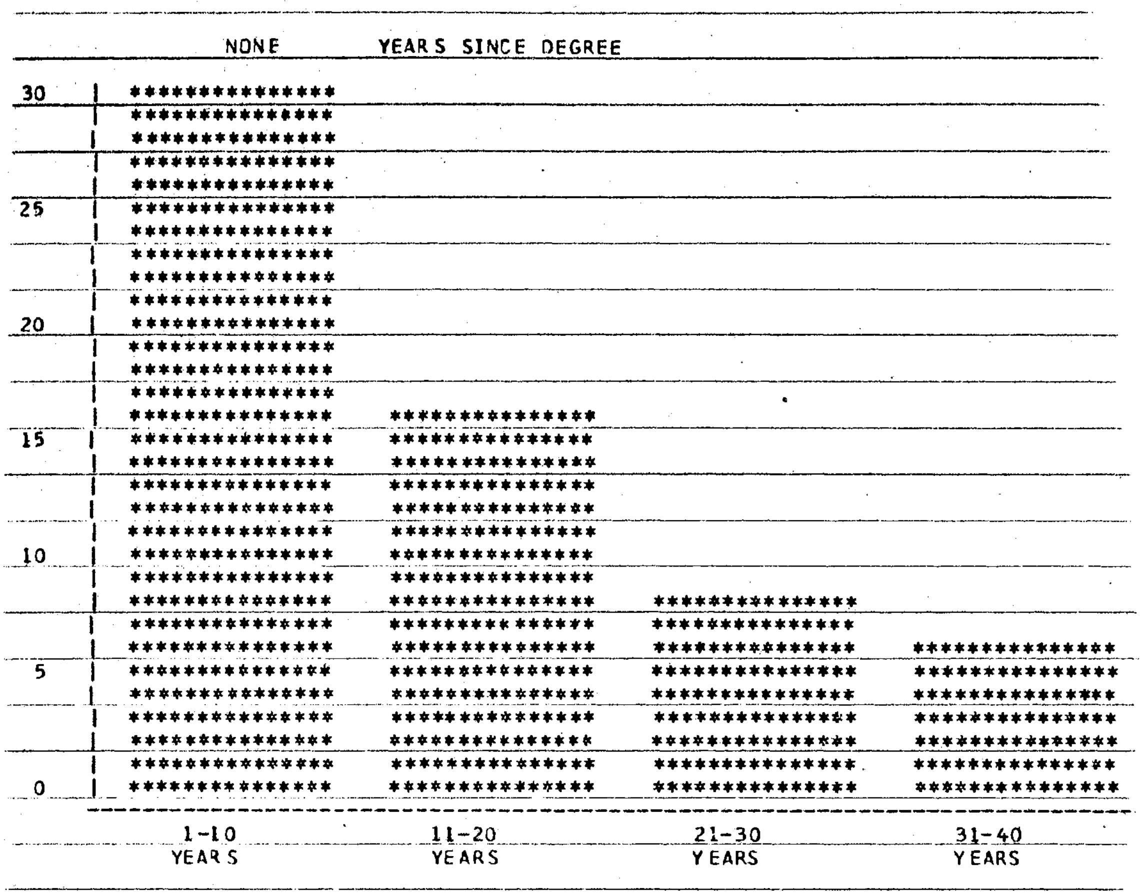
25
20
15
10
5
0
20-29 YEARS
30-39 YEARS
40-49 YEARS
60+ YEARS
60+ YEARS


MEDIAL AGE
150
125
100
75
50
25
0
20-29 YEARS
30-39 YEARS
40-49 YEARS
60+ YEARS
60+ YEARS

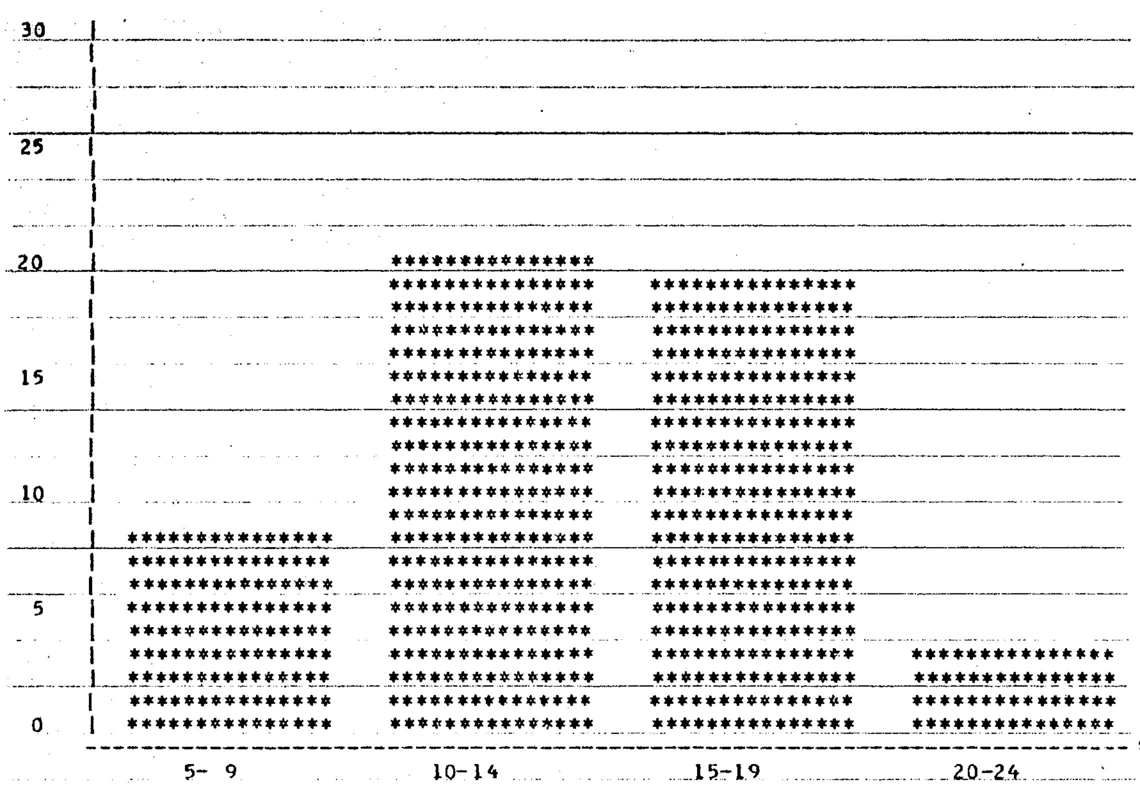

NONE
AGE
30
25
20
15
10
5
0
20-29 YEARS
30-39 YEARS
40-49 YEARS
60+ YEARS
60+ YEARS

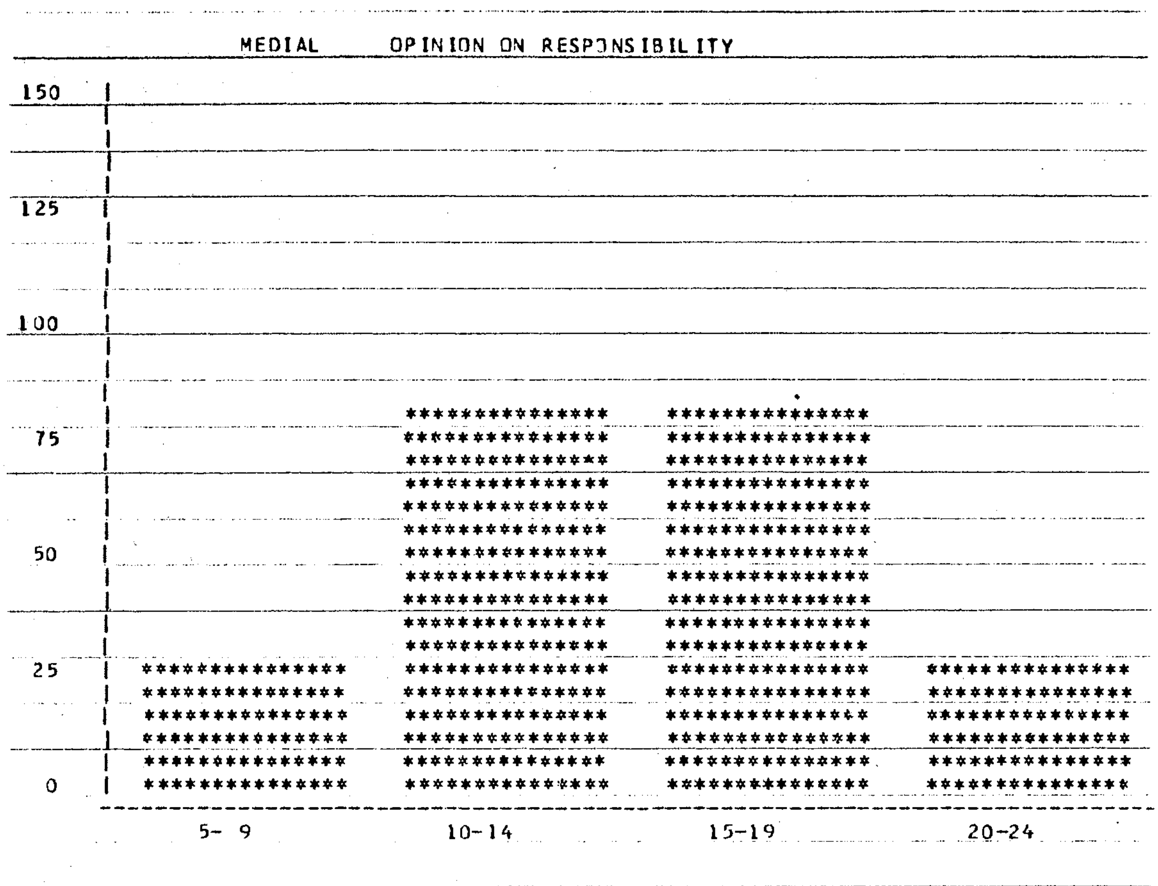

ACTIVE YEARS SINCE DEGREE
30
25
20
15
10
5
0
1-10 YEARS
11-20 YEARS
21-30 YEARS
31-40 YEARS

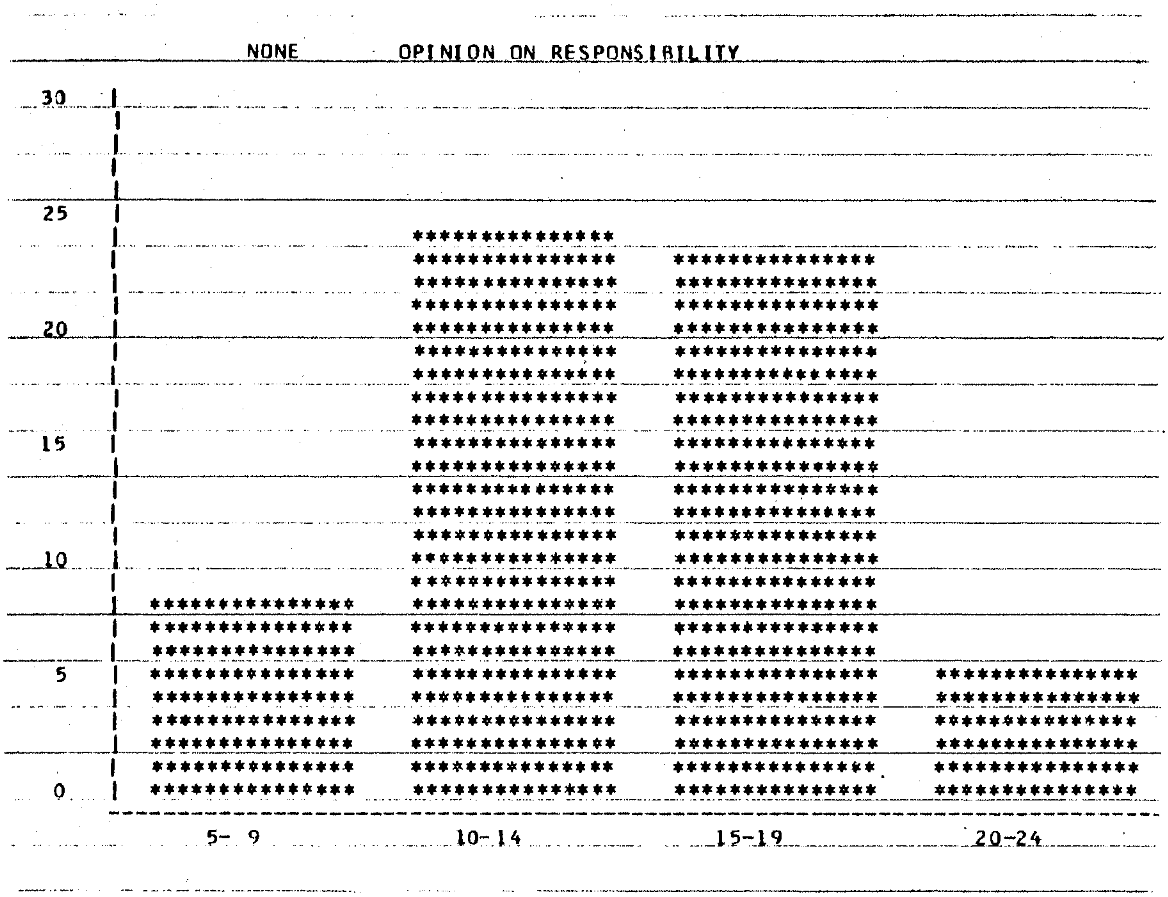

MEDIAL YEARS SINCE DEGREE
150
125
100
75
50
25
0
1-10 YEARS
11-20 YEARS
21-30 YEARS
31-40 YEARS


NONE
YEARS SINCE DEGREE
30
25
20
15
10
5
0
1-10 YEARS
11-20 YEARS
21-30 YEARS
31-40 YEARS

ACTIVE OPINION ON RESPONSIBILITY




MEDIAL OPINION ON RESPONSIBILITY
150
125
100
75
50
25
0
5- 9
10-14
15-19
20-24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OPINION ON RESPONSIBILITY
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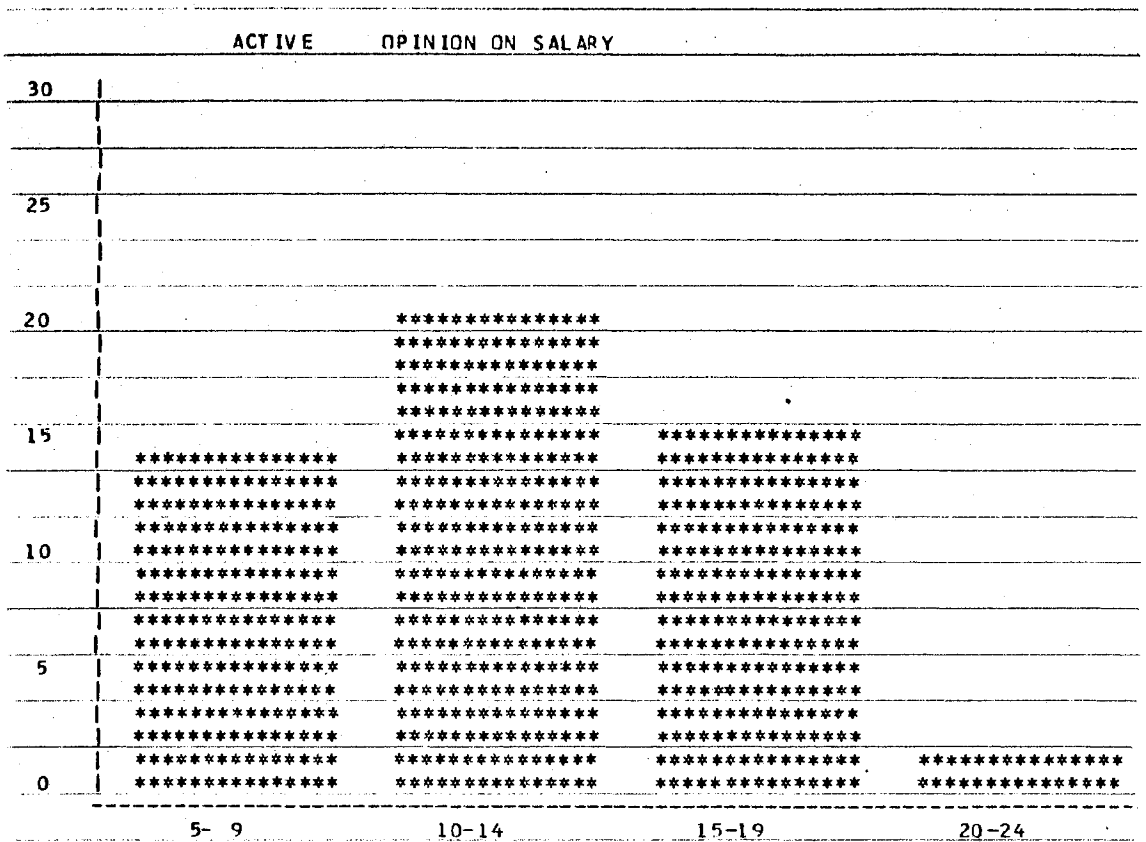
10
5
0
5- 9
10-14
15-19
20-24


ACTIVE OPINION ON SALARY
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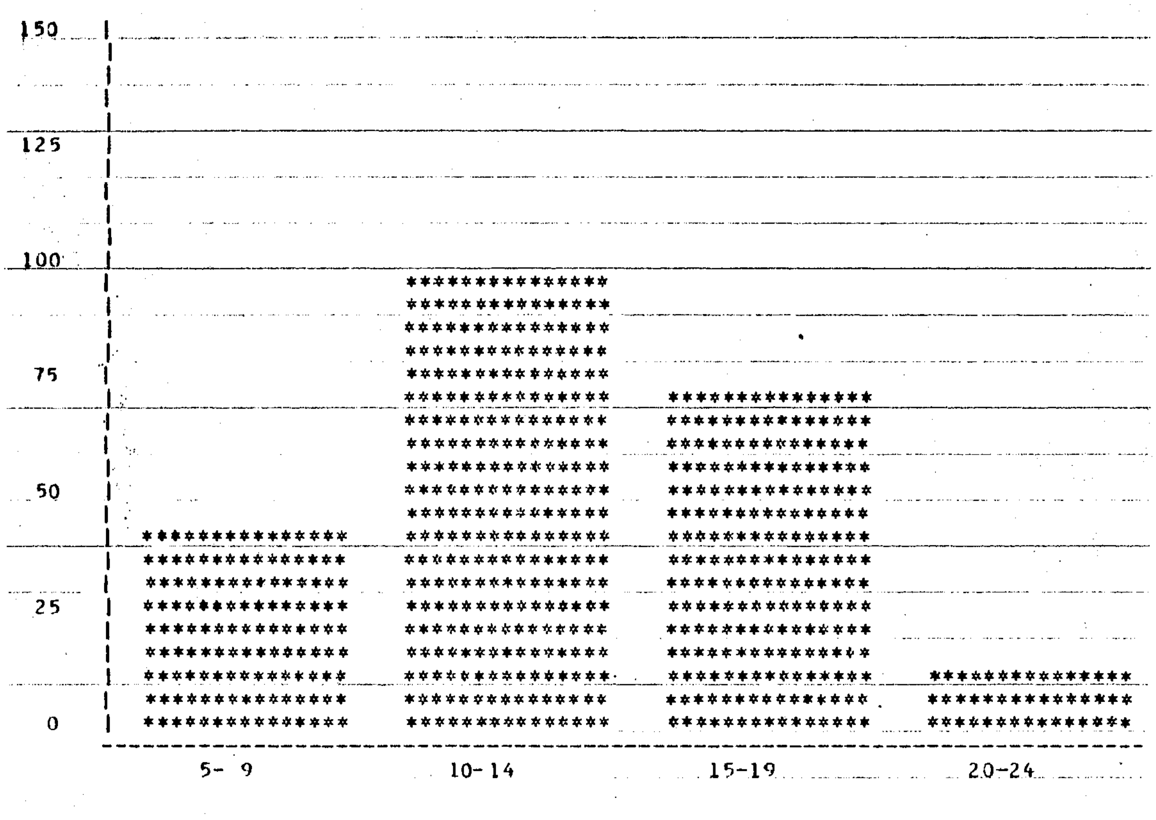
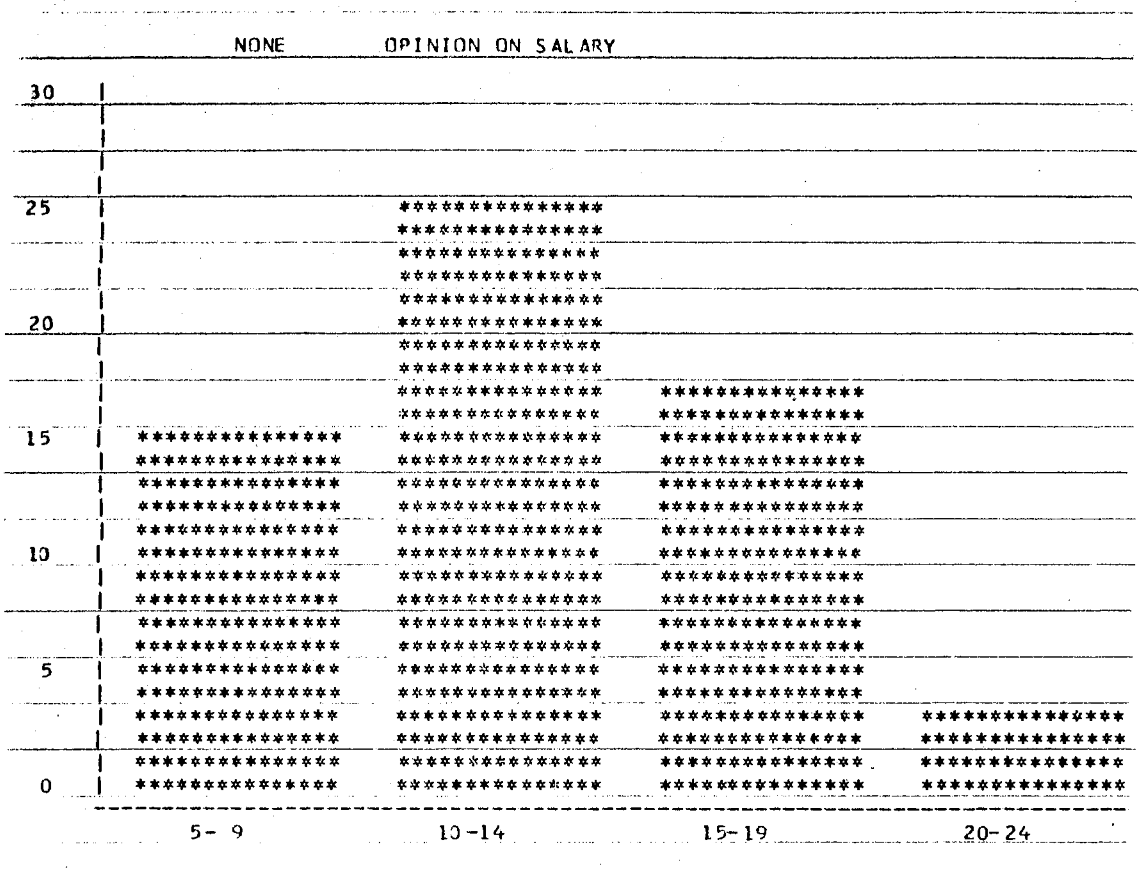
15
10
5
0
5- 9
10-14
15-19
20-24

MEDIAL OPINION ON SALARY




NONE
OPINION ON SALARY
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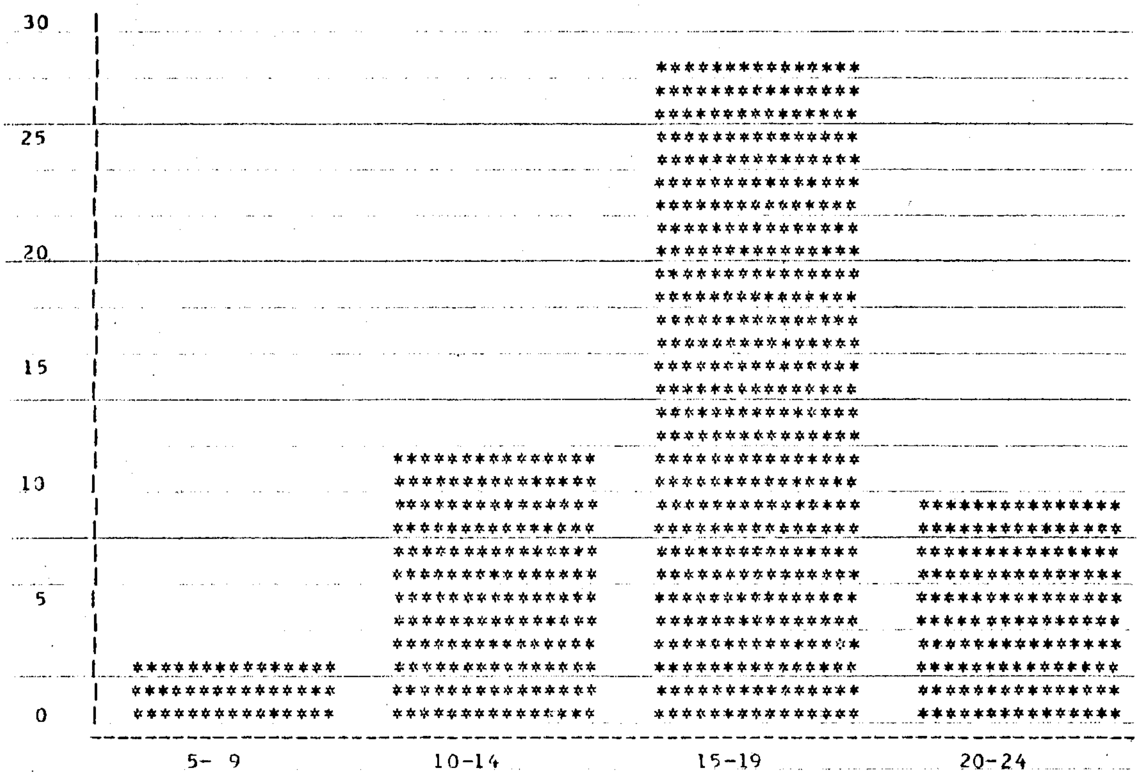
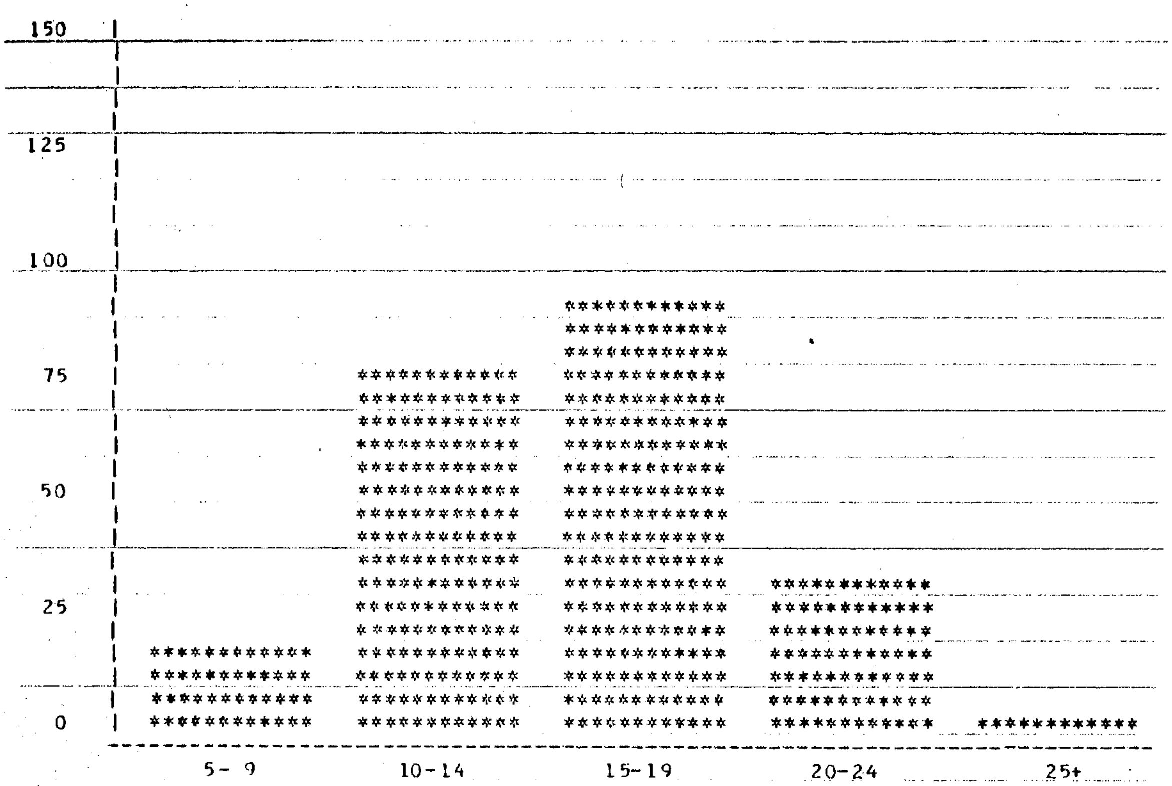
25
20
15
10
5
0
5- 9
10-14
15-19
20-24

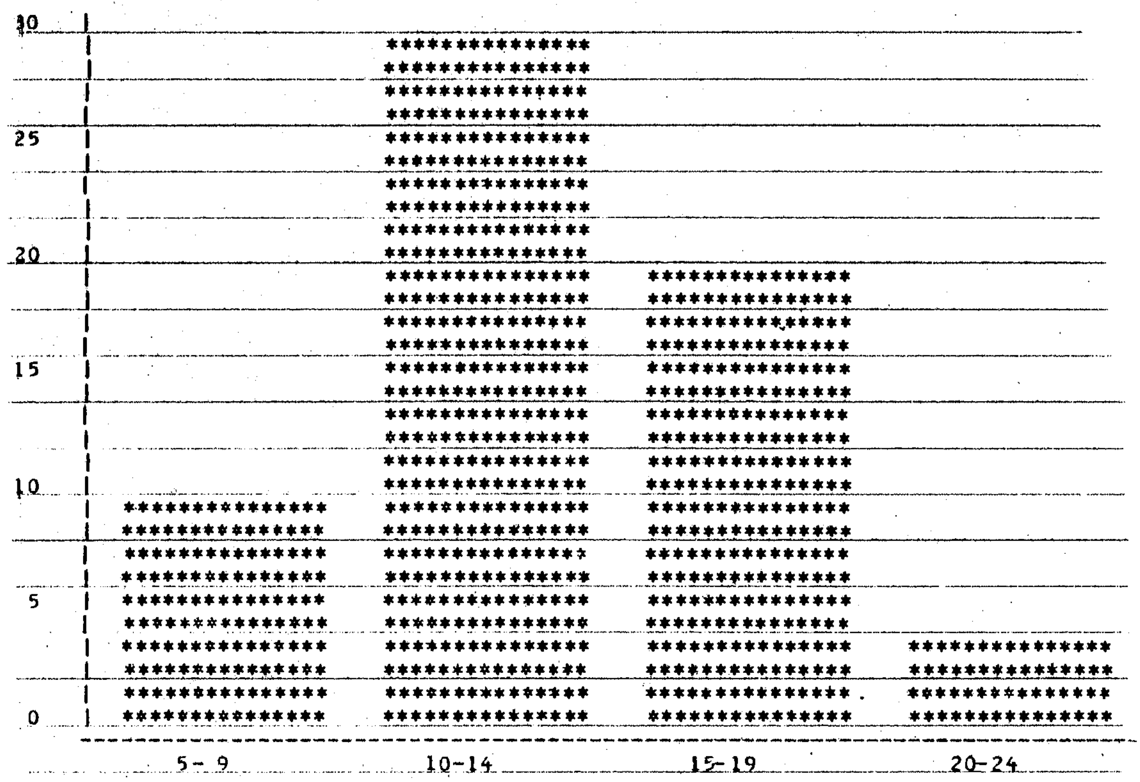
ACTIVE OPINION ON COMPANY POLICY

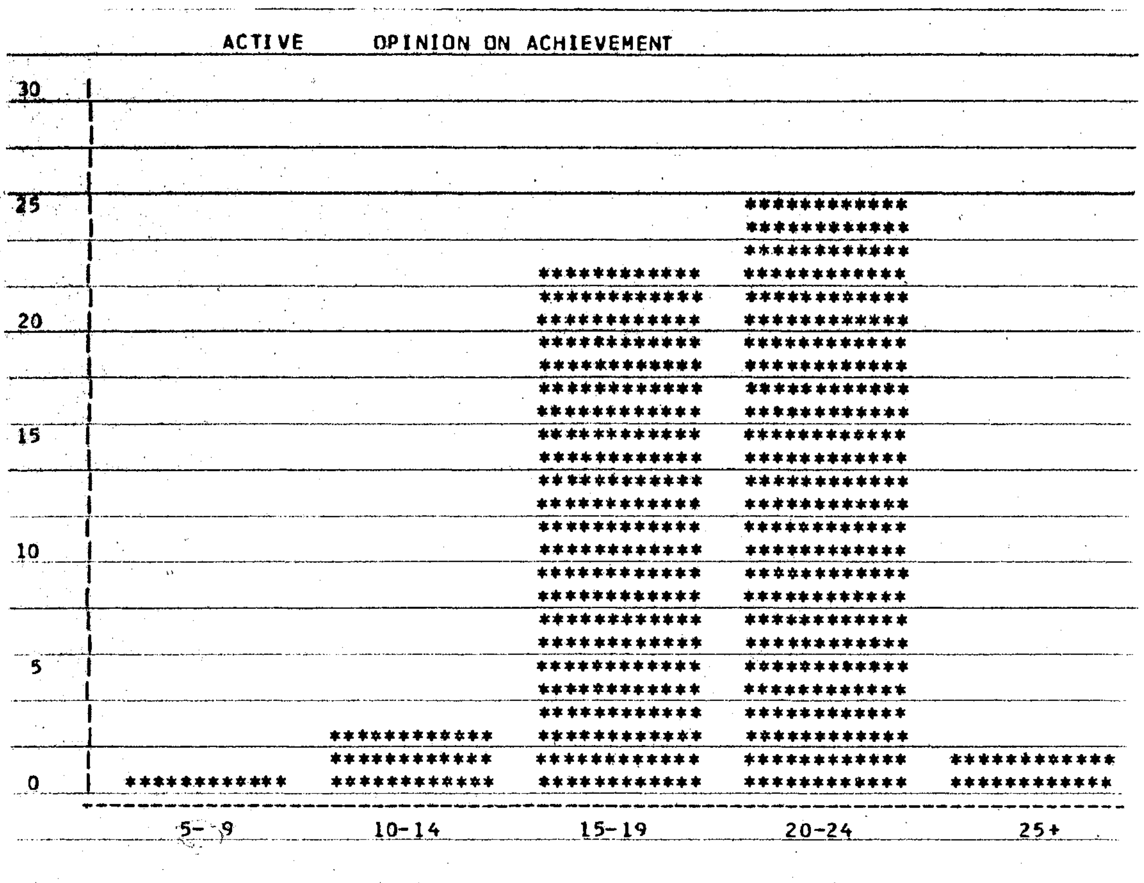


MEDIAL OPINION ON COMPANY POLICY



NONE OPINION ON COMPANY POLICY




ACTIVE OPINION ON ACHIEVEMENT
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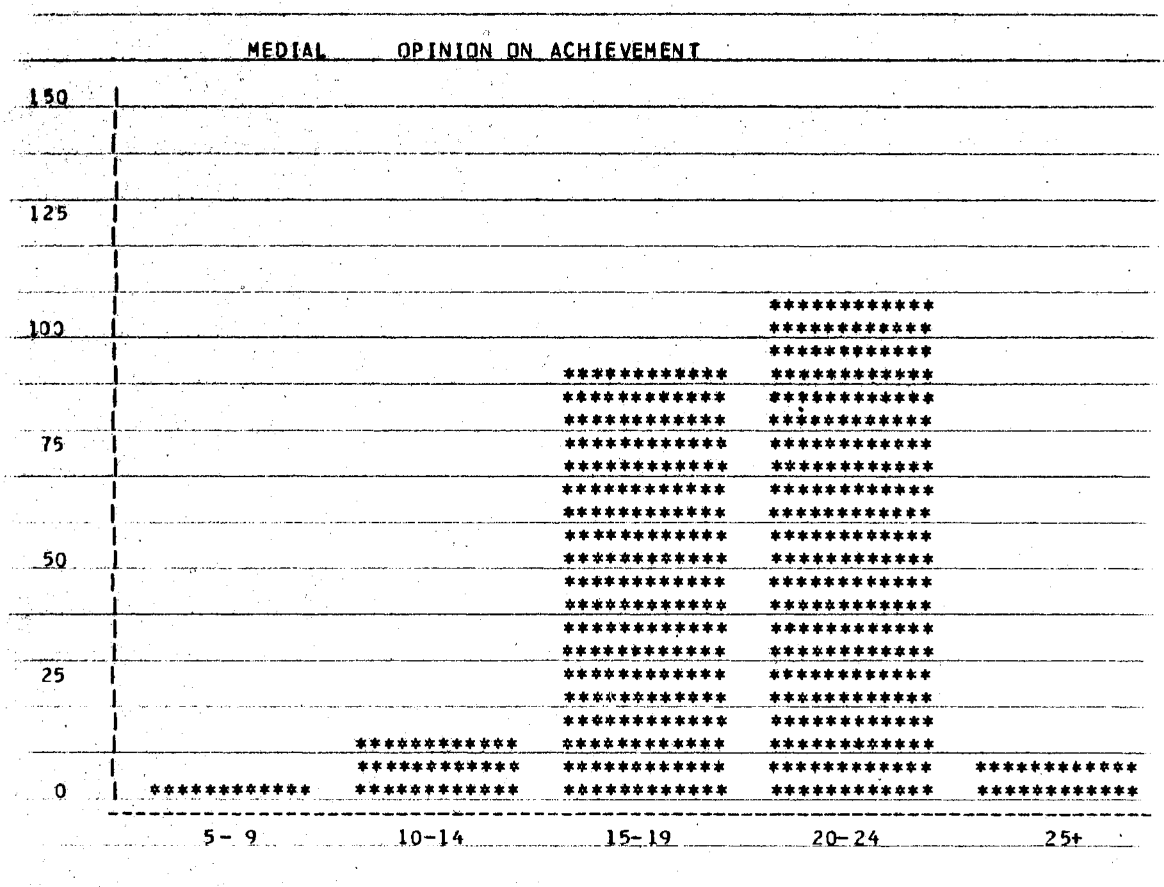
25
20
15
10
5
0
5-9
10-14
15-19
20-24
25+


MEDIAL OPINION ON ACHIEVEMENT
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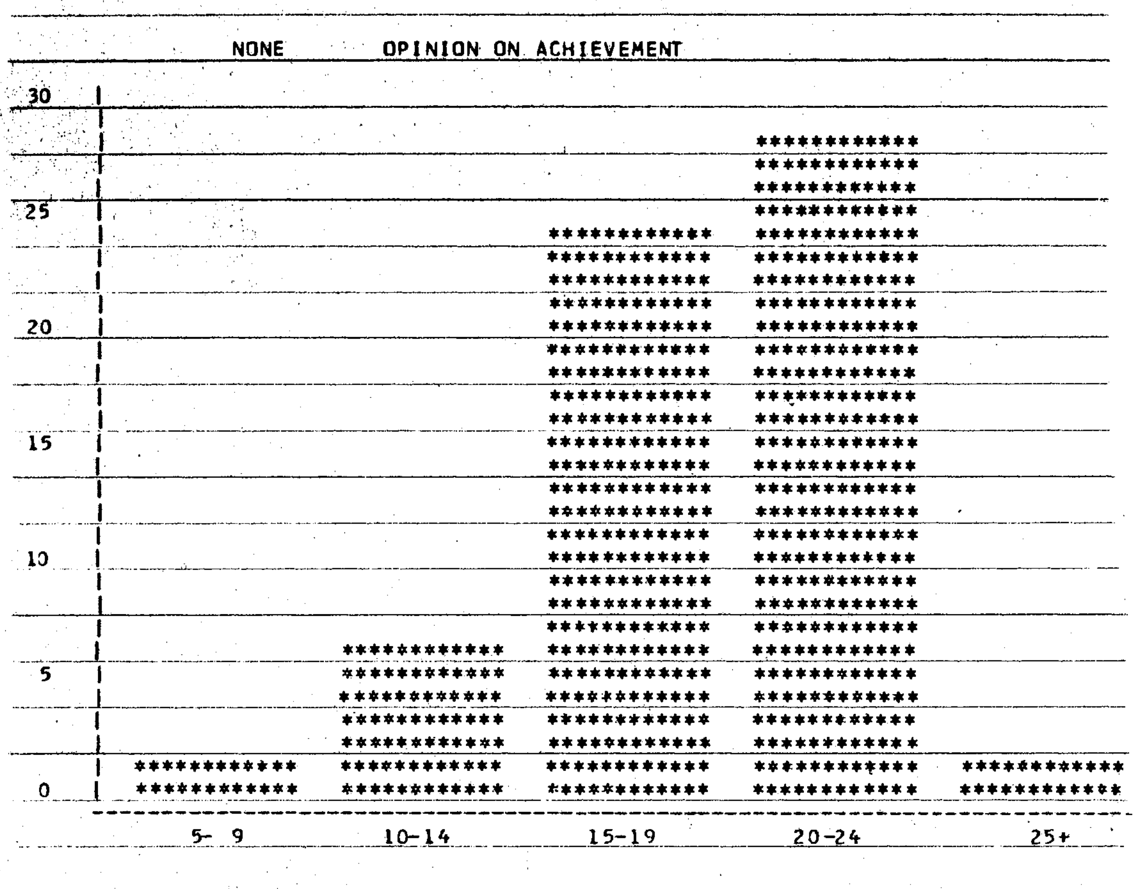
125
100
75
50
25
0
5- 9
10-14
15-19
20-24
25+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OPINION ON ACHIEVEMENT
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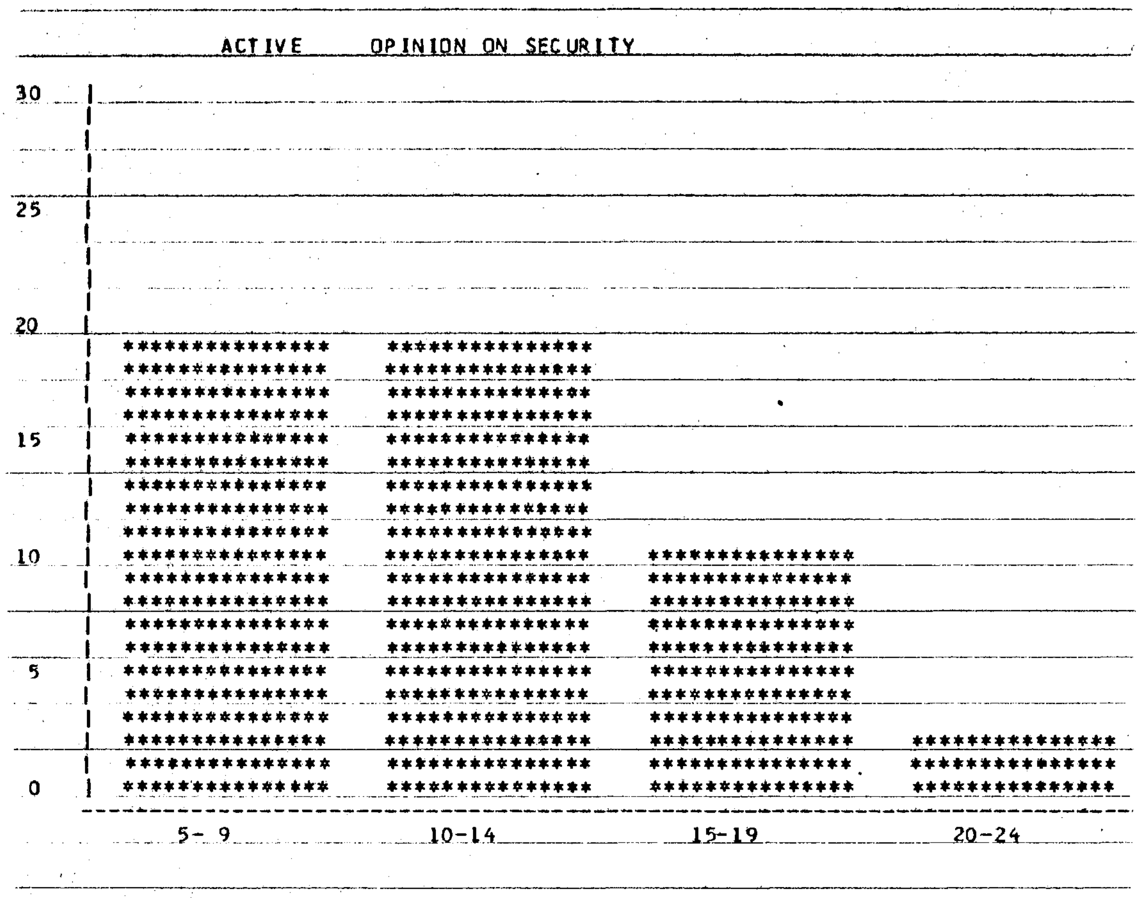
25
20
15
10
5
0
5- 9
10-14
15-19
20-24
25+


ACTIVE OPINION ON SECURITY
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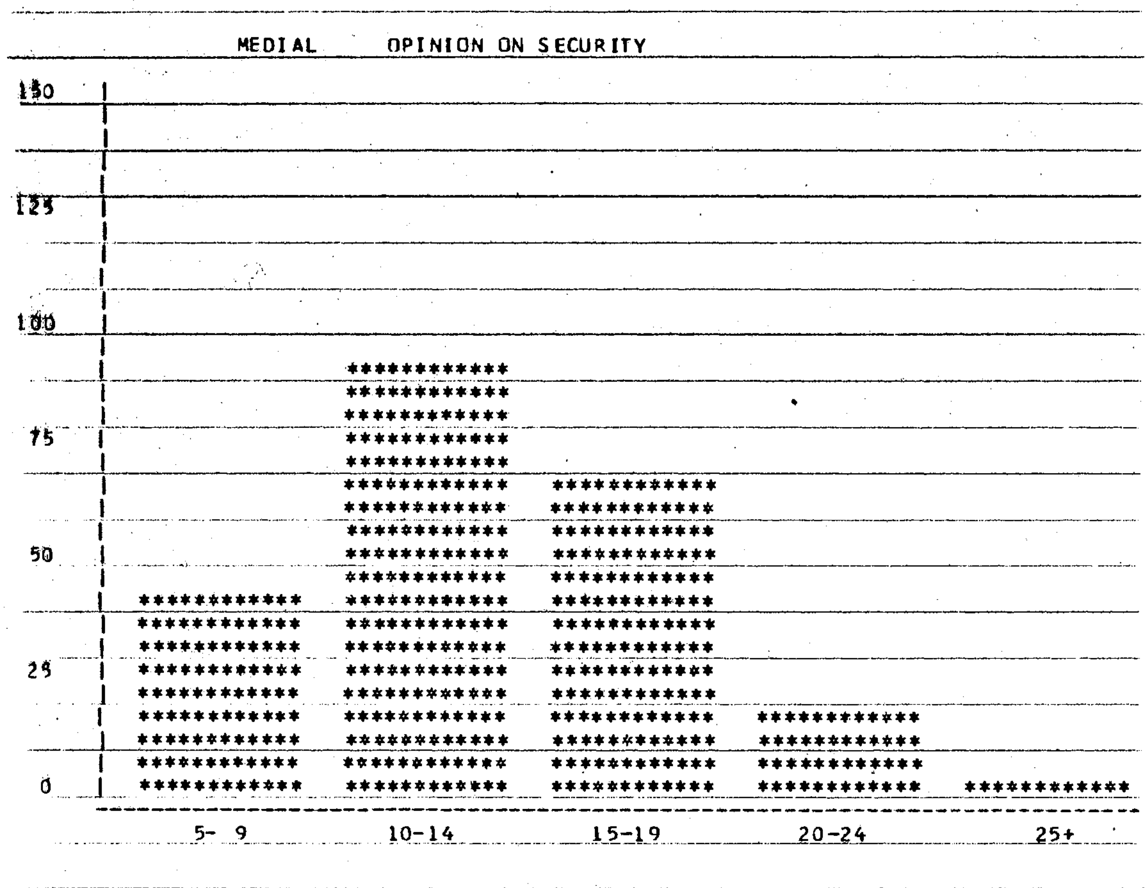
15
10
5
0
5- 9
10-14
15-19
20-24


MEDIAL OPINION ON SECURITY
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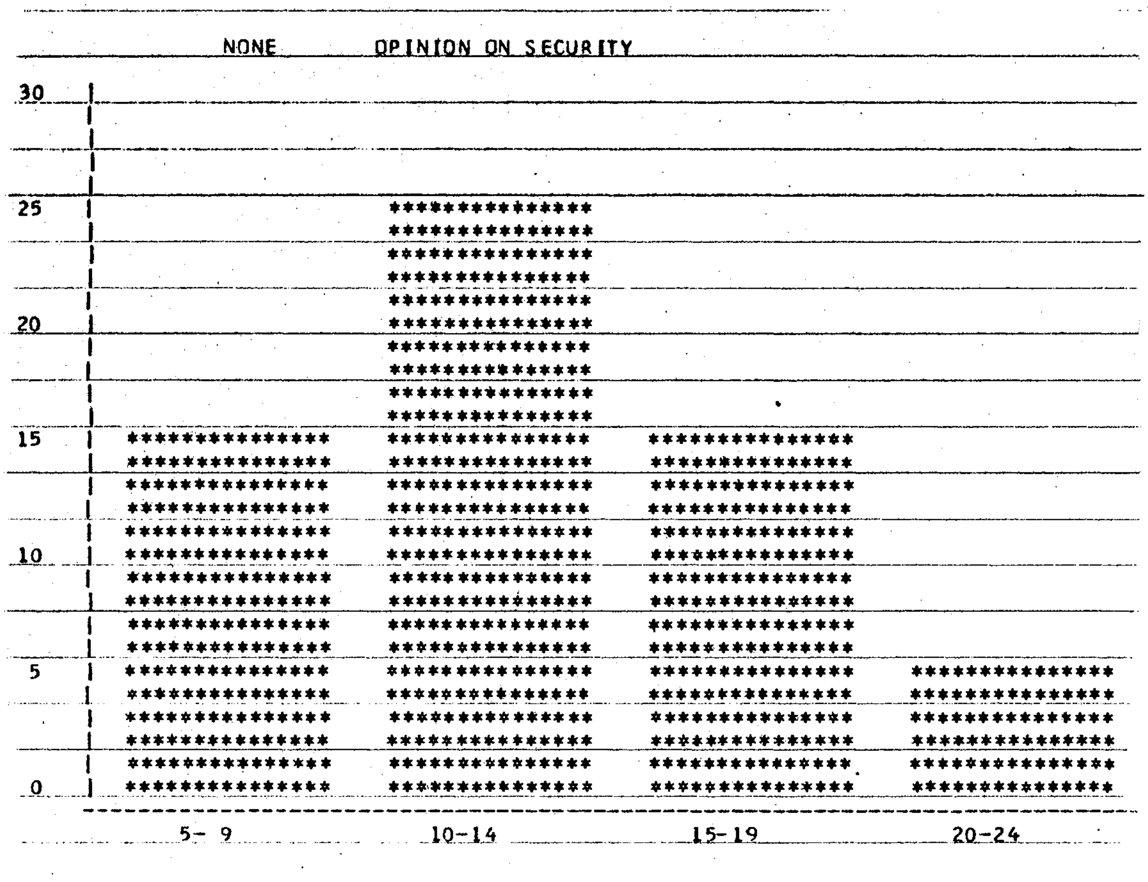
125
100
75
50
25
0
5- 9
10-14
15-19
20-24
25+


NONE OPINION ON SECURITY
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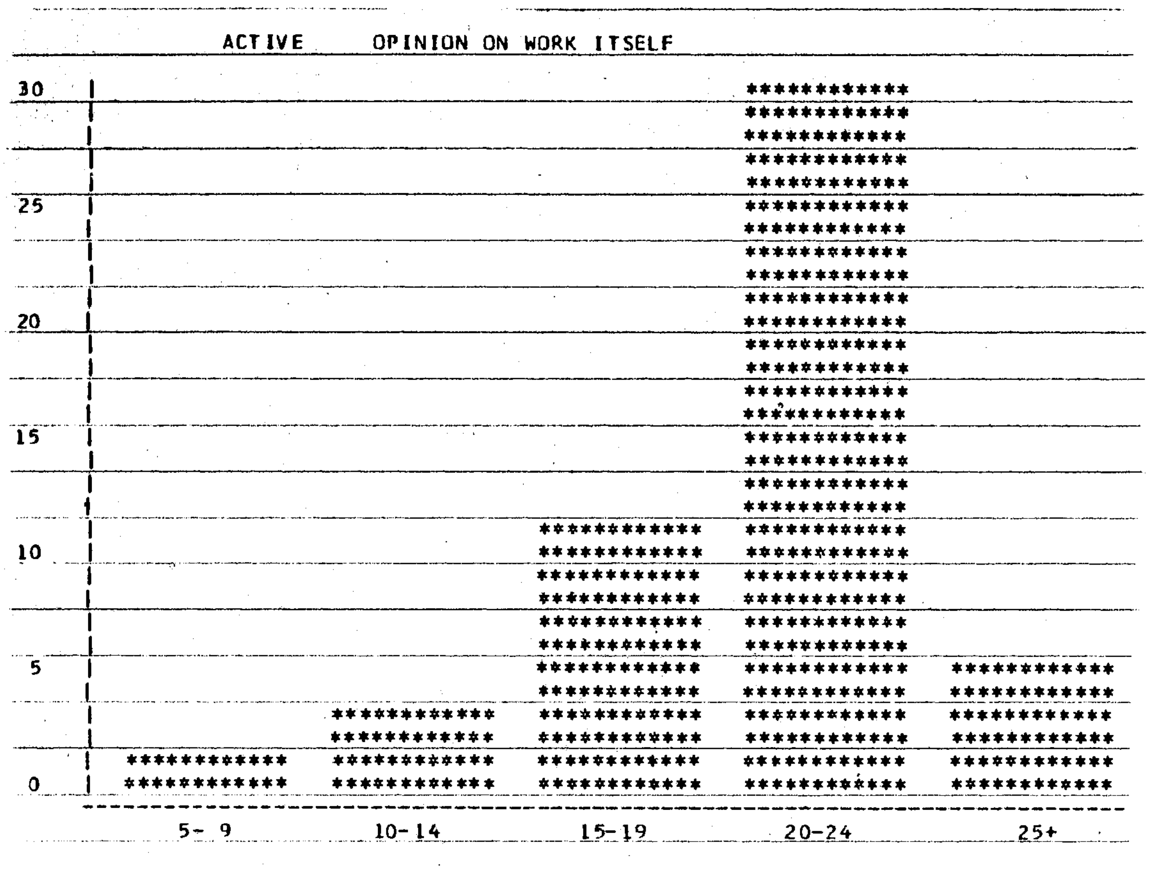
5- 9
10-14
15-19
20-24


ACTIVE OPINION ON WORK ITSELF
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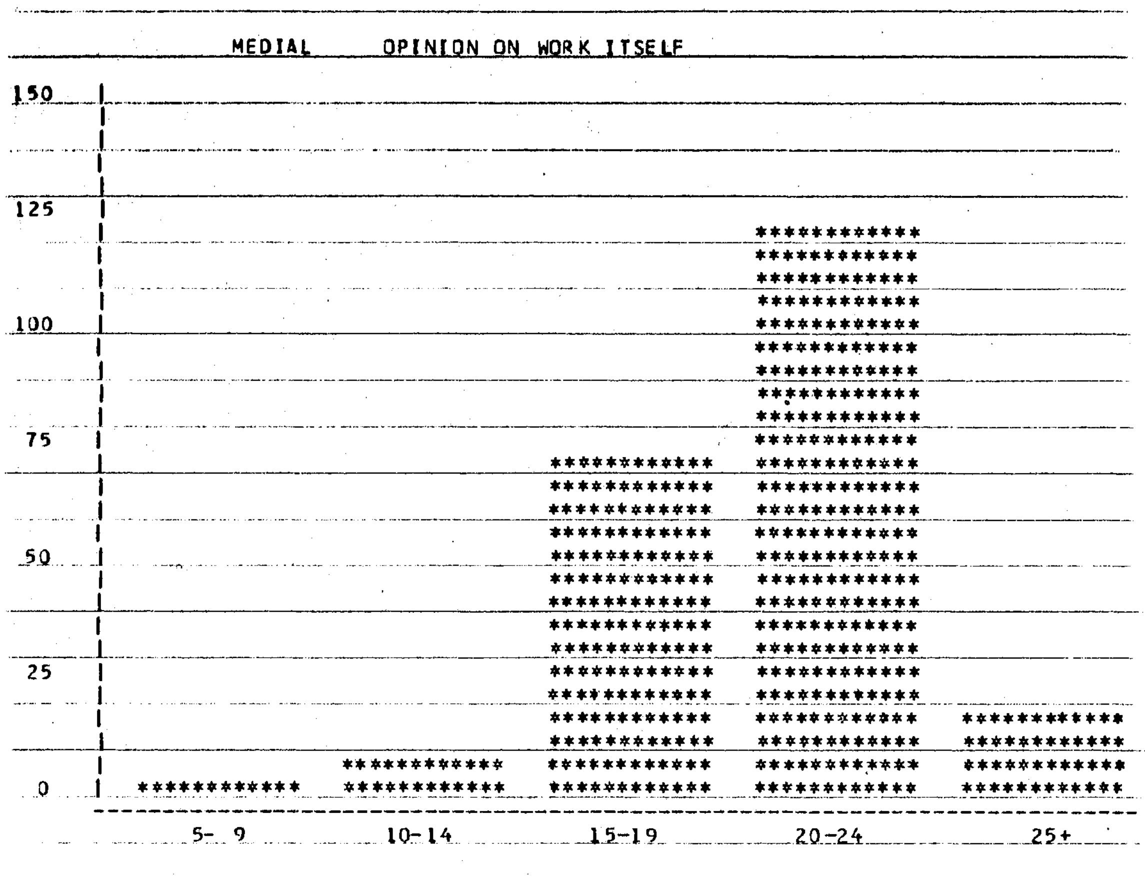
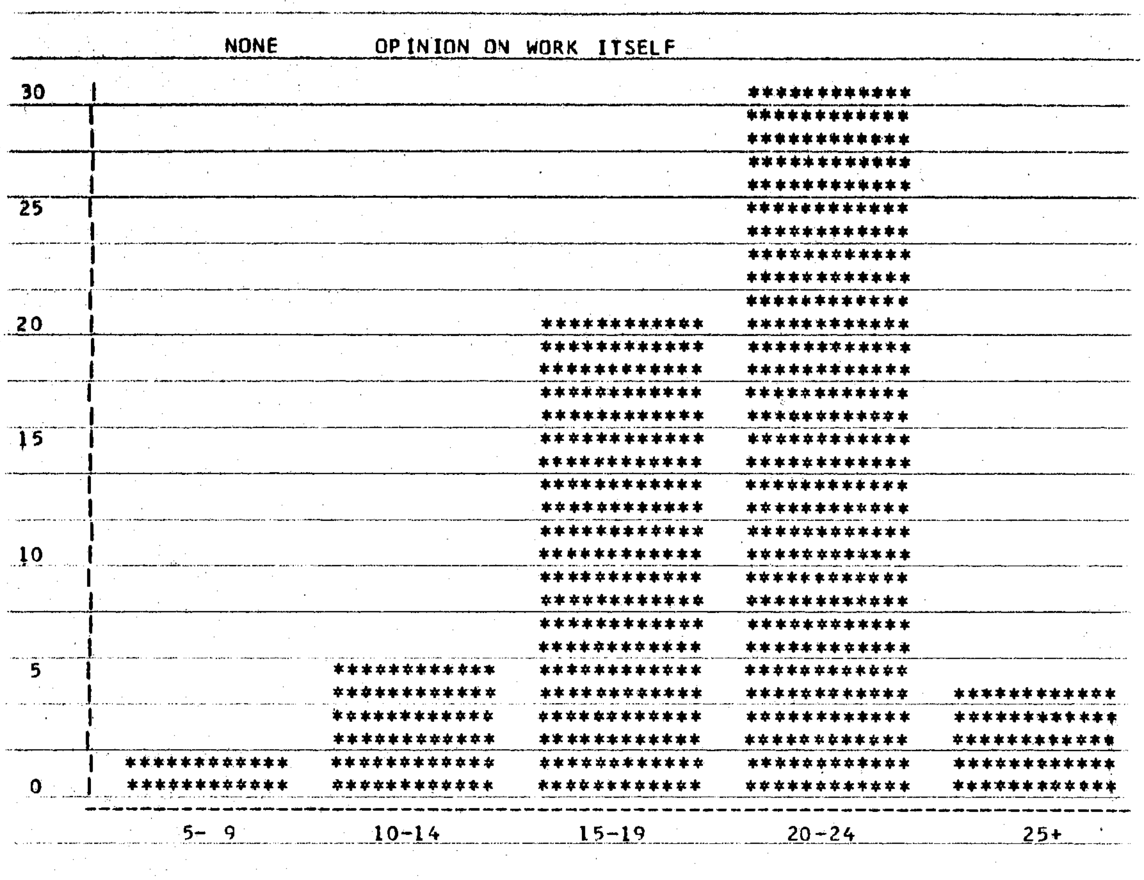
15
10
5
0
5- 9
10-14
15-19
20-24
25+


MEDIAL OPINION ON WORK ITSELF
150
125
100
75
50
25
0
5- 9
10-14
15-19
20-24
25+


NONE
OPINION ON WORK ITSELF
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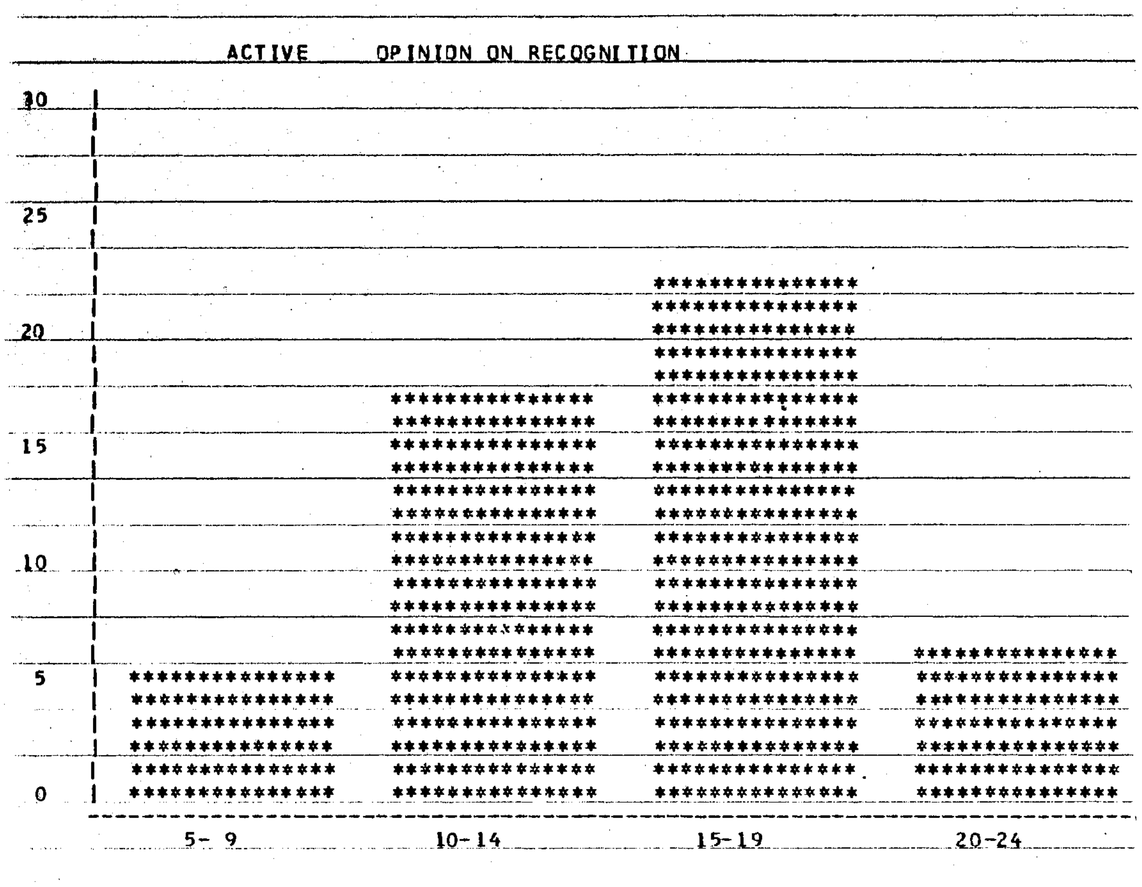
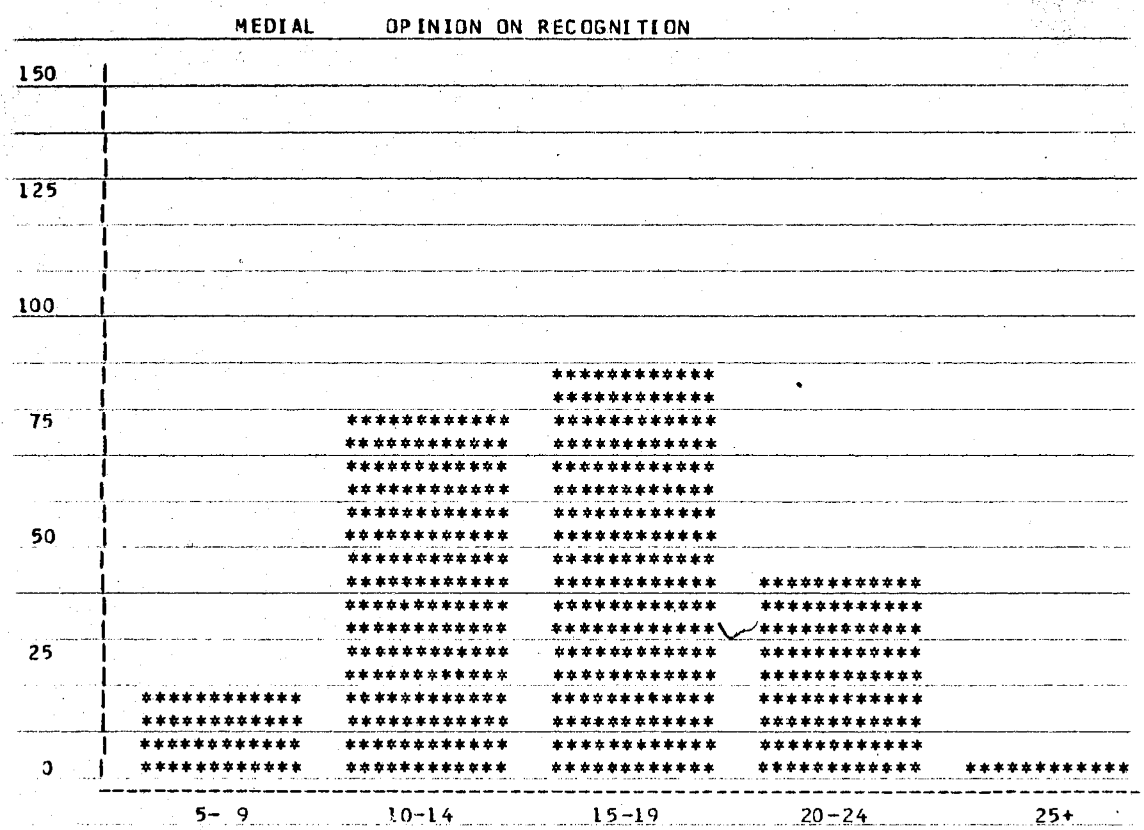
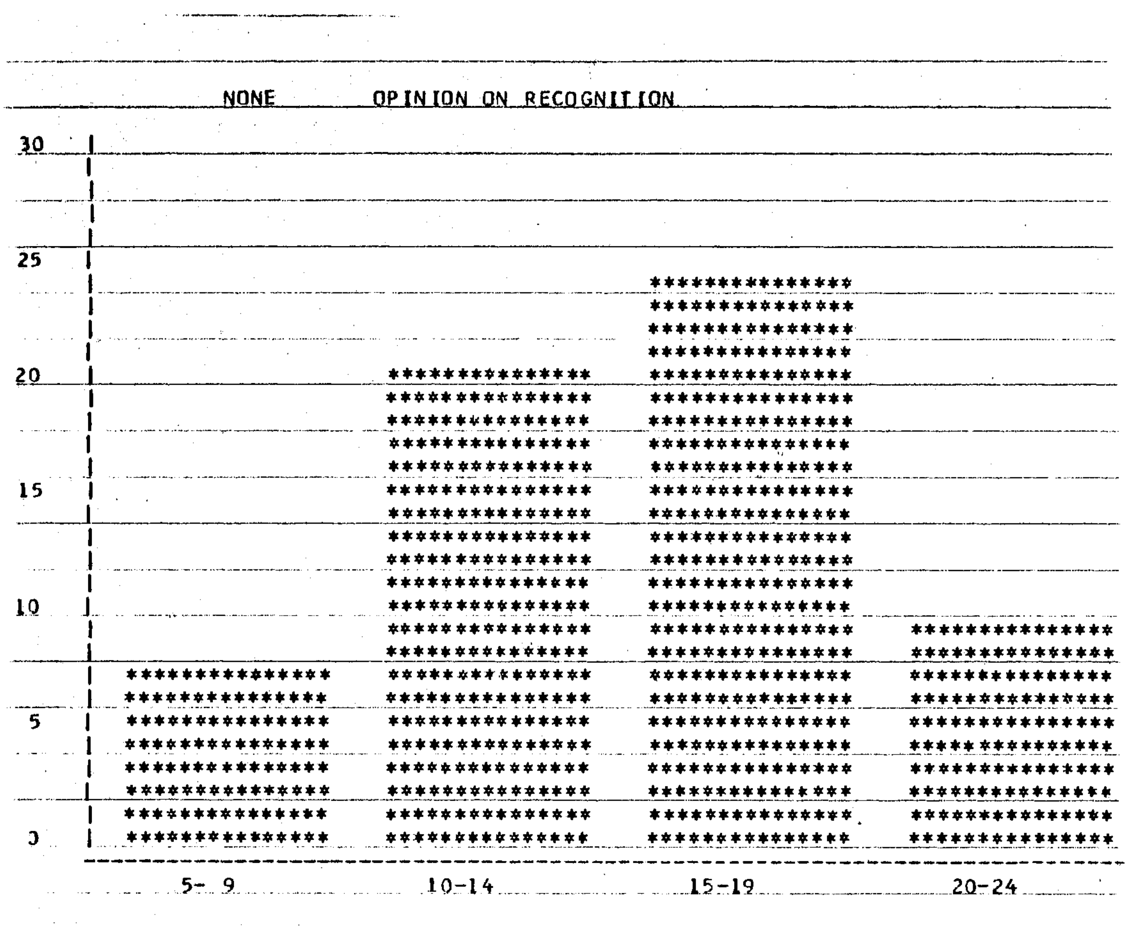
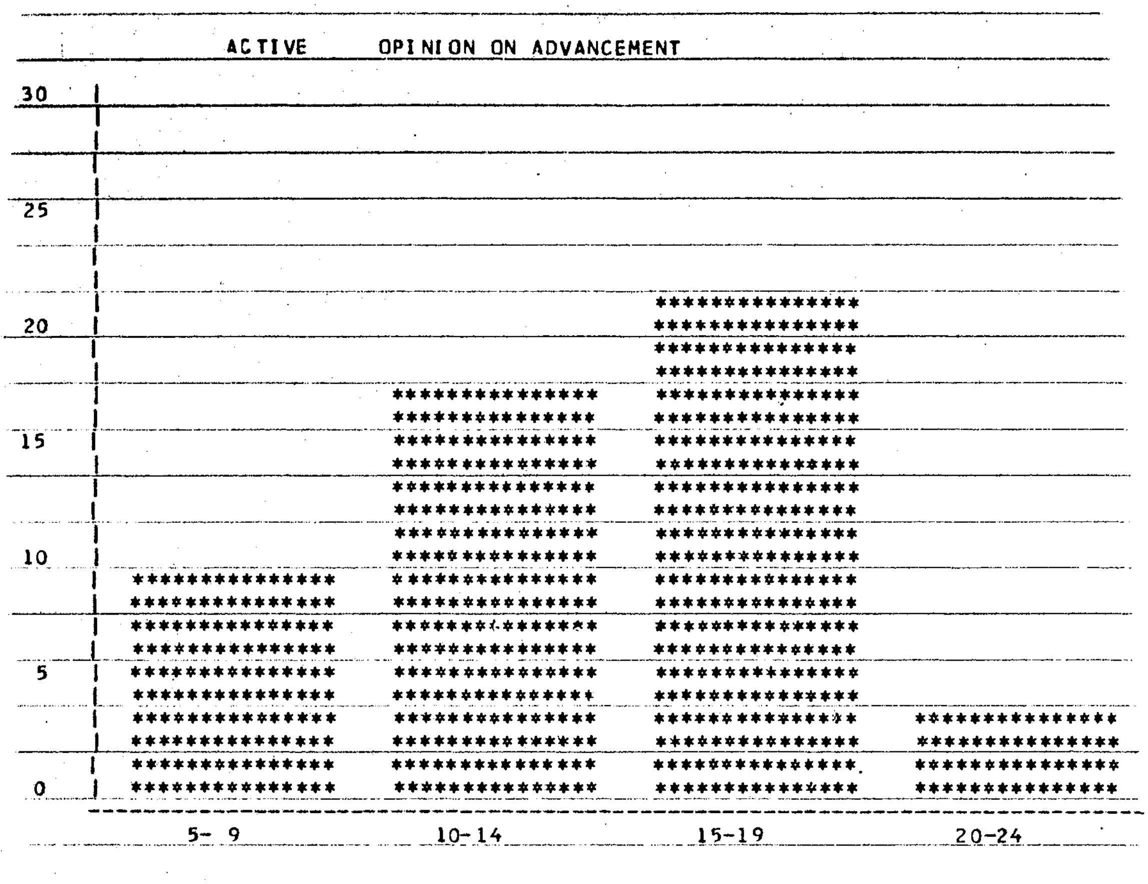
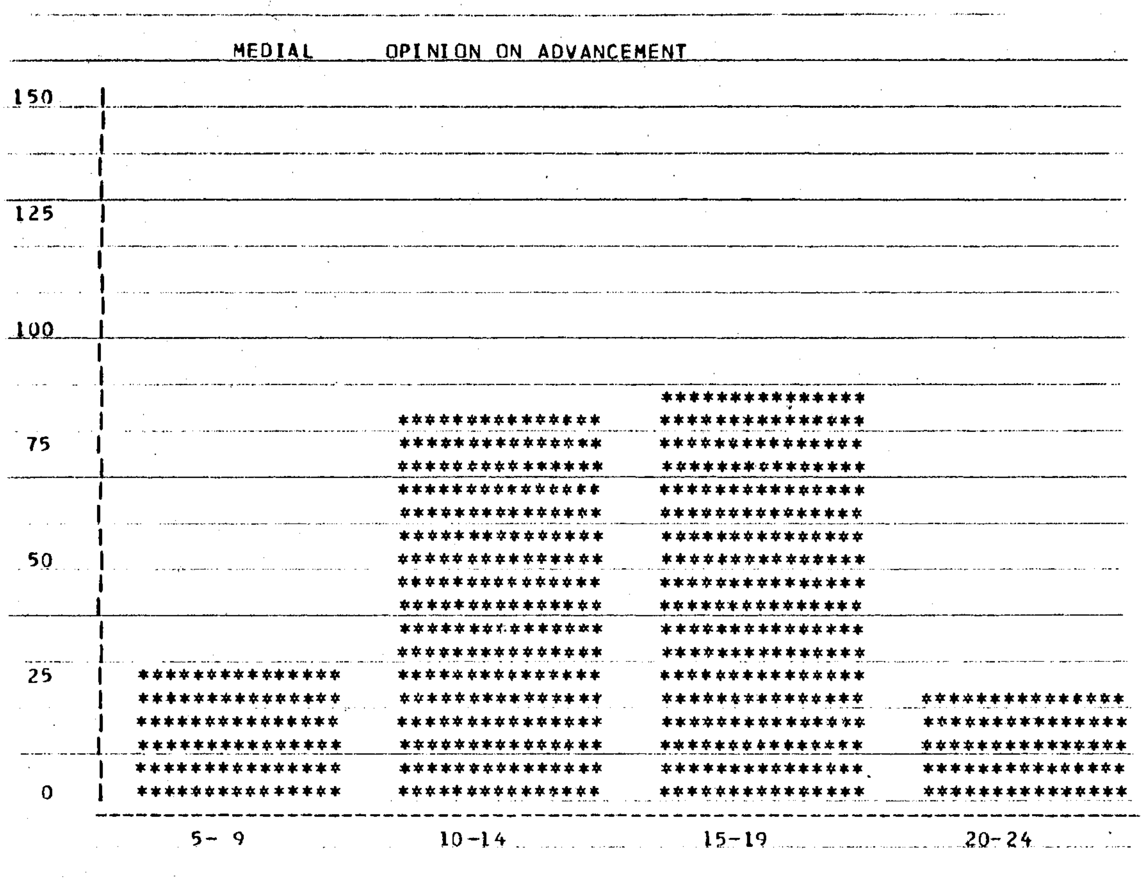
25
20
15
10
5
0
5- 9
10-14
15-19
20-24
25+

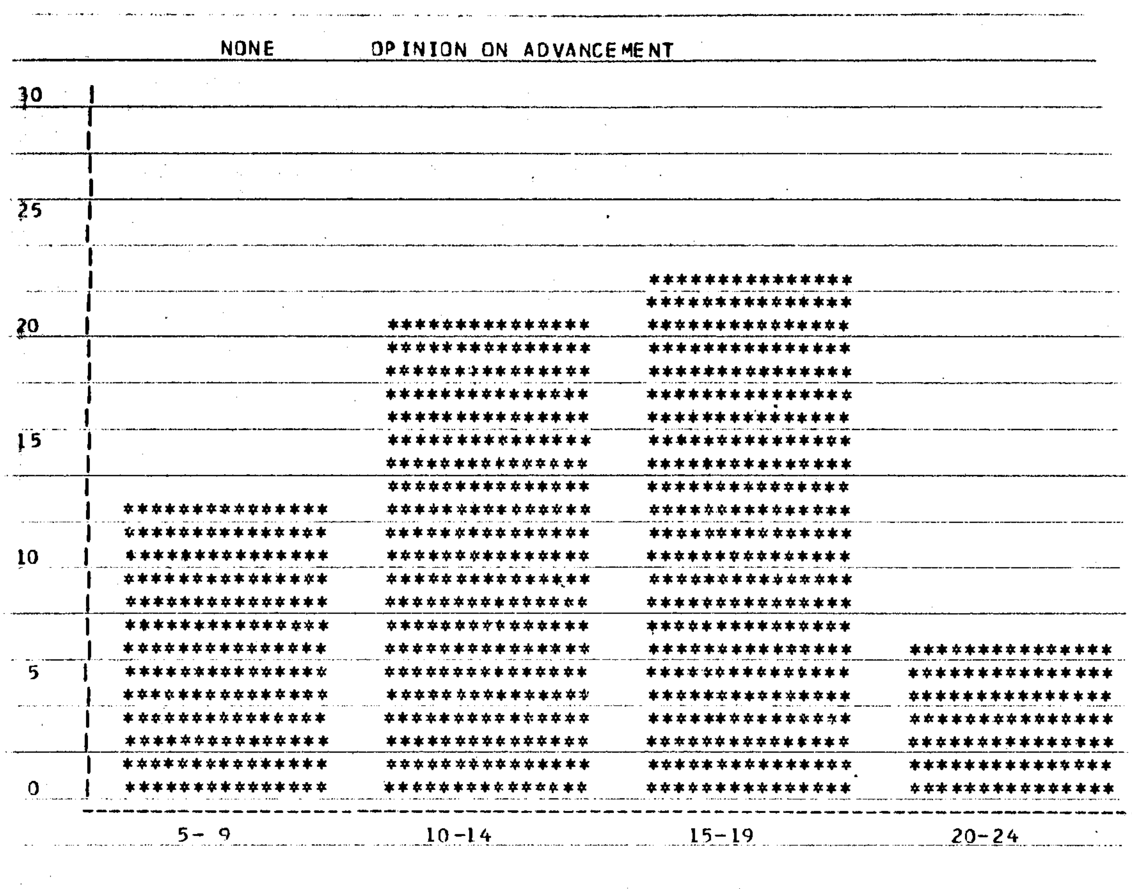

ACTIVE OPINION ON RECOGNITION
30
25
20
15
10
5
0
5- 9
10-14
15-19
20-24


MEDIAL OPINION ON RECOGNITION
150
125
100
75
50
25
0
5- 9
10-14
15-19
20-24
25+


NONE
OPINION ON RECOGNITION
30
25
20
15
10
5
0
5- 9
10-14
15-19
20-24


ACTIVE OPINION ON ADVANCEMENT
30
25
20
15
10
5
0
5- 9
10-14
15-19
20-24


MEDIAL OPINION ON ADVANCEMENT
150
125
100
75
50
25
0
5- 9
10-14
15-19
20-24


NONE
OPINION ON ADVANCEMENT
30
25
20
15
10
5
0
5- 9
10-14
15-19
20-24

APPENDIX F

STEPWISE DISCRIMINANT ANALYSIS

TEST NO. 1

BMD07M - STEPWISE DISCRIMINANT ANALYSIS - REVISED JULY 24, 1969
HEALTH SCIENCES COMPUTING FACILITY, UCLA

MODIFIED FOR TEXAS TECH COMPUTER SERVICES - JANUARY 27, 1969

PROBLEM CODE OVRALL

NUMBER OF VARIABLES 14

NUMBER OF GROUPS 2

NUMBER OF CASES IN EACH GROUP 6 27

VARIABLE FORMAT (8X,F4.1,F3.0,1X,12F2.0)

DATA INPUT FROM LOGICAL TAPE 10

MEANS (THE LAST COLUMN CONTAINS THE GRAND MEANS OVER THE GROUPS USED IN THE ANALYSIS)

VARIABLE	GROUP NONE	SOME	
1	3.56667	3.84815	3.79697
2	118.46666	124.41481	123.33333
3	13.70000	14.40741	14.27879
4	14.80000	15.35185	15.25151
5	19.41666	20.20369	20.06059
6	12.61667	12.80741	12.77273
7	18.89999	19.21481	19.15756
8	13.18333	15.40000	14.99697
9	12.18333	12.85926	12.73636
10	13.66667	14.17037	14.07879
11	12.51667	13.40741	13.24545
12	36.08333	37.09259	36.90909
13	14.25000	79.01851	67.24242
14	14.25000	62.72221	53.90909

STANDARD DEVIATIONS

VARIABLE	GROUP NONE	SOME
1	1.15519	0.95000
2	26.50066	24.60774
3	4.36199	4.09602
4	4.23383	3.98208
5	3.82361	3.25483
6	4.63688	4.44372
7	3.74029	3.05921
8	3.50055	3.92436
9	4.30013	4.10393
10	4.25725	4.11456
11	11.42472	8.35342
12	11.69856	9.06856
13	9.68244	21.99098
14	9.68244	28.95952

WITHIN GROUPS COVARIANCE MATRIX

VARIABLES
1 2 3 4 5 6 7 8 9

VARIABLE									
1	0.98020								
2	-5.15801	622.94263							
3	-0.71980	91.50394	17.18202						
4	-0.70662	85.42297	12.15750	16.22900					
5	-0.44760	53.19244	5.91787	5.95005	11.31811				
6	-0.78616	95.02994	14.05868	12.27335	6.01568	20.01225			
7	-0.67009	55.57729	6.41628	7.70537	7.91967	6.58487	10.19178		
8	-0.33180	64.71233	8.76910	8.03100	4.16279	8.67068	4.16729	14.83457	
9	-0.52440	87.82677	14.00226	11.55041	5.16199	14.32579	5.50681	7.56448	17.13884
10	-0.97158	89.68214	13.00068	11.52676	6.74673	13.08888	7.08561	8.51290	12.57653
11	5.03692	-17.35962	-3.13258	-2.26671	-1.95821	-1.25275	-2.00154	-2.84346	0.29818
12	5.07602	-17.66629	-3.31298	-2.27064	-2.11021	-1.00989	-1.87758	-3.67343	0.59026
13	1.03428	10.81060	1.48007	1.96105	-1.79037	-0.19293	-2.65716	13.50980	0.67058
14	-1.61241	22.47272	-0.44794	4.69932	7.42074	-1.86179	5.25485	10.64396	-2.89414

	VARIABLES 10	11	12	13	14
VARIABLE					
10	17.14449				
11	-4.20236	80.70627			
12	-4.00171	78.81929	92.06328		
13	-2.17023	-25.07787	-22.35176	413.47681	
14	-0.34216	-18.16432	-14.24976	52.91835	704.66187

WITHIN GROUPS CORRELATION MATRIX

	VARIABLES 1	2	3	4	5	6	7	8	9
VARIABLE									
1	1.00000								
2	-0.20874	1.00000							
3	-0.17540	0.88446	1.00000						
4	-0.17717	0.84958	0.72805	1.00000					
5	-0.13438	0.63349	0.42437	0.43902	1.00000				
6	-0.17750	0.85112	0.75816	0.68103	0.39971	1.00000			
7	-0.21201	0.69751	0.48487	0.59913	0.73739	0.46108	1.00000		
8	-0.08701	0.67317	0.54926	0.51759	0.32126	0.50323	0.33892	1.00000	
9	-0.12794	0.84999	0.81596	0.69257	0.37063	0.77354	0.41666	0.47441	1.00000
10	-0.23701	0.86780	0.75747	0.69103	0.48433	0.70663	0.53603	0.53380	0.73368
11	0.56631	-0.07742	-0.08412	-0.06263	-0.06479	-0.03117	-0.06979	-0.08218	0.00802
12	0.53435	-0.07377	-0.08330	-0.05874	-0.06537	-0.02353	-0.06130	-0.09940	0.01486
13	0.05138	0.02130	0.01756	0.02394	-0.02617	-0.00212	-0.04093	0.17250	0.00797
14	-0.06135	0.03392	-0.00407	0.04394	0.08309	-0.01568	0.06201	0.10411	-0.02634

	VARIABLES 10	11	12	13	14
VARIABLE					
10	1.00000				
11	-0.11297	1.00000			
12	-0.10073	0.91440	1.00000		
13	-0.02578	-0.13728	-0.11456	1.00000	
14	-0.00311	-0.07617	-0.05595	0.09804	1.00000

SUBPROBLEM 5
F-LEVEL FOR INCLUSION 0.0100
F-LEVEL FOR DELETION 0.0050
TOLERANCE LEVEL 0.0010
CONTROL VALUES 10111111111111

****

STEP NUMBER 0
VARIABLE ENTERED

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 328

1	3.9677	4	0.9209	6	0.0890	8	16.2601	10	0.7263	12	0.5431	14	163.6838
3	1.4296	5	2.6866	7	0.4774	9	1.3082	11	0.4826	13	498.0552		

****

STEP NUMBER 1
VARIABLE ENTERED 13

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 328

13 498.0552

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 327

1	0.2833	4	0.3714	6	0.0471	8	0.0135	10	0.8070	12	4.3515
3	0.2559	5	1.9578	7	1.0207	9	0.3692	11	5.6992	14	44.9611

U-STATISTIC 0.39707 DEGREES OF FREEDOM 1 1 328
APPROXIMATE F 498.05518 DEGREES OF FREEDOM 1 328.00

F MATRIX - DEGREES OF FREEDOM 1 328

	GROUP NONE
GROUP SOME	498.05493

****

STEP NUMBER 2
VARIABLE ENTERED 14

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 327

13 297.9148 14 44.9611

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 326

1	0.8461	4	0.0	6	0.0905	8	0.2032	10	0.7136	12	5.0136
3	0.2604	5	0.5964	7	0.2811	9	0.5478	11	6.9677		

U-STATISTIC 0.34907 DEGREES OF FREEDOM 2 1 328
APPROXIMATE F 304.88501 DEGREES OF FREEDOM 2 327.00

F MATRIX - DEGREES OF FREEDOM 2 327

	GROUP NONE
GROUP SOME	304.88428

```
**********************************************************************************************************

STEP NUMBER          3
VARIABLE ENTERED  11

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM     1  326

  11   6.9676          13 306.7131          14  46.2612

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM     1  325

   1   0.5363          4   0.0191          6   0.1469          8   0.0920          10   1.3229
   3   0.5230          5   0.8680          7   0.5100          9   0.5065          12   0.1722

U-STATISTIC           0.34177      DEGREES OF FREEDOM    3    1  328
APPROXIMATE F       209.28882      DEGREES OF FREEDOM    3  326.00

F MATRIX - DEGREES OF FREEDOM     3  326

               GROUP
              NONE
GROUP
 SOME     209.28806

**********************************************************************************************************

STEP NUMBER          4
VARIABLE ENTERED  10

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM     1  325

  10   1.3229          11   7.5695          13 306.8242          14  46.0571

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM     1  324

   1   0.2523          4   0.8231          6   0.3706          8   1.2323          12   0.1785
   3   0.0512          5   0.1834          7   0.0139          9   0.0429

U-STATISTIC           0.34038      DEGREES OF FREEDOM    4    1  328
APPROXIMATE F       157.45294      DEGREES OF FREEDOM    4  325.00

F MATRIX - DEGREES OF FREEDOM     4  325

               GROUP
              NONE
GROUP
 SOME     157.45253

**********************************************************************************************************

STEP NUMBER          5
VARIABLE ENTERED   8

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM     1  324

   8   1.2323          10   2.4638          11   7.5925          13 299.2402          14  47.0874

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM     1  323

   1   0.2005          4   0.4429          6   0.1433          9   0.0022
   3   0.0054          5   0.2683          7   0.0438          12   0.2696

U-STATISTIC           0.33939      DEGREES OF FREEDOM    5    1  328
APPROXIMATE F       126.29892      DEGREES OF FREEDOM    5  324.00
```

F MATRIX - DEGREES OF FREEDOM 5 324

GROUP
NONE
GROUP
SOME 126.29865

****

STEP NUMBER 6
VARIABLE ENTERED 4

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 323

4	0.4429	8	0.8506	10	2.7826	11	7.6719	13	297.8865	14	47.2046

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 322

1	0.2364	3	0.1295	5	0.3866	6	0.0250	7	0.2310	9	0.0414	12	0.2646

U-STATISTIC 0.33863 DEGREES OF FREEDOM 6 1 328
APPROXIMATE F 105.14192 DEGREES OF FREEDOM 6 323.00

F MATRIX - DEGREES OF FREEDOM 6 323

GROUP
NONE
GROUP
SOME 105.14182

****

STEP NUMBER 7
VARIABLE ENTERED 5

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 322

4	0.5605	5	0.3866	8	0.8978	10	2.1026	11	7.6855	13	297.6877	14	45.7322

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 321

1	0.2299	3	0.1163	6	0.0318	7	0.0114	9	0.0506	12	0.2524

U-STATISTIC 0.33822 DEGREES OF FREEDOM 7 1 328
APPROXIMATE F 90.00575 DEGREES OF FREEDOM 7 322.00

F MATRIX - DEGREES OF FREEDOM 7 322

GROUP
NONE
GROUP
SOME 90.03563

****

STEP NUMBER 8
VARIABLE ENTERED 12

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 321

4	0.5524	8	0.9706	11	2.5026	13	297.2485
5	0.3741	10	2.1561	12	0.2523	14	45.8060

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 320

1	0.2041	3	0.1112	6	0.0265	7	0.0142	9	0.0581

U-STATISTIC 0.33796 DEGREES OF FREEDOM 8 1 328
APPROXIMATE F 78.60370 DEGREES OF FREEDOM 8 321.00

F MATRIX - DEGREES OF FREEDOM 8 321

	GROUP NONE
GROUP SOME	78.60368

****

STEP NUMBER 9
VARIABLE ENTERED 1

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 320

1	0.2041	5	0.3681	10	1.9430	12	0.2266	14	45.2066
4	0.5873	8	0.9056	11	2.6946	13	290.5376		

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 319

3	0.1134	6	0.0377	7	0.0038	9	0.0566

U-STATISTIC 0.33774 DEGREES OF FREEDOM 9 1 328
APPROXIMATE F 69.71942 DEGREES OF FREEDOM 9 320.00

F MATRIX - DEGREES OF FREEDOM 9 320

	GROUP NONE
GROUP SOME	69.71948

****

STEP NUMBER 10
VARIABLE ENTERED 3

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 319

1	0.2061	4	0.6980	8	0.9892	11	2.6763	13	289.4133
3	0.1135	5	0.3548	10	1.2079	12	0.2210	14	45.1932

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM 1 318

6	0.1166	7	0.0060	9	0.0060

U-STATISTIC 0.33762 DEGREES OF FREEDOM 10 1 328
APPROXIMATE F 62.58508 DEGREES OF FREEDOM 10 319.00

F MATRIX - DEGREES OF FREEDOM 10 319

	GROUP NONE
GROUP SOME	62.58476

****

STEP NUMBER 11
VARIABLE ENTERED 6

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM 1 318

```
 1  0.2289      4  0.5657      6  0.1165     10  1.3100     12  0.2064     14  44.6705
 3  0.1921      5  0.3631      8  0.9215     11  2.6805     13 288.1230

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM   1  317

 7  0.0050      9  0.0389

U-STATISTIC          0.33750    DEGREES OF FREEDOM   11    1  328
APPROXIMATE F       56.74861    DEGREES OF FREEDOM   11  318.00

F MATRIX - DEGREES OF FREEDOM   11  318

          GROUP
          NONE
GROUP
 SOME    56.74825

**********************************************************************************************

STEP NUMBER         12
VARIABLE ENTERED     9

VARIABLES INCLUDED AND F TO REMOVE - DEGREES OF FREEDOM   1  317

 1  0.2305      4  0.5918      6  0.1491      9  0.0389     11  2.6542     13 285.7834
 3  0.0998      5  0.3768      8  0.8926     10  1.1570     12  0.2117     14  44.5725

VARIABLES NOT INCLUDED AND F TO ENTER - DEGREES OF FREEDOM   1  316

 7  0.0086

U-STATISTIC          0.33745    DEGREES OF FREEDOM   12    1  328
APPROXIMATE F       51.86562    DEGREES OF FREEDOM   12  317.00

F MATRIX - DEGREES OF FREEDOM   12  317

          GROUP
          NONE
GROUP
 SOME    51.86531

F LEVEL INSUFFICIENT FOR FURTHER COMPUTATION

         FUNCTION
          NONE          SOME
VARIABLE
  1       4.89252      4.73891
  3       0.18907      0.22785
  4       0.36265      0.28576
  5       1.59940      1.65268
  6      -0.14731     -0.18536
  8       0.48248      0.40355
  9      -0.14018     -0.11647
 10       0.00412      0.11961
 11      -1.63408     -1.51835
 12       1.59112      1.56124
 13      -0.00118      0.15714
 14      -0.00583      0.05431

CONSTANT
        -48.08641    -58.35527

  GROUP WITH          SQUARE OF DISTANCE FROM AND POSTERIOR
 LARGEST PROB.                PROBABILITY FOR GROUP -

 GROUP                  NONE        SOME
```

NONE
CASE

1	NONE	5.688	0.999,	19.730	0.001,
2	NONE	6.175	0.998,	18.757	0.002,
3	NONE	2.487	0.998,	14.887	0.002,
4	NONE	16.723	0.996,	27.541	0.004,
5	NONE	7.001	0.999,	21.770	0.001,
6	NONE	11.397	0.999,	25.649	0.001,
7	NONE	9.881	0.998,	22.315	0.002,
8	NONE	8.111	0.999,	22.190	0.001,
9	NONE	8.421	0.999,	22.184	0.001,
10	NONE	7.694	1.000,	23.523	0.000,
11	NONE	7.736	0.994,	17.953	0.006,
12	NONE	7.556	0.999,	21.272	0.001,
13	NONE	14.036	0.999,	28.736	0.001,
14	NONE	8.183	0.999,	22.715	0.001,
15	NONE	8.600	0.994,	18.744	0.006,
16	NONE	12.995	0.999,	27.096	0.001,
17	NONE	17.558	0.999,	30.898	0.001,
18	NONE	5.240	1.000,	21.272	0.000,
19	NONE	16.877	0.499,	30.891	0.001,
20	NONE	9.213	1.000,	25.170	0.000,
21	NONE	9.405	0.997,	21.152	0.003,
22	NONE	7.463	0.999,	21.877	0.001,
23	NONE	14.254	0.999,	27.739	0.001,
24	NONE	9.064	0.999,	23.391	0.001,
25	NONE	6.028	1.000,	21.684	0.000,
26	NONE	12.092	1.000,	27.371	0.000,
27	NONE	7.794	0.999,	20.934	0.001,
28	NONE	8.974	0.999,	23.722	0.001,
29	NONE	7.283	0.999,	22.440	0.001,
30	NONE	5.890	0.999,	19.639	0.001,
31	NONE	10.381	0.999,	24.950	0.001,
32	NONE	15.873	0.999,	29.719	0.001,
33	NONE	25.853	1.000,	41.803	0.000,
34	NONE	17.888	0.989,	26.979	0.011,
35	NONE	6.183	0.999,	20.716	0.001,
36	NONE	9.809	0.999,	24.320	0.001,
37	NONE	8.296	0.999,	23.402	0.001,
38	NONE	15.975	0.998,	28.416	0.002,
39	NONE	11.214	1.000,	27.383	0.000,
40	NONE	6.910	1.000,	22.775	0.000,
41	NONE	2.885	0.999,	17.054	0.001,
42	NONE	17.510	0.998,	29.965	0.002,
43	NONE	16.004	0.987,	24.608	0.013,
44	NONE	7.478	0.999,	22.397	0.001,
45	NONE	16.601	0.996,	27.625	0.004,
46	NONE	13.493	1.000,	29.474	0.000,
47	NONE	3.648	0.998,	16.117	0.002,
48	NONE	15.094	0.996,	26.145	0.004,
49	NONE	12.310	0.998,	24.767	0.002,
50	NONE	14.106	0.999,	27.751	0.001,
51	NONE	13.157	0.994,	23.522	0.006,
52	SOME	23.669	0.000,	5.392	1.000,
53	NONE	6.344	1.000,	23.356	0.000,
54	NONE	8.267	0.999,	22.695	0.001,
55	NONE	13.453	0.993,	23.362	0.007,
56	NONE	13.106	0.999,	27.544	0.001,
57	NONE	14.162	0.999,	29.269	0.001,
58	NONE	11.324	0.999,	25.521	0.001,
59	NONE	10.420	0.998,	22.606	0.002,
60	NONE	10.653	1.000,	26.205	0.000,

GROUP NONE SOME
SOME
CASE

1	NONE	33.413	0.887,	37.526	0.113,
2	SOME	23.049	0.000,	5.178	1.000,
3	SOME	29.046	0.000,	10.386	1.000,
4	SOME	18.876	0.001,	5.015	0.999,
5	SOME	31.307	0.000,	12.395	1.000,
6	SOME	35.258	0.000,	16.253	1.000,
7	SOME	26.873	0.001,	13.404	0.999,
8	NONE	23.526	0.768,	25.917	0.232,
9	SOME	24.338	0.000,	5.928	1.000,
10	SOME	33.096	0.001,	18.771	0.999,
11	SOME	26.343	0.000,	8.224	1.000,
12	SOME	23.647	0.000,	6.535	1.000,
13	NONE	4.567	0.999,	18.469	0.001,
14	NONE	18.688	0.999,	33.617	0.001,
15	SOME	38.017	0.011,	28.943	0.989,
16	SOME	16.770	0.003,	4.920	0.997,
17	SOME	20.553	0.000,	3.967	1.000,
18	SOME	24.276	0.000,	5.153	1.000,
19	NONE	16.239	0.909,	20.852	0.091,
20	SOME	23.434	0.000,	6.124	1.000,
21	SOME	27.188	0.000,	8.409	1.000,
22	SOME	22.228	0.002,	10.234	0.998,
23	SOME	23.112	0.000,	3.945	1.000,
24	SOME	28.160	0.000,	9.182	1.000,
25	SOME	36.856	0.004,	25.735	0.996,
26	SOME	24.459	0.000,	5.531	1.000,
27	SOME	20.831	0.001,	7.077	0.999,
28	NONE	19.879	0.977,	27.404	0.023,
29	SOME	18.437	0.004,	7.308	0.996,
30	SOME	32.129	0.000,	10.823	1.000,
31	SOME	16.058	0.012,	7.213	0.988,
32	SOME	24.327	0.000,	6.685	1.000,
33	SOME	39.922	0.000,	17.953	1.000,
34	SOME	24.757	0.001,	10.277	0.999,
35	SOME	26.950	0.000,	8.248	1.000,
36	SOME	34.720	0.000,	13.516	1.000,
37	SOME	22.582	0.000,	6.035	1.000,
38	SOME	38.544	0.000,	20.104	1.000,
39	SOME	35.778	0.000,	14.751	1.000,
40	SOME	31.576	0.000,	14.227	1.000,
41	SOME	29.825	0.014,	21.362	0.986,
42	NONE	22.600	0.949,	28.450	0.051,
43	NONE	16.427	0.941,	21.974	0.059,
44	SOME	20.298	0.003,	8.352	0.997,
45	SOME	23.300	0.001,	8.699	0.999,
46	SOME	26.057	0.000,	5.548	1.000,
47	SOME	22.663	0.002,	10.357	0.998,
48	NONE	4.647	0.997,	16.502	0.003,
49	SOME	25.036	0.000,	4.209	1.000,
50	SOME	25.079	0.000,	5.496	1.000,
51	SOME	22.188	0.004,	10.954	0.996,
52	SOME	26.065	0.000,	9.341	1.000,
53	SOME	29.093	0.000,	10.386	1.000,
54	NONE	7.625	0.994,	17.977	0.006,
55	SOME	21.731	0.000,	4.788	1.000,
56	SOME	13.764	0.011,	4.735	0.989,
57	SOME	26.222	0.000,	9.063	1.000,
58	SOME	20.138	0.003,	6.266	0.997,
59	SOME	27.455	0.003,	15.709	0.997,
60	SOME	26.993	0.000,	10.295	1.000,
61	SOME	31.003	0.000,	12.187	1.000,
62	SOME	13.804	0.141,	10.194	.859,
63	SOME	30.403	0.000,	9.444	1.000,
64	SOME	16.802	0.002,	3.983	0.998,
65	SOME	28.416	0.000,	6.666	1.000,
66	NONE	18.786	0.591,	19.522	.409,
67	SOME	20.475	0.001,	7.362	0.999,
68	SOME	29.987	0.000,	11.843	1.000,
69	SOME	18.099	0.017,	10.020	0.983,
70	SOME	24.588	0.000,	7.901	1.000,
71	NONE	22.355	0.859,	25.964	0.141,
72	SOME	19.018	0.004,	6.032	0.996,
73	SOME	38.437	0.000,	20.366	1.000,
74	SOME	25.547	0.900,	6.804	1.000,
75	SOME	26.333	0.000,	8.097	1.000,
76	SOME	28.976	0.000,	7.799	1.000,
77	SOME	20.398	0.009,	10.985	0.991,
78	SOME	22.220	0.000,	5.955	1.000,
79	SOME	28.965	0.000,	10.236	1.000,
80	SOME	22.349	0.004,	11.180	0.996,
81	SOME	30.043	0.000,	13.285	1.000,
82	NONE	14.455	0.903,	18.918	0.097,
83	SOME	25.163	0.001,	10.859	0.999,
84	SOME	27.343	0.016,	19.049	0.984,
85	NONE	12.949	0.808,	15.819	0.192,
86	SOME	28.123	0.001,	13.648	0.999,
87	SOME	39.892	0.000,	24.160	1.000,
88	SOME	21.953	0.002,	9.401	0.998,
89	SOME	23.510	0.013,	14.871	0.987,
90	SOME	30.004	0.000,	10.548	1.000,
91	SOME	29.028	0.000,	12.250	1.000,
92	SOME	36.924	0.104,	32.616	0.896,
93	SOME	27.258	0.003,	15.585	0.997,
94	SOME	22.724	0.009,	13.412	0.991,
95	SOME	24.120	0.003,	12.686	0.997,
96	NONE	13.980	0.997,	25.293	0.003,
97	SOME	16.398	0.280,	14.510	0.720,
98	NONE	16.936	0.819,	19.962	0.181,
99	SOME	25.145	0.004,	14.245	0.996,
100	SOME	25.396	0.012,	16.584	0.988,
101	SOME	21.453	0.000,	4.280	1.000,
102	SOME	21.415	0.001,	6.414	0.999,
103	SOME	27.201	0.000,	8.857	1.000,
104	SOME	38.218	0.000,	21.927	1.000,
105	SOME	15.836	0.010,	6.637	0.990,
106	SOME	29.312	0.000,	10.883	1.000,
107	SOME	25.107	0.000,	8.116	1.000,
108	SOME	36.656	0.000,	14.258	1.000,
109	SOME	23.775	0.000,	5.183	1.000,
110	SOME	28.917	0.000,	10.721	1.000,
111	SOME	27.628	0.000,	6.057	1.000,
112	SOME	23.889	0.000,	6.075	1.000,
113	SOME	26.323	0.000,	8.973	1.000,
114	SOME	27.692	0.001,	13.502	0.999,
115	SOME	26.042	0.000,	7.048	1.000,
116	SOME	25.898	0.000,	6.315	1.000,
117	SOME	27.814	0.000,	10.596	1.000,
118	SOME	30.083	0.000,	10.157	1.000,
119	SOME	33.884	0.000,	13.412	1.000,
120	SOME	19.979	0.000,	3.537	1.000,
121	SOME	27.499	0.007,	17.641	0.993,
122	SOME	28.972	0.000,	11.344	1.000,
123	SOME	28.954	0.002,	16.101	0.998,
124	NONE	17.492	0.935,	22.824	0.065,
125	SOME	26.443	0.000,	8.290	1.000,
126	SOME	25.876	0.000,	6.337	1.000,
127	SOME	22.209	0.000,	4.636	1.000,
128	SOME	27.751	0.001,	12.786	0.999,
129	SOME	22.567	0.000,	4.862	1.000,
130	SOME	26.643	0.000,	11.107	1.000,
131	SOME	17.381	0.011,	8.345	0.989,
132	SOME	24.911	0.000,	6.666	1.000,

133	SOME	20.782	0.004,	9.767	0.996,
134	SOME	31.779	0.000,	11.408	1.000,
135	NONE	7.180	0.997,	18.744	0.003,
136	SOME	21.218	0.000,	5.656	1.000,
137	SOME	25.664	0.000,	9.421	1.000,
138	SOME	28.492	0.000,	8.285	1.000,
139	SOME	27.291	0.000,	6.731	1.000,
140	SOME	27.710	0.000,	8.375	1.000,
141	SOME	28.764	0.000,	9.951	1.000,
142	SOME	30.156	0.004,	18.975	0.996,
143	SOME	22.601	0.000,	4.722	1.000,
144	SOME	40.398	0.000,	18.497	1.000,
145	SOME	20.998	0.000,	2.491	1.000,
146	NONE	7.978	0.988,	16.876	0.012,
147	SOME	24.512	0.000,	6.325	1.000,
148	SOME	32.566	0.000,	14.204	1.000,
149	SOME	25.577	0.000,	8.830	1.000,
150	SOME	24.462	0.000,	5.589	1.000,
151	SOME	40.403	0.013,	31.773	0.987,
152	NONE	27.718	0.839,	31.023	0.161,
153	SOME	33.874	0.000,	15.482	1.000,
154	SOME	41.431	0.000,	26.090	1.000,
155	SOME	26.699	0.001,	13.301	0.999,
156	SOME	30.493	0.014,	21.934	0.986,
157	SOME	32.100	0.000,	10.570	1.000,
158	SOME	18.084	0.002,	5.233	0.998,
159	SOME	17.747	0.008,	8.071	0.992,
160	SOME	26.797	0.000,	8.009	1.000,
161	SOME	26.516	0.000,	9.755	1.000,
162	SOME	30.624	0.000,	13.754	1.000,
163	SOME	26.108	0.000,	8.728	1.000,
164	SOME	26.411	0.000,	10.546	1.000,
165	SOME	21.261	0.001,	7.841	0.999,
166	SOME	20.070	0.042,	13.807	0.958,
167	SOME	23.784	0.000,	5.454	1.000,
168	SOME	24.749	0.000,	7.201	1.000,
169	SOME	29.141	0.000,	10.516	1.000,
170	SOME	24.218	0.000,	5.114	1.000,
171	SOME	28.817	0.000,	10.217	1.000,
172	SOME	24.355	0.000,	8.261	1.000,
173	SOME	27.762	0.000,	7.127	1.000,
174	SOME	27.797	0.000,	10.553	1.000,
175	NONE	22.006	0.966,	28.687	0.034,
176	SOME	43.693	0.000,	26.519	1.000,
177	SOME	27.068	0.000,	9.659	1.000,
178	SOME	32.334	0.000,	16.145	1.000,
179	SOME	34.446	0.001,	19.246	1.000,
180	SOME	45.671	0.000,	27.462	1.000,
181	SOME	21.205	0.000,	4.032	1.000,
182	SOME	21.529	0.003,	9.710	0.997,
183	SOME	26.378	0.000,	10.974	1.000,
184	SOME	24.100	0.012,	15.273	0.988,
185	SOME	42.170	0.000,	24.833	1.000,
186	SOME	23.256	0.000,	7.481	1.000,
187	SOME	19.244	0.000,	3.296	1.000,
188	SOME	17.532	0.002,	4.939	0.998,
189	SOME	26.752	0.001,	11.553	1.000,
190	SOME	31.935	0.000,	14.782	1.000,
191	SOME	39.955	0.000,	20.458	1.000,
192	SOME	21.492	0.000,	5.225	1.000,
193	SOME	29.181	0.003,	17.456	0.997,
194	SOME	37.522	0.000,	21.314	1.000,
195	SOME	24.435	0.002,	12.448	0.998,
196	SOME	23.912	0.000,	5.780	1.000,
197	SOME	18.093	0.002,	5.814	0.998,
198	SOME	22.207	0.001,	8.969	0.999,
199	SOME	17.627	0.015,	9.268	0.985,
200	SOME	33.711	0.000,	14.085	1.000,
201	SOME	17.335	0.006,	7.078	0.994,
202	SOME	29.921	0.000,	10.428	1.000,
203	SOME	28.340	0.000,	10.259	1.000,
204	NONE	16.911	0.964,	23.461	0.036,
205	SOME	20.851	0.001,	5.906	0.999,
206	SOME	37.020	0.000,	19.135	1.000,
207	SOME	17.839	0.028,	10.769	0.972,
208	NONE	5.197	0.999,	18.774	0.001,
209	SOME	27.968	0.000,	8.233	1.000,
210	SOME	12.783	0.020,	4.975	0.980,
211	SOME	23.546	0.000,	6.284	1.000,
212	NONE	62.802	0.566,	63.329	0.434,
213	SOME	30.380	0.002,	17.666	0.998,
214	SOME	26.184	0.000,	5.553	1.000,
215	SOME	24.938	0.001,	10.233	0.999,
216	SOME	17.871	0.007,	8.067	0.993,
217	SOME	18.410	0.007,	8.570	0.993,
218	NONE	13.186	0.939,	18.654	0.061,
219	SOME	19.491	0.003,	8.110	0.997,
220	SOME	18.905	0.012,	10.123	0.988,
221	SOME	27.836	0.000,	10.139	1.000,
222	SOME	31.203	0.000,	13.320	1.000,
223	SOME	25.002	0.000,	6.478	1.000,
224	SOME	26.175	0.007,	16.387	0.993,
225	SOME	32.311	0.001,	18.655	0.999,
226	SOME	17.141	0.004,	6.303	0.996,
227	SOME	17.974	0.015,	9.603	0.985,
228	SOME	19.271	0.002,	6.320	0.998,
229	SOME	35.290	0.000,	13.563	1.000,
230	SOME	19.727	0.005,	9.093	0.995,
231	SOME	31.842	0.000,	14.606	1.000,
232	SOME	28.178	0.000,	7.438	1.000,
233	SOME	22.185	0.001,	7.460	0.999,
234	SOME	25.214	0.001,	11.163	0.999,
235	SOME	25.316	0.000,	9.051	1.000,
236	SOME	29.517	0.000,	11.382	1.000,
237	SOME	22.758	0.000,	3.858	1.000,
238	SOME	27.267	0.000,	10.627	1.000,
239	SOME	21.907	0.000,	5.765	1.000,
240	SOME	26.540	0.020,	18.731	0.980,
241	SOME	18.146	0.003,	6.309	0.997,
242	SOME	31.015	0.000,	14.606	1.000,
243	SOME	43.296	0.000,	20.765	1.000,
244	SOME	27.677	0.000,	8.693	1.000,
245	SOME	16.581	0.023,	9.049	0.977,
246	SOME	24.531	0.000,	4.154	1.000,
247	SOME	18.165	0.017,	10.104	0.983,
248	SOME	10.671	0.107,	6.426	0.893,
249	SOME	23.616	0.009,	14.249	0.991,
250	SOME	25.152	0.003,	13.616	0.997,
251	SOME	26.165	0.000,	7.360	1.000,
252	SOME	13.714	0.184,	10.734	0.816,
253	SOME	12.107	0.164,	8.851	0.836,
254	SOME	29.244	0.001,	14.160	0.999,
255	SOME	24.140	0.000,	6.475	1.000,
256	SOME	31.949	0.000,	14.854	1.000,
257	SOME	20.623	0.002,	8.067	0.998,
258	SOME	19.445	0.016,	11.165	0.984,
259	SOME	15.731	0.004,	4.623	0.996,
260	SOME	39.615	0.000,	20.687	1.000,
261	SOME	26.192	0.000,	8.022	1.000,
262	SOME	23.438	0.005,	12.834	0.995,
263	SOME	27.160	0.041,	20.863	0.959,
264	SOME	18.028	0.007,	7.971	0.993,

265	SOME	21.946	0.002,	9.865	0.998,
266	SOME	20.293	0.189,	17.373	0.811,
267	SOME	22.358	0.002,	9.685	0.998,
268	SOME	33.225	0.000,	14.571	1.000,
269	SOME	40.060	0.000,	23.930	1.000,
270	SOME	17.547	0.002,	5.047	0.998,

	NUMBER OF CASES CLASSIFIED INTO GROUP -	
	NONE	SOME
GROUP		
NONE	59	1
SOME	25	245

VITA

Lee James Phillips, Jr.

Candidate for the Degree of

Doctor of Philosophy

Thesis: DISCRIMINANT FACTORS INFLUENCING PARTICIPATION IN CONTINUING ENGINEERING EDUCATION

Major Field: Engineering

Biographical:

Personal Data: Born in San Antonio, Texas, September 21, 1931, the son of Mr. and Mrs. Lee J. Phillips.

Education: Graduated from Thomas Jefferson High School, San Antonio, Texas, in May, 1949; received the Bachelor of Science degree in Electrical Engineering from Texas A and M University, College Station, Texas, in 1953; enrolled in the graduate program at Texas Tech University, 1966-70; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in May, 1972.

Professional Experience: Field Engineer, Texas Electric Service Company, 1958; Power Sales Engineer, Texas Electric Service Company, 1958-60; Commercial Manager, Texas Electric Service Company, 1960-66; Assistant to the Dean of Engineering, Texas Tech University, 1966-present.