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A STUDY OF RECOMMENDATIONS FOR TECHNICAL EDUCATION CURRICULA.

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DESCRIPTORS- *TECHNICAL EDUCATION, *CURRICULUM RESEARCH, *CORE CURRICULUM, ADMINISTRATIVE PERSONNEL, SUBPROFESSIONALS, *EDUCATIONAL NEEDS, EMPLOYER ATTITUDES, EMPLOYEE ATTITUDES, MANUFACTURING INDUSTRY, ILLINOIS,

THE PRIMARY PURPOSE OF THIS STUDY WAS TO HAVE MANAGEMENT PERSONNEL AND TECHNICIANS IDENTIFY CORES OF SUBJECT MATTER RELATED TO TECHNICIAN JOB PERFORMANCE AND TO DIFFERENTIATE BETWEEN THEIR JUDGMENTS. FIFTY-TWO TECHNICIANS AND 116 MANAGEMENT PERSONNEL IN 52 ILLINOIS FIRMS EMPLOYING 200 OR MORE PERSONS PARTICIPATED. A 99-CARD CURRICULUM DECK, REPRESENTING ESSENTIALLY ALL SUBJECT MATTER AREAS WHICH COULD BE CONSIDERED OF POSSIBLE VALUE AS PREPARATION FOR ANY ONE OF THE VARIOUS TECHNICAL OCCUPATIONS RESPONDED TO IN THE STUDY, WAS SORTED BY EACH RESPONDENT AS RELATED, SOMEWHAT RELATED, OR UNRELATED TO THE TECHNICIAN JOB PERFORMANCE. INTERVIEWS PROVIDED DATA ON THE AGE OF RESPONDENT, EDUCATIONAL BACKGROUND, JOB HISTORY, MANUFACTURING CLASSIFICATION OF THE EMPLOYING FIRM, AND MANAGEMENT-TECHNICIAN WORKING RELATIONSHIP. THE GENERAL CURRICULUM CORE DEFINED BY RESPONDENTS INCLUDED COMMUNICATION SKILLS, TESTING AND INSTRUMENTATION, MATHEMATICS, AND ENGINEERING GRAPHICS. INDIVIDUAL CORES EXTRACTED FROM THE CARD DECK WERE IDENTIFIED FOR ELECTRO-MECHANICAL, MECHANICAL, CHEM-MECHANICAL, CHEMICAL, AND CHEMICAL-FOODS TECHNICIANS. A SURPRISING NUMBER OF TECHNICIAN JOBS SEEMED TO BE HYBRIDS. SUCH HYBRIDIZATION HAS IMPLICATIONS FOR PROGRAMS OF STUDY WHICH MUST PROVIDE SUBJECT MATTER CONSISTENT WITH OCCUPATIONAL REQUIREMENTS. ALTHOUGH TECHNICIANS AND MANAGEMENT DIFFERED IN AGE, EDUCATIONAL ATTAINMENT, AND SALARY, THEIR VIEWS TOWARD 2-YEAR TECHNICAL CURRICULA WERE ESSENTIALLY THE SAME. THE CORE RECOMMENDATIONS, REPRESENTING THE COLLECTIVE VIEWS OF MANAGEMENT AND TECHNICIANS, WERE RECOMMENDED FOR USE AS GUIDELINES IN THE DESIGN AND REFINEMENT OF POST-HIGH SCHOOL TECHNICAL PROGRAMS. (HC)

A STUDY OF RECOMMENDATIONS FOR TECHNICAL EDUCATION CURRICULA

FINAL REPORT OF
PROJECT S-196
U.S.O.E.

Joseph P. Arnold

Purdue University

School of Technology

1965

A STUDY OF RECOMMENDATIONS FOR TECHNICAL EDUCATION CURRICULA

Cooperative Research Project No. S-196

Joseph P. Arnold

Purdue University
Lafayette, Indiana

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Investigator:	Joseph P. Arnold
Institution:	Purdue University Lafayette, Indiana
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BACKGROUND

Established curricular guidelines in technical education are lacking, a situation which has occurred during a time of acknowledged shortages of qualified technical personnel, both in established and in emerging occupational areas. The correspondingly different philosophies, resources, and internal structures of diverse types of institutions are in many cases providing industry essentially with variations of the same product--the technician. Within this varied ideational and organizational framework lies a basic need for recognizing, identifying, and relating the technicians' functions in industry to the curricula which would best assure them of occupational competence.

A great deal of the significance of this study to education lies in the identification of attitudes of technically qualified management personnel toward post high school technical curricula. These respondents (a) have direct responsibility for job performance of the technical personnel, (b) have some technical background themselves, and (c) are assumed to have a higher degree of knowledge and concern for company objectives and policies in comparison with the technicians themselves.

OBJECTIVES

The purposes for which this study was conducted are:

(1) Compare assessments made by management toward technical curricula content with assessments made by technical personnel themselves.

(2) Isolate and analyze selected variables and measure their relationship to curricula recommendations.

(3) Establish and assess degree of relationship between level of authority of management and generality of recommendations for

curricula content.

(4) Identify a core of courses which management agrees is desirable for most post high school technical programs.

(5) Test hypotheses that management will include more kinds of course content in their recommendations compared with recommendations of technicians.

PROCEDURES

The numbered paragraphs in this section separate and describe the major definitions, instruments and procedures which were fundamental to the conduct of the study.

1. Technicians were used as the criterion group of respondents in this study; therefore, a definition was needed which would serve to distinguish them from skilled operators, craftsmen, and other workers, as well as from professional and other semiprofessional occupations. The definition selected appeared to include essentially all the desired types of workers in the manufacturing establishments in the sample. Technician was defined as follows:

> The engineering or scientific technician is usually employed in (1) research, design, or development; (2) production, operation, or control; (3) installation, maintenance, or sales. When serving in the first of these functional categories, he usually follows a course prescribed by a scientist or engineer but (may or) may not work closely under his direction. When active in the third category, he is frequently performing a task that would otherwise have to be done by an engineer.
>
> In executing his function, the scientific or engineering technician is required to use a high degree of rational thinking and to employ post-secondary-school mathematics and principles of physical and natural science. He thereby assumes the more routine engineering functions necessary in a growing technologically based economy. He must effectively communicate scientific

or engineering ideas mathematically, graphically, and linguistically.[1]

Persons who had attained the baccalaureate and who were employed as technicians were excluded from the study as technicians.

2. Management and/or supervisory personnel also were utilized as respondents. Management is defined as describing those employees in positions within three steps of authority above and responsible for the work of at least one technician. Formal company organizational structure was not used as the total pattern for this identification, but rather responsibility for the work of one or more technicians was the prime criterion. Levels of management refers merely to the number of steps of authority removed from a given technician's job.

3. The initial portion of the sample of firms was randomly selected from the universe of manufacturing establishments in Illinois, as listed by the Illinois State Employment Service. 500 firms were so identified for possible participation in Project 2048* (Cooperative Research Branch, U.S.O.E., completed December, 1964). 40 of the larger firms in the 2048 sample were utilized in furnishing respondents for the writer's doctoral dissertation, 39 of which were used in this study (S-196). 13 additional firms from the same universe were added in July, 1965 to produce a total of 52 establishments, each of which employed 200 or more persons, and each of which supplied two, three, or four respondents for this study.

Participation by level of respondent was as follows: 52 technicians, 52 Management one, 46 Management two, and 18 Management three. Of

[1]Proposed by President's Committee on Scientists and Engineers

*The investigator was employed as a research associate on the Project 2048 staff, University of Illinois, Urbana.

the listed numbers, data from 39 of the technician respondents were used in both Projects 2048 and S-196, but the remaining 129 respondents were in no way connected to Project 2048.

The firms identified after July 1, 1965 were selected from product manufacturing classifications which would improve the sample's representativeness to manufacturing firms in Illinois as distributed in census manufacturing classifications.

4. An interview schedule and a curriculum deck were the two instruments utilized in this study. The interview form was closely structured and designed for numerically coded responses. Recorded were: age of respondent, manufacturing classification of employing firm, educational background, information on current job, time with present company, and data which identify each management respondent's working relationship to the technician respondent from the same firm.

Each technician and each management respondent were interviewed and all responses were recorded by the interviewer.

The curriculum deck was comprised of 99 3 x 5 cards which contained essentially all subjects, or course content, which might be considered related to technician job performance. The deck was designed for use in Project 2048 while the investigator of this project was employed on its staff.

Each technician (one from each firm) sorted the deck into three stacks in terms of relatedness to his own job; viz: related, somewhat related, and unrelated. Each management respondent sorted the cards similarly, i.e.: into three stacks of relatedness in terms of the job of the technician in the same firm. Hence, there were as many as four sets of responses to each technician job; (1) those of the technician, (2) those of his direct supervisor, (3) those of a second level of supervision, and (4) those of his department head, chief engineer, or other person whose functions were three steps removed from the technician but who still maintained responsibility for the technician's work. Thus, one technician and one, two, or three management respondents (from each firm) participated. In the remainder of this summary the four levels of respondents will be referred to as T, M_1, M_2, and M_3.

5. Actually two types of data were procured. A rather limited body of descriptive data was obtained which was used primarily to validate the levels structure established for the study. Experimental data were comprised of responses to the curriculum deck; these data were utilized in analyses and/or comparisons of curricular recommendations and for establishment of the cores of recommendations as described in the objectives.

6. A system of job families was established for the classification of respondents in which 46 of the 52 technician jobs in the study had respondents (moving upward only through M_2). Classifications and number of technicians in each are: Electro-Mechanical, 8; Mechanical, 21; Chem-Mechanical, 7; Chemical, 5; and Chemical-Foods, 4. It must be remembered that three respondents (T, M_1 and M_2) contributed data to each job family classification. A total of 45 is indicated because no analysis was performed for the Electrical family; it had only one technician respondent.

7. A general core of curricular recommendations (as contained on the cards) was identified as agreed upon by respondents of all five job families. Individual cores by job family were then identified. Each individual core was intended to contain the more differentiated content for a given job family and was considered as above and in addition to the general core.

Selection of cards for the general core was based on a scoring system of three points for each related response, two for each somewhat related, and one for each unrelated. The mean score for each card was then calculated for each group of respondents (T, M_1, and M_2). If any one of the three groups (across all five job families) rated the card 2.0 or above, the card was included in the general core. A parallel procedure was used for selection of cards for each individual core, but it utilized only those respondents who were concerned with a technician in that job family for which the core was being established. These procedures essentially allowed any group of respondents, T, M_1, or M_2, to identify a card for placement in a core. M_3 respondents were omitted from the core selections because of their limitation to only 18 technician respondents.

8. The .05 significance level was considered as minimal in all portions of the analysis.

One-way analysis of variance was used for multiple comparisons of mean responses for the three levels of respondents (T, M_1 and M_2), the purpose of which was to compare their relative contributions to each of the cores. When significant differences were found, Newman-Keuls procedures were used for establishing which means were significantly different.

Kruskal-Wallis one way analysis of variance was used in several portions of the analysis. Groups of respondents T, M_1, M_2, and M_3 were compared on age, salary, and other characteristics. It was also used for comparisons of management and technician responses to the card sort.

Rank difference correlation was used to assess for relationships between card sort ranks of Project 2048 technicians and each of the four groups of respondents in this study. The ranks assigned to the 99 cards were determined by the frequency of related response given the card by all respondents in each group.

RESULTS

The findings of the study are grouped into three divisions, i.e.: (1) differences between technicians and management, (2) identification of the core programs, and (3) comparisons with Project 2048. They are explained as follows:

(1) Age, educational attainment, salary, time on present job, and time with present company were analyzed for differences among the groups (levels). Application of Kruskal-Wallis one way analysis of variance produced significant values of H ($P < .02$) for the first three variables mentioned. The significant values of H and the consistency of the intervals among the means provide a basis for accepting the means of the groups as different from each other.

(2) Content of the general and individual cores was identified and summarized below:

A. General core (by card numbers)

1. Written and oral communication

17. Use of simple test equipment

52. Algebraic graphing, powers, roots, radicals

53. Metric system and square root, plane and solid geometry

66. ASA standards, use of handbooks, graphical treatment of empirical data

77. Use of measuring equipment to control a system

79. Calibration and use of typical industrial and laboratory instruments

98. Environmental testing of components, parts and products

B. The individual cores were identified and summarized as follows:

Electro-Mechanical - (by card numbers)

3. Numerical control, data processing, interpretation of engineering drawings

4. Thermosetting and thermoplastic materials; films, enamels, paints

8. Analysis and design of basic electronic circuits

12. Coulomb's Law, electrostatics, AC and DC theory

18. Principles of pulse and timing circuits

26. Basic psychology in planning, conducting, and evaluation of conferences and interviews

34. Composition and resolution of forces, Newton's Law, rotational motion, elasticity

35. Metal forming including machining, chemical milling, spinning, explosive forming

37. Metal forming including diecasting, casting, forming, extruding

38. Applied statics and strength of materials

44. (PERT) Selecting and sequencing of specific identifiable events necessary to successful completion of a project

46. Differential calculus

47. Graphical solution of problems involving points, lines, revolutions, intersections

51. Trigonometry

57. Vacuum tube and transistor theory

60. Analytic geometry

61. Sketching forms from observation

63. Machines elements and calculations

65. Preparation of block diagrams, schematics, layouts

67. Projection and graphic representation

70. Ferrous and non-ferrous metal heat treating, composition

71. Circuit theory, video amplifiers, tuned amplifiers

72. Pattern drafting and layout

73. Metal fabrication

75. Use of synchros and synchromechanisms, industrial control circuitry

80. Basic laws and theories of elements, compounds

89. Mechanics of fluids, temperature scales, thermal expansion

Mechanical -

For the sake of brevity cards in this core will be noted only by number if included in the previous core.

Cards 3,35,37,38,44,47,51,61,63,65,67,70,72,73 are listed accordingly (refer to pages eight and nine for content summary). One card of this core was not included previously; it is:

56. Linear, radical and quadratic equations, binomial theorems, complex numbers

Chem-Mechanical -

Cards numbers 3,34,35,37,38,47,51,61,63,67,70,72,80, previously summarized in the Electro-Mechanical core, were identified in this family. Cards included which have not been discussed previously were:

27. Time study and science of management

33. Tension and compression, Hooke's Law

83. Chemical testing of industrial materials and products

85. Carbon compounds, their structures

90. Atoms, single crystals and polycrystalline materials, nature and making of alloys

99. Equations of state, the first and second laws of thermodynamics

Chemical and Chemical-Foods -

Cores were identified for these two job families, but because of the small number of technician jobs to which were responded (n=4, n=5), no description is included in this summary.

(3) This third category of findings revealed that the responses of the technicians, Management one, Management two, and Management

three, all were closely related to the card ranks assigned by the technicians in Project 2048. High correlations ($P < .001$) were obtained between the technician responses of that project and each group in this study. The obtained value of r' was progressively lower for each higher level of management. Direct comparisons of card ranks for each group show isolated differences, but not large enough to affect a decision on the importance of each of the highly ranked cards. Card number one, oral and written communication, was ranked slightly lower by management, but still high in relation to the total deck.

CONCLUSIONS AND IMPLICATIONS

Implications for this study are considered as greatest in the Mechanical family of technician occupations. The analyses, findings and conclusions offered for the remaining four families are considered strongly suggestive of curricular concerns in their respective disciplines, but they may not be generalizeable to the universe of technicians in each of those occupational areas.

The results of the job classifications admittedly lie outside the objectives of this study. However, they are mentioned because of the surprising number of technician jobs which appeared as "hybrids" rather than as Electrical, Mechanical, or Chemical. All except one of the technicians interviewed from within the electrical manufacturing area were classified as Electro-Mechanical rather than as Electrical. If hybrid technical occupations are increasing or changing, the need for systematic identification of the extent and direction of that change is necessary. Programs of study which purport to prepare competent technicians must provide subject matter and skill development in areas which are consistent with occupational requirements.

This study was based on an assumption which at this time is pertinent to mention. It was assumed that management and/or supervisory personnel employed in the participating firms would be both willing and capable of cooperating in supplying the desired judgments as necessary to complete the card sort. This assumption has been verified as correct. There were very few cases observed in which respondents did not willingly work the interviews into their already busy work schedules.

The notion that management and technician respondents would differ measurably in their curricular recommendations has been concluded as untenable. A very close similarity of recommendations among the groups was indicated by the tests, which led instead, to the conclusion that views of the two groups (as tested) were essentially the same. The core recommendations were concluded to represent the collective views of management and technician respondents. These cores are recommended for use as guidelines in the design and refinement of post high school technical programs.

BIBLIOGRAPHY

There are 91 references listed in the final report.

PUBLICATIONS

No publications have resulted from this project.

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CHAPTER I

INTRODUCTION

Setting

Continuing changes in the occupational structure of industry have become a recognized problem center in the educational, business and industrial, and societal scene in the United States. Whether or not educators can or should remain apart from these closely interrelated changes and their implications has long ceased to be a question. The problems arising as a result of occupational trends as they apply to education, employment, and business and industry are assumed by the writer as among the most crucial of our time.

Clark (14) depicts the overall direction in educational trends as an attempt which educational institutions are making to adapt to occupational changes, therefore to the needs of society. The growth and refinement of the service industries, the increasing power and preimenence of the expert, and the effects of extensive, organized research efforts by industry, government, and educational organizations all are used by him as explanations of and factors involved in the observable educational movement toward the vocational. Venn (86) emphasizes that man's relationship to his work has changed because technological progress has resulted in a greater demand for and use of man's cognitive faculties. Hence, educational requirements have become recognized formal job requisites. These two authors appear to complement each other in regard to the interdependence of industry and education.

Technological and other changes in industry have created the need for the technician--a liaison man, a member of an occupational group which has caused a great deal of classification problems for nearly every person who has attempted to study him. Technician work functions are generally acknowledged to be indicative of a level between the professionally trained engineer and the skilled craftsman. However, the technician overlaps into one or the other of professional or skilled job levels to the extent that he may carry the title and many of the job functions of the engineer, or on the other hand may perform in situations which make it no easy task to differentiate him from the tradesman. The technician is not necessarily divorced from the tools and machines of the craftsman, although he is more likely to be skilled in the use of sophisticated instruments and/or calibration devices than is the craftsman and to have a greater depth of knowledge concerning the theoretical implications of their usage.

Brady discussed the close functional relationship between the technician and the engineer (10). Two main characteristics of technicians which he identifies are (1) proficiency in craft and manipulative skills and (2) the employment of scientific and engineering knowledge. Brady stated that some technicians use a high level of mathematics and science and are very difficult to distinguish from the engineer.

Isolation of the technician as a pure entity is further complicated by his engagement in supervisory duties over other technicians or factory personnel. Many of the technicians working in time study, methods, and sales, base their job success on technical knowledge, yet are not so easily recognized as technicians. The definition of technician used in this study is reported and discussed on page 6.

Extensive growth and technological changes have created the need for technicians in the areas of synthetics, plastics, metallurgy, ceramics, optics, and electronics, to name a few. The refinement and application of rocket and space hardware, automatic processing of foods and chemicals, numerically controlled machine tools, development of artificial bone structures from ceramics, and refinement and miniaturization of solid state electrical devices appear in a glimpse of the areas of industrial activity utilizing technicians.

Many factors could be established as contributors to industrial growth and change. The growing popularity of industrial research cannot be ignored. The amount of research conducted by government agencies, large corporations, and private foundations is claimed by the writer as a contributing cause of the increasing utilization of technicians. Argonne National Laboratories, an organization totally engaged in research, employed about 900 in 1965 and expects to hire 300 additional technicians shortly. The U. S. Department of Labor projects a 150 per cent increase in technician demand for the 1960-1970 decade, a projection which leveled only slightly when it was recast to 1975 (78, p. 54).

Problem

The primary purpose of this study was to identify cores of subject matter related to technician job performance based on the judgments of management and technician respondents, and to differentiate between the judgments of both groups.

It is premised by the investigator that the judgments made by respondents of the study would be appropriate for use as a basis for curricular recommendations for two-year post high school technical programs.

A subordinate problem that management curricular recommendations would be more general than the curricular recommendations of the technicians is considered as adequately tested in the investigator's doctoral dissertation (4). The effects of the dissertation on the content of this report are summarized with the objectives in the following section.

Objectives

The objectives of this study are itemized as follows:

(1) Compare assessments made by management toward technical curricular content with assessments made by technicians themselves. This objective is approached through analyses of the data supplied by this study and also by comparisons of the findings of this study with those of Project 2048 (47), from which Project S-196 was developed. The relationship to Project 2048 is explained on page 13.

(2) Isolate and analyze variables (age, time on current job, educational attainment beyond high school) and isolate their relationships to curricular recommendations. This objective was considered adequately tested in the writer's doctoral dissertation, the results of which indicated there are no significant differences as measured (4).

(3) Establish and assess degree of relationship between level of authority of management and generality of recommendations for curricula content. This objective is considered adequately tested in the disserta-

tion (4). No significant differences between or among the different levels were found.

(4) Identify a core of courses which management agrees is desirable for most post high school technical programs. Testing for and attaining this objective was considered the most important objective of this study and was treated accordingly.

(5) Test hypotheses that management will include more kinds of course content in their recommendations compared with recommendations of technicians. This objective is considered satisfied in the dissertation of the writer (4).

Definitions

Decisions were made concerning development and selection of definitions for technician, manufacturing, management personnel, and establishment. These definitions (excepting management) were also used in the Project 2048 study (47)* and all were used in the writer's doctoral dissertation (4).

Technician. A definition was needed which would serve to distinguish technicians from skilled operators, craftsmen, and other workers, as well as from professional and other semiprofessional levels. The definition selected appeared to include essentially all the desired types of workers in the manufacturing establishments in the sample. Technician was defined as follows:

*The investigator was employed as a research associate on the staff of Project 2048, United States Office of Education, Cooperative Research Branch. Detailed explanation of the relationship of Project 2048 to this current study are provided on page 13.

> The engineering or scientific technician is usually employed in (1) research, design, or development; (2) production, operation, or control; (3) installation, maintenance, or sales. When serving in the first of these functional categories, he usually follows a course prescribed by a scientist or engineer but (may or) may not work closely under his direction. When active in the third category, he is frequently performing a task that would otherwise have to be done by an engineer.
>
> In executing his function, the scientific or engineering technician is required to use a high degree of rational thinking and to employ post-secondary-school mathematics and principles of physical and natural science. He thereby assumes the more routine engineering functions necessary in a growing technologically based economy. He must effectively communicate scientific or engineering ideas mathematically, graphically, and linguistically (71, p. 3).

Persons who had attained the baccalaureate and who were employed as technicians were excluded from the study. The primary reason for this action was the assumption that course content to be identified as <u>related</u> by technician respondents would tend to be a function of educational level. Therefore, inclusion of a considerable number of graduates of four-year programs could result in recommendations biased in favor of content which may not necessarily be suitable for the more limited, two-year span of study. Non-utilization of degree personnel as technician participants also facilitated the exclusion of engineers, professional chemists and other personnel not normally considered as technicians, from participation as technicians. The exclusion of four-year degree holders does not apply to management respondents.

<u>Management Personnel</u>. Management in this study refers to employees in positions within three steps of authority above and responsible for the work of the technician. Formal company organizational structure was <u>not</u> used as a criterion for this identification, but rather responsibility for

the work of one or more technicians was the prime criterion. Levels of Management refers merely to the number of steps of authority removed from a given technician's job. Details concerning levels and selection of respondents are presented in Chapter II.

Manufacturing. The necessity for defining this term lies in providing an acceptable basis for identifying the universe of manufacturers from which the sample was selected. The definition is:

> ...the technical or chemical transformation of inorganic or organic substances into new products. The assembly of component parts of products is also considered to be manufacturing if the resulting product is neither a structure nor other fixed improvement. These activities are usually carried on in plants, factories, or mills, which characteristically use power-driven machines, and materials-handling equipment (3, p. 1).

Establishment. This word was defined because of the nature of the population and to avoid confusion with the term company. The Bureau of Census defines establishment as follows:

> An establishment is an economic unit which produces goods or services. For example, a farm, a mine, a factory, a store. In most instances, the establishment is at a single physical location and is engaged in only one or predominantly one type of economic activity for which an industry code is applicable (3, p.12).

Related Literature

The literature reviewed for this study was selected and classified as follows: (1) reports and articles which imply a need for research in the area of post-high-school technical curricula, (2) pertinent studies of current and recommended technical curricula, and (3) assessment of group views as a basis for research approach. The summarization is as follows:

(1) Reports and articles which imply a need for studies in technical curricula --

The 1964 Manpower Report of the United States Department of Labor contains the following statement concerning employment trends and their relationship to industry:

> Electronic data processing, advanced instrumentation, and automatic control, and a great number and variety of other technological developments are having diverse and frequently off-setting effects on employment in many industries and occupations. Their general effects include: (a) a reduction in the relative numbers of unskilled and semi-skilled jobs and of certain routine clerical jobs; (b) an increased demand for maintenance workers in many industries, and higher educational and training requirements for many maintenance positions and other types of skilled work; (c) creation of new, relatively high-level occupations in connection with electronic data processing and other advanced systems; and (d) an expanding demand for scientists and engineers, accompanied by the emergence of new specialties (computer technology, microelectronics, etc.), continual changes in the content of long-established fields, and consequent need for updating of knowledge and skills (77, p. 5).

The preceding paragraph pinpoints the current business and industrial trends as related to the increasing utilization of technicians and reflects the effects of these changes on the total occupational structure. The primary implication of the citation from the Manpower Report for this study is that as the technical occupations continue to develop and further specialize, it will become increasingly difficult to provide up-to-date programs of instruction for them.. Hence, it is assumed advantageous by this writer to recognize and establish areas of curricular agreement and disagreement as evidenced by different groups or levels of workers within participating industrial establishments. The 1965 Manpower Report revises the 1960-1970 projections only slightly for the 1965-1975 period. By 1975 employment of professional and technical workers may increase by well over two fifths (78, p.54).

The diversity of present post-high-school technical programs indicates that few of the present curricula find their bases in established norms. The American Society for Engineering Education states the following in this regard:

> Some technical curricula intend to cover their subject matter at a level close to that of the engineering college, or at least that of the engineering college of a few years ago. Others set their objectives at essentially the same level of difficulty as the secondary school. Between these extremes we find a well-distributed range of objectives and levels. The sole point of agreement, and even that is not unanimous, is that technical education is post-high school. Almost all technical curricula are admittedly after high school, but misunderstanding arises because the term post-high school is chronological rather than indicative of level of difficulty (32, p.13).

(2) Current and recommended curricula--

Perhaps the most comprehensive among recent technical education research efforts is <u>Technical Manpower in New York State</u>, prepared by Pearce and his associates (38). Based on questionnaires to 953 employers (only a part of the total study) the greatest frequency of respondents placed "emphasis on basic education" as first in importance, "emphasis on specialization in the technologies" as second, and "balance between basic education and specialization in the technologies" as third. A quite justifiable criticism of this portion of the study is that selection as a respondent carried only the requirement of being an employer of technicians, which is not necessarily indicative of first hand knowledge of their duties and hence of educational requirements. The recommendations as cited could be of value as guidelines in curriculum design but are not as specific as course and subject area suggestions would be.

A survey of current technical institute course catalogs was reported by Defore (16). Examination of the catalogs revealed the following distribution of content for two-year programs:

Physical Science	18 percent
Mathematics	12 percent
General Studies	18 percent
Technical Specialty	52 percent

Defore's study is an attempt to identify technical curricular norms in several leading technical institutions. Perhaps of value in comparisons of content, the study appears of little help in curriculum design.

Stewart and Workman used Flanagan's critical incidents method to study competencies necessary for technicians (55). This study resulted in the conclusion that most technicians do not require a high level of mathematical and scientific skills. This conclusion appears to conflict with other studies but differences in findings may lie in definitions and selection procedures used in obtaining technicians for the different studies. Conclusions of Stewart and Workman that a high level of mathematical skill is not necessary agree with conclusions of Barlow and Schill (5) and with those of Project 2048 (47).

A suggested core curriculum for junior college and community college technical education was reported by Harris (21). Community colleges and other educational institutions must broaden their curricular offerings for the educational needs of workers. He concluded that establishment of a core curriculum is advantageous, precluding the establishment of a complete program for each technical specialty. Certain minimum attainments were set for all students, regardless of specialty; thus, related science and mathematics are taught with the emphasis on fundamental principles rather than on narrowly conceived training. This investigation is the first of several reported herein to show interest in a core curriculum for technical education.

Bodine's study of Kansas industries attempted to identify the areas of technical skill and knowledge required of highly skilled technicians in selected Kansas employment (8). It was concluded from his analysis that a common core of experiences in related technical information for all technical training programs consists of mathematics, instrument uses and applications, industrial equipment, communication, human relations, and drafting and blueprint reading.

Several studies were reported by the California State Department of Education in which were identified the functions and needs of some kinds of technicians in California (50). The curricular needs of the computer programmers in Orange County were concluded to be basic electronics, computer circuitry, and mathematics through plane trigonometry and vector analysis.

Oakland City College reported a study in the above cited State of California publication that supported the findings of the Orange County study. In the Oakland study, it was concluded that a two-year program should not attempt to go beyond fundamentals, stressing functional principles and practices and use of test equipment. The main conclusion in this study was that a single program for the various kinds of electronics technicians is enough because all the electronics technician jobs are closely related.

A subjective study of technical education by Wood in California resulted in recommendations for technical curricula which included (a) content should be based on job requirements, (b) depth and scope of mathematics and science must be tailored to fit occupational needs, and (c) balance must exist between class and laboratory work; between technical and non-technical work (90).

(3) Assessment of group views as a basis for research approach--

Project 2048 (47) was undertaken to establish an empirical basis on which more accurate decisions concerning curricular content in technical education can be made prior to the institution of two year post high school technical programs. Data were collected through use of a highly structured personal interview and a card-sort technique. Of 500 randomly selected industrial establishments in the sample, 113 co-operated, providing a total of 348 technician respondents.

A common core of subject matter was found to exist among the technicians from the various technologies represented. The respondents were separated by job function into the following areas for analysis: Electronic, Electro-mechanical, Mechanical, Chem-mechanical, Chemical, and Electro-chemical. A summarization of subject areas found to be common to the six areas of technology were: (1) technical and scientific oral and written communication, (2) engineering graphics, (3) mathematics--only through algebra and trigonometry, (4) use of testing and measuring equipment, and (5) environmental testing.

It was concluded from the above findings that about thirty-seven courses from the above five subject areas could be considered common to all areas of technology; therefore, each and every technical area of study does not require a complete, unique curriculum.

Project 2048 bears a parallel relationship to this study which is explained as follows:

(1) The writer of this report was employed as a research associate on Project 2048, thus affording opportunity to become cognizant of and to develop the problem herein.

(2) This study and Project 2048 assumed contrasting positions in the selection of respondents. Whereas the management study utilized management viewpoints for the identification of subject areas functionally related to technician job performance, Project 2048 utilized the technicians themselves.

(3) Thirty-nine of the manufacturing establishments which participated in Project 2048 were utilized in providing data for this report. An additional twenty firms were identified and contacted for enlargement of the management study sample. Thirteen of these firms employed technicians and qualified supervisory personnel, and participated, thus enlarging the sample to fifty-two. (Identification procedures are discussed in Chapter II.) However, none of the management respondents in this study (S-196) participated as respondents in Project 2048.

(4) The curriculum deck developed for use in Project 2048 was used in the management study. See explanation on page 35 and Appendix A.

The doctoral thesis of the writer (4) provided the significant initial motivation for this study. Personal and occupational data and technical curricular recommendations were procured via personal interviews with supervisory technical personnel in forty of the firms which participated in Project 2048. The data were procured in a manner similar to the procedures and instrumentation used in Project 2048. However, the thesis problem was limited to a comparison of curricular assessments of technicians with those of management on the criterion of generality. It was not within the scope of the thesis to identify the core of curricular content as is central to this study. The hypothesis that the higher the level of management with respect to the technician, the more general would be the curricular recommendations, was found to be untenable, and therefore was not pursued in the analysis for this report.

The Vermilion County (Illinois) Technician Need Study revealed differences in viewpoint between technicians and employers (34, p.58). In a ranking of subject areas in order of importance to the job, a group of mechanical technicians and their employers ranked items differently, the most prominent difference being that knowledge of mathematics is considered more important by the technicians than by the employers.

Marks conducted a study which utilized company management opinions as a guide to the development of a junior and senior year program designed to expand Purdue University's two year technology programs to baccalaureate level (30). A control group was selected and executives cooperated in "brainstorming" orientation sessions prior to completing a questionnaire on curricular opinions. Each member of a larger group of company officials was requested to respond to the same questionnaire without the benefit of an orientation session. Mathematics through calculus, written and oral communication, and knowledge of production processes were concluded as the most important educational objectives for the proposed programs.

A study utilizing management viewpoints was conducted by the Manufacturing Chemists' Association, in which it was established that two-thirds of the employers (respondents who are members of the organization) prefer or require chemical technicians with a high school education plus one or two years of college (43). About 80 percent of the management respondents favored a formal two-year college level program over an in-service training program. This study indicated that management personnel in the chemical industries were decisive in their favor of post-high-school technical programs.

Benson and Lohnes studied the relationship between productivity and education through assessments made by members of industrial management (6). They found that those industrial establishments affected in their major processes by a rapidly changing technology would be expected to have a different occupational structure from those not so affected. In particular, the scientifically oriented plants were more likely to have a higher proportion of technicians in their structure. Accordingly, the authors established a physical science process group, comprised of technicians and other supporting scientific personnel in plants concerned with chemical processes, application of electrical theory, and instrumentation. Management respondents in companies within the physical science process group showed a strong preference for academic subjects in high school for the technicians. Mathematics was considered most important by these management representatives for the technical group.

An important difference between the Benson and Lohnes study and this research lies in the use of production and personnel managers for respondents in the former study, while the sample in this study makes use of chief engineers, technical directors, and other technically oriented members of the management team. Use of the latter kinds of management personnel is likely to include respondents who are qualified to assess the relationship of curricular choices to the job functions of the technicians. The use of production and personnel managers in the Benson and Lohnes study (6) constitutes the utilization of personnel who were unfamiliar with the technicalities of the job functions of the technicians, a criticism previously offered in discussion of _Technical Manpower in New York State_ (38). This observation is based on an assumption that it is seldom necessary for a personnel manager to possess depth in a technical area.

Rationale

Initial interviews with management personnel of many firms in the Project 2048 sample indicated strong interest in the kinds of curricula available to their technical employees, both for the purposes of ongoing maintenance and improvement of job skills and as job prerequisites. These interviews were the genesis of the research ideas reported herein. When approached on participation in the Project 2048 study (47), a common reaction from management was "Don't you want our comments as well as those of our technical personnel?" It was subsequently decided that the attitudes of management personnel toward technical curricula may be advantageously explored.

It is assumed by the investigator that the overall reason for initiation of post-high-school technical programs is to better adapt our youth to the current and future job requirements. It is industry then which is doing the leading, and any success the educational planners may have at producing employable personnel is contingent upon satisfying the personnel needs of the management herein used as respondents, for it is they who do the hiring. Hence, it was reasoned that many supervisory personnel are in key positions to know what industry needs and desires in technical competencies. Detailed criteria used for the selection of respondents are explained in Chapter II.

Several groups within our society have previously been cited as occupying positions which support their concern and authority in the many technical curricular areas. Within this context Stanley discussed the makeup and role of groups in our society, saying that marked differentiation of labor has meant that men, in their working hours at least, live differently from each other; consequently, they think differently (53, p. 7). Some of these organized groups have their roots deep in the social structure itself, i.e., occupational and professional organizations based upon the functional relationships of different groups to the economic processes of society. Also claimed is that these organized associations occupy a much more significant place in twentieth century America than they did years ago.

Although Stanley's discussion pertains to organized, special interest groups, the writer of this report claims a similar communality of purpose among management personnel as a group. Corporate management exhibits this described tendency in its nearly exclusive formation of the membership of certain of the professional and occupational associations. It is not unreasonable to assume, then, that management respondents from a variety of manufacturing establishments would be likely to show communality of views toward curricula which are different from the views of technician respondents.

Four groups interested in technical education are: (1) university, technical institute, and college staff members, (2) labor union educational specialists, (3) management and/or supervisory personnel of companies which employ technicians, and (4) technicians themselves. If these groups are assumed to fit in Stanley's vein, all should be given a say in technical curriculum matters. In this regard, he states, "Members of these groups typically conceive their purposes, not in terms of private advantage, but in terms of their conceptions of the common weal" (53, p. 8). The four groups, as those concerned with technical curricula, all qualify as definite segments of society, while simultaneously appearing to have unique qualifications for making technical curricular decisions. The opportunity for different groups to be represented in educational planning is evidenced in the structure of the Vocational Education Act of 1963 and other acts.

Government officials and others in positions to make nominations for advisory committees undoubtedly realize that a company president would be likely to have different ideas on certain issues than would, say, a labor representative. However, it may not be readily noticeable that membership in a given group may suggest a controlling influence on curricular choices. The issue suggested is whether or not nominations for advisory committees, boards of education, and curriculum committees should be made with consideration of the potential member's job level and function as well as the usual framework for selection.

There are divergent opinions available on curricular problems in most areas of American education, and there is no reason to assume the situation is different for education which prepares for the technical areas of work. Because of the comprehensive nature of, and the currently rapid pace of changes in industry, it might be claimed that more conflict of viewpoint is likely to exist as compared with education in more stable areas. Whyte pointed out this conflict of viewpoint in The Organization Man in the following excerpt:

> ...Lately, leaders of U.S. business have been complaining that there are nowhere near enough 'generalists.' The average management man, they have been declaring, has been far too narrowly educated. One company...feels so strongly on this it has been detaching some of its most promising middle-management men to the University of Pennsylvania for a year of special study in the humanities. But this, executives concede, is a stop-gap measure: it is the kind of education a trainee should have gotten in the first place. Give us the well-rounded man, business leaders are saying to the colleges, the man steeped in fundamentals; we will give him the specialized knowledge he needs (91, p.101).

CHAPTER II

METHODOLOGY AND INSTRUMENTS

In this chapter is presented a description of the procedures and instrumentation which were utilized in the design and conduct of the study.

General Methodology

Prior to separating the techniques and instrumentation into parcels for explanation, the reader will be helped by the presentation of an overview of the total design. A detailed procedural breakdown follows within the chapter.

To this point it has been mentioned that respondents were selected from among management personnel and from among technicians in several Illinois firms. One technician and as many as three management respondents of a given firm were asked to respond to the research procedures in terms of the job of the technician from that firm.

A card sorting procedure was completed by each respondent during each data collection interview. Via the card sort, respondents identified subject areas which they considered related to technician job performance by making selections from the deck containing course descriptions of essentially all subject areas of possible need. Each technician and each management respondent sorted the 99 card deck into related, somewhat related, and unrelated stacks, based on the respondent's knowledge of the job function of the technician job to which he was responding. The card sorting procedure, the design of the deck, and its content are explained on page 35.

Data were recorded numerically on the interview form (Appendix B) and later punched into IBM cards to facilitate analysis by computer.

Identifying the Universe and the Sample

The universe of manufacturing firms for the study was as supplied by the Illinois Employment Security Division of the Illinois Department of Labor. The use of that department's list of manufacturers had several advantages for use in this study, among which are: (1) it was listed on IBM cards and (2) it was separated by establishment rather than by company.

It is required by law that companies with four or more employees in Illinois within each of twenty or more different calendar weeks in any calendar year are required to register with and pay contributions to the Department of Unemployment Compensation (1, p. 5). This law establishes the population utilized as inclusive of essentially all manufacturing establishments in Illinois.

Manufacturing Classifications. U. S. Census classifications contained in the population of manufacturers in Illinois are as follows:

TABLE I

MANUFACTURING CLASSIFICATIONS

Classification		No. in Revised Sample
(20)	food and kindred products	4
(21)	tobacco manufacturers	0
(22)	textile mill products	0

TABLE I (continued)

Classification		No. in Revised Sample
(23)	apparel and other finished products made from fabrics and similar materials	0
(24)	lumber and wood products except furniture	0
(25)	furniture and fixtures	2
(26)	paper and applied products	2
(27)	printing, publishing, and allied industries	1
(28)	chemical and allied products	5
(29)	petroleum refining and allied industries	0
(30)	rubber and miscellaneous plastic products	0
(31)	leather and leather products	0
(32)	stone, clay and glass products	1
(33)	primary metal industries	12
(34)	fabricated metal products except ordinance machinery and transportation equipment	6
(35)	machinery except for electrical	11
(36)	electrical machinery, equipment and supplies	7
(37)	professional, scientific and controlling instruments, photographic, optical, watches and clocks	0
(38)	transportation equipment	0
(39)	miscellaneous manufacturing industries	1
	Total	52

The census classifications provide a breakdown of the kinds of establishments utilized in the study. It should be noted that the classifications as numbered are consistent with those used by the Illinois Employment Service as established in the Standard Industrial Classification Manual (18).

Observation of Table I reveals the number of participating firms as distributed by manufacturing classification. The term revised sample is explained in subsequent paragraphs which delineate the procedures involved in identifying and confirming participating establishments for this study and for two research efforts which are basic to this project.

The Sample. There are three different but related samples and/or segments of the S-196 sample associated with this project, an explanation of which is enumerated as follows:

(a) Project 2048 - random identification of 500 manufacturing firms in Illinois in which to locate technicians for participation in that study.

(b) Dissertation - Selection of the largest (200 employees and over) firms from the Project 2048 sample for the management study basic to the dissertation; forty establishments cooperated. Dissertation data from thirty nine of these forty firms were utilized in the S-196 study, therefore are included in the figures in Table I.

(c) Project S-196 - this final report is descriptive of analyses performed on data from the thirty-nine "dissertation" firms (and their respondents) plus an additional thirteen firms which were identified and participated independently of the sample of firms discussed under (a) and (b). Table IV shows the number of respondents interviewed from the additional thirteen firms.

The original sample of manufacturing firms (for Project 2048) was selected from the listed total of 14,764 manufacturing establishments in Illinois, including 6,899 which employ 20 or more persons.* Companies with fewer than twenty employees were excluded from the sample in order to maximize the probability of locating technical personnel. It was assumed at the time of sample selection and was borne out in later preliminary interviews that companies this small would be unlikely to employ an adequate number of technicians to make them practicable for

*The listing used was for the fourth quarter of 1962, Illinois State Employment Service, Employment Security Administration, Illinois Department of Labor, 165 North Canal Street, Chicago, Illinois. On June 4, 1964, this list was updated to use the employment figures of the third quarter of 1963.

inclusion in Project 2048 (47).

To obtain the random sample of 500 companies for Project 2048, an alphabetized listing was used by selecting a random starting point and every thirteenth card thereafter. The identification of these establishments constituted the sample of manufacturing establishments for that project and ultimately provided the source from which the management sample for the dissertation and a portion of the firms which furnished respondents for this research.

Initial personal conferences with management representatives of all of the 500 establishments resulted in judgments by Project 2048 staff that 118 of these 500 companies employed technicians or technical workers consistent with the definition of technician (see page 6). It is from these 118 companies confirmed as employing technical personnel that the larger firms (employing 200 or more persons) were selected for possible participation in the management study for the dissertation and ultimately for this study. An establishment was confirmed on the basis of its employment of one or more technicians.

Firms employing 200 or more persons were chosen for the dissertation because it appeared more likely for company structure to contain the three desired levels of technical supervision (see page 30). A further reason is that the technical personnel of small companies were usually found performing a multiplicity of functions which made classification difficult. Their concerns often included sales, supervision, bookkeeping, and purchasing, as well as duties more closely related to the technical activities. This apparently overlapping, less specialized function of the technicians in the smaller firms was an important factor in the decision to omit these establishments from the sample.

The expansion of the sample as deemed necessary for the analyses to be completed in Project S-196 was completed from the Illinois Directory of Manufacturers (23), which lists a variety of company information indexed by geographic area within the state. The inclusions in this directory are consistent with the previous selection of Illinois manufacturers as supplied by the Illinois State Employment Service; therefore, the expanded sample is part of the previously discussed universe of Illinois manufacturing industries.

Twenty-two firms were initially identified from the directory and were chosen on the basis of product manufacturing classification and minimum number of employees listed as equal to or in excess of 200. Because of the relatively few firms to be identified and contacted, it was considered unnecessary to attempt selection from all areas of the state; the expanded sample is not claimed to be geographically representative of all areas of the state.

Efforts were made to select the firms to be added for the revised sample on a ratio system designed to yield a distribution of establishments (throughout the manufacturing classifications) which would closely parallel the distribution of participating technicians in Project 2048. The intent of this procedure was to produce a sample of firms for Project S-196 which would be representative of the Project 2048 sample of technicians. Therefore, the analyses and findings of the two studies would be more appropriately comparable.

The formula utilized as a guide in the identification of establishments for initial contact is:

$$\frac{\text{No. of technicians interviewed in a manufacturing classification (project 2048)}}{348} = \frac{A - B}{113}$$

A = total No. of firms desired

B = firms from which respondents had already supplied data for dissertation.

A − B = No. of firms desired for addition to sample (in each mfg. category)

348 = total No. of technicians interviewed in Project 2048.

113 = total No. of firms supplying technicians for Project 2048.

The above formula guided the selection of firms for the sample of this study. However, limitations imposed by company organizational structure played a major role in precluding identification and cooperation of precisely the number of firms in the categories as planned. Nine of the firms which were initially contacted lacked the technicians or the appropriate management structure. Table II is offered for visualization of the similarities of the two samples.

Although some differences are noticeable through inspection of Table II, strong similarities between the two samples are apparent in the majority of the manufacturing categories.

Limitations of the Sample. It was stated previously that the sample of manufacturers was representative of essentially all manufacturing establishments in Illinois employing twenty or more persons. By selecting management respondents only from companies which employ 200 or more persons the S-196 sample cannot be referred to as random. However, the selection of only the larger companies does not preclude generalization to establishments employing 200 or more persons, subject to the considerations in the succeeding paragraph.

TABLE II

VISUAL COMPARISON OF S-196 AND PROJECT 2048 SAMPLES
OF FIRMS BY MANUFACTURING CLASSIFICATIONS

Mfg. Category	2048 # of firms employing technicians	S-196 participating firms
20	6	4
21	0	0
22	1	0
23	0	0
24	1	0
25	3	2
26	6	2
27	3	1
28	11	5
29	1	0
30	3	0
31	1	0
32	2	1
33	13	12
34	20	6
35	19	11
36	17	7
37	0	0
38	5	0
39	6	1
	118	52

Chi square was not utilized because of low expected frequencies.

Review of Table I shows that five of the census manufacturing classifications contain forty-one of the fifty-two participating plants and that nine of the classifications were not represented by a single establishment. However, Schill reports the unrepresented classifications in Project 2048 as employing a relatively small percentage of the technicians in Illinois manufacturing (47). There are many firms in the state which fall within the unrepresented classifications; therefore, it is acknowledged that the area of manufacturing should be considered in any generalizations made from the study.

Chi square analyses to determine the representativeness of the sample in terms of the population of Illinois manufacturing industries were decided as inappropriate because of the tendency of the larger firms to cluster in Chicago and other metropolitan areas and because of the relatively small sample of establishments to be utilized in this study. The apparent non-uniformity of employment of technicians from one industry to another was the main consideration in the decision against use of Chi square. However, a Chi square analysis reported by Schill and Arnold to assess the representativeness of the Project 2048 sample (500 firms) supported the assumption that the Project 2048 sample of firms was sufficiently representative of the population of Illinois manufacturing industries so as to make generalization of conclusions to a statewide basis highly tenable (46 , p.13).

The personnel managers, vice-presidents, plant managers and other cooperating company officials obviously were able to exercise some control over whom research staff were allowed to interview. This situation held to a considerable extent both for the technicians and for the management respondents. Attempts to randomize the choice of respondents were successful in some companies by having the company officials prepare a list of all the technicians employed in the plant, to be used by research staff for a random selection of technician respondents and ultimately to be used as a starting point in choice of management respondents. Management respondent selection usually involved less choice than technician selection because possible participants quite often were away from the plant for various reasons and few of the manufacturing firms possessed more than one or two possible lines of authority which fit the structure imposed by the study.

Limitation of the study to the sample of manufacturers excludes the public utilities, nonprofit organizations and the military. This intentional limit to the scope of the study was considered a natural dividing point and also was influenced by available time and financial resources.

Identifying and Selecting Respondents

The Identified Technician. First, the technicians were identified for Project 2048; then management personnel for the dissertation, the raw data from which has been basic to this project. Following selection of the technicians, it was possible to identify one technician job which potentially had the most qualified and accessible management respondents. The one technician identified for management to respond to depended on: (1) whether respondents from three levels of technically qualified management were available and (2) judgments of company officials and the researcher that this technical position was representative of the technical work of the participating industrial establishment.

When the expanded portion of the sample was selected it became necessary to identify a technician from each firm in a manner which had previously been accomplished through Project 2048. Interviews were then planned for the one technician in each firm and for the management subjects who direct that technician's work.

Defining Levels of Management. To separate management or supervisory respondents into meaningful levels which were appropriate for making comparisons between a given level of management and the technicians, it was necessary to devise a system for selecting management respondents which would facilitate cooperation of personnel from a variety of organizational patterns in the participating establishments. The levels of management structure designed to accomplish the described end is clarified by the following model:

Figure 1

Levels of Management

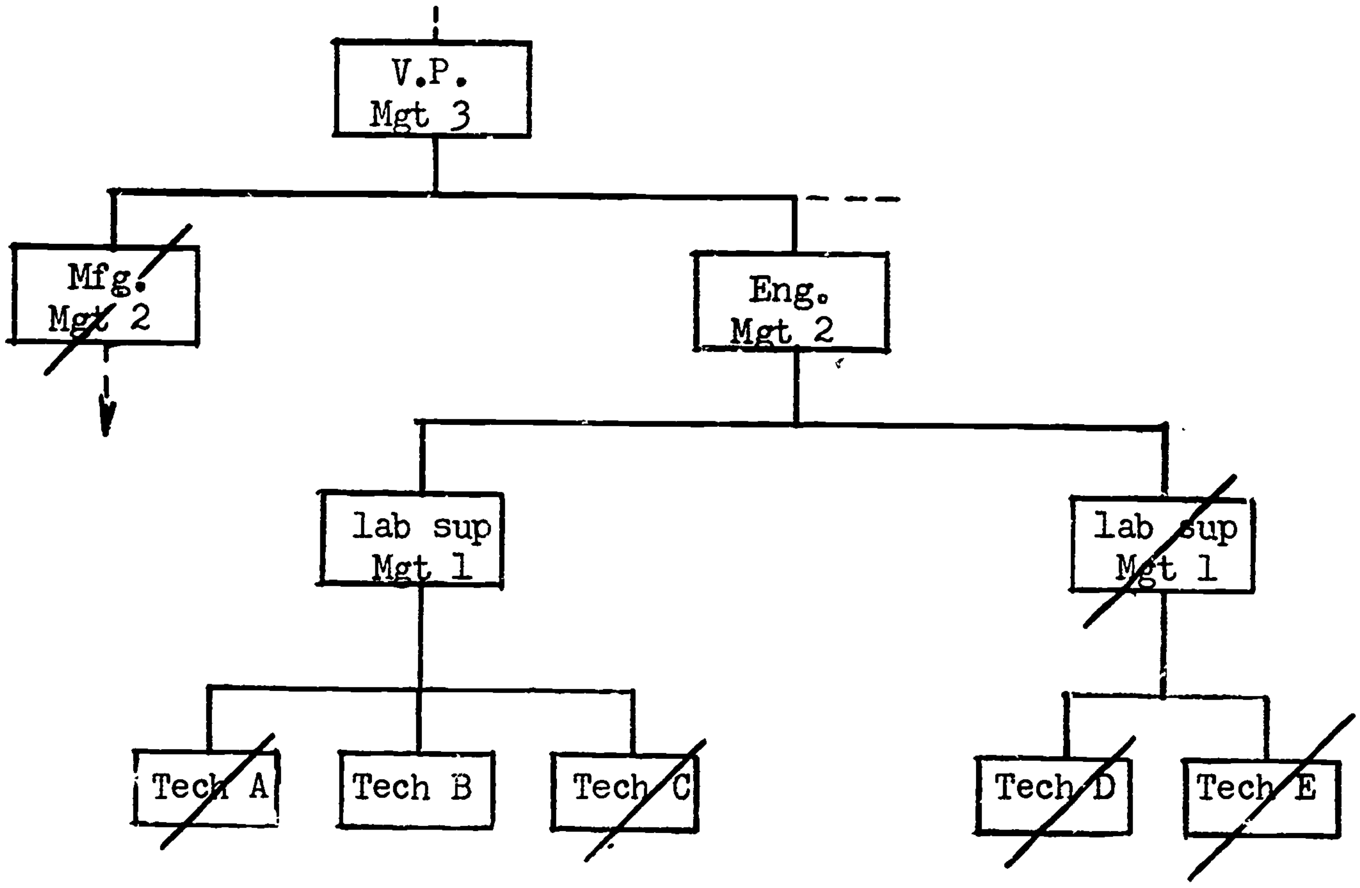

Figure 1, identifies technician B as a performer of the job to which he and the three levels of management responded. Technicians A, C, D, and E are the technicians whose data were not used in this study. All three management respondents were, at different levels of authority, responsible for the work of technician B. Management participants were requested to make content selections which could serve as preparation for any person who might be employed in the position of technician B. It should be noted that management subjects were asked to respond to the job of the technician; they were asked not to rate or evaluate the individual who performs the job.

Management Levels and Salary Levels. During data collection interviews, each management and each technician respondent were asked to establish salary levels of their current positions. The purposes of the study did not mandate concern over salary information except as desired to support the separation of management respondents into levels. It was reasoned that the higher the level of management, the higher should be the salary. It is assumed by the writer that industry uses degree of responsibility over others as a prime criterion for determination of pay level. Therefore, existence of a positive relationship between level of management and level of salary would provide some degree of justification for use of the management levels as defined. Table III strongly suggests the premised relationship.

TABLE III

SALARY MEANS BY MANAGEMENT LEVELS

Group:	Techs.	Level 1	Level 2	Level 3
$\bar{X}$	$7,250	$10,250	$11,450	$15,501

Salary information was procured by having each respondent classify himself into one of twenty-five salary levels as shown in Appendix E. The top salary level, 25, was for those respondents with annual salaries of $15,501 or over. Consequently, the mean for Level 3 management as shown in Table III, could only be calculated using $15,501 as a maximum.*

It should be stated that the salary levels which were used to calculate the means in Table III were based on eighteen respondents at each level; viz: eighteen technicians, eighteen Management 1, eighteen Management 2, and eighteen Management 3; all the respondents from those eighteen firms which were able to supply the total structure of respondents as requested. Therefore, the limited sample of eighteen firms in this case may not have produced figures which are representative of the population but they do indicate that a salary differential exists which favors those in positions of authority.

Selecting Management Respondents. One representative of each of three levels of management and one technician were sought as respondents as defined in Figure 1. The previously mentioned company organizational patterns were avoided as guides because many of the Management 1 respondents in this study were not considered as management by the companies employing them. Careful explanation to company officials was usually necessary in order to obtain respondents from among group leaders, foremen, and other direct levels of supervisory personnel.

A basic criterion for selection of a given management respondent (in addition to the levels structure) was familiarity with the duties of the technician respondent. Other obvious considerations concerning selection were availability and willingness to cooperate. Many of the Management 2 and Management 3 personnel engage large blocks of time in

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*Twenty-one levels were used as a maximum (with the same interval) in the writer's dissertation. Combining the two systems still leaves a mean for level 3 which is depressed.

conferences in and away from the plant; thus, limitations in accessibility were imposed.

As previously stated, management respondents were utilized from fifty-two establishments. The number of respondents ultimately interviewed is provided as follows:

TABLE IV

NUMBER OF RESPONDENTS BY LEVEL

Levels	Total Sample of Interviews	Interviewed After July 1, 1965
Management 3	18	5
Management 2	46	11
Management 1	52	13
Total management:	116	29
Technicians	52	13
Total respondents interviewed	168	42

The Interviews

The name of a company official for initial contact was provided by the Illinois Manufacturers Directory, the use of which has been mentioned previously. The company official usually chosen for initial contact was the president or vice-president of a smaller company or the vice-president, manager of industrial relations, technical director, or personnel manager for larger establishments. It was found that an informal conference with the initial contact usually resulted in referral to, and subsequently an appointment with, the person ultimately handling the arrangements for company participation.

Two kinds of interviews were used in the completion of the study. One, and often two, sessions with company officials were required prior to actually collecting data. The first of these contacts was focused on orientation to the problem and to the needs of the study, with emphasis placed on identifying the technician and the management personnel to be interviewed as respondents. Additional conferences often were necessary to acquaint department heads and other company personnel with the desires of the research staff.

The initial interviews were most satisfactorily carried out when entry had been structured by telephone.

Data Collection Interviews. During the initial interview a second date was set which in many cases was the date for data collection interviews of management personnel and the technician. Several follow-up contacts among the fifty-two companies were necessary to complete the interviews of the third and sometimes for the second levels of management because of unexpected absences or business complications. Duplicates of Appendix F were distributed to company officials to aid in the structuring of interviews for data collection.

The data collection interviews were scheduled to avoid busy work periods and vacation periods with some success. However, it was not uncommon to find companies whose personnel were always busy, but who still were willing to give complete cooperation. Limits to this accessibility are reflected in Appendix G. As previously stated, additional appointments were necessary in several establishments in order to secure the responses of a Management 2 or a Management 3 respondent.

Method of Analysis

Design of Curriculum Deck. The group of 99 3" x 5" cards was developed with the intent of containing or representing essentially all subject matter areas which could be considered of possible value as preparation for any one of the various technical occupations responded to in the study. Appendix A contains a complete listing of the content of the 99 cards. Each card contains a brief description of a subject area which may or may not be functionally related to the job of a given technician. The sorting procedure, yet to be explained, utilized this deck exclusively. The design of the curriculum deck is considered a most crucial factor in this study and in Project 2048 for which the instrument was designed. The procedure involved in its design is summarized below:

(1) Course catalogs were collected from public and private institutions in U.S. offering less than 4-year technical programs of study. Included in the search were junior colleges, private technical institutes, and military establishments. Course listings were received from schools in forty of the fifty states. Reasonable coverage of the technical programs then in operation was assumed. The course descriptions thus obtained provided a universe of course content from which to make selections to be placed on the cards.

(2) Obviously repetitious course descriptions were deleted from the list and others were added in areas which appeared to be lacking.

(3) All remaining courses were typed on 3" x 5" cards, resulting in a deck of 250 cards. Course titles were purposefully omitted to help prevent erroneous interpretations caused by previous educational

experiences.

(4) The three members of the research staff of Project 2048 separated the deck into subject areas as follows (51): Biological Sciences, Business and Management, Physical Sciences, Engineering, and Mathematics.

(5) A jury of consultants comprised of seven University of Illinois professors was utilized for opinions on the content coverage, wording, and other characteristics of the cards. An orientation to the intended use of the deck preceded each jury member's analysis (4, p.35).

(6) Revisions suggested by the jury were incorporated into the deck. These revisions amounted generally to reducing the number of cards by combining and regrouping the content of several, by adding items which jury members felt would update the deck, and by deleting repetitious or obsolete material.

(7) The deck was then used in three pilot studies, two of which were utilized for the dissertation; hence, also for this study. The pilot studies resulted in considerable modification of the deck. Cards were added as a result of recommendations of technicians and the content of a few cards was regrouped. The result was the 99 card deck, as listed in Appendix A, finalized for use in Project 2048 and ultimately in this study.

The Interview Schedule. The form used by the investigator to record information was designed with the intent of providing data as follows (see Appendix B):

1. Identification number for the respondent by management level and assignment of a company number.
2. Manufacturing classification for the establishment in which employed.
3. Personal data such as age and place of birth.
4. Educational history, including high school, college, military training, correspondence courses and adult education experiences.
5. Supportive data concerning the respondent's qualifications to respond to a particular technician job.
6. A limited job history which concentrated on definition of and/or description of present job.
7. Salary of current job.

It was the function of the investigator to record all information during the interview; no portion of the interview form was completed by the respondent. Responses were numerically coded at the time of interview to facilitate later classification of data and transfer to IBM cards. The code information is listed on the interview form; Appendix B.

<u>The Unforced Sort</u>. The primary means through which data were acquired by the investigator was the card sorting procedure. The direction sheet utilized by respondents is shown in Appendix C.

All management and technician respondents were asked to sort the 99 card curriculum deck into three stacks; cards judged to be <u>related</u> to the identified technician's job, cards judged as <u>somewhat related</u> and cards judged as <u>unrelated</u>. No restrictions were placed on the number of cards to be assigned to a given category of relatedness. Because of this freedom of interpretation and because of the variety of jobs responded to, the related responses varied in frequency from 2 for one respondent to 47 for another. Upon completing the task, respondents were asked to review their selections before the investigator recorded them on the response sheet (Appendix D).

Administering the Interview and the Sort. Respondents were scheduled for interview at intervals of 45 minutes to one hour. Technicians were usually interviewed and performed the card sort in a conference room or lunch room, but the management subjects usually had personal desk or office space which was utilized. Upon completion of a five to ten-minute orientation to the problem at hand, respondents were asked for responses to the interview items listed in Appendix B. Responses were recorded in the presence of the interviewee as a part of the procedure which already had been explained to him. The interview portion of the contact with management respondents varied because of the conversational factor involved, but usually about ten minutes were used for it. Between fifteen and forty-five minutes time were then taken for the card-sorting procedure. The management respondents were reminded that they were sorting the cards in terms of relatedness to the job of the identified technician, not to their own jobs. When the card sort was completed, the responses were tabulated and preparations were made for the next respondent.

Statistical Analyses. Chapter II describes in detail the statistical tests applied to the problem in this study. However, a summary of the procedures at this time is appropriate.

One way analysis of variance was used extensively for the purpose of determining differences between means in the several classifications or groupings necessary to approach the problem. Newman-Keuls procedures were applied as a basis for determining which means were significantly different from one another.

Comparison of the data in this study with that from Project 2048 was accomplished through use of non-parametric procedures. Kruskal-Wallis One Way Analysis of Variance and Spearman Rho were both considered appropriate because comparable portions of the Project 2048 analysis were based on rankings of frequencies of technicians' responses to the card sort.

Pilot Studies

Two pilot studies were conducted which were utilized for restructuring and refining the procedures of this study.

(1) Hiram Walker, Inc., Peoria, Illinois cooperated in supplying personnel and facilities for a pilot study on February 13, 1964. Management responses to the interview resulted in reordering of the items in the format and in the addition of questions designed to establish the management respondents' familiarity with the technical occupations in the employing establishment. Time expectations were established relative to both the interview and to the card sort.

(2) Caterpillar Tractor Company, Peoria, Illinois supplied technical and management personnel for a second pilot study on February 20, 1964. As a result of this study, interview formats and codes for recording data were revised, procedures for administering the interview and card sort were revised both for technicians and for management, and it was found that management respondents were willing to supply information on salary level when they were not asked to respond in a specific dollar amount. The procedure for procurement of salary information is discussed on page 31. It was apparent from this pilot study that individual respondents at all levels were willing to cooperate.

CHAPTER III

DATA ANALYSIS

This section of the report will describe the procedures established and the analyses performed on the data, and will include the findings of each portion of the analysis.

Management and Technician Differences

The purpose of reporting this information is to more adequately validate the levels structure used in the study and identify and differentiate among a limited number of characteristics of the respondents. Tables showing the complete data are located in the Appendices H through L and are referred to throughout this chapter as deemed appropriate.

In the treatments used in this portion of the analysis the main attempt was made to differentiate among the different levels of respondents. Hence, it was necessary and desirable to utilize all four levels of respondents. A system of "matching" was used which consisted of using all data from the firms which provided respondents at all four levels. Hence, each of the eighteen firms utilized in these comparisons furnished three management participants and one technician. Each level or group of respondents therefore is comparable with the next because the levels are essentially "matched" by company; the levels structures of participants from the firms were identical to one another. This system of matching is carried throughout the following five analyses:

Age of Respondents. (Appendix H)

	Mean
Technicians	31.6 years
Management 1	36.9
Management 2	43.1
Management 3	47.9

Computation of Kruskal-Wallis one way analysis of variance resulted as follows:

$H = 25.8$ 3 df. $P < .001$

The probability associated with an H of 25.8 and the relatively uniform spread among the levels support the conclusion that the mean ages are different.

Educational Attainment Beyond High School. (Appendix I)

	Mean
Technicians	64.8 semester hours
Management 1	130.6
Management 2	113.3
Management 3	144.2

Computation of Kruskal-Wallis one way analysis of variance computation produced results as follows:

$H = 11.7$ 3 df. $P < .01$

The reported probability ($P < .01$) and visual inspection of the educational attainment means lead to the conclusion that the semester hours of educational attainment are different, probably for each level.

The lowest mean listed occured for Management 2 respondents. This might seem unusual but can probably be explained by reference to the age group of the Level 2 respondents. The 43.1 mean age of this group places them at maturity prior to the postwar rush for college education. Many in their age group who did obtain college degrees are, by this date, above the level 2 category.

Salary of Current Job (annually). (Appendix J)

	Means
Technicians	$7,250
Management 1	$10,250
Management 2	$11,450
Management 3	$15,501

Calculation of Kruskal-Wallis:

$H = 45.0$ 3 df $P < .001$

The salary means of the levels of four respondents are accepted as different from each other. The relatively consistent interval and apparent positive relationship with management level should be noted.

Time on Present Job (in months. (Appendix K)

	Mean
Technicians	53.2
Management 1	49.4
Management 2	89.3
Management 3	62.0

Kruskal-Wallis computation produced: $H = .2$, $P > .5$

The low obtained value of H indicates that any apparent differences among the means are likely to be a chance event. It is concluded that the respondents of all four levels do not differ significantly in time with present employer. However, note that Level 2 appears to contain the group with the least job mobility, while it is this same group which has the lowest mean for educational attainment.

Time With Present Company (in months). (Appendix L)

	Means
Management 1	83.4
Management 2	146.7
Management 3	185.8

Data on the technicians were not available*

Calculation of Kruskal-Wallis produced:

$H = 4.5$ 2 df $P < .2$

*Project 2048 data

The high probability of the obtained value of H supports the conclusion that the means are the same. It is assumed that total time with company has no apparent relationship with management level as measured. This finding and the conclusion from it appear to be consistent with the results for time on present job.

The Core Programs

Identification of the core of subject areas which are related to all the technical areas and identification of each individual core associated with each of five job families presented several problems. Many studies in the past have avoided this problem by simply ranking selections or other data and leaving it to the reader to decide where to draw the line separating, in this case, the core requirements from the subjects to be considered unrelated. Schill (47) used factor analysis, which essentially established a consistent cutoff point between core and noncore items; hence, the decision became one of probability level. The Newman-Keuls procedures essentially would have performed the same task for this study, that of identifying which cards among the most frequent card selections carried a high enough value to warrant inclusion at a given probability level.

Establishing a Scoring System for Card Sort Data. It was decided by the writer that the foregoing procedures could be simplified and perhaps improved upon by establishing a scoring system for the card selections, then making core identifications on the basis that one group of respondents (Technicians, Management 1, or Management 2) must present a mean score equal to a situation in which every respondent would regard the card as at least somewhat related. The scoring system is explained as follows:

		Points:
Each card item rated as Related	=	3
Each card item rated as Somewhat Related	=	2
Each card item rated as Unrelated	=	1

Therefore, if any single group of respondents--Technicians, Management 1, or Management 2--all of whom are respondents from within a given job family, produced a minimum mean value of 2.0 for a card item, that card was included in the core for the job family of which the respondents are members. When a card was identified with a minimum mean value of 2.0 for one group within each of all five job families, that card became part of the general core.

The foregoing procedure is considered appropriate for its purpose because:

1. The values assigned to each response represent an ordinal relationship among the three possible responses in a manner which is consistent with the card sort technique as it was performed by the respondents.
2. The somewhat related, or 2.0 mean value utilized as a basis for inclusion in the core, places the card so scored in a position of having been regarded a related one time for each time it was considered as unrelated; hence, weight is given to both extremes in the decision.
3. When one group, say the technicians within a job family, produced a mean of 2.1 for a given card, it was observed that the two remaining groups of respondents Management 1 and Management 2 usually produced means which were reasonably close. Inspection

of Appendix G will support this statement.

Prior to further explanation of the core selection it is necessary to present a breakdown of the job classifications into which respondents were grouped. They are:

TABLE V

TECHNICIAN RESPONDENTS BY JOB FAMILY

Job Family	No. of Technicians	Mgt. 1	Mgt. 2
*Electrical	(1)	(1)	(1)
Electro-Mechanical	8	8	8
Mechanical	21	21	21
Chem-Mechanical	7	7	7
Chemical	5	5	5
Chemical-Foods	4	4	4
Total (minus Electrical)	45	45	45

*Not totaled because not included in the analysis.

The job families were selected by the investigator and the classifications were effected based on technician job function as recorded on the interview form. The Electrical job family was deleted from the analysis at this point because even with the management personnel participating there was still only one job to which responses were made.

The results of the classifications are different from what one might expect with inclusion of technicians from the seven firms engaged in the manufacture of electrical machinery and equipment, as is contained in Table I.

The implications derived from the classifications in Table V should be noted. The high frequency of participating firms which supplied respondents for the Mechanical job family is as expected. However, the large number of technicians classified as Electro-Mechanical and as Chem-Mechanical show a preponderance of hybrid jobs as viewed from the traditional classifications usually followed.

The Chem-Foods family was separated from the Chemical because it appeared that these persons represent a different facet of chemical knowledge and application.

Although separation into the five job families (actually six, counting Electrical) produced a small n in several cases, it was considered to have lessened contamination by narrowing the job families into more meaningful categories. The relatively small n in most of the categories restricts the recommendations to be made in Chapter IV. However, it must be remembered that for each job family there are (in this analysis) three sets of responses; viz: Technicians, Management 1, and Management 2. Management 3 level was deleted because of its limitation to eighteen firms, therefore to only eighteen technician jobs.

The core programs are identified as follows:

General Core. Using the previously described procedures, several cards were identified as a core which had the highest scores across all five job families. The general core is comprised of the cards as listed: 1, 17, 52, 53, 66, 77, 79, 98.

The curricular implications of the general core are discussed in Chapter IV.

Individual Core. The five job families were reasoned to possess subject matter which would not be selected by respondents representing all technological areas. However, a given card may then find itself in as many as four of the five individual cores without being included in the general core. Therefore, there is a great deal of repetition from one individual core to another. The individual cores are over and above the cards found in the general core.

The individual cores are established as indicated in itemizations A through F.

A. Electrical - no analysis performed; n = 1

B. Electro-Mechanical - 27 cards

3,4,8,12,18,26,34,35,37,38,44,
46,47,51,57,60,61,63,65,67,70,
71,72,73,75,80,89

C. Mechanical - 15 cards

3,35,37,38,44,47,51,56,61,63,
65,67,70,72,73

D. Chem-Mechanical - 19 cards

3,27,33,34,35,37,38,47,51,61,63,
67,70,72,80,83,85,90,99

E. Chemical - 12 cards

4,7,31,32,36,80,81,83,85,86,97,99

F. Chemical-Foods 24 cards

2,3,5,9,14,30,32,46,47,50,51,54,
58,60,64,76,80,83,84,88,89,92,
96,99

A discussion of the general and individual core items at this time would quickly lead to curricular implications and recommendations.

To give proper attention to such discussion, Chapter IV is more appropriate.

Simple analysis of variance procedures were utilized in the attack on the second portion of the problem as cited in the introduction. As a review, the problem was not only to identify the core program, as was accomplished in the previous section, but to differentiate among the different levels of respondents in an attempt to identify differences among the card selections of Technicians, Management 1, Management 2, and Management 3. As reported earlier, Management 3 has been omitted from most of the analyses because it would limit comparison to the eighteen technician jobs in the eighteen firms employing these respondents.

<u>Assessing Contribution to Cores</u>. Simple analysis of variance was used as a tool to differentiate among the three levels of respondents in their contributions to the general core. The means of the scored responses of the three groups--Technicians, Management 1, and Management 2--were handled as treatments. The number of observations in each analysis of variance problem became the individual program for the job family under treatment. Table VI was included as an example, showing the arrangement of data as used for analysis of variance performed on the five job families, or rather on the individual core extracted for each job family. (Tables for the other job families are included as appendices.) The analysis of variance for the Mechanical Core was a multiple comparison of the three means at the base of Table VI. In the tests which produced a significant F value, the means were subjected to Newman-Keuls procedures to identify which means were acceptable as different from each other.

TABLE VI

ONE WAY ANALYSIS OF VARIANCE
OF MECHANICAL JOB FAMILY CORE, k = 3

Card No.s in Core	Techs	M_1	M_2
3	2.52	2.24	2.43
35	2.62	2.48	2.24
37	2.67	2.48	2.14
38	2.52	2.14	2.24
44	2.14	1.67	1.57
47	2.43	2.00	2.57
51	2.38	2.29	2.52
56	2.10	1.33	1.38
61	2.29	2.33	2.38
63	2.33	2.24	2.43
65	2.43	2.19	2.29
67	2.71	2.25	2.38
70	2.04	2.43	2.10
72	2.67	2.14	2.19
73	2.14	2.24	2.19
Σ	35.99	32.43	33.05
$\bar{X}$	2.40	2.16	2.20

.05 was used as a minimum level of significance throughout the tests in this chapter.

Testing of the cards identified for the Electro-Mechanical core are reported in Table VII.

TABLE VII

ONE WAY ANALYSIS OF VARIANCE

Electro-Mechanical Core

Source	df	SS	MS	F	P
Between	2	1.718	0.859	4.89	$< .01$
Within	78	8.020	0.103		
Total	80	9.738			

Observations in each column (treatment): 27 (cards in core)
Treatments: 3; Technicians, Management 1, Management 2.

Analysis of the Electro-Mechanical core produced an F which is acceptable as a basis for saying that the means are different. Application of Newman-Keuls to the three means established the means of Management 1 and Management 2 as different from each other; ($\alpha = .05$). It is concluded that the two levels of management differed in their contributions to the Electro-Mechanical core; that Management 2 rated more of the Electro-Mechanical core cards as related than did Management 1.

TABLE VIII

ONE WAY ANALYSIS OF VARIANCE

Mechanical Core

Source	df	SS	MS	F	P
Between	2	.480	0.240	2.88	> .05
Within	42	3.503	0.083		
Total	44	3.983			

Observations in each column (treatment): 15 (cards in core)
Treatments: 3; Technicians, Management 1, Management 2.

The obtained F in testing for differences between levels in the Mechanical core did not fall within the .05 level. Therefore, it is concluded that there were no significant differences between any two of the three means; Technicians, Management 1 and Management 2 respondents did not differ significantly in their contributions to this core.

TABLE IX

ONE WAY ANALYSIS OF VARIANCE

Chem-Mechanical Core

Source	df	SS	MS	F	P
Between	2	.193	.097	1.43	>.05
Within	51	3.451	.068		
Total	53	3.644			

Observations in each column (treatment): 19 (cards in core)
Treatments: 3; Technicians, Management 1, Management 2.

The minimum F value at .05 level of significance is 3.18. Therefore, the three means are considered the same for this core. It is concluded that the three groups or levels did not differ in their contributions to the Chem-Mechanical core.

The raw data for this analysis are tabled in Appendix N, Table II.

TABLE X

ONE WAY ANALYSIS OF VARIANCE

Chemical Core

Source	df	SS	MS	F	P
Between	2	1.676	.788	2.67	>.05
Within	33	9.743	.295		
Total	35	11,319			

Observations in each column (treatment): 12 (cards in core)
Treatments: 3, Technicians, Management 1, Management 2.

Non-significant differences are indicated by the obtained F for this core. It is concluded that the three levels (or groups) of respondents did not differ in their contributions to the Chemical core.

TABLE XI

ONE WAY ANALYSIS OF VARIANCE

Chemical-Foods

Source	df	SS	MS	F	P
Between	2	7.924	3.962	18.49	<.005
Within	69	14.781	0.214		
Total	71	22.705			

Observations in each column (treatment): 24 (cards in core)
Treatments: 3; Technicians, Management 1, Management 2.

The probability of <.005 supports the conclusion that the contribution to the Chemical-Foods core is not the same for each group or level of respondents. Application of Neuman-Keuls procedures identified the means of Management 2 and Technicians as the same. However, both the Technicians and Management 2 means are different from Management 1. In this case it is concluded that the Management 1 group contributed most to the Chemical-Foods core. Consideration of the small number of technician jobs (n = 4), on which these tests are based, minimize generalizability of these results.

Analysis of variance tests also were used for two analyses of the general core. It was considered within the realm of the problem to check:

(1) differences in contribution to the general core between all respondents (treatments), the five job families combined; and

(2) differences in contribution to the general core among the five job families (treatments), the 3 levels of respondents combined.

Retaining the numbering in the previous statement, the one way analysis of variance summarizations are:

TABLE XII

ONE WAY ANALYSIS OF VARIANCE

(1) Three Levels of Respondents Compared on General Core

Source	df	SS	MS	F	P
Between	2	.030	0.015	.04	>.05
Within	118	33.300	0.382		
Total	120	33.360			

Observations in each column (treatments): 40 (5 job families x 8 cards in general core)
Treatments: 3; Technicians, Management 1, Management 2.

The insignificant F listed in the table supports the conclusion that there are no significant differences among the three levels of respondents in their contributions to the general core.

The data for this analysis of variance were extracted from Appendix M.

TABLE XIII

ONE WAY ANALYSIS OF VARIANCE

(2) Five Job Families Compared on General Core

Source	df	SS	MS	F	P
Between	2	.212	.053	.55	>.05
Within	21	3.452	.099		
Total	23	3.665			

Observations in each column (treatment): 8 (General core card means of technicians, Management 1, and Management 2; $\frac{T + M_1 + M_2}{3}$; to produce 8 grand means in each job family)
Treatments: 5; the five job families.

The F value obtained in Table XIII supports the conclusion that there are no significant differences among the means of the five job families; no single job family or grouping of families was unique in its contribution to the general core.

The data for this analysis were calculated from general core data in Appendix M.

Comparisons with Project 2048

A review of the sampling procedures for this study indicates an attempt to make the Project S-196 sample representative of the sample of manufacturing establishments used in Project 2048. The sample of the latter study was claimed by its director as sufficiently representative of the manufacturing establishments in Illinois (47, p.18). Therefore, the closer the relationship which can be structured between the two samples, the greater the generalizability which can be claimed for Project S-196 findings.

A second reason exists for structuring the sample as explained, which is that utilization of similar samples and the same instruments and procedures for procuring and recording data, it then becomes feasible to make certain comparisons of the findings of the two studies. It is the intent of this section of the chapter to present brief analyses and discussions of comparisons which seem appropriate.

General Core Comparisons. Although quite different procedures were utilized in the identification of the general core in each study, the findings were quite similar. The cards in Appendix A. appeared in the general cores as shown in Table XIV.

The content on card 79, the lone selection not chosen in Project 2048, is the calibration and use of typical industrial and laboratory instruments and actual use...It might appear unusual that this card was not rated highly by the Project 2048 respondents.

Cards in the 2048 core which are not found in the S-196 core provide a pertinent discussion topic. Card number three became a part of four of the five individual cores, indicating that it was actually rated similarly in the two studies. The sample of Chemical respondents, (n = 5) rejected this card. Respondents to the 5 jobs in this category apparently felt little need for knowledge of data processing programming, and numerical control. Inclusion of card number three in the larger sample (Project 2048) is concluded as a more appropriate decision because of the greater number of chemical jobs in which its data are based.

The remaining differences (cards 51,61,63,65, and 67) not included in the S-196 core became parts of most of the individual cores. Card 51, basically trigonometry, was rejected by the Chemical group. Card 63, machine elements and calculations, was rejected by Chemical and Chemical foods groups as might be expected. Card 65 preparation of block diagrams and schematics, as might be expected, was rated highly only by the Electro-Mechanical and Mechanical groups.

The fewer cards identified for the S-196 core appear that the procedures for identification may be more stringent in that study. However, this conclusion is not warranted because of the lesser number and lesser variety, of technicians utilized in the S-196 sample. It is interesting to note that all the cards which were selected for the S-196 core, with the exception of No. 79, are found in the 2048 core.

TABLE XIV

GENERAL CORES COMPARED

	Card Numbers, S-196	Card Numbers, 2048
	1	1
	-	3
	17	17
	-	51
	52	52
	53	53
	-	61
	-	63
	-	65
	66	66
	-	67
	77	77
	79	-
	98	98
Total	8	13

Overall it appears that comparison of the general cores of the two studies shows the effects of differences in classifications to a greater extent than it reveals actual differences.

Comparisons of Individual Cores. Comparison of these findings will not contain a detailed discussion of differences because the classifications into which the technical jobs were grouped may not have been comparable.

However, a side by side listing of the cores is provided for review by the reader. It must be noted in reviewing the tables containing the listings that it was necessary to include the appropriate general core for each group, the cards for which were identified by parentheses in Table XV.

The consistently greater number of cards identified for most of the individual cores in Project S-196 can be quite naturally attributed to differences in the two samples, and differences in core selection procedures. However, the latter of the two reasons stated is considered the most prominent factor. If the core extraction procedure for Project S-196 is reviewed briefly one notices that a card was included in a core if any one group of respondents considered it of enough importance to produce a minimum mean score for that card of 2.0. Hence, three groups, Technicians, Management 1, and Management 2 all in actuality had a shot at the inclusion of the card. It is concluded therefore, that the considerably more extensive inclusion of items in most of the five individual cores is due to this cumulative selection effect. Therefore, dilution of technician responses by the groups of management probably played a role in the S-196 individual core selections.

TABLE XV

COMPARISON OF INDIVIDUAL CORES, PROJECTS S-196 AND 2048

Job Family	S-196	2048
Electro-Mechanical (General core in parentheses)	(1),3,4,8,12,(17),18,26, 34,35,37,38,44,46,47,51, (52),(53),57,60,61,63,65, (66),67,70,71,72,73,75, (77),(79),80,89,(98)	(1),(3),8,(17),35,38 (51),(52),(53),(61),(63), (65),(66),(67),72,73,75, (77),79,(98)

TABLE XV (continued)

Job Family	S-196	2048
Mechanical (General core in parentheses)	(1),3,(17),35,37,38,44 47,51,(52),(53),56,61,63 65,(66),67,70,72,73,(77), (79),(98)	(1),(3),(17),37,(51) (52),(53),(61),(66),(67), 70,(77),(98)
Chem-Mechanical (General core in parentheses	(1),3,(17),27,33,34,35, 37,38,47,51,(52),(53), 61,63,(66),67,70,72,(77), (79),80,83,85,90,(98),99	(1),(3),4,(17),(51),(52), (53),(61),(63),(65),(66), (67),(77),80,81,83,(98)
Chemical (General core in parentheses)	(1),4,7,(17),31,32,36, (52),(53),(66),(77),(79), 80,81,83,85,86,97,(98),99	(1),(3),4,(17),32,(51) (52),(53),(61),(63),(65), (66),(67),(77),79,80,81, 83,84,85,86,89,90,97,(98)
Chem-Foods (General core in parentheses)	(1),2,3,5,9,14,(17),30,32, 46,47,50,51,(52),(53),54, 58,60,64,(66),76,(77),(79), 80,83,84,88,89,92,96,99	Not classified for core identification
Electronic (General core in parentheses)	Insufficient sample	(1),(3),8,12,(17),18, (51),(52),(53),57,(61), (63),(65),(66),(67),71, 75,(77),79,(98)

Schill and Arnold refer to deletion of the supervision core as one which was inappropriate for two-year technical programs (46, p.83). It since has been decided by the writer that the subject areas which indicate concern over coursework which would prepare a student for the supervisory functions of a job should be included. This decision leaves such curricular items in the order of importance which respondents assigned them; program planners should be made aware of the importance assigned the supervisory items both for the implications toward two-year and toward four-year programs. The supervisory core identified by Schill (47, p.90) was made up of the cards utilized in Table XVI.

TABLE XVI

SUPERVISORY CORE COMPARISON
INDIVIDUAL CORES OF S-196

Cards	El/Mech	Mech	Chem/Mech	Chem	Chem/Foods
23					
26	X				
27			X		
28					
30					X
42					
44	X	X			

It is interesting to note that the supervisory core in Project 2048 was not present to as great an extent in the S-196 individual cores. The S-196 Chemical group did not rate any of the supervisory core in Table XVI sufficiently high for inclusion in an individual core. The content of the supervision items in the S-196 individual cores is discussed in Chapter IV.

Comparisons of Card Sort Ranks. Previous discussion of the core comparisons involved difficulties because of the different procedures utilized in identification of the cores. However, if one returns to the several groups of raw card sort data, the problem of different procedures does not occur; the card sort data as recorded for all respondents of Project 2048, the writer's dissertation, and Project S-196 involved response to the curriculum deck for each and all respondents. Hence, Appendix R was compiled, using the total number of respondents in each group. The frequency of selection for each card within each group was utilized as the basis for ranks obtained.

The ranking procedure established a rank of 1 for the card with the lowest frequency of rating as <u>related</u> to technician job performance, and the highest frequency was assigned a rank of 99. It can be noted via visual comparisons across Appendix R that there is a great similarity of rankings across all groups. Computation of Spearman Rho to assess the degree of association between Project 2048 technician 1 and each of the other groups produced correlations as follow:

TABLE XVII

SPEARMAN r COMPARISONS OF
ROUGH SORT DATA, PROJECT 2048
TECHNICIANS CORRELATED WITH ALL OTHER GROUPS

	S-196 Technicians	S-196 Total Respondents	Management 1	Management 2	Management 3
Project 2048 Technicians	.942	.931	.928	.911	.896

In testing the significance of the obtained correlations (one tailed t test), a probability of less than .001 was obtained for each of the correlations. Schill and Arnold (46, p. 78) reported slightly higher correlations using the more limited samples as they existed prior to expansion of the sample for Project S-196. However, the high correlations do not rule out the existence of isolated differences in rankings.

The significance tests for the correlations in Table XVII support the conclusion that the S-196 sample is representative of the same population as Project 2048. Further discussion of this point is found in Chapter IV.

The slight decrease in correlations as one moves from the technicians through the three management levels (in Appendix R and in Table XVII) gives the appearance of greater differences of responses for the higher levels of management. However, this conclusion is not warranted because it must be remembered that Management 3 respondents identified content for only eighteen specific technician jobs; Management 2 for forty-six jobs; and finally Management 1 for 52 jobs. As an attempt to test whether or not the conclusion of different ratings by Management is warranted, data from only the eighteen respondents from each of the levels within the eighteen firms which participated at all four levels (Technicians through Management 3), were tabled for calculation of Kruskal-Wallis one way analysis of variance. (Appendix Q.) The table in Appendix Q is structured in manner in which the total group of eighteen respondents at each level is responding to the same group of eighteen technician jobs. Therefore, in this analysis significant differences could logically be assigned to differences due to level of respondent. The Kruskal-Wallis test of the described data is summarized as follows:

$H = 5.9$ $\qquad$ $d.f. = 3$ $\qquad$ $P < .2$

The low value of H and its associated probability support the conclusion that the recommendations of the four groups of respondents are the same. The limited number of jobs to which these groups responded precludes further consideration or treatment.

CHAPTER IV

THE CORE RECOMMENDATIONS AND CONCLUSIONS

Curriculum design in technical education is occurring in an unique setting. Formerly regarded as a relatively narrow segment of the educational spectrum, it now is moving in several directions simultaneously. Governmental, business, industrial and educational interests are rapidly realizing that established guidelines are lacking. In the apex of this situation are the divergent institutional structures which have programs for educating technicians. Guided by greatly varying educational philosophies, financial structures, organizational patterns, and physical and staff resources, many of these institutions purport to supply industry and society with essentially the same product.

It is not the intent of the recommendations of this study to offer advice which would ignore the expertise which the staffs of the described institutions have developed; it is they who must decide on method, approach, course sequence, time allotments, and other arrangements appropriate for their individual situations.

It is the purpose of this chapter to bring together the respondents' core of recommendations for technical curricula, with the intent of providing curricular guidelines which are worthy of use by the many varieties of educational institutions.

A summary of findings and conclusions as they relate to the five objectives of this study s presented.

Discussion of the General Core

The general core was previously defined as that content (on cards) which respondents across all job families considered as important to technician job performance. The general core was identified only numerically (by card number) in the analysis, but herein is identified and grouped for discussion purposes as is listed in succeeding paragraphs. Table XVIII, page 74 provides a means of visualizing the relationship between the general core and each of the individual cores.

Communications Skills. Acknowledged as a standout in its rating by technicians in Project 2048 (47), this study produced a similar, but not identical finding with regard to card number one. Reference to Appendix P reveals card number one as occupying a position of fifth in importance, and Appendix R ranks it similarly, based on respondents from all the firms. Appendix R, it should be noted, compares ranks across all groups of respondents for both studies. Card number one is:

1. Technical and scientific oral and written communication including business forms, reports, emphasizing the different types of business letters. Techniques of collecting and presenting scientific data. Informal reports and formal reports; special types of technical papers.

Review of the fact that the high ranking was obtained in competition with the technical, basic science, mathematics, and all other content in the deck is considered worthy of impact on many present technical curricula. The findings of Marks (30), Pearce (39), and of Schill and Arnold (46) support the establishment of the communications skills as a major requisite of technician job performance.

It is concluded that courses such as speech, English composition, technical writing, business communication, conference participation, and perhaps others in verbal communication collectively should occupy a prominent position in the structure of two-year technical programs.

Testing and Instrumentation. Several cards in the general core were grouped into a family which appeared to indicate a concern for understanding, familiarization with, and orientation to the devices and instruments along with methods and procedures associated with their usage. The cards are:

17. Use of simple test equipment. Theory and application of commercial test equipment, trouble analysis and test and alignment methods and practices.

77. The use of measuring equipment in a system to measure or control the system; such as thermocouples, strain gauges, pressure transducers and various current or voltage pick-ups. Accuracy inherent in alternate methods of measurement. Methods of transcribing or indicating measured values, or of using measured quantities to control the system.

79. The calibration and use of typical industrial and laboratory instruments and their actual use in the analysis of equipment representative of various fields. Calorimetric, spectrophotometric, spectrographic, electrolytic, and potentiometric methods.

98. Environmental testing of components, parts, and products for assessment of performance in actual application.

Card number 17 was scored near the top in importance by most of the respondents in this study. Allowing for some commonality, it can be reasoned from the card that courses in the different technologies would be concerned with different kinds of test equipment and correspondingly different approaches to troubleshooting, alignment, and application of the equipment. In short, card 17 implies a varying body of content for the different technical areas. Items 17, 77, 79, and 98 comprise the largest single group of cards in the general core. It may be interesting to note that all of them fall within the "application" area which tends to discriminate between the technician and the engineer.

Mathematics. Recommendations which may be of value in determining the level of a technical program are those in mathematics. The recommendations may appear to be meager, but were established as:

52. Algebraic graphing, exponents, powers, roots, radicals, imaginary and complex numbers through ratio proportions, variations, and logarithms.

53. Metric system and square root; geometry from plane figures to geometric solids; algebra from operations with signed numbers through algebraic expressions, equations, special products, factoring, and fractional equations and simultaneous equations.

The establishment of the core program in mathematics will appear to some persons as inadequate. However, it should be recalled that each group; viz.: the technicians, Management 1, and Management 2; all had the opportunity to select from several additional mathematics cards and rate them as related. This finding is consistent with the results of certain other studies (5) (46) (47), but is in conflict with the current offerings in many, if not most, technical programs.

The general core in mathematics is minimal; later discussion presents the individual cores which build upon this core because high ratings were assigned to other mathematics content. Card 51, a description of trigonometry, narrowly missed inclusion in the general core; hence, was selected in most of the individual cores. This area of the general core is not concluded to represent universally low mathematics recommendations for technicians. However, it is concluded from this core that all (families of) technicians do not at present need appreciable amounts of knowledge or facility in differential and integral calculus, differential equations, and other courses of a level beyond the general core. However, in view of mobility to higher level jobs and the ever-rising level of technological activity, minimum requirements cannot be based wholly on normative evidence.

Appropriately mentioned at this time is that all cards do not necessarily contain equivalent, or even similar, amounts of material in terms of content for a given course. Similarly, it is in most cases difficult to attempt to establish the degree of necessary depth based on results of the card sort analysis. The traditional sequence of difficulty in the mathematics field tends to represent an exception.

Engineering Graphics. Card number 66 is alone in this category in the general core. Its content is:

66. ASA standards, use of handbooks, graphical treatment of empirical data, conversion charts and nomograms, graphical differentiation and integration, tolerance and limit dimensioning.

Discussion of the Individual Cores

As described in the analysis, the individual cores extracted from the deck apply above and beyond the general core and were analyzed in classifications by job families. The cores so identified are described in the following paragraphs. A visual delineation is offered in Table XVIII.

Electrical. Classification of technician respondents into six job families resulted in only one technician in this category, thereby precluding further analysis.

Electro-Mechanical. Identification of twenty-seven cards in this core represents a considerable expansion of the Electro-Mechanical core identified in Project 2048 (see Table XV, page 57). It must be stated immediately that the difference between the two studies on this core area would seem to be attributable to differences in the methods used in categorizing respondents into job families and to the two different approaches utilized in defining the cores. Respondents herein classified as Electro-Mechanical probably were classified as Electrical in the parallel study (47). However, the job classifications of the S-196 technician respondents were accomplished directly from the interview sheets as supplied by respondents, and are, therefore, claimed as a valid classification.

The strong influence of the electrical industries was evident in the next group of cards. Card selections in electrical theory and equipment were:

8. Analysis and design of basic electronic circuits involving vacuum-tube and semi-conductor devices. Graphical characteristics and coefficients. Linear equivalent circuits. Elementary feedback analysis.

12. Coulomb's Law and the basic concepts of electrostatics, direct and alternating current theory, magnetism, electromagnetism, Ampere's Law, oscillator circuits, and L/c and R/c circuits.

18. Principles of pulse and timing circuits, including multivibrators, limiters, clippers, blocking oscillators, and counting circuits. Quantitative analysis of differentiating and integrating circuits.

57. Vacuum tube and transistor theory. AC parameters, resonance, transformers, coupling, filters, bandpass, and complex wave forms. Tuned and untuned circuits, and vacuum tube power supplies.

71. Electronic circuit theory of video amplifiers, tuned amplifiers, and basic feedback oscillators. Nonlinear amplifiers, modulators and demodulators. Noise in electron devices. Relaxation phenomena and Wave-form generation.

75. The use of synchros and servomechanisms, synchro generators, motors, differentials and control transformers. Control circuitry for error detection, anti-hunt systems, servo amplifiers, thyratron motor control, the Ward Leonard control systems, the amplidyne, and AC servomotors. Industrial application of electronic controls including photoelectric devices.

The mathematics recommendations for the Electro-Mechanical technicians appear to be in conflict with the relatively low level established as important to technicians in other studies (47) (5).

The cards are:

46. A branch of mathematics dealing chiefly with the rate of change of functions with respect to their variables--differential calculus.

51. Trigonometric functions and fundamental formulae. Logarithms and solution of triangles, identities and equations. Trigonometry from ratios, right triangles and identities through vectors and graphs of trigonometric functions.

60. Analytic geometry, extremal problems limits, continuity, derivatives, antiderivatives, and the calculation of area by approximation methods and by use of antiderivative functions.

All cards of the deck which deal with electrical and electronic principles and equipment are included in the above selection. This leads the writer to conclude that this technical area of study is of prime importance to Electro-Mechanical technicians; therefore, an area which demands considerable emphasis.

A group of cards which was assumed to be broadly classifiable as the engineering graphics was included in the core; it is:

47. Graphical solution of problems involving points, lines, planes, revolutions, intersections, angles, tangent planes and developments. Plus problems involving contoured and warped surfaces.

61. Sketching forms from observation; emphasizing volumes, perspective, composition, and measurements.

63. Machine elements and calculations in determining the size and shape of various machine parts. Factors which influence the selection of materials to be used. Prototypes.

65. Preparation of block diagrams, schematics, and layouts using standard conventions.

67. Projection and graphic representation: use of instruments, lettering, applied geometry, dimensioning, sections, conventions (e.g., welding, pipe, electronic), auxiliary views, screw threads, cams, gears, theory of perspective, preparation of working and assembly drawings.

72. Pattern drafting and layout; tool operations as related to processes of manufacturing sheet and plate products.

The engineering graphics content confirms that this concern of the Electro-Mechanical group is a major one.

Core selections classified as engineering theory are cards:

3. Numerical control, data processing, interpretation of engineering drawings, depiction of data by manuscript, minimum dimensions and use of formulae, left data, translation, programming, and quality control.

34. Composition and resolution of forces, equilibrium conditions, Newton's laws of motion, uniformly accelerated motion, projectile motion, concept of work, power and energy, elasticity, rotational motion, and simple harmonic motion.

38. Applied statics and strength of materials, dealing with forces, stresses, and the design of simple machines and structures. Applications of the characteristics of modern engineering materials to structures.

70. Ferrous and non-ferrous metal heat treating, macrostructure, composition, physical and chemical testing. Metallography, metallurgical examinations, inspection procedures, and corrosion testing.

89. Mechanics of fluids, temperature scales, thermal expansion, methods and laws of heat transfer, calorimetry, properties of gases, fusion and vaporization, and an introduction to thermodynamics; wave motion and sound.

In alignment with the current thinking on technician functions and activities is a group of cards which normally fits within the topic of metals manufacturing and production processes. The cards are:

35. Metal forming including machining, chemical milling, spinning, electrical forming, and explosive forming.

37. Metal forming including casting, die casting, forging, extruding and the accompanying pattern and tool construction.

73. Metal fabrication including oxyacetylene welding and cutting; electric arc welding; heliarc and shielded arc welding; friction and vacuum welding, and cold fasteners.

The succeeding two cards were grouped for the sake of convenience. Both appear as choices which are consistent with the functions in the Electro-Mechanical family and are:

4. Thermosetting and thermoplastic materials. Films, enamels, paints, lacquers, alkyds, phenolics.

80. The basic laws and theories of elements, compounds, and their structure and behavior.

The two remaining cards in the core indicate concern for preparation for advancement or for supervisory activities. However, it may seem unusual that these two cards were not identified as important in many other job families (Table XV). The cards are:

26. Practical application of basic psychology in planning, conducting and evaluating conferences and interviews. Emphasis on employee selection, classification, training, evaluation, working conditions, counseling, group attitudes in the occupational situation as they affect motivation, status and morale.

44. (PERT) Selection and sequencing of specific identifiable events necessary to successful completion of a project. Estimates of time, evaluation procedures, information channels, and use of data processing techniques to permit periodic summaries of projects.

Mechanical. The core selections are begun with those in the area of mathematics, in which it is noted that the mathematical selections for the Mechanical technicians are slightly different from the selections made for the Electro-Mechanical. Notably absent is differential calculus, number 46. Perhaps also unusual is the failure of analytic geometry (number 60) to appear. It is suggested here that separation of the Electrical functions from the Mechanical may be closely related to this lesser level o. mathematics recommendations. The cards selected are:

51. Trigonometric functions and fundamental formulae. Logarithms and solution of triangles, identities and equations. Trigonometry from ratios, right triangles and identities through vectors and graphs of trigonometric functions.

56. Linear, radical, and quadratic equations; simultaneous solutions of second-degree equations; binomial theorems, deMoivre's theorem, rational and irrational roots of polynomial equations of any degree; complex numbers, cubic and quadratic equations, theorems on roots, isolation, limits and approximation of real roots.

No differences in the cores for Electro-Mechanical and Mechanical are evident in the area of engineering graphics. The cards selected are, therefore, indicated numerically. They are numbers 47, 61, 65, 67, and 72. Interested readers may return to page 68 for identification of content.

The core identified in the manufacturing processes group consists of the same cards identified in the Electro-Mechanical core. The cards are 35, 37, and 73. Please return to page 69 for identification of content.

The general area of engineering theory produced a more limited core for this job family than for the one identified for the Electro-Mechanical family. The cards are:

3. Numerical control, data processing, interpretation of engineering drawings, depiction of data by manuscript, minimum dimensions and use of formulae, left data, translation, programming, and quality control.

38. Applied statics and strength of materials, dealing with forces, stresses, and the design of simple machines and structures. Applications of the characteristics of modern engineering materials to structures.

70. Ferrous and non-ferrous metal heat treating, macrostructure, composition, physical and chemical testing. Metallography, metallurgical examinations, inspection procedures, and corrosion testing.

The last card in the Mechanical core (number 44) also appeared in the Electro-Mechanical core. However, card 26 from that previous core (basic psychology in industry) was not selected. The reader is referred to page 70 for the content of card number 44.

Chem-Mechanical. The core cards for this job family and each of the two which follow it (Chemical and Chemical-Foods) are based on a number of technician jobs which is too small to provide a basis for the generalizability which one might apply to the Mechanical group (N=3 x 7). Table V shows the number of cases in each job family for the core analysis. Therefore, the described cores are offered for use only to provide a breakdown which may be useful for additional research in those areas.

The only card in the mathematics area which was selected is card number 51, the content of which is presented on page 68.

The identification of only trigonometry as compared with the selections in the two previous individual cores is concluded as representing an apparent lesser concern for and use of mathematics in the Chem-Mechanical family. The conclusion is offered only as supported by the findings of Project 2048, which utilized a considerably larger sample of technicians in this job family (47).

Retaining most of the grouping procedures used previously, the Chem-Mechanical core contains a group of cards which, as one would expect, sets them apart from the previous group. These cards are:

80. The basic laws and theories of elements, compounds, and the structure and behavior.

83. Chemical testing of industrial materials and products; preparation of solutions and reagents; and investigation of gravimetric, volumetric, and gasometric methods. Chromatographic, spectrophotometric, spectrographic, potentiometric, and conductimetric, and microscopic procedures.

85. Carbon compounds; their structures, properties and nomenclature; types of reactions of important functional groups. Laboratory techniques, preparations and qualitative analysis.

90. Atoms, single crystals and polycrystaline materials. Properties of the metallic state; nature of alloys; making of alloys; phase equilibrium diagrams; micro-constituents of alloys; mechanical and thermal treatment; survey of non-ferrous and ferrous metallurgy.

99. Preparations of specimens for testing by processes such as slicing, polishing, electro-polishing, etching, dyeing, and impregnating.

A group of cards previously classified as engineering theory was selected; it contains cards 3, 33, 34, 38, and 70. Refer to page 87 for content descriptions.

Cards identified in the area of engineering graphics were selected. Again, to avoid unnecessary repetition, the cards are listed only by number; viz: 47, 61, 63, 67, and 72. Page 68 contains the necessary complete discriptions.

Concern for machine processes and operations were indicated by the following core selections: 35 and 37.

The selection of this group illustrates a retention of the mechanical family of functions which one might expect. However, the relatively few cards identified have implications toward limitation of the programs in this area of study to a much lesser variety and depth than for the Mechanical family.

The last card indicated concern for supervisory functions. It is:

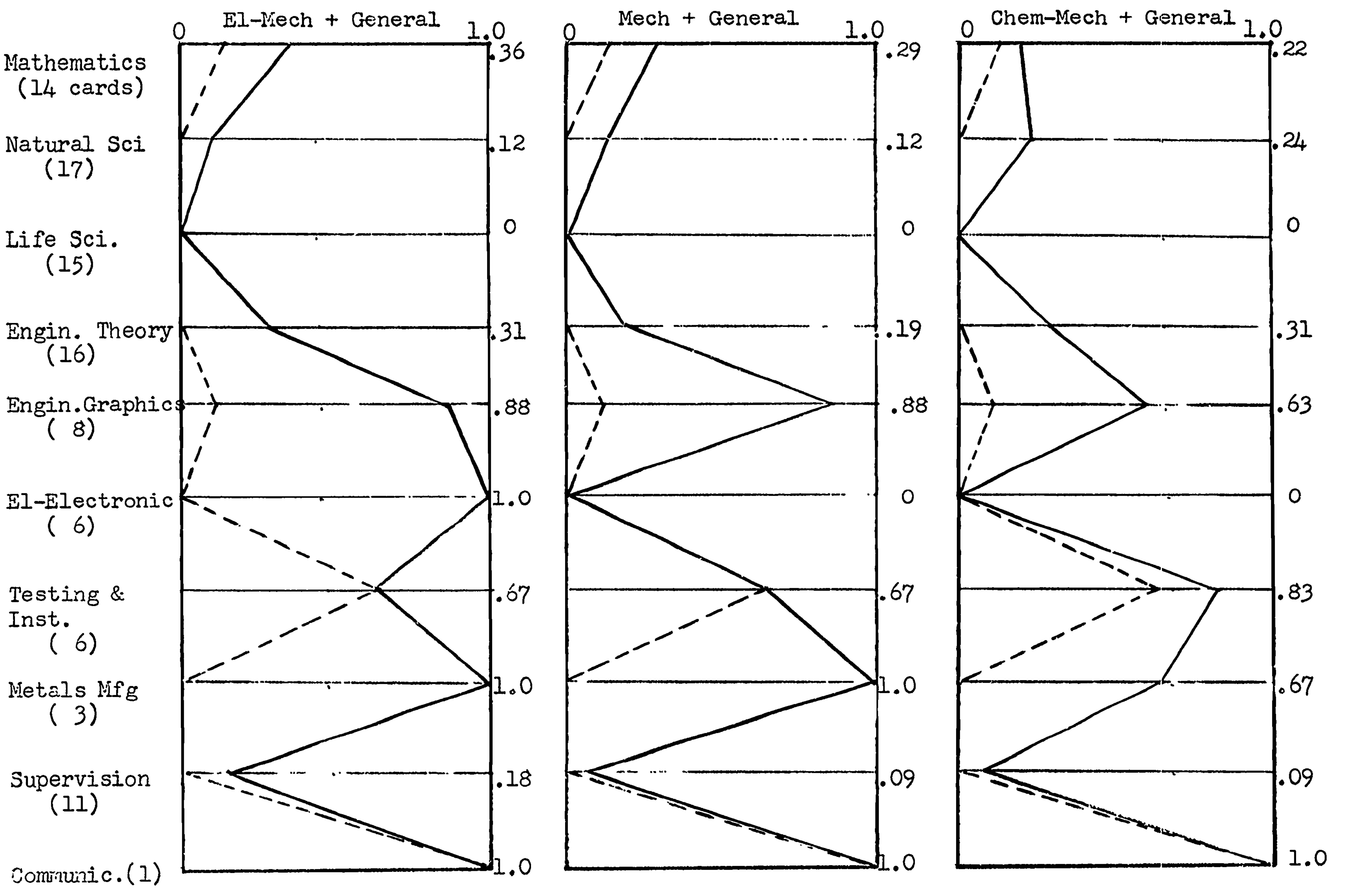
27. Time study and the science of management; process charts, operation analysis, motion economy and job design; time study preparation, observation, calculation and adjustment; ration delay study; formula development and construction of tables, curves and multivariable charts.

It may seem unusual that this particular supervision card appeared while others were excluded.

<u>Chemical</u>. Previously identified as based on a very limited number

TABLE XVIII

CORE COMPARISONS OF THREE JOB FAMILIES BASED ON PROPORTION OF TOTAL CARDS SELECTED



Proportion of cards selected in each of 10 areas

(N=5), the core in this area is not listed in the recommendations. However, the reader is referred to Table XV in Chapter II, should he be interested in identifying same.

Chemical-Foods. The number of technicians for this group (n=4) is considered insufficient for listing in this chapter. Reference to Table XV provides the listing of the core for this group.

Attainment of Objectives - A Summary

This section of the recommendations is comprised of a summary of the findings and conclusions resulting from the study, which are grouped as they relate to each of the five objectives. Each objective is included herein as worded in Chapter I.

(1) Compare assessments made by management toward technical curricular content with assessments made by technicians themselves.

The total organization of this study was focussed upon development of a structure which would permit assessment of differences and relationships between the curricular recommendations of management and of technicians. The tests and procedures were applied to (1) the 348 technicians of Project 2048 and the 168 (52 technicians included) respondents of this project; and (2) the four levels of respondents within this project. In turn, each of the divisions, (1) and (2), functioned as a framework which was used for making two kinds of tests; viz: (a) comparisons of the various core recommendations, and (b) comparisons based on ranking and/or correlational procedures, and Kruskal-Wallis one way analysis of variance.

Testing the relative contribution of each group to the general core revealed significant differences in two job families as reported in Chapter III. However, since the number of technician jobs in each of these groups was extremely limited, it was decided that no conclusions were appropriate.

Rank difference correlation was applied to the 99 items of the card sort to test for relationship between the technician responses and each of the other groups of management and the technicians in Project 2048. The high values of r' (all at $P < .001$) support the conclusion that differences between management and technician responses are minimal. Visual comparisons using Appendix R may locate the few isolated differences which exist.

Kruskal-Wallis one way analysis of variance yielded a non-significant value of H when card ranks were compared across all four levels, using responses from only those eighteen firms which provided a respondent at all four levels. Visual analysis of Appendices Q and R shows that but few differences can be located. Searching for differences only among the cards ranked of high importance draws attention to cards 1, 52, 67, and 77, all of which appear to be ranked lower in importance than the technicians ranked them; three of these four cards still scored adequately for placement in the general core.

(2) Isolate and analyze variables (age, time on current job, educational attainment beyond high school) and isolate their relationships to curricular recommendations.

This objective was considered partially attained in the investigator's dissertation, the findings of which indicated no significant differences as measured (4). Testing was structured around the criterion of generality of card sort items, for which procedures and instruments were designed (see Appendix S).

Kruskal-Wallis one way analysis of variance was used to assess for differences between management and technicians and produced several significant findings (Chapter III). Technicians and management differed in educational attainment, age, and salary, as determined by mean rank comparisons in the tests. Age was positively related to level of management. Educational attainment was apparently different at every level, but level 1 was higher than level 2. Salaries were positively related to the levels structure as one would expect. Comparisons on time on current job and on time with current employer yielded no significant differences.

This conclusion that the levels structure performs its function adds meaning to a prior conclusion in this study, which was that management and technicians agree rather closely on technical curricular matters. However, had there been no significant differences between levels on the comparisons of age, salary, and educational attainment, one would hardly expect differences on choices of curriculum.

(3) Establish and assess degree of relationship between level of authority of management and generality of recommendations for curricula content.

Major emphasis was accorded this objective in the investigator's dissertation (4); therefore, further pursuit in this study is considered unnecessary. Extensive testing resulted in the findings that management and technicians did not differ significantly in the generality of their card sort selections. As a review, the dissertation and this study have 125 respondents which are common to both studies. The reader is referred to Appendix S for further explanation of the generality tests.

(4) Identify a core of courses which management agrees is desirable for most post high school technical programs.

The devotion of a major section of this chapter to the core program makes further presentation on this point rather redundant. However, on the basis of the direct rank comparisons of groups of respondents and the significance level of the correlations ($< .001$), and largely insignificant differences in the extent to which each group contributed to the various cores, it is concluded that management supports the core programs identified in this study. The same findings support the conclusion presented under objective number one--that management and technician views toward two year technical curricula are essentially the same.

(5) Test hypotheses that management will include more kinds of course content in their recommendations compared with recommendations of technicians.

This objective and objective number 3 were tested as the main problem in the writer's dissertation (4). The criterion of generality was defined in terms of the number of cards a respondent selected; see Appendix S. No significant differences in relationship were found between number of card selections and levels of respondents. Two way analysis of variance, Chi square and contingency coefficient were basic to these tests.

Concluding Statement

The classification of technician respondents into job families was based on job functions as recorded during each data collection interview. The results of these classifications lie outside the realm of the objectives of this study but are mentioned because of the surprising number of technician jobs which appeared as "hybrids" rather than as Electrical, Mechanical, or Chemical. All except one of the technicians interviewed from within the electrical manufacturing area were identified as Electro-Mechanical, not as Electrical. A similar pattern prevailed in the area between Mechanical and Chemical (see Table V). If hybrid technical occupations are increasing or changing, the need for systematic identification of the extent and direction are necessary. Programs of study which purport to prepare technicians must provide subject matter and emphases which are consistent with occupational requirements.

This study was based on an assumption which at this time is pertinent. It was assumed that management and/or supervisory personnel employed in the participating firms would be both willing and capable of cooperating in supplying the desired judgments as necessary to complete the card sort. This assumption has been verified.

The notion that management and technician respondents would differ measurably in their curricular recommendations has been concluded as untenable. The close similarity which was indicated by the tests, leads instead, to the conclusion that views of the two groups (as tested) are essentially the same. The core recommendations are concluded to represent the collective views of management and technician respondents. These cores are recommended for use as guidelines in the design and refinement of post high school technical programs.

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APPENDIX A

THE CURRICULUM DECK

Card No.	Content
1.	Technical and scientific oral and written communication including business forms, reports, emphasizing the different types of business letters. Techniques of collecting and presenting scientific data. Informal reports and formal reports; special types of technical papers.
2.	Fundamental physical and chemical principles governing food preservation by freezing, canning, drying, concentration, salting, smoking, fermenting, carbonating.
3.	Numerical control, data processing, interpretation of engineering drawings, depiction of data by manuscript, minimum dimensions and use of formulae, left data, translation, programming, and quality control.
4.	Thermosetting and thermoplastic materials. Films, enamels, paints, lacquers, alkyds, phenolics.
5.	The biology of the common bacteria and microorganisms. Laboratory work in the techniques of sterilization, disinfection; isolation and maintenance of pure cultures; staining and identification.
6.	Lab procedure to identify and protect against radiation and electrical hazard including medical and nursing methods.
7.	Relationships between the structure and the physical and chemical properties of ceramic materials, including clays, refractories, and cement.
8.	Analysis and design of basic electronic circuits involving vacuum-tube and semi-conductor devices. Graphical characteristics and coefficients. Linear equivalent circuits. Elementary feedback analysis.
9.	The chemistry of food; carbohydrates, protein, fats, minerals, vitamins, and food pigments. Basic nutritional needs.
10.	Mendelism, the chromosomal theory, the physio-chemical nature of the gene, cytoplasmic inheritance and environmental influences; emphasis on human inheritance, problems of genetic counseling, and eugenics; experiments with fruit flies, protozoa and plants.
11.	The constellations, solar system, structure of the universe, determination of time and calendars. Use of astronomical instruments for data collection.

12. Coulomb's Law and the basic concepts of electrostatics, direct and alternating current theory, magnetism, electromagnetism, Ampere's Law, oscillator circuits, and L/c and R/c circuits.

13. Agglutination, planting, and transplanting of cultures; animal inoculations; preparations of smears and media utilizing bacteriological material and mycological material from patients. Diagnostic procedure for identification of pathogenic bacteria and fungi. Antibiotic sensitivity studies.

14. Microbial life with emphasis on morphology, culture, and the biochemical activities of bacteria, viruses and fungi; pathogenic micro-organisms, human protozoan and helminth parasites; antiseptics, disinfectants, sterilization, infection and resistance, diagnostic tests and immunizations.

15. Laboratory techniques in use for identification of parasites. Thick film for malaria, concentration techniques for ova and cysts, wet and stained preparations for intestinal parasites, especially of the common pathological forms.

16. General and economic entomology; taxonomy of the principal orders in insects; life histories, habits, recognition, and control of some of the principal insect pests.

17. Use of simple test equipment. Theory and application of commercial test equipment, trouble analysis and test and alignment methods and practices.

18. Principles of pulse and timing circuits, including multivibrators, limiters, clippers, blocking oscillators, and counting circuits. Quantitative analysis of differentiating and integrating circuits.

19. Mineralogy including physical properties, blowpipe and chemical methods; the origin occurrence and association of minerals; basic crystallography, and the identification of minerals by means of physical and chemical properties.

20. Identification and classification of minerals and rocks with particular emphasis on well cuttings, field mapping, subsurface mapping and well correlation. Historical geology, geophysical methods, and electric log interpretation. Rotary drilling equipment, prime movers circulation systems derricks and masts, bits, lubrication, drilling technique, and mud control and drilling problems.

21. Thermodynamic aspects of gas turbine and turbo-jet engine design. Perfect and real gas relationships and their application to problems of flow through compressors and turbines. Modern gas turbine cycles and their application to power plant, industrial, and aircraft installations.

22. Engine cycles, performance, characteristics, analysis of problems, theory of internal combusion engines. Fuel systems on internal combustion engines and the functions of the parts.

23. Organization and methods involved in establishment and conduct of training programs for company employees.

24. Analysis of organizational structure of business.

25. Development of the labor movement and the main forces underlying the labor problem. Government regulation of labor relationships, approach of workers to labor problems; the development of the National Labor Relation Acts, the Wagner Act, the Taft-Hartley Act; management-labor relations.

26. Practical application of basic psychology in planning, conducting and evaluating conferences and interviews. Emphasis on employee selection, classification, training, evaluation, working conditions, counseling, group attitudes in the occupational situation as they affect motivation, status and morale.

27. Time study and the science of management; process charts, operation analysis, motion economy and job design; time study preparation, observation, calculation and adjustment; ration delay study; formula development and construction of tables, curves and multivariable charts.

28. Maintaining labor force and control so that the objectives and purposes of the company are attained as effectively and economically as possible. Methods and procedures related to the efficient utilization of resources in production planning and control; materials procurement and control; methods improvement; time study and wage determination; selection of layout, etc.

29. The underlying principles of plane surveying; surveying instruments and their use; adjustment of the level and transit; calculations; introduction to mapping and optical tooling.

30. Basic principles underlying human behavior and its control; perception, learning, motivation, emotion, intelligence, personality and adjustment.

31. Automotive fuels, fuel requirements, fuel ratings, fuel tanks, lines, fittings, pumps, carburetors, fuel injectors, superchargers, govenors, gauges, manifolds, and exhaust systems; automotive batteries, generators, alternators, rectifiers, current regulators, cranking motors, ignition systems, lighting systems, signaling devices, wiring, power windows, and convertible top electrical apparatus.

32. Elementary techniques and practices of manipulation and fabrication of simple laboratory apparatus of heat resistant glass. Bending, cutting, grinding, pulling, and joining glass.

33. Tension and compression within the elastic range. Hooke's Law, working assembly, and thermal stresses. Mohr's circle, bending moment and shear diagrams. Deflection of transversely loaded beams. Theory of columns. Combined loadings. Laboratory tests.

34. Composition and resolution of forces, equilibrium conditions, Newton's laws of motion, uniformly accelerated motion, projectile motion, concept of work, power and energy, elasticity, rotational motion, and simple harmonic motion.

35. Metal forming including machining, chemical milling, spinning, electrical forming, and explosive forming.

36. Kinematics of a particle, kinetics of rigid bodies, moments in inertia of masses, rotation of rigid bodies, any plane motion of rigid bodies, impulse, momentum, impact, properties of solids and liquids, and introduction to vector analysis.

37. Metal forming including casting, die casting, forging, extruding and the accompanying pattern and tool construction.

38. Applied statics and strength of materials, dealing with forces, stresses, and the design of simple machines and structures. Applications of the characteristics of modern engineering materials to structures.

39. The physical and chemical fundamentals of glasses. The roles of constituents in relation to the formation, structure and properties of glasses. Basic concepts in the glassy state.

40. Fundamentals of propulsion. Thermodynamic cycles and basic characteristics of ram jets, turbo jets, turbo props, pulse jets and rockets; analysis of propulsion systems.

41. Functions and manipulation of the basic business machines, with emphasis on the various duplicating processes and dictaphone machines. Some working knowledge of the comptometer, the 10-key and other calculator and adding machines.

42. Cost accounting, job-lot process cost. Accounting methods for material, labor and factory overhead, and preparation of financial statements from cost data.

43. Tax laws as they affect business and accounting procedures; preparation of personal, partnership, and corporate income tax returns; computation of capital stock, excess profits, estate, gift and excise taxes.

44. (PERT) Selection and sequencing of specific identifiable events necessary to successful completion of a project. Estimates of time, evaluation procedures, information channels, and use of data processing techniques to permit periodic summaries of projects.

45. Techniques in presenting market data, evaluating market potential, and selecting locations for wholesale, retail, and service establishments.

46. A branch of mathematics dealing chiefly with the rate of change of functions with respect to their variables--differential calculus.

47. Graphical solution of problems involving points, lines, planes, revolutions, intersections, angles, tangent planes and developments; problems involving contoured and warped surfaces.

48. Cartesian and polar coordinates, straight lines, conics, reduction of general quadratics to type forms, locus problems, parametric equations.

49. Differential equations; line integrals; vector analysis gradient, divergence and curl; solutions of the equations. Partial differential equations and boundary value problems, wave equation, heat conduction, complex variable theory and conformal mapping. Couchy integral theorem, residue theorem.

50. Separation of variables, homogeneous functions, exact equations, integrating factors, linear equations of the first order first degree, Bernoulli's equations, coefficients linear in the two variables, series integration, orthogonal trajectories, hyperbolic functions and applications.

51. Trigonometric functions and fundamental formulae. Logarithms and solution of triangles, identities and equations. Trigonometry from ratios, right triangles and identities through vectors and graphs of trigonometric functions.

52. Algebraic graphing, exponents, powers, roots, radicals, imaginary and complex numbers through ratio proportions, variations, and logarithms.

53. Metric system and square root; geometry from plane figures to geometric solids; algebra from operations with signed numbers through algebraic expressions, equations, special products, factoring, and fractional equations and simultaneous equations.

54. Permutations, combinations and probabilities; infinite series; determinants; inequalities, and mathematical induction.

55. Laplace transforms, Gamma, Bessel and Legendre functions; Fourier series and orthogonal functions; multiple, line and surface integrals; vector field theory, theorems of Gauss, Green, and Stokes.

56. Linear, radical, and quadratic equations; simultaneous solutions of second-degree equations; binomial theorems, deMoivre's theorem, rational and irrational roots of polynomial equations of any degree; complex numbers, cubic and quadratic equations, theorems on roots, isolation, limits and approximation of real roots.

57. Vacuum tube and transistor theory. AC parameters, resonance, transformers, coupling, filters, bandpass, and complex wave forms. Tuned and untuned circuits, and vacuum tube power supplies.

58. Elementary logic, mathematical induction, permutations, combinations probability, the theory of matrices and matrix transformations, theory of vector spaces, and the concept of set.

59. Integration as the converse of differentiation, integrals as the limit of a sum, reduction of type forms; applications to geometry and mechanics.

60. Analytic geometry, extremal problems limits, continuity, derivatives, antiderivatives, and the calculation of area by approximation methods and by use of antiderivative functions.

61. Sketching forms from observation; emphasizing volumes, perspective, compsotion, and measurements.

62. Preparation of zoological and botanical materials for microscopic examination; including principal techniques and histochemical preparations.

63. Machine elements and calculations in determining the size and shape of various machine parts. Factors which influence the selection of materials to be used. Prototypes.

64. Basic illustrating techniques, color concepts, organization of space and aesthetic judgment.

65. Preparation of block diagrams, schematics, and layouts using standard conventions.

66. ASA standards, use of handbooks, graphical treatment of empirical data, conversion charts and nomograms, graphical differentiation and integration, tolerance and limit dimensioning.

67. Projection and graphic representation: use of instruments, lettering, applied geometry, dimensioning, sections, conventions (e.g., welding, pipe, electronic), auxiliary views, screw threads, cams, gears, theory of perspective, preparation of working and assembly drawings.

68. Programming of electronic digital computers for applications in business and industry. Data processing, characteristics of computers, and computer programming or coding. Machine organization, problem formulation, automatic programming, numerical analysis, machine language programming, and applications of computers.

69. The organization and basic operation of a digital computer. Programming, number systems, and Boolean Algebra. Analysis, design, and utilization of principle computer circuits such as logic gates, flip-flops, and memory networks. Design of binary counters and application of Boolean Algebra to perform binary arithmetic.

70. Ferrous and nonferrous metal heat treating, macrostructure, composition, physical and chemical testing. Metallography, metallurgical examinations, inspection procedures, and corrosion testing.

71. Electronic circuit theory of video amplifiers, tuned amplifiers, and basic feedback oscillators. Nonlinear amplifiers, modulators and demodulators. Noise in electron devices. Relaxation phenomena and wave-form generation.

72. Pattern drafting and layout; tool operations as related to processes of manufacturing sheet and plate products.

73. Metal fabrication including oxyacetylene welding and cutting; electric arc welding; heliarc and shielded arc welding; friction and vacuum welding, and cold fasteners.

74. Plant morphology, physiology, genetic, inheritance, identification, classification, and environmental relationships,

75. The use of synchros and servomechanisms, synchro generators, motors, differentials and control transformers. Control circuitry for error detection, anti-hunt systems, servo amplifiers, thyratrom motor control, the Ward Leonard control systems, the amplidyne, and AC servomotors. Industrial application of electronic controls including photoelectric devices.

76. Feedback problem in linear systems. Techniques such as: transfer and weighting functions; block diagrams, signal flow graphs, time-domain analysis, root locus technique and frequency-domain analysis.

77. The use of measuring equipment in a system to measure or control the system; such as thermocouples, strain gauges, pressure transducers and various current or voltage pickups. Accuracy inherent in alternate methods of measurement. Methods of transcribing or indicating measured values, or of using measured quantities to control the system.

78. The growth and development of dairying. (A) Principles and practices in the production of milk; basic feeding, management, and disease control practices. (B) Basic principles of dairy industry practices; common dairy tests; general survey of all important branches of the industry.

79. The calibration and use of typical industrial and laboratory instruments and their actual use in the analysis of equipment representative of various fields. Calorimetric, spectrophotometric, spectrographic, electrolytic, and potentiometric methods.

80. The basic laws and theories of elements, compounds, and the structure and behavior.

81. The principles, equipment, operation, and flow of chemical processes. Production of the common acids, bases, salts, gases, and cryogenic liquids.

82. Basic photography with emphasis on graphic arts procedures and applications in the preparation of negatives for offset lithography, basic photographic materials and supplies, developer reaction, color sensitive materials and supplies; and filters and halftone screens.

83. Chemical testing of industrial materials and products; preparation of solutions and reagents; and investigation of gravimetric, volumetric, and gasometric methods. Chromatographic, spectrophotometric, spectro-

graphic, potentiometric, and conductimetric, and microscopic procedures.

84. The fundamental laws governing the behavior of gases, liquids and solutions. Chemical equilibrium in homogeneous and heterogeneous systems. Electrolysis, conductance, transference. EMF's of cells with and without transport. First law of thermodynamics with application to thermochemistry. Application of thermodynamics. Chemical kinetics including photochemistry and chain reactions. Quantum theory and infra-red and Roman spectra.

85. Carbon compounds; their structures, properties and nomenclature; types of reactions of important functional groups. Laboratory techniques, preparations and qualitative analysis.

86. The physical chemistry of polymerization, basic kinetics and mechanisms of condensation and addition of polymerizations. The measurement of the physical properties of high polymer systems including molecular weight, solution properties, and polymer structure.

87. Technique of venepuncture. Practice in the common biochemical medical tests (blood sugar, nonprotein nitrogen, proteinometry, etc.) and the uncommon tests (e.g., sodium, potassium, phosphatases, etc.) Liver and kidney function tests, simple toxicological tests, pregnancy tests.

88. The problems and effects of industrial wastes discharge upon a sewerage collection system and treatment plants to which it is tributary. Industrial wastes ordinances and representative control problems.

89. Mechanics of fluids, temperature scales, thermal expansion, methods and laws of heat transfer, calorimetry, properties of gases, fusion and vaporization, and an introduction to thermodynamics; wave motion and sound.

90. Atoms, single crystals and polycrystaline materials. Properties of the metallic state; nature of alloys; making of alloys; phase equilibrium diagrams; micro-constituents of alloys; mechanical and thermal treatment; survey of nonferrous and ferrous metallurgy.

91. Equations of state, the first and second laws of thermodynamics, reversible and irreversible processes, isothermal and adiabatic processes, Carnot processes, absolute temperature scale, entropy, free energy, Gibbs potential, equilibrium, Nerst's heat theorem, specific heats of solids.

92. The properties of fluid and vapors including use of vapor tables and charts: flow of fluids in nozzles; combustion calculations; vapor cycles and steam power applications; mixtures of vapor and gases.

93. The principles and practice of heat transfer by conduction, radiation, free and forced convection, vapor condensation, and boiling liquids. Unsteadystate heat transfer.

94. Fission, neutron diffusion, neutron moderation, bare homogeneous

thermal reaction, Reactor Theory, special relativity, x-rays, nuclear structure, natural and artificial transmutation, and radioactivity.

95. The nature and propagation of light, photometry, diffraction and interference, dispersion, spectra and color, polarized light, radiant energy, electrolysis, photoelectric effect and quantum of light, Bohr's theory, spectra of atoms.

96. Bacteria, yeasts and molds; physiology, morphology, and systematic relationships; the significance of bacterial, yeasts and molds in general sanitation, agriculture, home economics and communicable diseases.

97. Elementary aspects of organic unit processes including nitration, sulfonation, halogenation, hydrogenation, oxidation and alkylation.

98. Environmental testing of components, parts, and products for assessment of performance in actual application.

99. Preparations of specimens for testing by processes such as slicing, polishing, electropolishing, etching, dyeing, and impregnating.

APPENDIX B
INTERVIEW SCHEDULE

1. Management information:

Co. ID _/ _/ _ Mfg code _/ _/ _/ _

Age _/ _/ Level of Mgt _

Are tech. working w/in your resp?___

Have you ever worked as/w a tech in a capacity similar to tech job to which you are responding? ___

2. Educational History

A H.S. Location__, Diploma__

B Post H.S. Loc__ Major ______
Sem Hrs_/ _/ _Wk Days _/ _/ _

C Post H.S. Loc__ Major ______
Sem Hrs_/ _/ _Wk Days _/ _/ _

D Post H.S. Loc__ Major ______
Sem Hrs_/ _/ _Wk Days_/ _/ _

E Post H.S. Loc__ Major ______
Sem Hrs_/ _/ _Wk Days_/ _/ _

F Educational Attainment_/ _/ _

G Comments:____________________

____

____

3. Job History

First job
Loc___, Length_/ _/ _
Comments on first job:__________

____

____

____

____

____

SES __

Present Job
Location__, Length_/ _/ _
Total time w/pres co _/ _/ _
Salary _/ ___
Comments on present job:______

____

____

Total no. of jobs since leaving high school__/ ___

4. Code:

Mgmt Level

3 = 3 lev
2 = 2 lev
1 = 1 lev
0 = tech

Resp for Tech

1 = no
2 = yes

H.S. Diploma

1 = none
2 = regular
3 = G.E.D.
4 = other

Mfg. Area Code
00-other than mfg
10-ordinance and access
20-food and kindred pr
21-tobacco mfrs
22-textile mill prod
23-apparel & other fin prod made fr fabric & sim mat
24-lumber & wood prod except furn
25-furn & fix
26-paper & appl pr
27-pr, publ & alld pr
28-chem & alld pr
29-petrol ref & allied ind
30-rubber & misc plas prod
31-leather & lther pr
32-stone, clay, and glass prod
33-primary metal indus
34-fabri metal prod except ordinance mach & trans equip
35-mach, non-elec
36-el mach, equip & suppl
37-transpt equip
38-prof, sci & con. ins. photo, opti. & watches
39-misc mfg indus

APPENDIX C

DIRECTIONS FOR THE SORT

Each of the cards in the deck of cards you have been given describes an area of knowledge or skills. The cards are to be sorted according to the extent to which the descriptions on them are related to the successful performance of the technician job to which you are responding. Do not concern yourself with logical order or prerequisite knowledge. To do this most readily, the following procedures would be useful:

1. Read through all the cards to become familiar with the material.

2. Sort the cards into three groups:

   a. one group of cards which describe knowledges and skills that are most essential to successful job performance: Related

   b. one group of cards about which you are in doubt: Somewhat Related

   c. one group of cards which describes knowledges and skills which are least essential to successful job performance: Unrelated

3. Record the numbers of these cards on the sheet supplied.

APPENDIX D
CARD SORT REPORTING FORM

ID ____________/____________

For the two smaller stacks of cards, record the number of each card under its appropriate heading. Beyond placing each card into one of the three groups, the order of writing them down is unimportant.

Related	Somewhat Related	Unrelated

APPENDIX E

SALARY LEVEL CARD

Annually	Weekly
01 = under 4000	01 = under 77
02 = 4001 to 4500	02 = 77.01 to 86
03 = 4501 to 5000	03 = 86.01 to 96
04 = 5001 to 5500	04 = 96.01 to 106
05 = 5501 to 6000	05 = 106.01 to 115
06 = 6001 to 6500	06 = 115.01 to 125
07 = 6501 to 7000	07 = 125.01 to 134
08 = 7001 to 7500	08 = 134.01 to 144
09 = 7501 to 8000	09 = 114.01 to 154
10 = 8001 to 8500	10 = 154.01 to 163
11 = 8501 to 9000	11 = 163.01 to 173
12 = 9001 to 9500	12 = 173.01 to 182
13 = 9501 to 10,000	13 = 182.01 to 192
14 = 10,001 to 10,500	14 = 192.01 to 202
15 = 10,501 to 11,000	15 = 202.01 to 212
16 = 11,001 to 11,500	16 = 212.01 to 221
17 = 11,501 to 12,000	17 = 221.01 to 231
18 = 12,001 to 12,500	18 = 231.01 to 240
19 = 12,501 to 13,000	19 = 240.01 to 249
20 = 13,001 to 13,500	20 = 249.01 to 260
21 = 13,501 to 14,000	21 = 260.01 to 269
22 = 14,001 to 14,500	22 = 269.01 to 279
23 = 14,501 to 15,000	23 = 279.01 to 288
24 = 15,001 to 15,500	24 = 288.01 to 298
25 = 15,501 and above	25 = 298.01 and above

APPENDIX F

INTERVIEW ARRANGEMENTS

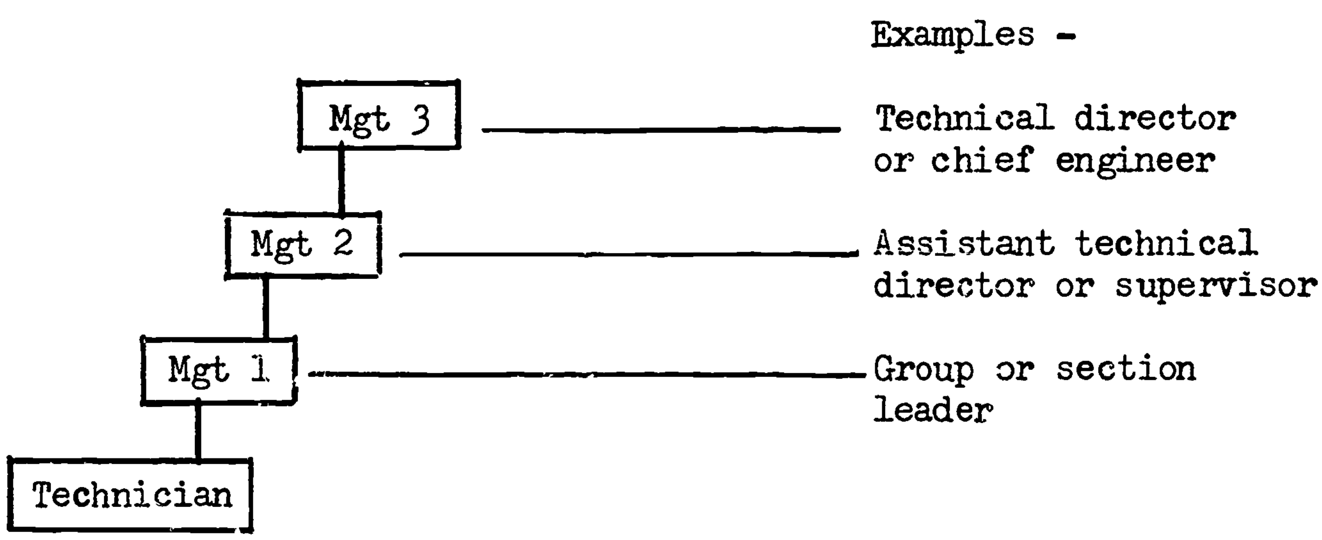
1. Technician respondent

   A. One technician is needed as a participant. He should be selected from a department, section, or division of the plant which would allow management selection as discussed under number 2, below.

   B. He should be working at a level commensurate with the definition of technician (as attached) and should not have a 4 year college degree.

2. Supervisory respondents

   A. Three management or supervisory personnel, each representing a different level of authority in relation to the technician being interviewed, are desired. If the intended structure could be isolated from the total line functions of all employees in the plant it might appear as follows:



   B. All three management or supervisory respondents need to have appropriate educational or technical background and familiarity with the technician's job to which they are responding.

APPENDIX F (continued)

3. Space and time requirements

   A. A desk (or table) and two chairs are helpful. Respondents are interviewed one at a time.

   B. Complete privacy is unnecessary. A lunch room, conference room, or small office space is suitable.

   C. About 30 minutes per respondent are usually needed, although some respondents will complete both the interview and the card sort in about 15 minutes.

APPENDIX G

PARTICIPATING FIRMS

A. Original Sample

No.	Mfg. Classification	No. of Employees	Coded Location	Techs Interviewed for S-196:	Mgt. Interviewed:
1	36	1036	3	1	2
2	36	1309	1	1	3
*3	(Deleted from S-196 data)				
4	28	664	1	1	3
5	38	2651	1	1	2
6	35	467	2	1	2
7	35	611	2	1	3
8	33	523	1	1	1
9	33	436	1	1	2
10	33	202	1	1	2
11	26	600	1	1	3
12	20	312	1	1	2
13	38	257	1	1	2
14	35	258	1	1	2
15	36	816	1	1	1
16	33	210	2	1	2
17	34	500	1	1	3
18	33	3700	1	1	3
19	35	610	1	1	3
20	35	540	2	1	3
21	33	2950	2	1	2
22	34	250	1	1	2
23	25	530	1	1	2
24	28	200	1	1	2
25	35	603	1	1	2
26	34	420	1	1	2
27	25	1041	1	1	1
28	36	330	1	1	3
29	28	892	1	1	2
30	35	773	1	1	2
31	35	300	2	1	2
32	36	480	1	1	3
33	33	425	1	1	2
34	33	840	1	1	3
35	34	230	3	1	3
36	33	1541	1	1	2
37	33	371	1	1	2
38	28	326	1	1	3
39	36	250	1	1	2
40	33	1420	1	1	1

APPENDIX G (continued)

B. Sample enlargement

No.	Mfg. Classification	No. of Employees	Coded Location	Techs Interviewed for S-196	Mgt. Interviewed:
41	34	1500	2	1	3
42	35	4400	2	1	2
43	20	300	1	1	2
44	36	240	1	1	2
45	20	1800	1	1	3
46	34	300	1	1	3
47	36	1000	3	1	2
48	20	300	1	1	3
49	32	400	1	1	1
50	27	575	1	1	1
51	35	1200	1	1	2
52	35	950	2	1	3
53	35	200	1	1	3

*Data from this company were deleted prior to analysis because it was decided that the technician interviewed was below the technical level as defined on page 6.

APPENDIX H

TABLE I

AGE, RAW DATA

(N= 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	29	40	44	58
4	22	24	60	54
7	30	44	30	30
11	26	29	32	43
17	43	38	42	48
18	23	29	33	42
19	23	46	51	49
20	52	48	52	39
18	43	42	44	53
32	49	49	47	50
34	25	41	47	45
35	43	36	48	45
38	24	34	43	51
41	20	37	36	61
45	24	31	44	44
46	26	35	43	47
52	28	34	41	50
53	38	27	38	54
Σ	568	64	775	863
$\bar{X}$	31.56	36.89	43.06	47.94

APPENDIX H

TABLE II

H RANKINGS FOR MATCHED DATA

AGE: ALL LEVELS

(N = 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	14	32	46	70
4	2	6	71	68.5
7	17	46	17	17
11	9.5	14	20	39.5
17	39.5	29	36	56
18	3.5	14	21	36
19	3.5	51	63.5	59
20	65.5	56	65.5	31
28	39.5	36	46	67
32	59	59	53	61.5
34	8	33.5	53	49.5
35	39.5	25.5	56	49.5
38	6	22.5	39.5	63.5
41	1	27	25.5	72
45	6	19	46	46
46	9.5	24	39.5	53
52	12	22.5	33.5	61.5
53	29	11	29	68.5

H = 25.8, 3 df, P < .001

APPENDIX I

TABLE I

EDUCATIONAL ATTAINMENT
RAW DATA
(N= 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	93	76	147	58
4	8	41	1	83
7	54	251	170	17
11	19	208	231	260
17	91	145	200	158
18	120	85	145	131
19	51	191	272	324
20	113	130	24	173
28	129	126	11	135
32	32	120	48	176
34	31	108	0	156
35	60	34	1	35
38	73	130	175	330
41	60	166	145	12
45	59	211	214	182
46	101	148	210	152
52	40	9	106	149
53	32	172	149	64
Σ =	1166	2351	2039	2595
$\bar{X}$ =	64.8	130.6	113.3	144.2

APPENDIX I

TABLE II

H RANKINGS FOR MATCHED DATA

EDUCATIONAL ATTAINMENT; ALL LEVELS
(N = 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	31	27	47	21
4	4	17	2.5	28
7	20	68	55	8
11	9	63	67	69
17	30	45	62	53
18	36.5	29	45	42
19	19	61	70	71
20	35	40.5	10	57
28	39	38	6	43
32	12.5	36.5	18	59
34	11	34	1	52
35	23.5	14	2.5	15
38	26	40.5	58	72
41	23.5	54	45	7
45	22	65	66	60
46	32	48	64	51
52	16	5	33	49.5
53	12.5	56	49.5	25

H = 11.7, 3 df, $P < .01$

APPENDIX J

TABLE I

SALARY LEVEL, RAW DATA
(N=18 for each group)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3	
2	11	13	21	21	Project 2048 Firms
4	3	6	12	21	
7	7	9	14	9	
11	8	14	17	21	
17	9	20	21	21	
18	9	11	13	21	
19	6	20	21	21	
20	7	21	17	21	
28	9	12	21	21	
32	10	18	21	21	
34	3	10	14	21	
35	14	16	9	20	
38	7	13	16	21	
41	4	17	18	25	
45	5	11	18	25	
46	10	14	25	25	
52	12	14	16	25	
53	10	13	15	25	
Σ	8.0	14.0	16.9	21.4	
$\bar{X}$	$7250	$10,250	$11,450	$15,501	

APPENDIX J

TABLE II

H RANKINGS FOR MATCHED DATA
SALARY: ALL LEVELS
(N= 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	22	28.5	61	61
4	1.5	5.5	25	61
7	8	13.5	33.5	13.5
11	10	33.5	42	61
17	13.5	48	61	61
18	13.5	22	28.5	61
19	5.5	48	61	61
20	8	61	42	61
28	13.5	25	61	61
32	18.5	45	61	61
34	1.5	18.5	33.5	61
35	33.5	39	13.5	48
38	8	28.5	39	61
41	3	42	45	61
45	4	22	45	61
46	18.5	33.5	61	61
52	25	33.5	39	61
53	8.5	28.5	37	61

$H = 45.0$, 3 df, $P < .001$

APPENDIX K

TABLE I

TIME ON PRESENT JOB
RAW DATA
(N= 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	96	84	156	60
4	8	24	240	7
7	48	68	36	6
11	36	4	7	36
17	156	48	12	7
18	21	30	60	144
19	26	90	72	18
20	60	9	484	8
28	86	120	24	48
32	48	8	204	228
34	20	96	48	24
35	48	24	36	84
38	30	84	36	276
41	18	48	48	54
45	11	8	24	48
46	66	60	42	120
52	60	60	6	60
53	120	24	72	164
Σ	958	889	1607	1116
$\bar{X}$	53.2	49.4	89.3	62.0

APPENDIX K

TABLE II

H RANKINGS FOR MATCHED DATA
TIME IN PRESENT JOB: ALL LEVELS
(N = 4 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	59.5	55	65.5	46
4	8.5	20.5	70	5
7	37	51	29	2.5
11	29	1	5	29
17	65.5	37	13	5
18	17	25.5	46	64
19	24	58	52.5	14.5
20	46	11	72	8.5
28	57	62	20.5	37
32	37	8.5	68	69
34	16	59.5	37	20.5
35	37	20.5	29	55
38	25.5	55	29	71
41	14.5	37	37	42
45	12	8.5	20.5	37
46	50	46	32	62
52	46	46	2.5	46
53	62	20.5	52.5	67

$H = .2$, 3 df, $P < .98$

APPENDIX I

TABLE I

TOTAL TIME (MONTHS) WITH PRESENT COMPANY
RAW DATA
(N = 3 x 18)

Co.	Techs	Mgt 1	Mgt 2	Mgt 3
2	(Data	132	252	348
4	not	74	492	324
7	available)	83	84	85
11		30	21	72
17		150	12	84
18		68	132	144
19		90	84	18
20		9	348	18
28		144	120	216
32		60	204	228
34		96	300	264
35		180	216	336
38		108	120	396
41		96	44	66
45		11	24	48
46		60	60	302
52		66	56	336
53		44	72	60
Σ		1501	2641	3345
$\bar{X}$		83.4	146.7	185.8

APPENDIX L

TABLE II

H RANKINGS FOR MATCHED DATA
TOTAL TIME WITH CURRENT EMPLOYER,
MANAGEMENT ONLY
(N= 3 x 18)

Co.	Mgt 1	Mgt 2	Mgt 3
2	34.5	44	51.5
4	22	54	48
7	27	25	27
11	8	6	20.5
17	38	3	25
18	19	34.5	36.5
19	28	25	4.5
20	1	51.5	4.5
28	36.5	32.5	41.5
32	14.5	40	43
34	29.5	46	45
35	39	41.5	49.5
38	31	32.5	53
41	29.5	9.5	17.5
45	2	7	11
46	14.5	14.5	47
52	17.5	12	49.5
53	9.5	20.5	14.5

$H = 4.5$, 3 df, $P < .2$

APPENDIX M

MEANS OF RESPONSES BY LEVEL OF RESPONDENT WITHIN JOB FAMILIES, N=46 FOR EACH LEVEL

	El-Mech (n=8)			Mech (n=21)			Chem-Mech (n=7)			Chem (n=5)			Chem-Foods (n=4)		
	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2
1	2.25	2.25	2.25	2.57	2.19	2.19	2.14	2.14	1.86	2.20	2.00	2.00	2.75	2.5	2.50
2	1.00	1.00	1.13	1.10	1.10	1.10	1.00	1.00	1.14	1.40	1.60	1.00	1.50	2.00	2.00
3	1.75	1.25	2.25	2.52	2.24	2.43	1.86	1.57	2.00	1.40	1.60	1.40	1.00	2.50	1.25
4	1.50	1.38	2.13	1.67	1.76	1.76	1.43	1.71	1.86	2.40	2.40	1.40	1.00	1.50	1.00
5	1.00	1.00	1.00	1.00	1.05	1.05	1.00	1.00	1.00	1.20	1.20	1.00	2.25	2.25	2.25
6	1.75	1.38	1.63	1.05	1.29	1.33	1.14	1.00	1.14	1.40	1.40	1.00	1.50	1.50	1.25
7	1.25	1.00	1.25	1.19	1.19	1.33	1.57	1.29	1.43	2.00	1.40	1.60	1.00	1.00	1.25
8	2.38	1.88	1.75	1.38	1.29	1.24	1.14	1.14	1.00	1.40	1.00	1.00	1.00	1.25	1.00
9	1.00	1.00	1.00	1.00	1.05	1.00	1.00	1.14	1.00	1.60	1.80	1.60	2.50	2.75	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.00	1.00	1.00	1.00	1.25
11	1.00	1.00	1.00	1.00	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	2.25	2.25	2.25	1.57	1.52	1.48	1.29	1.57	1.14	1.20	1.20	1.40	1.00	1.25	1.25
13	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.00	1.00	1.25	1.25	1.50
14	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.00	1.00	2.00	1.75	1.75
15	1.00	1.13	1.00	1.00	1.05	1.00	1.00	1.00	1.00	1.20	1.00	1.00	1.75	1.00	1.25
16	1.00	1.25	1.00	1.00	1.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.75	1.75	2.00
17	2.50	2.88	2.88	2.52	1.76	2.48	2.57	2.57	2.43	2.80	2.60	2.80	2.50	2.75	2.50
18	2.00	1.50	1.88	1.52	1.29	1.29	1.00	1.14	1.14	1.00	1.00	1.00	1.00	1.00	1.00
19	1.00	1.00	1.00	1.24	1.19	1.14	1.14	1.43	1.14	1.40	1.40	1.20	1.25	1.25	1.00
20	1.00	1.00	1.00	1.14	1.10	1.00	1.00	1.29	1.00	1.20	1.20	1.40	1.00	1.00	1.00
21	1.25	1.38	1.25	1.19	1.05	1.19	1.14	1.14	1.00	1.00	1.00	1.00	1.00	1.00	1.00
22	1.25	1.38	1.25	1.48	1.19	1.43	1.14	1.14	1.14	1.00	1.00	1.00	1.00	1.25	1.00
23	1.25	1.38	1.38	1.52	1.24	1.48	1.29	1.29	1.29	1.40	1.00	1.00	1.50	1.75	1.25
24	1.38	1.25	1.38	1.33	1.29	1.38	1.29	1.14	1.14	1.20	1.00	1.00	1.00	1.25	1.00
25	1.25	1.13	1.00	1.24	1.05	1.19	1.14	1.14	1.29	1.00	1.00	1.00	1.00	1.25	1.00

APPENDIX M (continued)

	El-Mech (n=18)			Mech (n=21)			Chem-Mech (n=7)			Chem (n=5)			Chem-Foods (n=4)		
	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2
26	2.00	1.38	1.50	1.48	1.29	1.29	1.43	1.29	1.14	1.40	1.00	1.20	1.50	1.75	1.25
27	1.25	1.50	1.88	1.95	1.67	1.81	1.71	1.86	2.00	1.60	1.40	1.20	1.50	1.75	1.00
28	1.75	1.50	1.38	1.86	1.48	1.71	1.71	1.71	1.43	1.00	1.00	1.20	1.50	1.50	1.00
29	1.13	1.13	1.00	1.29	1.10	1.14	1.14	1.00	1.14	1.00	1.00	1.00	1.00	1.00	1.00
30	1.63	1.50	1.63	1.81	1.43	1.57	1.71	1.29	1.71	1.40	1.60	1.60	1.00	2.00	1.00
31	1.25	1.38	1.38	1.32	1.19	1.29	1.14	1.14	1.14	2.00	1.00	1.00	1.00	1.25	1.25
32	1.13	1.13	1.63	1.43	1.33	1.43	1.57	1.43	1.29	2.20	2.20	2.00	2.00	2.00	2.25
33	1.50	1.50	1.63	1.81	1.67	1.76	2.00	1.71	2.00	1.40	1.40	1.40	1.00	1.25	1.00
34	1.63	2.00	2.00	1.71	1.81	1.86	2.14	1.57	1.57	1.60	1.20	1.40	1.00	1.50	1.00
35	1.63	1.75	2.38	2.62	2.48	2.24	2.00	1.43	2.29	1.40	1.00	1.40	1.00	1.00	1.00
36	1.13	1.50	1.63	1.67	1.48	1.67	1.57	1.43	1.57	2.00	1.00	1.20	1.00	1.75	1.25
37	1.75	2.00	2.25	2.67	2.48	2.14	2.71	2.43	2.14	1.20	1.00	1.20	1.00	1.00	1.00
38	2.00	2.13	2.50	2.52	2.14	2.24	2.29	2.14	1.86	1.20	1.00	1.00	1.75	1.50	1.00
39	1.00	1.00	1.00	1.05	1.00	1.05	1.14	1.00	1.00	1.40	1.40	1.40	1.00	1.25	1.00
40	1.25	1.38	1.25	1.10	1.10	1.10	1.00	1.14	1.14	1.20	1.00	1.00	1.00	1.75	1.00
41	1.00	1.13	1.13	1.76	1.43	1.67	1.43	1.71	1.43	1.40	1.00	1.00	1.25	1.25	1.50
42	1.00	1.75	1.63	1.67	1.43	1.52	1.57	1.43	1.43	1.00	1.40	1.00	1.50	1.25	1.00
43	1.13	1.00	1.00	1.14	1.05	1.10	1.14	1.10	1.00	1.00	1.00	1.00	1.00	1.00	1.00
44	2.25	1.38	1.50	2.14	1.67	1.57	1.43	1.71	1.43	1.20	1.00	1.40	1.25	1.50	1.00
45	1.13	1.25	1.00	1.10	1.10	1.00	1.14	1.14	1.00	1.20	1.00	1.00	1.00	1.50	1.00
46	2.00	1.50	1.88	1.62	1.43	1.67	1.43	1.29	1.43	1.40	1.20	1.40	1.00	2.50	1.00
47	1.63	1.38	2.25	2.43	2.00	2.57	1.71	1.57	2.00	1.40	1.20	1.40	1.00	2.50	1.25
48	1.38	1.13	1.50	1.57	1.43	1.62	1.14	1.00	1.57	1.20	1.00	1.00	1.00	1.50	1.00
49	1.50	1.38	1.25	1.57	1.29	1.33	1.14	1.43	1.29	1.40	1.00	1.00	1.00	1.75	1.00
50	1.13	1.25	1.38	1.67	1.24	1.29	1.14	1.43	1.14	1.40	1.00	1.00	1.00	2.50	1.00
51	2.25	2.00	2.63	2.38	2.29	2.52	2.00	2.14	1.71	1.60	1.60	1.20	1.00	2.00	1.00
52	2.25	2.00	2.13	2.33	1.95	2.10	2.00	1.86	1.57	2.00	1.20	1.60	2.25	2.25	1.25
53	2.13	1.88	2.50	2.33	2.33	2.43	2.00	2.14	1.71	2.60	2.60	2.20	2.50	2.50	1.50
54	1.00	1.13	1.50	1.67	1.19	1.52	1.57	1.14	1.29	1.40	1.00	1.20	1.00	2.25	1.25
55	1.38	1.13	1.25	1.14	1.00	1.04	1.00	1.00	1.14	1.20	1.00	1.00	1.00	1.00	1.00

APPENDIX M (continued)

	El-Mech (n=18)			Mech (n=21)			Chem-Mech (n=7)			Chem (n=5)			Chem-Foods (n=4)		
	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2
56	1.63	1.50	1.63	2.10	1.33	1.38	1.00	1.43	1.43	1.60	1.60	1.40	1.00	1.50	1.00
57	1.88	2.00	1.88	1.29	1.38	1.29	1.29	1.57	1.14	1.00	1.00	1.00	1.00	1.00	1.00
58	1.38	1.13	1.75	1.43	1.29	1.33	1.57	1.57	1.71	1.20	1.00	1.20	1.75	2.25	1.00
59	1.38	1.13	1.63	1.76	1.33	1.57	1.43	1.4	1.29	1.20	1.00	1.20	1.00	1.75	1.00
60	1.63	1.88	2.00	1.81	1.48	1.76	1.43	1.57	1.57	1.40	1.40	1.00	1.00	2.00	1.25
61	1.88	1.88	2.50	2.29	2.33	2.38	2.00	2.14	2.00	1.40	1.40	1.60	1.00	1.50	1.25
62	1.00	1.00	1.00	1.05	1.00	1.00	1.00	1.14	1.00	1.20	1.00	1.20	1.00	1.50	1.25
63	2.38	1.75	1.88	2.33	2.24	2.43	2.00	1.86	2.14	1.00	1.60	1.20	1.50	1.50	1.25
64	1.13	1.50	1.25	1.10	1.43	1.29	1.29	1.00	1.57	1.60	1.20	1.20	1.00	1.25	1.00
65	2.38	2.75	2.25	2.43	2.19	2.29	1.57	1.57	1.71	1.00	1.40	1.40	1.50	2.00	1.25
66	2.38	1.88	2.50	2.33	2.43	2.67	2.29	2.43	2.29	2.20	2.40	2.40	1.25	1.75	1.00
67	2.13	2.25	2.38	2.71	2.25	2.38	2.57	1.86	1.86	1.60	1.20	1.20	2.75	1.00	1.75
68	1.00	1.13	1.50	1.29	1.19	1.24	1.29	1.14	1.14	1.00	1.00	1.00	1.25	1.75	1.00
69	1.38	1.13	1.25	1.29	1.24	1.25	1.29	1.00	1.14	1.00	1.00	1.00	1.00	1.00	1.00
70	1.63	1.38	2.38	2.04	2.43	2.10	2.57	2.43	2.29	1.60	1.40	1.20	1.00	1.25	1.00
71	2.00	1.63	1.88	1.19	1.24	1.14	1.29	1.29	1.14	1.00	1.00	1.00	1.00	1.00	1.00
72	1.75	2.00	2.25	2.67	2.14	2.19	2.00	2.00	2.00	1.00	1.00	1.20	1.00	1.25	1.00
73	1.75	1.38	2.25	2.14	2.24	2.19	1.57	1.57	1.71	1.20	1.00	1.00	1.00	1.25	1.00
74	1.25	1.00	1.00	1.05	1.05	1.00	1.29	1.00	1.00	1.20	1.20	1.00	1.00	1.00	1.00
75	1.25	1.50	2.13	1.52	1.52	1.52	1.29	1.86	1.00	1.00	1.00	1.00	1.00	1.50	1.25
76	1.38	1.50	1.25	1.38	1.14	1.14	1.14	1.14	1.14	1.20	1.00	1.00	1.00	1.00	1.00
77	2.38	2.38	2.75	2.14	2.04	2.10	2.57	1.86	2.00	1.80	1.40	2.20	1.00	2.00	1.00
78	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.00	1.00	1.50	2.00	1.75
79	2.00	1.88	2.25	1.76	2.00	1.67	1.71	1.86	2.14	1.80	2.80	2.20	1.75	1.25	1.00
80	1.38	1.75	2.00	1.71	1.52	1.95	1.71	2.14	2.00	2.60	1.00	1.40	2.25	2.50	1.50
81	1.00	1.38	1.25	1.38	1.19	1.19	1.29	1.43	1.14	2.20	1.80	2.20	2.25	2.50	1.75
82	1.13	1.13	1.13	1.14	1.14	1.29	1.43	1.00	1.00	1.00	1.40	1.20	2.25	2.50	1.75
83	1.25	1.13	1.38	1.33	1.52	1.38	2.00	2.00	1.86	2.40	2.60	2.80	1.50	1.00	1.25
84	1.13	1.50	1.38	1.52	1.29	1.38	1.14	1.57	1.43	1.80	1.20	1.40	2.25	3.00	2.25
85	1.13	1.13	1.25	1.43	1.19	1.14	2.29	2.00	1.71	2.40	2.80	2.80	1.50	2.25	1.75

APPENDIX M (continued)

	El-Mech (n=18)			Mech (n=21)			Chem-Mech (n=7)			Chem (n=5)			Chem-Foods (n=4)		
	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2	T	M_1	M_2
86	1.13	1.00	1.25	1.10	1.14	1.04	1.57	1.43	1.43	2.60	1.80	2.20	1.50	1.75	1.00
87	1.00	1.00	1.00	1.00	1.00	1.00	1.14	1.00	1.00	1.40	1.00	1.00	1.00	1.00	1.00
88	1.00	1.00	1.00	1.24	1.14	1.10	1.43	1.14	1.29	2.00	1.20	1.00	1.50	1.75	1.00
89	1.50	1.88	2.25	1.57	1.76	1.67	1.86	1.57	1.57	1.80	1.40	1.40	1.00	2.00	1.50
90	1.25	1.50	1.13	1.48	1.38	1.33	2.14	1.86	2.14	1.60	1.60	1.40	1.25	1.00	1.00
91	1.00	1.25	1.38	1.29	1.25	1.24	1.29	1.29	1.29	1.40	1.20	1.00	1.25	1.75	1.00
92	1.50	1.63	1.25	1.38	1.29	1.52	1.57	1.57	1.29	1.40	1.80	1.60	1.00	2.00	1.25
93	1.38	1.50	1.88	1.67	1.71	1.67	1.29	1.57	1.43	1.60	1.20	1.60	1.50	1.75	1.00
94	1.00	1.00	1.00	1.10	1.05	1.05	1.14	1.14	1.00	1.40	1.20	1.00	1.00	1.00	1.00
95	1.13	1.25	1.38	1.19	1.19	1.29	1.43	1.29	1.29	1.40	1.60	1.20	1.50	1.75	1.75
96	1.00	1.00	1.00	1.05	1.05	1.00	1.14	1.00	1.00	1.40	1.00	1.20	2.50	2.00	1.75
97	1.00	1.00	1.13	1.19	1.00	1.10	1.29	1.29	1.00	1.80	2.20	1.80	1.50	1.75	1.00
98	2.13	2.63	2.50	2.10	2.00	2.24	2.29	1.71	1.86	1.40	2.00	2.00	1.50	2.25	1.00
99	1.50	1.63	1.50	1.71	1.67	1.57	2.00	2.29	2.14	2.00	1.80	1.60	2.00	1.25	1.25

APPENDIX N

TABLE I

DATA FOR ANALYSIS OF VARIANCE, ELECTRO-MECHANICAL CORE

27 observations, 3 treatments

Card No.	Techs	M_1	M_2
3	1.75	1.25	2.25
4	1.50	1.38	2.13
8	2.38	1.88	1.75
12	2.25	2.25	2.25
18	2.00	1.50	1.88
26	2.00	1.38	1.50
34	1.63	2.00	2.00
35	1.63	1.75	2.38
37	1.75	2.00	2.25
38	2.00	2.13	2.50
44	2.25	1.38	1.50
46	2.00	1.50	1.88
47	1.63	1.38	2.25
51	2.25	2.00	2.63
57	1.88	2.00	1.88
60	1.63	1.88	2.00
61	1.88	1.88	2.50
63	2.38	1.75	1.88
65	2.38	2.75	2.25
67	2.13	2.25	2.38
70	1.63	1.38	2.38
71	2.00	1.63	1.88
72	1.75	2.00	2.25
73	1.75	1.38	2.25
75	1.25	1.50	2.13
80	1.38	1.75	2.00
89	1.50	1.88	2.25
$\bar{X}$	1.87	1.77	2.12

APPENDIX N

TABLE II

DATA FOR ANALYSIS OF VARIANCE
CHEM-MECHANICAL CORE

19 observations; 3 treatments

Card No.	Techs	M_1	M_2
3	1.86	1.57	2.00
27	1.71	1.86	2.00
33	2.00	1.71	2.00
34	2.14	1.57	1.57
35	2.00	1.43	2.29
37	2.71	2.43	2.14
38	2.29	2.14	1.86
47	1.71	1.57	2.00
51	2.00	2.14	1.71
61	2.00	2.14	2.00
63	2.00	1.86	2.14
67	2.57	1.86	1.86
70	2.57	2.43	2.29
72	2.00	2.00	2.00
80	1.71	2.14	2.00
83	2.00	2.00	1.86
85	2.29	2.00	1.71
90	2.14	1.86	2.14
99	2.00	2.29	2.14
$\bar{\bar{X}}$	2.09	1.95	1.98

APPENDIX N

TABLE III

DATA FOR ANALYSIS OF VARIANCE, CHEMICAL CORE

13 observations, 3 treatments

Card No.	Techs	Mgt_1	Mgt_2
4	2.40	2.40	1.40
7	2.40	1.40	1.60
31	2.00	1.00	1.00
32	2.20	2.20	2.00
36	2.00	1.00	1.20
88	2.00	1.20	1.00
80	2.60	1.00	1.40
81	2.20	1.80	2.20
83	2.40	2.60	2.80
85	2.40	2.80	2.80
86	2.60	1.80	2.20
97	1.80	2.20	1.80
99	2.00	1.80	1.60
$\bar{X}$	2.23	1.78	1.77

APPENDIX N

TABLE IV

DATA FOR ANALYSIS OF VARIANCE, CHEM-FOODS CORE

24 observations, 3 treatments

Card No.	Techs	M_1	M_2
2	1.50	2.00	2.00
3	1.00	2.50	1.25
5	2.25	2.25	2.25
9	2.50	2.75	1.00
14	2.00	1.75	1.75
30	1.00	2.00	1.00
32	2.00	2.00	2.25
46	1.00	2.50	1.00
47	1.00	2.50	1.25
50	1.00	2.50	1.00
51	1.00	2.00	1.00
54	1.00	2.25	1.25
58	1.75	2.25	1.00
60	1.00	2.00	1.25
64	1.50	2.00	1.25
76	1.00	2.00	1.00
80	2.25	2.50	1.75
83	2.25	3.00	2.25
84	1.50	2.25	1.75
88	1.50	1.75	1.00
89	1.00	2.00	1.50
92	1.00	2.00	1.25
96	2.50	2.00	1.75
99	2.00	1.25	1.25
$\bar{X}$	1.52	2.17	1.41

APPENDIX O

RAW DATA, FREQUENCY OF RELATED RESPONSE BY CARD, MANAGEMENT AND TECHNICIANS TOGETHER BY FIRM
(N = 4 x 18)

Item	freq.	Item	freq.	Item	freq.	Item	freq.
1	33	26	6	51	31	76	2
2	2	27	12	52	25	77	27
3	18	28	10	53	41	78	1
4	18	29	0	54	5	79	28
5	1	30	12	55	1	80	21
6	8	31	3	56	14	81	7
7	18	32	11	57	11	82	3
8	9	33	7	58	5	83	16
9	5	34	12	59	5	84	3
10	0	35	27	60	8	85	13
11	0	36	5	61	28	86	4
12	13	37	24	62	0	87	0
13	0	38	25	63	23	88	3
14	0	39	0	64	7	89	12
15	0	40	3	65	35	90	4
16	2	41	8	66	43	91	1
17	49	42	9	67	27	92	6
18	9	43	0	68	3	93	9
19	1	44	17	69	2	94	1
20	0	45	0	70	18	95	5
21	3	46	6	71	5	96	2
22	5	47	23	72	20	97	5
23	7	48	5	73	22	98	31
24	3	49	2	74	0	99	9
25	1	50	1	75	8		

APPENDIX P

RANKINGS FOR MANAGEMENT
AND TECHNICIANS BY FIRM
(N=4x18)

Item	Rank	Item	Rank	Item	Rank	Item	Rank
1	95	26	48	51	93.5	76	24.5
2	24.5	27	67.5	52	85.5	77	89
3	76.5	28	63	53	97	78	17.5
4	76.5	29	7	54	41.5	79	91.5
5	17.5	30	67.5	55	17.5	80	80
6	55.5	31	31	56	72	81	51.5
7	76.5	32	64.5	57	64.5	82	31
8	60	33	51.5	58	41.5	83	73
9	41.5	34	67.5	59	41.5	84	31
10	7	35	89	60	55.5	85	70.5
11	7	36	41.5	61	91.5	86	35.5
12	70.5	37	84	62	7	87	7
13	7	38	85.5	63	82.5	88	31
14	7	39	7	64	51.5	89	67.5
15	7	40	31	65	96	90	35.5
16	24.5	41	55.5	66	98	91	17.5
17	99	42	60	67	89	92	48
18	60	43	7	68	31	93	60
19	17.5	44	74	69	24.5	94	17.5
20	7	45	7	70	76.5	95	41.5
21	31	46	48	71	41.5	96	24.5
22	41.5	47	82.5	72	79	97	41.5
23	51.5	48	41.5	73	81	98	93.5
24	31	49	24.5	74	7	99	60
25	17.5	50	17.5	75	55.5		

APPENDIX Q

CARD SORT RANKS MATCHED DATA
(For Computation of H)
(N=4x18)

Card	Techs	Mgt 1	Mgt 2	Mgt 3	Card	Techs	Mgt 1	Mgt 2	Mgt 3
1	394.5	355.5	355.5	340	37	340	323	323	369.5
2	60.5	205.5	60.5	205.5	38	355.5	323	355.5	340
3	323	269	355.5	269	39	60.5	60.5	60.5	60.5
4	323	269	303.5	340	40	205.5	205.5	205.5	60.5
5	60.5	60.5	60.5	205.5	41	143	205.5	143	269
6	205.5	143	143	269	42	303.5	143	205.5	143
7	60.5	60.5	60.5	60.5	43	60.5	60.5	60.5	60.5
8	269	205.5	143	269	44	369.5	269	205.5	323
9	205.5	60.5	205.5	269	45	60.5	60.5	60.5	60.5
10	60.5	60.5	60.5	60.5	46	143	60.5	269	205.5
11	60.5	60.5	60.5	60.5	47	355.5	269	369.5	323
12	303.5	143	303.5	269	48	143	205.5	143	60.5
13	60.5	60.5	60.5	60.5	49	205.5	205.5	205.5	60.5
14	60.5	60.5	60.5	60.5	50	60.5	60.5	205.5	60.5
15	60.5	60.5	60.5	60.5	51	388.5	303.5	380.5	355.5
16	205.5	205.5	60.5	60.5	52	380.5	303.5	380.5	269
17	395.5	391.5	391.5	386	53	395.5	355.5	388.5	369.5
18	143	143	143	269	54	303.5	60.5	205.5	60.5
19	60.5	60.5	60.5	205.5	55	205.5	60.5	205.5	60.5
20	60.5	60.5	60.5	60.5	56	369.5	209.5	303.5	205.5
21	205.5	205.5	205.5	60.5	57	269	143	269	269
22	143	205.5	205.5	205.5	58	143	60.5	269	60.5
23	269	205.5	143	205.5	59	269	60.5	143	60.5
24	143	60.5	60.5	205.5	60	269	143	269	60.5
25	205.5	60.5	60.5	60.5	61	369.5	340	369.5	340
26	269	60.5	143	205.5	62	60.5	60.5	60.5	60.5
27	303.5	269	269	143	63	340	303.5	340	355.5
28	269	269	205.5	269	64	269	60.5	205.5	269
29	60.5	60.5	60.5	60.5	65	386	369.5	355.5	386
30	303.5	143	143	303.5	66	391.5	380.5	394.5	380.5
31	60.5	205.5	60.5	143	67	391.5	340	323	303.5
32	303.5	269	269	205.5	68	205.5	60.5	205.5	205.5
33	205.5	205.5	143	269	69	143	60.5	60.5	60.5
34	205.5	269	269	323	70	269	303.5	323	340
35	369.5	323	355.5	355.5	71	143	60.5	143	205.5
36	269	60.5	143	60.5	72	369.5	303.5	303.5	303.5

APPENDIX Q (continued)

Card	Techs	Mgt 1	Mgt 2	Mgt 3	Card	Techs	Mgt 1	Mgt 2	Mgt 3
73	340	143	340	369.5	87	60.5	60.5	60.5	60.5
74	60.5	60.5	60.5	60.5	88	143	60.5	60.5	205.5
75	205.5	269	205.5	355.5	89	143	269	205.5	340
76	60.5	205.5	205.5	60.5	90	143	60.5	205.5	205.5
77	369.5	323	380.5	323	91	60.5	60.5	60.5	205.5
78	60.5	60.5	60.5	205.5	92	205.5	143	143	205.5
79	355.5	323	369.5	369.5	93	323	143	205.5	205.5
80	340	303.5	340	323	94	60.5	205.5	60.5	60.5
81	143	143	205.5	143	95	143	205.5	143	60.5
82	205.5	205.5	60.5	205.5	96	205.5	60.5	60.5	205.5
83	269	303.5	303.5	323	97	60.5	205.5	205.5	269
84	205.5	60.5	205.5	205.5	98	380.5	355.5	380.5	340
85	303.5	269	269	269	99	269	205.5	269	143
86	143	205.5	60.5	205.5					

$H = 5.9$, 3 df, $P < .2$

APPENDIX R

RANKINGS OF ROUGH SORT DATA PROJECTS 2048 AND S-196

Card No.	2048 Techs N=348	Total S-196 N=168	Techs S-196 N=52	Mgt 1 N=52	Mgt 2 N=46	Mgt 3 N=18
1	97	95	96	87	85	89
2	23	28	16	37	29	42.5
3	95	83	84	86	92.5	72
4	63	77	75	75	76	85.5
5	16	30	23.5	26.5	35	33.5
6	25	51	31.5	56	50	55
7	33	32	40	15	44.5	25.5
8	61	58	62	51.5	49	64
9	24	47	37	40	48	60
10	2	2	2	1.5	6.5	10
11	1	1	1	7	2.5	2.5
12	73	71	71	72	69	70.5
13	5.5	12	3	4	11.5	10
14	12	17	14.5	18	21	10
15	5.5	7.5	12.5	7	6.5	2.5
16	10	20	10.5	25	22.5	17
17	99	99	99	99	99	98.5
18	52	57	56	49	61	64
19	32	26	25	29.5	18	47
20	11	4	7	11	11.5	10
21	14	19	17	21.5	26	10
22	26	36	38	29.5	42.5	36
23	70	40.5	42	40	44.5	50.5
24	45	27	33.5	16	33	47
25	36	85	19	9.5	26	17
26	68.5	40	47	36	38	42.5
27	75	73	67.5	73	75	58
28	82	67	67.5	65	64	67.5
29	20	14	19	9.5	22.5	17
30	72	63	55	66	57.5	74
31	37	34	28	38	32	54
32	41	66	69	55	71	42.5
33	59	68	73	60	72	70.5
34	67	72	65	68	73	77.5
35	86	87	86	83	88	90.5
36	49	49	57	47.5	57.5	25.5
37	92	91	93	93	81	93.5
38	85	90	92	91	86	87

APPENDIX R (continued)

Card No.	2048 Techs N=348	Total S-196 N=168	Techs S-196 N=52	Mgt 1 N=52	Mgt 2 N=46	Mgt 3 N=18
39	15	13	12.5	18	14	10
40	3	21	14.5	28	24	10
41	60	60	60	54	55	67.5
42	74	62	64	62	53	56.5
43	18	3	7	4	11.5	2.5
44	81	75	81	71	56	79
45	22	5	7	12.5	2.5	22.5
46	64	52	48	59	59	53
47	78	85	83	82	96	80
48	30	42	41	35	65	22.5
49	43	39	46	43	37	30
50	29	37	35.5	53	36	20.5
51	90	92	90	94	89.5	92
52	87	81	89	80	79	73
53	96	97	95	97	97	95
54	38	40.5	52	33.5	89.5	25.5
55	13	11	19	7	16	10
56	56	61	77	47.5	51	36
57	54	48	51	70	62	64
58	53	44	53	51.5	53	31
59	55	65	58	42	41	25.5
60	55	65	66	67	66	28.5
61	89	88	82	88.5	94	83.5
62	8	9	4.5	18	11.5	10
63	88	86	85	84	91	90.5
64	44	54	59	57.5	39	69
65	93	89	87	90	84	98.5
66	98	98	97	98	98	97
67	94	96	98	95	87	76
68	34	25	29	12.5	31	42.5
69	27	16	26	14	19	19
70	80	80	79	85	83	85.5
71	47.5	45	45	50	42.5	50.5
72	83	82	88	81	80	75
73	79	79	76	76	78	93.5
74	9	18	23.5	23	6.5	2.5
75	68.5	59	49.5	64	46.5	64
76	42	22	22	32	26	20.5
77	91	93	94	92	95	82
78	7	7.5	4.5	4	2.5	32
79	77	84	80	88.5	82	95
80	76	78	74	79	77	81
81	51	43	33.5	57.5	34	56.5
82	19	31	31.5	26.5	30	42.5

APPENDIX R (continued)

Card No.	2048 Techs N=348	Total S-196 N=168	Techs S-196 N=52	Mgt 1 N=52	Mgt 2 N=46	Mgt 3 N=18
83	66	76	70	78	74	77.5
84	50	46	49.5	45	46.5	47
85	62	69	72	69	68	64
86	35	35	44	40	9	42.5
87	4	6	10.5	1.5	2.5	10
88	28	29	39	24	16	36
89	71	70	54	74	67	83.5
90	46	53	63	46	63	42.5
91	31	23	21	33.5	20	42.5
92	47.5	50	35.5	63	53	50.5
93	65	56	61	61	60	50.5
94	17	10	9	20	6.5	10
95	39.5	38	43	44	40	28.5
96	21	24	30	21.5	16	33.5
97	39.5	33	27	31	28	61
98	84	94	91	96	92.5	88
99	58	74	78	77	70	59

APPENDIX S

TECHNICAL EDUCATION CURRICULAR RECOMMENDATIONS BY MANAGEMENT REPRESENTATIVES OF MANUFACTURING ESTABLISHMENTS IN ILLINOIS

Abstract of Ed.D. dissertation (4)

The Problem. The increasing needs of industry for individuals who are prepared to function in technical occupations have resulted in an apparent gap in the development of appropriate public educational offerings. The curricula of such programs are of concern to several groups in our society. The problem studied is whether or not a group of technically qualified management personnel of manufacturing establishments which employ technicians will exhibit more general views toward post-high school technical curricula than will technicians themselves.

Statistical tests were used to assess the relationships between generality of curricular selections and the variables (1) age, (2) educational attainment, (3) company size, and (4) length of time with present employer.

Design. The sample of manufacturing establishments was selected from those plants in Illinois with 200 or more employees. A total of 130 respondents was utilized from 40 plants; 1 technician and 1, 2, or 3 management respondents from each of the same plants. Each management respondent of a given company represented a different level of authority in relation to the technician job to which he responded.

A 99 card curriculum deck contained descriptions of essentially all subject areas which feasibly could be judged related to the performance

of some type of technician job. Data were procured by personal interview and by having the respondents sort the deck into related, somewhat related and unrelated stacks.

Generality was defined and tested in two ways, (1) in number of items from the deck rated as related by each respondent and (2) by the value of each card selected as determined by a general to specific continuum.

Two-way analysis of variance, Chi square, and product moment correlation were used in the testing of research hypotheses.

Conclusions and Implications. Insignificant differences (.05 level) indicated that, on the criterion of generality, technicians tend to agree with management. It was concluded that the occupational level as structured in this dissertation is not important as a basis for nomination of members for educational advisory and curriculum committees. While it is important that these two kinds of committees have capable members, it was concluded that the views of any one group tested in this study are not measurably different on the criterion of generality from the views of the other groups. Therefore, committee nominations, either from among technicians or from among management personnel, would not narrow the curricular views of the committee. If one assumes that certain management personnel are in key positions to identify educational needs of technicians, the technician himself should be considered as occupying a similar position.