FACTORS ASSOCIATED WITH THE EFFECTIVENESS OF PERSONNEL IN POSITIONS APPROPRIATE FOR DEGREE-LEVEL INDUSTRIAL TECHNOLOGISTS

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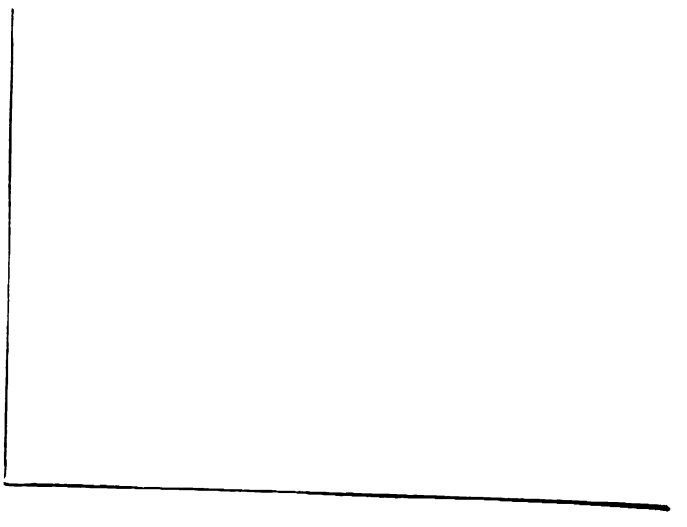

ABSTRACT

FACTORS ASSOCIATED WITH THE EFFECTIVENESS
OF PERSONNEL IN POSITIONS APPROPRIATE
FOR DEGREE-LEVEL INDUSTRIAL TECHNOLOGISTS

by Raymond Leslie Keil

Body of Abstract

The problem investigated by this study was the identification of those factors associated with the effectiveness of management-oriented technical personnel employed by a major chemical company during a specified six-year period at the intermediate ranges of technical employment where graduates of baccalaureate degree-level industrial technology curriculums offered by divisions or departments of industrial education might be employed.

The company personnel records of thirty-five identified high achievers from four functional areas of employment were investigated, and the critical incident technique was utilized to collect, through personal interviews, 106 reports of critical incidents of effective on-the-job performance.

The investigation of the company personnel records revealed the following: (1) The educational backgrounds of the subjects were somewhat varied, but were predominately technical in nature. The technical sales area was the one functional area where a variety of types of degrees was utilized. (2) Academic rank in major was found to be a more discriminating criterion for identifying high achievers than cumulative grade point average. (3) The mean grade point average

for the group studied was slightly above average, but it was not considered to have been exceptionally high. (4) The advantages of holding a master's degree were not clear and further investigation of this subject was recommended. (5) 23% of the subjects had participated in college work experience curriculums. (6) 29% of the subjects had held research or teaching assistantships while in college. (7) One-third of the subjects had earned 80% to 100% of their college expenses, and almost two-thirds had earned 50% or more of their college expenses.

The data from the critical incident reports were analyzed on the basis of three dimensions: (1) functional task performed, (2) primary medium of involvement, and (3) type of skill utilized. The following summarizes the findings of the preceding analysis: (1) The six functional tasks of "investigating", "evaluating", "coordinating", "negotiating", "consulting", and "initiating" were identified in higher percentages of the critical incidents (37% to 52%) than the functional tasks of "planning", "organizing", and "promoting" which were identified in lower percentages (21% to 26%) of the critical incidents. (2) There was no identifiable pattern of behaviors common to all four functional groups studied. (3) The human relations medium was most frequently identified as the principal medium of involvement associated with effectiveness. (4) The five established skill categories—conceptual, human relations, technical, communication, and business and organizational—were all utilized in high percentages of the critical incidents reported (65% to 85%); however, human relations, technical, or business and organizational skills were classified most

frequently as the "most important" skill associated with the key effective behavioral act.

In addition to the foregoing the thirty-five high achievers most frequently cited company job experience and specific technical courses as having contributed to their effective performances.

The findings of this study were interpreted as support for industrial technology curriculums, and recommendations were made for further investigation of industrial technology curriculums.

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By

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CHAPTER I

THE PROBLEM AND DEFINITION OF TERMS USED

The scientific and technological revolution of the past few decades has placed new demands on industry and has caused rapid changes in all areas of industrial activity. The increasing rate of change of our technology has brought about new problems associated with the education of technically-oriented personnel. These rapid technological changes have given impetus to new types of educational preparations which will equip individuals with broad understandings as well as specializations. A particular need has developed for the investigation of the demands resulting from the new series of management-oriented technical positions which have been created within the intermediate ranges of the personnel structure of the modern industry.

I. STATEMENT OF THE PROBLEM

The problem investigated in this study was the identification of those factors associated with the effectiveness of management-oriented technical personnel employed by a major chemical company in a delineated area of employment. Specifically, this study was concerned with: (1) an analysis of critical incidents reported by individuals classified as having been effective employees, and (2) an analysis of the available company personnel records to determine whether there was an identifiable pattern of behaviors, backgrounds, and qualifications associated with the effectiveness of individuals staffing positions within the intermediate ranges of management-oriented technical employment.

Another facet of the problem investigated by this study was the relationship between: (1) the types of behaviors identified as having been factors associated with effectiveness and (2) the educational experiences of the person who performed the behavioral act.

The following questions were also investigated: (1) Is there a relationship between the effective individual's academic record and the fact that he had been identified as having been an effective employee? (2) To what extent do effective individuals from different areas of employment report different types of effective behavior? (3) Is there a common pattern of behaviors? and (4) Are individuals from a variety of educational backgrounds being employed by the cooperating company to staff positions of similar type?

II. PURPOSE OF THE STUDY

The primary purpose of this study was to conduct an exploratory investigation into a defined area of management-oriented technical employment in which graduates of degree-level industrial technology curriculums might be employed. The intent was to build a body of descriptive information concerning the nature of the types of behavioral tasks which persons identified as effective employees within a defined area of employment performed which were considered to have contributed to their effectiveness on the job. It was intended that the identified behavioral tasks could then be available for use as a basis for selecting and developing educational experiences which might be incorporated into the design of degree-level curriculums of industrial technology.

A secondary purpose of this study was to analyze and organize the collected data into a form which administrators and/or faculties of institutions offering degree-level industrial technology curriculums might use as: (1) a basis for developing analytical tools for conducting further research related to degree-level industrial technology curriculums as defined in this study, (2) a basis for evaluating existing curriculum patterns, and (3) a basis for identifying potential areas of employment for the graduates of degree-level industrial technology curriculums as defined in this study.

This study is believed to be unique in that: (1) it investigated a broad sector of potential employment which cut across various functional types of activity rather than to have surveyed the graduates of industrial technology curriculums staffing particular positions, and (2) only persons identified as having been "most effective" personnel were utilized as the primary source of information.

III. SIGNIFICANCE OF THE STUDY

The significance of the study is related to the following needs:

1. The need for technical manpower in the intermediate ranges ranges of technical employment.
2. The need for research related to the area of degree-level industrial technology curriculums.
3. The need for information concerning the evaluation, development and selection of management-oriented technical personnel.

The Need for Technical Manpower

The general significance of this study rests in the fact that

it was concerned with a facet of technological education at a time when our American society was acutely aware of the need for technical competency. Technological and scientific education had shared the spotlight of attention in American education in recent years since the orbiting of the first Russian satellite.

The literature is replete with articles and reports indicating the increasing demands for various types of technical manpower.

The President's Science Advisory Committee stated that:

> Today in America we need a wide variety of human talents . . . , each with special training but all with a broad background and point of view. Furthermore, as knowledge advances each generation, and as new innovations accumulate, new kinds of skills emerge and students must be trained in new professions to cope with new problems.[1]

A particular need has arisen for persons with technical backgrounds qualified to staff the management positions emerging in the intermediate ranges of technical employment.

Nelson pointed out that:

> . . . By professionalizing managerial positions, by creating a research and development corps of engineers; by introducing scientific machines; and through creation of vast industrial complexes, the occupational technologist has been created.[2]

Cunningham made essentially the same point when he stated:

> The divisions of administration and research and development have become highly specialized in their duties, leaving a large area of activities which are not served by either division.[3]

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[1]President's Science Advisory Committee, Education for the Age of Science, (Washington: Government Printing Office, 1959), p. 26.

[2]Hilding E. Nelson, "Prospectus for a Graphic Arts Technology Curriculum," Industrial Arts and Vocational Education, LIII (February 1964), p. 18.

[3]Beryl M. Cunningham, "Applied Sciences in Education and Industry" (Peoria, Illinois: College of Applied Sciences, Bradley University, 1964), p. 1. (Mimeographed.)

Historically many of these positions would have been filled by graduates of professional engineering schools, and some of these positions will continue to be staffed by graduate engineers. Several conditions, however, have altered this pattern and limited the extent of this practice. First, engineering education has changed and "all engineering activities, regardless of field, rest on and ever-increasing foundation of mathematics and science."[4] The engineer no longer finds the time to perform many of the functions which he performed in previous years. Secondly, as S. C. Hollister, Dean of the College of Engineering at Cornell University, pointed out, an apparent "turning point" has been reached in the engineering profession as the percentage of the population available "to be made into engineers" is no longer increasing despite the accelerating need for engineers in our economy.[5] Many experts have estimated that our nation's engineering schools must graduate twice the present 35,000 engineers per year if we are to meet the expanding needs. Since it now appears improbable that the nation's engineering colleges will be able to attain the goal of 70,000 to 80,000 engineers per year, another approach to the problem is necessary.[6]

It has become apparent that if a readjustment of technical

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[4]Massachuetts Institute of Technology, A Proposal for Experimental Developments in Engineering Education. A Report Prepared by the Faculty of the School of Engineering at the Masssachuetts Institute of Technology, (Cambridge: Massachuetts Institute of Technology, March 1959), p. 7.

[5]S.C. Hollister, "A Goal for American Engineering Education," Journal of Engineering Education, XLIII (September 1952), p. 8.

[6]Purdue University Bulletin. School of Technology: Announcements 1965-1966, LXV (February 1965), No. 14, p. 9.

manpower is to be made, special attention must be given not only to the training of engineering technicians, but also to management-oriented professional personnel who have the additional managerial and human relations skills necessary to complement their technical qualifications.

The Need for Research Related to Industrial Technology Curriculums

Industrial technology curriculums have been in urgent need of research data upon which to formulate their objectives and to design their curriculums. It is a truism that good curriculum development should proceed from a well-defined set of objectives. However, industrial technology curriculums, for the most part, have not been founded upon any thoroughly formulated set of objectives. In many cases the the programs have been based upon some loosely stated aim such as "to prepare persons to go into industry." Weber noted that "in the absence of any previous experiences or literature, each school planning to initiate such a curriculum must make its own individual attempt toward providing this apparently needed curriculum."[7] Additional information has been sought as a basis for guiding the development of these degree-level industrial technology curriculums.

In discussing industrial technology curriculums Gallington pointed out that "the areas of need must be discovered."[8] There is a

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[7]Earl M. Weber, "A Comparative Study of Industrial Technology Programs in American Colleges and Universities With Industrial Arts Teacher Education and Technical Institute Programs (unpublished Ed. D. dissertation, The Pennsylvania State University, University Park, 1961), p. 7.

[8]R. O. Gallington, "Industrial Technology Programs: Questions and Comments" (paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963), p. 3.

pressing need to determine present and future manpower requirements and to determine the demands which the four-year industrial technologist should be qualified to fulfill.

The Need for Personnel and Counseling Data

The findings of this study should contribute information valuable for purposes of evaluation, transfer and promotion of individuals staffing those technically-oriented[9] positions investigated by this study. The findings should be of value not only to the cooperating company but also to other companies with similar personnel requirements.

Placement staff personnel are constantly seeking additional information about the nature of those elements or factors associated with effectiveness which may be used as a basis for selecting valid employment criteria and for evaluating the indices that have been used for selection purposes.

The problem of attracting competent individuals is one of the most basic problems facing industry today[10] due to the current technical manpower shortage. Selecting the most competent of available applicants is particularly critical due to the competitive salary "bidding" necessary to attract technical personnel.

Effective recruitment and hiring practices must be based upon

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[9] cf. p. 13.

[10] e.g., "Dow is determined to maintain and improve its position in today's dynamic industrial society. To do this, Dow recognizes, the company must continue to attract individuals of the same type that brought it to its present position—young people with vision and determination." cf. Appendix D, Exhibit B. Cited in "Dow . . . at a Glance" (Midland, Michigan: The Dow Chemical Company, 1963), p. 1.

many factors, but they are developed, to a large measure, on the basis of what is known about job assignments and effective employees staffing those particular assignments. If industrial firms are to recruit the best qualified persons and utilize their existing technical personnel in the most efficient manner, they must know the kinds of things effective individuals do, the backgrounds and experiences they bring to their respective positions, and the relationships which exist between these variables.

Any study which identifies and analyzes the elements or factors associated with "effectiveness" should also provide information which will aid in the prediction of "potential effectiveness" of new applicants.

Due to the recency of the attention which has been given to degree-level industrial technology curriculums, there is a lack of knowledge of the nature of these curriculums and the qualifications and capabilities of the graduates of these curriculums. Many students, counselors and representatives of industrial firms are not aware of the existence of this type of curriculum. There is a need for companies, like The Dow Chemical Company which is not currently utilizing the graduates of four-year industrial technology curriculums, to investigate and consider the products of these curriculums.

Boaz found that one of the major criticisms of graduates of industrial technology curriculums was "that they lacked publicity."[11]

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[11] Holland E. Boaz, "Degree-Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance," p. 4. (A mimeographed summary of the findings, conclusions and recommendations of a doctoral study conducted at the University of Missouri and received in a personal letter from Holland E. Boaz on June 24, 1965.)

The majority of the graduates reported that they had secured their first job after graduation through their own efforts and that most employers were found to lack any knowledge of the curriculums of degree-level industrial technology or the qualifications of their graduates.[12]

The Boaz study also found that a large number of the students had transferred into the curriculum and had not entered the curriculum until their second year of college. The conclusion was reached that "the programs need more and better publicity and more effective counseling."[13]

The findings of the present study should be valuable to college placement directors and also to counseling personnel. Counselors may find that the industrial technology curriculum patterns fit the interests and motivations of those students who like technical work but who are not interested in the more theoretical work of engineering or who no not want to teach industrial education.

This study should be of general interest to guidance and counseling personnel on the secondary school level. A knowledge of the opportunities and demands of degree-level industrial technology curriculums by high school couhselors provides them with "another alternative" for the college-bound student who is technically inclined. Earlier counseling may encourage the high school student interested in this curriculum pattern to develop some of the manipulative skills on the secondary level as well as the necessary foundations in mathematics and science which will permit the student to use his

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[12] Ibid.

[13] Ibid.

college coursework to develop additional breadth or depth within his areas of interest.

IV. DEFINITION OF TERMS

A clarification of the intended meanings and connotations of various terms is important to the correct interpretation of their use in this study. Terminology always poses problems, regardless of the field, but the problem has been acute in the field of technological education as institutions, groups, and individuals of different orientations use different terms to define the same things. The following list contains definitions of terms as used in this particular study.

Applied scientist. The applied scientist is:

> . . . . a college graduate who is associated with managerial and scientific activities in the industrial field . . . . He has a solid background in mathematics, physical sciences, and human relations with extensive educational experiences in technical theory and manipulative abilities in a field of specialization as well as in closely related fields. He is able to work with scientific personnel and contribute to their efforts in the utlization of materials and machines for producing and distributing industrial products.[14]

The term is used in this study synonymously with the term "industrial technologist".[15]

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[14]Cunningham, op. cit., p. 24.

[15]cf. p. 12. It must be pointed out that the term "applied scientist" is sometimes used differently within industry to describe persons such as a physicist. The term "applied scientist" is introduced in this study because there is some evidence that those institutions, schools or departments administering degree-level programs of industrial technology are using the term "applied sciences" as a part of their titles. It is too early, however, to determine whether or not this is a definite trend.

Critical incident. The performance of a behavioral act, an occurrence with clear-cut facts attached to it. It is something which the employee does that results in his success or failure in a particular situation.[16] To be considered "critical", an incident must occur in a situation where the purpose or intent of the act is clear and "where its consequences are sufficiently definite to leave little doubt concerning its effects."[17] Any incidents which are a part of the normal expectations of an employee in the performance of a particular assignment are not considered to be "critical".

Critical incident technique. A technique which records descriptive statements of specific behaviors reported by those persons in the best position to make observations and evaluations. The technique involves the collection of these descriptive statements rather than collecting opinions, hunches and estimates.[18]

Effectiveness. "The ability to get something done that directly or indirectly is moving a company towards its goals."[19]

Four-year Industrial Technology Curriculum. A baccalaureate degree curriculum designed to prepare students for technical,

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[16]The term is used in this study to refer to "effective" critical incidents only. cf. Delimitation number one page 24.

[17]John C. Flanagan, "The Critical Incident Technique," Offprinted from the Psychological Bulletin, LI (July 1954), No. 4, p. 327.

[18]Ibid., p. 355.

[19]George E. Spaulding, Jr., "The 'Effective' Executive: What Qualities Make the Difference?" Management Review, LIII (November 1964), No. 11, p. 6.

supervisory, or managerial positions in the manufacturing and fabrication industries which is administered by a department of industrial education.

Industrial technologist. A college graduate who is associated with technical, supervisory or managerial activities in an industrial field. He is management oriented, rather than engineering oriented, in his approach to technical, scientific or human relations problems. The industrial technologist's background is broad and general rather than specialized; he has had a solid foundation of courses in mathematics and the physical sciences; he has had a variety of experiences in shops and laboratories designed to give him insight into how goods are produced; he has had some courses in business administration designed to give him insights into the problems of management, distribution and economics; and he has had general education courses designed to equip him with communication and human relations skills and an ethical foundation for making decisions.[20]

Most effective individual. A person who has been judged by the cooperating company as having been an individual whose performance has been outstanding in contributing toward a company goal. These terms have been used interchangeably with the terms "high achiever" in this study.

Performance rating. An appraisal of over-all effectiveness given to an employee on the basis of the judgment of one or more of

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[20]Weber, op. cit., p. 175.

the employee's superiors.

Technically-oriented individual (or employee). An individual, or employee, whose work may not be dominated by the technical aspect and may not require a great depth of specialization in any one particular subject matter area; but, an individual who must possess a solid foundation of technical knowledge and skill in order to participate effectively in the respective position. The levels of technical complexity investigated in this study were those in the intermediate ranges of technical employment.[21]

V. BACKGROUND OF THE PROBLEM

Throughout the history of the American culture, industries have been developed for the purpose of processing natural resources for the benefit of mankind. The strength of our free enterprise system rests in the fact that competition demands more efficient utilization of natural and human resources through the employment of improved technology, more efficient business organization and better understanding of human relations.[22]

Robert Bruce Lindsay states, ". . . technology may be defined as human activity directed toward the satisfaction of human needs (real or imagined) by the more effective use of man's environment," and "the story of technology is the story of man's ceaseless striving to extract what he calls a better living out of his surroundings. . ."[23]

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[21] cf. p. in Chapter III and also Chart I in Appendix B.

[22] Cunningham, op. cit., p. 1.

[23] Robert Bruce Lindsay, The Role of Science in Civilization, (New York: Harper and Row Publishers, 1963), p. 197. (Parentheses in the original.)

The Changing Pace of Technological Development

The historical tradition of technology has been to accelerate the conquest of nature. The tempo of technological change has been increasing markedly over the years as can be demonstrated by the following examples.

> . . . Prior to the industrial revolution in Western Europe and America, increasing scientific knowledge was rarely, or at best slowly translated into useful forces for the betterment of man. Since 1850, however, the lag between discovery and utilization of scientific knowledge has been decreasing.[24]

Kenneth Meade, Director of Educational Relations at General Motors Technical Center, cited some figures to note this change:

> Not long ago I saw some figures demonstrating how much time elapses between the basic discovery and the resulting commercial product. This has decreased rapidly since this country became a nation. Here are a few examples: Photography, 112 years; the telephone, 56 years; radio, 35 years; radar, 15 years; television, 12 years; the atomic bomb, 6 years; and transistors, 5 years.[25]

The historical example of man's utilization of energy was used in another report to demonstrate the increasing pace of technological development:

> . . . Until about a century and a half ago the available sources of energy—human beings, animals, wind and falling water—had remained unchanged, and the methods of converting this energy to useful work had scarcely altered, in a thousand years. The long period of stability was interrupted by the introduction of the steam engine. . . [It was well over a century, however, before the principles of the science of thermodynamics could be lucidly described]. In the course of the same century, the hot air engine, the internal combustion engine, the steam turbine, and the

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[24]Fremont E. Kast and James E. Rosensweig, Management in the Space Age (New York: Exposition Press, Inc., 1962), p. 14.

[25]Kenneth Meade, "Cultural Change in the Area of Industry and Technology" (Paper read at the National College of Education Conference, Chicago, Illinois, February 21, 1964), p. 9.

> diesel engine all developed slowly but steadily. But these devices, like the steam engine, were not so much the product of thermodynamic principles understood and consciously applied, as of intuitive invention and empirical development. Not until the 1930's, more than one hundred and fifty years after the introduction of the steam engine, did the development of the technology and the formulation of the principles appear complete. At that time, indeed, there seemed little more to do in the field of energy conversion and utilization.[26]

This apparent plateau in the development of energy sources was interrupted during the Second World War by the introduction of several new energy sources. These developments included the gas turbine for the propulsion of aircraft, the refinement of rocket propulsion, and the major technological breakthrough of obtaining energy from nuclear fission.

Changing Patterns of Technological Development

In addition to the differences in the pace with which the steam engine and the jet engine were developed, the differences in the pattern of their development are also worthy of note.

> . . . The jet engine was not the invention of some intuitive individual working in ignorance of the scientific principles involved. The men who made it could draw upon a great reservoir of scientific and technical information. Familiar now with thermodynamics, they could draw also upon indispensible new findings in fluid dynamics and metallurgy.[27]

The examples of the steam engine and the jet engine demonstrate the difference between the organizing force of development behind the Industrial Revolution and the present so-called Scientific Revolution.

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[26]Massachusetts Institute of Technology, A Proposal for Experimental Developments in Engineering Education, A Report Prepared by the Faculty of the School of Engineering at the Massachusetts Institute of Technology (Cambridge: Massachusetts Institute of Technology, March 1959), p. 3.

[27]Ibid., p. 4.

The concept of invention was the signature of the Industrial Revolution, while the organizing force of the present era of technological development has come from theoretical developments in the field of science. With a rapidly expanding body of scientific knowledge becoming available and a concerted effort to apply this knowledge, industrial applications of this knowledge and new materials, processes and products are now imminent.

The Fostering of Technological Development

The hallmark of our present economy is the organized forcing of technological advances through increased national efforts to promote both basic and applied research. This policy has been intensified as a result of international competition and the rivalries of political ideologies.

The magnitude of this national effort is reflected in the increase in the amount of funds being spent for research and development in the United States. The National Science Foundation reports that the Federal Government alone doubled its cumulative expenditure for research and development for each successive five-year period since 1940. Expenditures during the latest five-year period (1960-1964) were expected to be over five and one-half times those of the previous five-year period (1955-1959). It is noteworthy that since 1953-1954 Federal expenditures for research and development increased at a faster rate than did total expenditures.[28]

An examination of the number of persons involved in scientific

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[28]National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, (Washington: Government Printing Office, 1964), XII, p. 50.

endeavors provides another indicator of the efforts being made to foster scientific and technological development.

> One reliable estimate states that 90 per cent of all scientists that ever lived since the beginning of time are alive today and that more basic discoveries have been made since 1900 than in all the one and one-half million years of mankind's development. Knowledge of our physical universe doubles itself in each ten year period.[29]

An examination of the number of patents granted annually by the United States Patent Office provides tangible evidence that these efforts have been productive. At the present time the Patent Office grants in excess of 48,000 patents each year.[30]

The Impact of Technological Advances

Technological achievement has become a pervasive influence in our present society and few facets of man's existence or his social organization have been able to escape its impact.[31] Technological advances have fostered new industries and new occupations; it has altered the responsibilities of many job classifications; and it has increased the educational requirements of many existing job classifications. New job titles and new job classifications are constantly emerging.[32]

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[29]Meade, op. cit., p. 3.

[30]United States Bureau of Census, Statistical Abstracts of the United States: 85th Edition, (Washington: Government Printing Office, 1964), Table no. 751, p. 546.

[31]Kast and Rosensweig, loc. cit.

[32]Lynn A. Emerson, Education for a Changing World of Work: Appendix I: Technical Training in the United States, (Washington: Government Printing Office, 1963), p. 3.

The Changing Occupational Structure

Since the Second World War, occupational patterns in industry have changed significantly. The Scientific Revolution of the past several decades has been accompanied by a standardization of machines and processes resulting in automation. Automation has eliminated many repetitive type work assignments and has created positions which require personnel who have a high degree of mental and technical abilities.

Need for managerial skills. In an attempt to adjust to these changes, a reassignment of the various types of technically-oriented manpower functions has been made in an effort to achieve greater overall efficiency through more effective management of available resources.

Kast and Rosensweig point out that the rapidly advancing technology has emphasized the need for effective management.

> . . . With new product ideas that are constantly pushing the state of the arts, plus rapid obsolescence, the management functions of planning and control are crucial. Accelerating technology has lead throughout history to a shorter and shorter lifespan for each new generation of products. Planned obsolescence has become a byword in our modern industrial society. In addition, the amount of time and money required to design and develop a product and set up production facilities has increased. . . .[33]

The United States Department of Labor predicted that there will have been a forty-four per cent increase in the demand for persons in the professional and managerial areas of employment by 1970.[34]

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[33]Kast and Rosensweig, op. cit., p. 29.

[34]Seymour L. Wolfbein, "Manpower in the United States With Projection to 1970," Study of Population and Immigration Problems, (Washington: Government Printing Office, 1962), p. 22.

The technical manager is "the man who keeps the wheels of industry going and sells its products."[35] Many of these technical management positions will continue to be staffed by graduates of engineering colleges; but in our research-oriented industrial economy the role of the engineer is changing and engineering education has been directed more toward the preparation of the engineering scientist.

> In modern industry the engineer and scientist are concerned with such new developments as cryogenics, magnetohydrodynamics, microminiaturization, space communications systems, laser development engineering. No longer does the engineer find time to perform many of the tasks that fell to his lot in former years.[36]

The need for technicians. Some of the tasks formerly done by engineers have been taken over by technicians. The need for technicians and the vital role of the technician was first emphasized by the Wickenden and Spahr Report; the Henninger Report reiterated these earlier findings; and numerous other reports and articles have been written on the subject.

Many fine technical institute curriculums exist which train persons to perform valuable roles. The very nature and purpose of

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[35]Statement by John D. Ryder, Dean of the College of Engineering, Michigan State University, East Lansing, Michigan in a personal interview.

[36]Emerson, Education for a Changing World of Work, p. v.

[37]William E. Wickenden and Robert E. Spahr, A Study of Technical Institutes (Lancaster, Pa.: Society for the Promotion of Engineering Education, 1931).

G. Ross Henninger, The Technical Institute in America (New York: McGraw-Hill Book Company, Inc., 1959).

these curriculums, however, limits the extent to which a graduate of a technician curriculum can move into management-oriented technical positions.

The limitations of the technician curriculums. The two-year technician programs can equip a student to be qualified to do a fine job at the initial entry level for which they were designed, but cases may be cited where unless the individual continues his education in some manner after employment he finds it extremely difficult to advance beyond a certain point.[38]

Since the two-year technician curriculums have been designed to prepare students for particular types of industries and for particular classifications of jobs within those industries, their primary objectives are related to the development of specific technical and manipulative skills and an understanding of the related technical and scientific theory associated with a particular area of specialization. In order to provide the students a sufficient depth of technical competency and specialization and the complimentary manipulative skills necessary within a given field of technology within the time available, the typical technician curriculum has not been able to devote any significant amount of general, managerial, business, or professional coursework. Yet, it is through the student's contact with these disciplines that he receives the qualifications which are usually demanded for promotion into higher levels supervisory and middle management positions.

The lack of general education is often cited as one of the

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[38] e.g., cf. p. 82.

shortcomings of the technical institute type curriculums. Those technician curriculums which are three years in length usually utilize the additional time to provide added depth within the area of specialization rather than to provide the student with breadth. The sacrifice of any appreciable amount of technical subject matter in favor of general education courses has been difficult to justify within the time limitations of the typical two-year technician curriculum.

This then appears to be the dilemma of the two-year technician curriculum. In contrast, the four-year curriculum of industrial technology permits the individual to receive a broader, more diversified education which enables him to become more utilizable in the management-oriented technical positions emerging in the changing structure of industry.

Increased Educational Requirements

In hearings before the Joint Economic Committee of Congress[39] it was pointed out that the fastest growth of employment in the current decade (1960-1970) would occur among the professional and technical occupations which require the most education and training. In 1959 those persons working in professional and technical occupational classifications had completed an average of 16.2 years of education.[40] As the standard of living increases in the United States,

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[39] Current Economic Situation and Short-Run Outlook, Hearings before the Joint Economic Committee of the Congress of the United States of America, Eighty-Sixth Congress, Second Session, December 7-8, 1960.

[40] Wolfbein, op. cit., p. 24.

the formal educational requirements will continue to increase. Donald D. Dauwalder states:

> There is no question that for many years the high school diploma has been considered a minimum formal education standard in many fields of employment. An increasing number of employment areas now are requiring the associate of arts degree from the junior college or a baccalaureate degree. . . . Degrees will be increasingly necessary during the next several years for more and more areas of employment.[41]

The aforementioned changes which have occurred in our industrial culture have given impetus to the development of degree-level industrial technology curriculums.

VI. BASIC ASSUMPTIONS UNDERLYING THE PROBLEM

The following assumptions were made in this study:

1. That the cooperating company's personnel evaluation system had been accurate in the identification of the most effective employees who had been hired within a specified six-year period of time prior to the study. This assumption was accepted on the basis of the fact that excellent personnel records were available and an established system of personnel evaluation did exist. Further support for this assumption was evidenced by the fact that the cooperating company was included as one of the companies cited in the American Institute of Management's "List of Excellent Managements" for 1964.

2. That the functional areas and levels of employment of the technically-oriented employees had been defined adequately for purposes of providing a framework for the identification and analysis

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[41]Donald D. Dauwalder, Education and Training for Technical Occupations (Los Angeles: The Los Angeles City Junior College District, June 1961), p. 106.

of the respective categories of employment investigated by this study.

3. That the categorization of the functional activities identified as factors associated with effectiveness had been made objectively and consistently.

4. That the critical incident technique is a tested and accepted research tool for identifying factors which are characteristic of effectiveness. The review of the literature related to the critical incident technique provided evidence of the use of this research tool for this purpose and supported this assumption.

5. That the assumption implied within the critical incident technique can be accepted, i.e., that the reporter can distinguish effective behavior and report it objectively.[42]

6. That the degree-level industrial technology curriculums have a unique role in our total educational scheme. Degree-level curriculums of industrial technology do exist and they do have identifiable characteristics as was revealed in the comparative study reported by Weber.[43] An increasing number of institutions are planning or considering offering curriculums of industrial technology[44] and the Boaz study concluded that "additions to and strengthening of

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[42]Mayhew pointed out that "the evidence in the literature tends to support this assumption." vide Lewis B. Mayhew, "The Critical Incident Technique in Educational Evaluation," Journal of Educational Research, XLIX (April 1960), p. 594.

[43]Weber, op. cit., p. 176.

[44]Haurer reported that eleven institutions were planning or considering the establishment of degree-level curricula of industrial technology. cf. Nelson A. Haurer, et al "Industrial Technology Programs" (paper read at the Fifieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963), p. 5.

existing four-year industrial technology programs seemed to be the trend, with no respondent indicating plans to drop a program.[45]

VII. DELIMITATIONS OF THE STUDY

The study was delimited in the following ways:

1. Only those critical incidents associated with effective on-the-job behavior or activity were solicited.[46]

2. No attempt was made to study the personality characteristics of those persons who were identified as having been "most effective" employees. Personality plays a vital role in the effective performance of any task, but the study of personality is a highly complex endeavor which has not been investigated in this study because of the following reasons: (1) the only personality test information available on the high achievement group was of such a controversial nature that there was real question as to its value, and (2) the circumstances were such that the Company was reluctant to release any information of a personal nature.

3. The size of the sample and also the fact that this study investigated a particular type of industry with a sophisticated work force limited the statements which could be made from the findings of this study. Nevertheless, the size and composition of the sample and the industrial situation studied did provide extensive information with respect to the area of employment and the type of industry investigated.

4. It is realized that this study was limited to the extent

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[45] Boas, op. cit., p. 1.

[46] cf. p.58 in Chapter III.

that the reporters understood the requirements of the critical incident technique and with respect to the accuracy of the reporting.[47]

5. This study was limited to the identification and classification of those factors associated with the effectiveness of "high achievers", and it did not intend to undertake such an assignment as designing specific curriculums. The body of information obtained in this study did suggest some curriculum patterns which would be appropriate for this area of employment and this information should be valuable for curriculum development purposes at some later date.

6. This study was limited in that it did not investigate any high achievers within the business and administrative staff and services functional areas of employment.

7. The study was limited to an investigation of personnel employed within the salaried job classifications. This delimitation was not considered to have any effect upon the study and was made in order to avoid the problems associated with obtaining the cooperation of the union which represented the hourly wage employees. This delimitation did not eliminate the possibility of two-year technicians from being included in the high achievement group as the cooperating company employed a group of technicians as salaried employees.

VIII. SUMMARY OF THE CHAPTER

A demand for a wide range of technically competent manpower qualified to assume supervisory and managerial responsibility has

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[47]The literature indicated that these were not necessarily serious limitations and several checks which were made during the execution of the study indicated that these limitations had been controlled satisfactorily.

developed. The precise boundaries or classifications for these types of manpower have not been defined clearly. Likewise, the nature of those factors which contribute toward the effectiveness of persons employed in this general area have not been identified.

The changing patterns within our society and the changing patterns of organization within industry suggested the need for an investigation of the educational demands of modern industry with respect to the intermediate range of management and/or technological employment.

The increasing rate of technological change has brought about new problems associated with equipping individuals with a wide range of abilities which will provide these persons with the flexibility necessary to be able to anticipate technological changes and adjust to their repercussions.

The rapid technological changes have given impetus to new types of educational preparations designed to equip students with broad understandings as well as specializations. One of the variety of new types of curriculums emerging in the American educational system in recent years has been the degree-level industrial technology curriculum offered through departments of industrial education.

As a result of changes in the technical manpower structure, the recruitment practices of many industrial firms have changed in recent years. In some areas of specialization the traditional pattern of recruiting graduates from a specified curriculum continues to be practiced in order to obtain the necessary depth of qualifications. There are many other classifications of employment, however, where industry has not prescribed a specific educational background as a

criterion of employment. In fact, in some cases, companies have been known to recruit persons for positions which did not appear to have any direct relationship with the person's educational preparation.[48]

Curiosity about the extent of this practice coupled with a professional interest in degree-level industrial technology curriculums which are designed to provide their graduates with a "flexible" technical preparation potentially suitable for many of the emerging management-oriented technical positions prompted this study.

This study was designed to identify those factors associated with the effectiveness of personnel who were staffing positions within a delineated area of the intermediate ranges of technical employment to accumulate a body of information which curriculum designers can draw upon to determine what types of educational experiences are essential for preparing individuals for this type of employment.

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[48] *e.g.*, One major automotive firm was known to have employed an art major for a position in management rather than for employment in an area such as design directly related to the student's academic major. In this particular case the selection was based primarily upon the student's high academic achievement.

CHAPTER II

THE LITERATURE PERTAINING TO INDUSTRIAL TECHNOLOGY CURRICULUMS

Much has been written in regard to the general field of technical education, but because most of the literature on technical education concerns technicians and engineering education with objectives and emphases different from those of degree-level industrial technology curricula as defined in this study, this review stresses research studies and reports which are directly concerned with degree-level curriculums of industrial technology.

I. RESEARCH STUDIES

The search for studies dealing specifically with four-year industrial technology curriculums revealed a paucity of literature. This lack of research may point up the fact that it is only in recent years that the four-year industrial technology curricula has received other than local attention.

The search for research studies completed since 1944[1]

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[1]This date was selected since only two institutions reported having established curriculums prior to 1944 in a report presented to the Fiftieth Mississippi Valley Industrial Arts Conference. cf. Nelson A. Haurer, et al., "Industrial Technology Programs: Status Study Industrial Technology" (paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963).

It might also be pointed out that the investigator has been intimately familiar with the history and purposes of the earliest established curriculum by being associated with the Bradley University curriculums of industrial technology as a faculty member for six years. An investigation of the other institution offering a curriculum antedating 1944 was conducted. On this basis the review of the research studies since 1944 was considered to have been justified.

related to non-engineering degree-level industrial technology curriculums as defined in this study revealed only three doctoral studies dealing specifically with this type of program.

Earl M. Weber Study

A comparative study of industrial technology programs, industrial arts teacher education programs, and technical institute programs was completed at The Pennsylvania State University in 1961.[2] This pioneer research investigation of industrial technology curriculums was prompted by the curious fact that despite the professed differences in purpose between college-level industrial arts education and technical education, four-year industrial technology curriculums were emerging from existing industrial arts curriculums. Weber stated:

> . . . Industrial arts on the college level is, for the most part, a teacher-training program. Industrial arts, a phase of general education, is quite different in purpose from technical or trade education, although its curriculum embraces many of the same processes, materials, and concepts.[3]

The Weber study was designed to determine:

1. The nature of industrial technology curriculums.
2. The purposes of industrial technology curriculums.
3. The manner in which industrial technology curriculums differed from industrial arts teacher education and technical institute programs.[4]

The methodology of the study was to first define the development, purpose, and nature of both technical institute type training

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[2]Earl M. Weber, "A Comparative Study of Industrial Technology Programs in American Colleges and Universities With Industrial Arts Teacher Education and Technical Institute Programs" (unpublished Ed. D. dissertation, The Pennsylvania State University, University Park, 1961).

[3]Ibid., p. 2.

[4]Ibid., p. 3.

and industrial arts education. Then, to use these two curriculums "as a kind of measuring device to determine, as nearly as possible the relative nature and purpose of the programs of industrial technology."[5]

The findings of the study revealed that industrial technology programs have the following characteristics:

1. Their purposes are management-oriented rather than engineering-oriented.
2. Their curriculums are broad and general in nature and not as narrowly specialized as most technician curriculums.
3. These curriculums include a variety of required courses in shops and laboratories.
4. The requirements for graduation are similar to those of other four-year college curriculums.
5. The qualifications of the instructional staffs are identical to those of other four-year college curriculums.[6]

In addition to the foregoing, this study showed that industrial technology curriculums "are concerned with the preparation of students for positions of leadership in the manufacturing industries."[7] Weber made the following summation concerning this type of preparation:

> Though there is considerable overlapping of purposes and some similarity of curriculums, the results of this study clearly indicate that the industrial technology programs are quite different from industrial arts education and technical institute training. Industrial technology programs are not engineering-oriented as are the technical institutes, nor are they teacher education programs. The main differences between industrial technology and the other two types of programs is in the general area of preparing students for positions in management.[8]

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[5] Ibid.

[6] Ibid., p. 176.

[7] Ibid.

[8] Ibid.

Charles W. Keith Study.

An appraisal of the industrial technology program at Kent State University was completed at The Ohio State University in 1964.[9] The purposes of the Keith study were as follows:

1. To determine the common goals of four-year industrial technology programs.
2. To study industrial technology programs at other colleges.
3. To develop criteria for evaluating industrial technology programs.
4. To evaluate the Kent State University program in terms of the established criteria.
5. To recommend needed changes in the Kent State University program.[10]

After an industrial technology program had been defined, Keith developed and validated the following sixteen criteria for an industrial technology program:[11]

1. The catalog should reflect the purposes of the program.
2. Ideally the teaching staff should have from two to five years of industrial experience, fifteen to thirty semester hours of professional preparation, eighteen to forty semester hours in special allied areas, and at least a master's degree.
3. Proficiency in teaching is essential.
4. Writing for publication is important.
5. The program should consist of a sequence of respective areas or disciplines.
6. The scholastic level of the students in the program should be equal or above that of other students in the school.
7. Graduates of the program should be qualified for employment in more than one type of industry.
8. The program should be accepted and actively supported by the administration of the school.
9. The areas and disciplines included in the program of study should contribute toward the purposes established for the program.

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[9]Charles W. Keith, "The Industrial Technology Program at Kent State University: An Appraisal and Recommendations" (unpublished Ph. D. dissertation, The Ohio State University, Columbus, 1964). (Microfilm.)

[10]Ibid., p. 2.

[11]Ibid., pp. 28-37.

10. The practices for selecting students should be such that only those students which could successfully complete the program would be admitted.
11. Enrollment should be related to the needs of industry.
12. Staff load should permit the maximum contribution of each faculty member.
13. The physical plant should provide sufficient space and up-to-date equipment to meet the requirements of the program.
14. The fiscal allocation should be sufficient to support the program.
15. An advisory committee of employees, graduates, parents and educators should be consulted.
16. Staff members should be actively identified with professional, educational and industrial organizations.

A questionnaire based upon these sixteen criteria was sent to: (1) Forty-nine chairmen of industrial technology programs, (2) Ninety-one graduates of the Kent State University program, and (3) Forty-seven supervisors of these graduates.

The data collected was categorized and compared with that of the Kent State Program, its graduates, and that obtained from industrial supervisors of the graduates. The Kent State University program was found to have met fully six of the sixteen criteria. Recommendations were made for meeting those criteria which the program failed to meet or met only partially.

Holland E. Boaz Study

Holland E. Boaz completed a doctoral study at the University of Missouri in 1965.[12] Fifty-four selected four-year industrial technology programs were studied to ascertain the organizational structure and purpose of degree-level technology programs; to report

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[12]Holland E. Boaz, "Degree-Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance" (unpublished Ed. D. dissertation, University of Missouri, Columbia, 1965).

enrollments and numbers of graduates; to reveal the socio-economic background, training, employment, and occupational success of the programs in comparison with the Engineers' Council for Professional Development criteria; and to reveal the acceptance of the programs by institutions, by the graduates, and by the employers of these graduates.[13]

The findings of the study revealed that the geographic distribution of the fifty-four programs studied was quite general over the United States. Twenty-seven states reported one or more programs, however, few programs were reported from the Eastern and New England states.

The reasons reported most frequently for offering a technology program (curriculum) in a department of industrial education were "to supply the needs of industry" and "to meet the needs of students not interested in teaching."[14]

Of the industrial technology curriculum graduates included in the study the largest number entered managerial or supervisory positions in industry. The largest number of graduates were employed in "production management."[15]

Boaz noted that it was of interest that although fifty-two per cent of the graduates entered the occupation for which they were

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[13]Holland E. Boaz, personal letter to Raymond Keil, May 4, 1965.

[14]Holland E. Boaz, "Degree-Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance" (Summary, conclusions, and recommendations of the doctoral study cited above and received in a personal letter from Holland E. Boaz, Assistant Professor of Industrial Arts, Western Kentucky State College, Bowling Green, Kentucky, June 25, 1965), p. 1. (Mimeographed.)

[15]Ibid., p. 2.

prepared or one closely related to their preparation, forty-eight per cent of them entered unrelated employment that offered broader opportunities, better salaries, or greater interest to them.[16]

In evaluating the adequacy of their educational preparation with respect to the requirements of the position in which they were employed, the graduates reported more "strengths" than "weaknesses". The strength most frequently reported was that they had received adequate technical knowledge, whereas the most frequently reported weakness was that they had not received sufficient practical experience.[17]

The acceptance of the program was shown to be favorable, in general, as was evidenced by the increase in the number of programs and curricula, an increase in enrollments, the number of graduates working in occupations related to their preparation, and the large percentage of the employers who were satisfied with the graduates of of degree-level technology programs.[18]

Boaz noted that the "acceptance of the four-year technology programs seemed to be more important to the supervisors of the programs than accreditation."[19] No organization was found that had as its main purpose the accreditation of industrial technology curriculums. The Boaz study reported that only thirteen per cent of the supervisors of

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[16] Ibid. It is of particular interest and significance to note that nearly one half (forty-eight per cent) of the industrial technology curriculum graduates studied had staffed positions unrelated to their preparation. The breadth of the degree-level curriculums apparently served them well.

[17] Ibid.

[18] Ibid., p. 3.

[19] Ibid.

the curriculums studied were in favor of such an organization. Thirty-five per cent of the supervisors of the degree-level technology programs did indicate some interest in accreditation by the Engineers' Council for Professional Development (ECPD). Boaz recommended that if the ECPD "cannot or will not accredit these curricula, perhaps some professional organization such as the American Vocational Association or the American Industrial Arts Association might investigate the possibility of accrediting these four-year technology programs."[20]

The Boaz study emphasized the need for giving more attention to the areas of counseling, placement, follow-up, publicity, and "indoctrination of industry about the technology program."[21]

Summary of Research Studies Reviewed

The three research studies reviewed above were significant to the present study in that they established the characteristics of the degree-level industrial technology curricula and provided a working definition of this type of curriculum pattern. These research studies also revealed the acceptance, status and growth of degree-level industrial technology curricula and established the fact that degree-level industrial technology curricula provided a unique and valuable type of educational experience to their graduates.

Studies in Progress

A number of studies were located which were in progress at the time that this review of the literature was accomplished.

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[20] Ibid., p. 5.

[21] Ibid., p. 4.

Eugene Gardner, Professor of Industrial Education at Bradley University, Peoria, Illinois, was conducting a doctoral study involving one hundred and five recent graduates of that university's College of Applied Sciences' industrial technology curriculums.

The American Vocational Association had established a committee to investigate the various topics associated with degree-level industrial technology curricula. These reports were not available for review at the time this review of the literature was accomplished.

Periodical Literature

The search of the periodical literature revealed a limited number of articles pertaining directly to degree-level industrial technology curricula. Since the views expressed were based largely upon the personal opinions of the authors and were not supported by any substantial research, they have not been reviewed here. Those articles which were considered to be pertinent have been referred to in the discussion of industrial technology curriculums in Section III of this chapter.

Other Sources

Several reports to either organizations or institutions were located. These reports dealt specifically with the topic of industrial technology and have provided some pertinent information.

Beryl M. Cunningham, Dean of the College of Applied Sciences of Bradley University, prepared a report to the president of that institution which developed a concept of industrial technology and

defined the role of the industrial technologist.[22]

The clearest expression of a philosophy undergirding the industrial technology type curricula found in the literature was embodied within the Cunningham report which reviewed the scientific and technological changes and developments which have occurred in recent years to show the need for industrial technologists (or "applied scientists") in the manufacturing and fabrication industries.

Cunningham presented an analysis of industry which had been developed on a horizontal basis rather than the traditional vertical basis (i.e., engineer—technician—skilled craftsman). Three major divisions within the operational organization of industry were identified. The established divisions were designated as: (1) administration, (2) research and development, and (3) applied sciences.

Cunningham pointed out that the divisions of administration, and research and development have become so highly specialized in their duties that a large area of activities is not adequately served by either division.[23] The development of this large area of activities has created the need for industrial technologists.

The functions performed within the applied science division were identified as follows: (1) design and refinement, (2) production and manufacturing, (3) field service and product utilization, (4)

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[22]Beryl M. Cunningham, "Applied Sciences in Education and Industry" (Peoria, Illinois: College of Applied Sciences, Bradley University, 1964). (Mimeographed.) This report uses the terms "applied science" rather than the terms "industrial technology" on the basis of the analysis of industry developed within the study.

[23]Ibid., p. 15.

distribution and sales, and (5) education and training.[24]

The analysis of industry provided in the Cunningham report was found to be a workable framework for analyzing the industry investigated in this study.

In discussing the meaning of technology, Cunningham stated that "art and science are the major elements in technology," and "a technology could not be developed apart from a body of knowledge and the skillful actions of human beings." The industrial technologist, then, must not only be competent with a body of knowledge he must also be able to utilize that body of knowledge through skillful application and expertness of performance.

> Technology is the result produced by the integration of human behavior and the body of knowledge. The quality of a technology is determined by the quality of both the body of knowledge and the skillful utilization of the body of knowledge.[25]

The strength of an industrial technology curriculum, then, rests not only in its ability to present effectively the student with a body of knowledge, but also upon its effectiveness in equipping the student with the technical, communicative, and mental skills with which to utilize that body of knowledge in the solution of technical and human relations problems.

Mississippi Valley Industrial Arts Conference Reports.

Several reports concerning the status of industrial technology curriculums were presented to the Fiftieth Mississippi Valley Industrial Arts Conference held in Chicago, Illinois in November of

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[24]Ibid., pp. 15-16.

[25]Ibid., pp. 22-23.

1963. These reports covered the topics of purpose, development, curriculum patterns, organization and administration.

In line with the historical purpose of the Mississippi Valley Industrial Arts Conference which has been to provide leadership in the field of industrial arts education, these reports were designed to explore the status of the newly emerging programs of industrial technology. The reports provided only a summary of present practice and did not necessarily represent the most desirable situation. However, these reports were significant in that they focused attention upon the industrial technology program and provided an initial attempt to clarify terminology and to strive for agreement upon the basic ingredients of the program.

These reports have been utilized in the general discussion of industrial technology curriculums presented in the following section.

Miscellaneous sources. Since there was a scarcity of literature directly related to industrial technology curriculums, some of the leaders in the field were solicited as possible sources of information. The almost universal response was that their efforts were still in the embryonic stage and were not refined to the point where they merited general circulation.

III. INDUSTRIAL TECHNOLOGY PROGRAMS

Because industrial technology curriculums have received little attention until recent years and the image of the graduates of these programs is not always clear, a brief discussion of their nature, purposes, development, curriculum patterns, and organization and adminis-

tration is presented in the following section.

Nature and Purposes

The general purpose of industrial technology programs is to prepare persons for technical, supervisory, and managerial positions related to the design, refinement, manufacturing, utilization, distribution, and service of industrial products.

One of the common characteristics of the industrial technology curricula which was stressed by a number of writers on the subject was that their objectives were management-oriented in nature. For example, Weber made this point in comparing the purposes of the industrial arts education and technical institute education:

> . . . Industrial technology programs are not engineering oriented as are the technical institutes, nor are they teacher education programs. The main difference is in the general area of preparing students for positions in management.[26]

Cunningham enumerated that one of the major objectives of industrial technology curricula was "to lay the foundation for the development of professional efficiency"[27] in management-oriented positions in the field of industrial technology. Cunningham pointed out that the industrial technologist does not usually go into a management position when entering employment, but he "is frequently selected because of his potential for rapid promotion into a management position."[28] Nelson described the industrial technologist as a

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[26]Weber, op. cit., p. 176.

[27]Cunningham, op. cit., p. 39.

[28]Ibid., p. 27.

"connecting link between the highly specialized managerial and engineering functions, and the production and office workers."[29] Likewise, Boaz stated:

> . . . Through their four-year technology programs the colleges and universities have endeavored to supply a portion of the technically trained personnel needed to communicate the theories of the engineer, scientist, and management to the skilled worker.[30]

According to Groneman the four-year industrial technology curriculum leading to a Bachelor of Science degree is preparation for positions "in the area of middle management."[31]

The purpose of industrial technology curriculums is to provide the graduate with a combination of: 1) a solid foundation of courses in theoretical and applied mathematics and physical sciences; 2) a variety of experiences in shops and laboratories designed to equip him with certain practical skills and an insight into how goods are produced; 3) courses in business administration designed to give him insights into the problems of management, distribution, and economics; and 4) general education courses designed to equip him with communication and human relations skills and an understanding of the industrial culture in which he lives. This preparation is designed to enable the graduate to move into technical and managerial positions in various industrial fields at the intermediate levels of technical employment.

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[29]Hilding E. Nelson, "Prospectus for a Graphic Arts Technology Curriculum," Industrial Arts and Vocational Education, LIII (February 1964), p. 18.

[30]Boaz, "Degree-Level Technology Programs," loc. cit.

[31]Chris H. Groneman, "Industrial Technology Programs: Purposes, Development" (paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963), p. 1.

Development

The changing patterns of technology and the changing organizational structure of industry has created an area of employment seemingly suitable for the utilization of the industrial technologist.

> Modern industry in its rapid acceleration toward immensity and complexity is creating a whole new series of positions in the occupational structure. By professionalizing managerial positions; by creating a research and development corps of engineers; by introducing scientific machines; and through creation of vast industrial complexes, the occupational technologist has been created.[32]

The programs which have been preparing industrial technologists to meet these demands have evolved, for the most part, out of college-level industrial arts teacher education curriculums.[33]

The historical pattern has been for a certain percentage of the teacher trainees to select employment in industry rather than in the field of education. As a result, some institutions began to offer a "non-teaching option."

Many of the industrial technology curriculums "seem to have been built on an existing industrial arts program using whatever related courses are available on a particular campus (Engineering, Business, etc.)."[34]

The curriculums of industrial technology had an early beginning, but were slow in making progress. Bradley University was the first institution to initiate a curriculum in 1923. Some nine years later West Virginia State College at Institute, West Virginia esta-

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[32]Nelson, loc. cit.

[33]Weber, op. cit. p. 2.

[34]Wesley S. Sommers, Chairman Industrial Technology Department, Stout State College, Menomonie, Wisconsin, personal correspondence dated May 18, 1965. (parentheses in the original.)

blished a curriculum. It was not until after the Second World War, however, that the trend to establish this kind of curriculum became well established. Fifty programs were reported by Haurer as having been established by 1963.[35]

An exact figure of the number of industrial technology curriculums in existence at the time of this writing was not located as no definite criteria had been established for classifying this type of curriculum.[36]

Curriculum Patterns

Industrial technology curriculums are general in nature rather than specialized as most technician curriculums. They are designed to be broad enough to prepare the student for a variety of positions and flexible enough to permit the election of courses which satisfy the needs and interests of the students. Cunningham pointed out that on the other hand the curriculum "must contain a core of courses that are basic to efficient performance. . ."[37]

The three major objectives of the industrial technology curriculum at Tennessee Technological University may be summarized

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[35]Haurer, op. cit.

[36]Some institutions may have reported having an industrial technology curriculum but an examination of their curricular offerings revealed that it was basically a college-level industrial arts program with only the name changed.

The evidence is quite clear, however, that this type of program is being offered (or considered) by more and more institutions, e.g., Haurer, op. cit., reports eleven institutions either planning to offer, or considering offering, this type of program. Boaz reported that among the institutions he investigated that "additions to and the strengthening of existing four-year programs seemed to be the trend. "Degree-Level Technology Programs," p. 1.

[37]Cunningham, op. cit., p. 41.

as follows:

1. To develop the student scientifically and professionally so that he can make distinctive contributions to the welfare of society and to prepare him to face new problems which call for skill, initiative, and leadership.
2. To instill in the student the desire to progress professionally and to expand his knowledge and abilities through the media of research, development, design, production, construction, sales or education.
3. To provide a cultural foundation which will enable the student to comprehend economic and social problems and which will encourage him to contribute constructively to his community as a mature, thinking individual.[38]

The "Education for Industry" degree-level curriculums of industrial technology at the University of Maryland are designed to develop the following four basic competencies:

1. Technical competence.
2. Human relations and leadership competence.
3. Communications competence.
4. Social and civic competence.[39]

The industrial technology curriculums investigated by Weber reported required courses in the following areas: commerce, communications, engineering, general education, science, shop courses and electives. The mean semester hours of required courses were reported as follows:

	Mean Semester Hours Required
Commerce	11.83
Communications	8.71

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[38] Tennessee Technological University Bulletin, (Cookeville: Tennessee Technological University, February 1965), L, No. 1, p. 209.

[39] The University of Maryland Bulletin, The University of Maryland, Vol. XIX, April 24, 1964, p. 25.

Engineering	3.39
General Education	14.09
Science	19.85
Shop Courses	38.64
Free Electives	15.38[40]

According to Cunningham the curriculum should satisfy the criteria below in order to achieve the objectives of industrial technological education:

1. Be directed toward a field of specialization with generous educational experiences in related fields of industrial technology.
2. Provide an opportunity for development of a thorough understanding of mathematical and scientific principles and a practical application of these principles to a field of specialization and closely related fields.
3. Provide opportunity for development of a basic understanding of the humanities and social studies and a knowledge of how they can be utilized for achieving better human relations.
4. Provide opportunity for the development of sound principles of management and supervision and an understanding of how these principles can be used to achieve the objectives of the industrial enterprise.
5. Be of college level and of a quality required for graduates to obtain employment in accordance with the objectives of the curriculum.
6. Be reviewed frequently and changed to meet existing needs of industry.[41]

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[40]Data taken from Table XXXIV, "Comparisons of Required Courses in the Curriculums of Industrial Arts Education, Industrial Technology, and Technical Institutes," Weber, op. cit., p. 163.

[41]Cunningham, op. cit., p. 41.

It was noted by both Haurer[42] and Barnhart[43] that the curriculums, for the most part, appeared to take one of two forms: (1) a so-called "specialized" curriculum pattern which followed somewhat the two-year technical institute type program, broadened and given depth, or (2) a so-called "general" curriculum pattern which appeared to be designed primarily for the preparation required for managerial positions requiring a broad technical background combined with a working knowledge of business and managerial techniques.[44] The "specialized programs" were designated by Barnhart as those which placed less emphasis upon the professional courses and required a fairly specialized training in one technical field of technology.

Nelson stated that:

> Whether a particular-field or a general-field approach shall be made toward technological education, the heart of the curriculum will be the development of broad comprehensive foundations of experiences related to a particular industry. These foundations must provide bases for creative decision-making, for adaptability to innovations, for facility in communication, and for further intellectual growth.[45]

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[42]Nelson A. Haurer, "Degree Programs of Industrial Technology: Observations and Comments" (Baton Rouge: Louisiana State University, February 1963). (Mimeographed.)

[43]E. L. Barnhart, "Industrial Technology Programs: Curriculum Patterns" (paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963), p. 1.

[44]The so-called "general program" as defined above was the primary concern of this investigation.

[45]Nelson, op. cit., p. 19.

Barnhart found a wide variation among the requirements of individual programs but "an astonishing similarity between the mean requirements for any one subject area among the different programs."[46]

General education aspect. The literature revealed all industrial technology curriculums shared a common concern for general education.[47] The Arizona State University General Catalog stated:

> . . . it is the added purpose of these curriculums to make the student keenly aware of the urgent problems of society and to develop deeper appreciation of the cultural achievements of man.[48]

A major objective of industrial technology programs enumerated by Cunningham stated that these curriculums should help the student "develop a comprehensive understanding of citizenship that promotes intelligent, sympathetic, and harmonious living in a democratic culture;"[49] and Weber remarked that "it would appear that in addition to training for some competency in technology a college program also has a great responsibility to prepare graduates who will be able to make the right decisions in an attempt to control technology for the total good of mankind."[50]

The manipulative skills aspect. These industrial technology curriculums do provide the student with some manipulative skills, but

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[46]Barnhart, loc. cit.

[47]It would be interesting to investigate whether this concern for general education is a reflection of the fact that most of these programs have evolved out of college-level industrial arts (a phase of general education) programs.

[48]Arizona State University General Catalog, LXXVIII, No. 2 May 1963, p. 215.

[49]Cunningham, op. cit., p. 39.

[50]Weber, op. cit., p. 12-13.

the emphasis is not placed on skills *per se* as in trade curriculums or a two-year technician curriculum. The student who is primarily interested in developing manipulative skills should not enroll in an industrial technology program. The trade curriculums or the "two-year technical program can take care of the skills interested student."[51]

The *Arizona State University General Catalog* stated that:

> . . . these curriculums (of industrial technology) combine general foundations of scientific theory and facts with laboratory experiences which are designed to instruct in methods rather than to develop extensive skills.[52]

Cunningham also pointed out that "in contrast to the craftsman the applied scientist industrial technologist does not profit significantly from the development of a high degree of manipulative skills taught from a vocational approach."[53] The emphasis of industrial technology curriculums is on the "application of scientific principles more than manual skills" and the integration of "the activities of the skilled craftsman with those of highly scientific personnel."[54]

Industrial technology curriculums do provide the student a general knowledge of machines, materials, processes, and techniques in addition to an appreciation of, and a degree of competency in, the area of manipulative skills.

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[51]Groneman, *op. cit.*, p. 1.

[52]*Arizona State University General Catalog*, *op. cit.*, p. 214.

[53]Cunningham, *op. cit.*, pp. 39-40.

[54]*Ibid.*, p. 40.

Organization and Administration

The names of the department offering industrial technology curriculums were found to vary. Over half of the programs studied by Haurer[55] were offered under a department title of "Industrial Education" or "Industrial Arts." Some departments, however, included the words "science" or "technology" in their titles.

The name of the degree offered was found to vary. Four practices were reported in designating the degree offered for curriculums in industrial technology: (1) the greater number chose to offer the Bachelor of Science in Industrial Technology; (2) several institutions offered the Bachelor of Science in Industrial Education with the designation of a non-teaching option; (3) other institutions chose to title the degree according to the specific area of concentration; and (4) there were those institutions that offered a degree that was more descriptive of their particular curriculum and which might be called unique (e.g., B.S. in Technical Science, B.S. in Applied Science, or B.S. in Industrial Preparation).[56]

A mean semester hour requirement for graduation of 128.82 was reported by the institutions studied by Weber.[57] Keith examined the catalogs of twenty-three institutions offering an industrial technology curriculum and found the mean semester hour requirement for graduation was 127.3 with a range from 120 to 144 semester hours. One institution required 144 semester hours for graduation and three

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[55]Haurer, "Status Study Industrial Technology," p. 2.

[56]Ibid., p. 3.

[57]Weber, op. cit., p. 163.

required 120 semester hours for graduation.[58]

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[58]Charles W. Keith, "The Industrial Technology Program at Kent State University: An Appraisal and Recommendations" (unpublished Ph.D dissertation, The Ohio State University, Columbus, 1964), p. 41. (Microfilm.)

CHAPTER III

METHODS AND PROCEDURES

A nationally recognized company that employed persons from a variety of educational backgrounds was identified to provide an industrial situation for the investigation of management-oriented job classifications at the intermediate range of technical employment. The company had the appropriate size, diversity of operation, and geographical location and met the established criteria.

The company was requested to identify those individuals: (1) who had been employed during a specified six-year period, and (2) who were considered to have been the most effective performers in the general area of employment which might have been staffed by industrial technologists as defined in this study. These employees were considered to be "identified high achievers". They represented four functional areas of employment and were utilized as a primary source of information for determining those factors associated with effectiveness in the general area of employment investigated by this study.

The critical incident technique was used as the primary data-gathering procedure in an attempt to identify specific types of behaviors the high achievers exhibited which contributed to their effectiveness. The critical incident reports were obtained from the identified high achievers through personal interviews conducted by the investigator. The incidents that were reported were selected by the interviewees on the basis that they had contributed toward achieving a stated objective which had been developed for each of the four respective functional areas of employment. The information was recorded

on questionnaire forms (see exhibits B and C in Appendix A).

Each interviewee was requested to describe three critical incidents in which he had considered himself to have been effective in contributing toward the agreed upon stated objective. Each critical incident was coded to protect the anonymity of the performer of the functional task which had been described, and was transferred to Royal McBee Keysort cards to simplify the referral and classification procedures.

The critical incident reports were analyzed and the behaviors described were abstracted according to three separate dimensional systems. These dimensions were: (1) functional task,[1] (2) media of involvement, and (3) skill. Each set of dimensions comprised a system of classification of the elements or factors which were associated with the effective performances described in the critical incident reports.

The personnel files of the high achievers were investigated to determine the qualifications and background of experiences which the high achievers brought to their respective positions in an attempt to determine those biographical factors which were associated with effective performance. Work experience, type of educational background, grade point average, and other biographical information were studied.

The analyses of the data will be discussed in Chapters IV and V. After the data had been analyzed, categorized and compared, the task of interpretation remained. The concluding statements based upon

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[1]A functional task is a behavioral activity included with the responsibilities of a particular job assignment.

these interpretations are summarized in Chapter VI.

In this chapter the methods and procedures used in this investigation will be discussed. The chapter is divided into the following sections: (1) the selection of the cooperating company; (2) a description of the cooperating company; (3) identification of the individuals considered to have been effective performers; (4) the research technique; (5) the procedures used in gathering the data; and (6) the coding and recording of the data.

I. THE SELECTION OF THE COOPERATING COMPANY

The following criteria were established for selecting an industrial enterprise at which to conduct the investigation:

1. A company employing a large enough work force to be capable of supplying a sample for study.
2. A company of suitable geographical location which would permit personal contact with the interviewees by the investigator.
3. A company which was willing to cooperate in the study.
4. A company which had a diversity of job classifications in the intermediate ranges of management or technical employment.
5. A company which had an established system of personnel evaluation.
6. A company which recruited nationally and employed individuals from a variety of educational backgrounds to staff positions in the area under investigation.
7. A company which was nationally recognized as a leader in its field.

Personal contacts were established with the Technical Placement Department personnel of the home office of the Dow Chemical Company at Midland, Michigan. An investigation of the research laboratories and production complexes, the personnel policies, and the organizational structure of the Midland Division of The Dow Chemical Com-

pany revealed that it satisfactorily met the established criteria.

The Dow Chemical Company (hereinafter referred to as the Company) expressed an interest in the study and a willingness to provide the personnel and the industrial situation necessary for conducting the study.[2]

II. DESCRIPTION OF THE COOPERATING COMPANY

The Dow Chemical Company was founded in 1897 at Midland, Michigan by a young chemist, Herbert Henry Dow. Since its founding, the Company has expanded and diversified on the strength of numerous pioneering discoveries in the field of chemistry and related fields. The Company's roster of products numbered more than eight hundred in the categories of plastics, chemicals, bioproducts, metals, and textile fibers.[3] In 1964 chemicals accounted for fifty-one per cent of the Company's total sales; plastics, including textile fibers, thirty-four per cent; bioproducts, eight per cent; and metals, seven per cent.[4]

The corporate enterprise was one of eight chemical companies (five in the United States and three in Europe) whose annual sales exceeded one billion dollars in 1964.

For additional information about the organizational philosophy of the Company and its personnel policies and practices see Appendix D, Exhibit B.

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[2]See Appendix D.

[3]"Dow . . . at a Glance" (Midland, Michigan: The Dow Chemical Company, 1963), p. 2.

[4]"Dow Annual Report: 1964" (Midland, Michigan: The Dow Chemical Company, March 1965), p. 4.

The Midland Division

The Midland location includes the Company's oldest and most diversified production facilities as well as the firm's corporate headquarters. Approximately eleven thousand persons were employed at the Midland location.[5]

The Midland Division's plants, shops, laboratories, service and office facilities occupied more than five hundred buildings and two thousand acres in plant sites and it was considered to be one of the largest chemical production facilities located in one complex.[6]

III. IDENTIFICATION OF THE HIGH ACHIEVERS

The Company was requested to identify those salaried[7] employees whom the Company considered to have been their most effective employees and who met the following criteria:

1. The persons selected were to have entered continuous employment with the Company within the six-year period from January 1, 1958 to January 1, 1964. The persons selected were also to have had some kind of formal collegiate education since 1957. This criterion was established so that the individual's educational background would have reflected some of the recent curriculum changes and so that the individual being interviewed might be better qualified to relate the demands of his position to his educational experiences.
2. All persons who were selected were to have been associated with the Midland location in order to permit personal interviews.
3. The persons selected were to have been employed in positions which might be staffed by graduates of

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[5] "Dow . . . at a Glance," op. cit., p. 16. Approximately three thousand of these employees were salaried personnel.

[6] Ibid.

[7] Those employees not subject to the Fair Labor Standards Act.

degree-level industrial technology curriculums.[8]

If the identified high achievers met the three criteria stated above, the educational qualifications of the individuals were not a consideration in the selection of the effective individuals. Persons without earned degrees and persons who had earned advanced degrees were also eligible for selection.

The general area of employment which was investigated in this was delineated as the range between the fourth and ninth stanines of a vertical "technical qualifications" scale and the sixth and tenth stanines of the horizontal "human relations and business qualifications" scale (see Appendix E).[9]

In order to determine the levels of competency and responsibility demanded of a particular assignment the Company's job description was compared with the descriptions for the various grades of the General Schedule (GS) classification system developed by the Federal Civil Service Commission. This system was selected because

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[8]At the time of this investigation the Company was not recruiting graduates of degree-level industrial technology curriculums. The design of this study was to delineate an area of "potential employment" of industrial technologists and then determine those factors which were associated with the actions of effective individuals staffing the identified positions as a means of determining the nature of the backgrounds and skills utilized by effective employees staffing these positions.

This decision was based upon the fact that the graduates of degree-level industrial technology curriculums were so few in number and so scattered geographically that no single corporation could have provided an adequate sample of industrial technologists as defined in this study which could be compared with graduates of other curriculums staffing the same types of positions.

[9]The scales and graphic analysis chart of the areas of employment which was used (see Appendix E) were developed by the Company's placement personnel and were used for recruitment interviewing purposes.

it was designed to classifiy a particular assignment according to the "grade" or "level" of involvement regardless of the functional area of employment. Any Company job classifications comparable to those within the GS-5 to GS-11 range were included in the study.

Methods Used to Identify the High Achievers

The assumption was made that the Company could identify their most effective employees within the delineated area of employment who met the established criteria. However, one of the keys to the significance of the study was the Company's ability to identify their "high achievers". Therefore, the procedures and criteria used to make these selections are reviewed below.

The selections were based upon the following factors: (1) performance evaluations, (2) recommendations of superiors, (3) salary progression, (4) job progression, (5) miscellaneous (research, patents, operations improvement suggestions, et cetera).

The Company had a system of performance ratings ranging from one to four. A performance evaluation of either a "one" or a "two" was the highest possible evaluation and it meant that the individual was considered to have been "outstanding or excelling" in his work. A "three rating" indicated a "good performer" and a "four rating" indicated "marginal performance". All of the subjects included in the study had been given a "one" or a "two" performance rating.[10]

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[10]There were three exceptions where a "three rating" was held. This still indicated a "good" performer and each of these three individuals had received a promotion during the previous eighteen month period and they had received significant salary increases during the previous year. Therefore, the Company judged that their over-all records indicated that they were high achievers and they were included in the sample.

The Salary Administration Department was consulted to determine whether the individual had received salary increases commensurate with the performance evaluations given by the superiors. The job progression pattern of the individual was a second method used in an attempt to check the consistency of the individual's performance. It also supported the fact that the identified individuals were effective performers who were "moving" in the Company organizational structure.

IV. THE RESEARCH TECHNIQUE

The critical incident technique was used as one of the primary data-gathering procedures in this study. A brief discussion of the critical incident technique and its use is presented in the following section.

The Critical Incident Technique

The critical incident technique was used to obtain reports of effective performance in an attempt to identify specific behavioral acts which individuals had performed which they judged contributed to their "being effective".

John C. Flanagan, the person most widely recognized as having been responsible for the development of this technique, stated that ". . . the critical incident technique, rather than collecting opinions, hunches, and estimates, obtains a record of specific behaviors from those in the best position to make observations and evaluations."[11]

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[11]John C. Flanagan, "The Critical Incident Technique," offprinted from the Psychological Bulletin, LI (July 1954), No. 4, p. 355.

The classic formulation of the critical incident technique has five steps:

1. General Aims. These are brief statements obtained from the authorities in the field which express in simple terms those objectives to which most people would agree.
2. Plans and Specifications. The set of rules concerning the reporters, the situations reported, the relevance of the critical incidents to the general aim, and the extent of the effect of the critical incidents on the general aim.
3. Collecting the Data. As a result of steps (1) and (2), certain data concerning activities that are judged to be "critical" in the performance of a task are collected. Interviews, questionnaires, record forms and observations are utilized.
4. Analyzing the Data. The data collected are analyzed, categories are formulated, and general behaviors are extrapolated and identified.
5. Interpretation of the Data. The final step is the interpretation of data (significance) by the researchers involved.[12]

The critical incident technique is essentially a procedure for gathering important information concerning the nature of the activities and behaviors exhibited in defined situations. The versatility of the procedure is evidenced by the diversity of topics reported in the literature as having been investigated with the aid of the critical incident technique.

Flanagan pointed out that:

> . . . It should be emphasized that the critical incident technique does not consist of a rigid set of rules. . . . Rather it should be thought of as a flexible set of principles which must be modified to meet a specific situation at hand.[13]

The procedure has considerable efficiency, according to Flanagan, because of the use of only extreme behaviors. In this

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[12] Ibid., pp. 336-346.

[13] Ibid., p. 355.

investigation only outstandingly effective performance which directly or indirectly contributed to a stated aim were collected. Extreme incidents of effectiveness were sought because they are more discriminating and "it is well known that extreme incidents can be more accurately identified than behavior which is more nearly average in character."[14]

The review of the literature related to the use of the critical incident technique revealed no studies which applied the principles of this research technique in the manner in which it was utilized in this study. However, these studies clearly indicated the versatility of the procedure and the appropriateness of the use of this research tool in an investigation of this nature.[15]

V. DATA GATHERING PROCEDURES

The data collected in this study were obtained from two primary sources: (1) reports of critical incidents performed by effective individuals and reported by the performers through personal interviews; and (2) the available personnel records which were on file at the Company.

Biographical Data

Pertinent biographical data were obtained from the "Qualifi-

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[14] Ibid., p. 338.

[15] A twenty-five page review of the literature and an accompanying bibliography of selected studies utilizing the critical incident technique was prepared and has been placed on deposit at the Bradley University Library, Peoria, Illinois. cf. Raymond L. Keil, Literature Related to the Critical Incident Technique: A Survey and Bibliography" (unpublished paper, Bradley University, Peoria, Illinois, November 1965). (Mimeographed.)

cations Record" (see Appendix F) of each subject. An "Interview Control Data Form" was developed (see Appendix G) because it was found that the Company was in the process of establishing a system for immediate updating of personnel records but that some of the personal data had not been updated at the time of this investigation. This form was used at the time of the personal interview to validate certain information in the files and to make any necessary changes (e.g., additional educational experiences).

The personnel records were also used to check upon the job progression and Company work experience of each subject.

The Personal Interviews

Critical incident reports were obtained through personal interviews which ranged in length from forty-five minutes to one hour and fifteen minutes. These interviews were conducted by the investigator between February 18, 1965 and July 9, 1965.[16] Employees were interviewed who had been identified as high achievers from each of the following areas of employment: (1) technical service and development, (2) technical sales, (3) research, and (4) production.

Criteria Used for the Collection of the Critical Incident Reports

The following criteria for a good usable critical incident report were used:

1. An accurate, authentic, detailed description of on-the-job behavior;

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[16]Circumstances did not permit one subject to be contacted by personal interview. The data were obtained from this subject by telephone conversation and a mailed questionnaire. The literature indicated that the use of a mailed questionnaire was not found to have any effect upon the quality of the data.

2. An objective unbiased description of behavior;
3. Reported by a person classified by the Company as having been a high achiever and performed by the reporter in a specific on-the-job situation;
4. Judged by the reporter to have been effective in contributing toward achieving an agreed upon stated objective.[17]

The authenticity of the critical incident reports depended upon: (1) the honesty and accuracy of the reporter; (2) the skill of the interviewer in bringing out the salient points; and (3) the ability of the interviewer to report the information received accurately. In order to safeguard the authenticity of the reports the interviewer took notes during the interview and then dictated back and verbally reconstructed the incident to the reporter who in this study was a primary source of information as the performer of the functional activity. In all cases, the reports were written out and typed on five inch by eight inch Royal McBee Keysort cards (see Appendix H) the same day that they were reported. Personal character and integrity are generally recognized as essential factors associated with success[18] and because the reporters had been designated as effective personnel and were found to have been conscientious and dedicated individuals, there was no reason to question their honesty.[19]

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[17]The basic criteria was adapted from the American Institute for Research Report "Criteria for a Good Critical Incident," Technical Appendices for Critical Requirements for Research Personnel, (Pittsburgh: American Insitute for Research, 1949), p. 30. (p. B-4 of Appendix B).

[18]Regardless of what other qualifications and characteristics an employee may have any reputable organization demands honesty and and personal integrity from its employees.

[19]Domas pointed out that "making it absolutely clear to the reporter that his judgment . . . was neither questioned nor evaluated helped to safeguard honesty." cf. Simeon J. Domas, Report of an Exploratory Study of Teacher Competence, (Cambridge, Mass.: The New England School Development Council, 1950), p. 26.

The objectivity of the reporting was also safeguarded by several factors. First, only those critical incidents which had occurred within a time span approximately six months prior to the reporting of the incident were collected. This criterion provided a reasonable assurance of accuracy of recall of the essential details surrounding the critical incident and fostered objective reporting. The literature pertaining to the critical incident technique revealed that incidents having occurred six months prior to their reporting can be reported without serious loss of detail. Secondly, the reporters were assured that the anonymity of the information would be protected and that the information would not be used in any way which might be damaging to them personally.[20] The interviewer did not discern any reluctance on the part of the reporters to report the critical incidents as objectively as they could, and it was that objectivity was improved by the fact that only effective critical incidents were solicited.

Complete objectivity cannot be obtained in the data collected in a study of this nature due to the human factors involved. The selection of a particular incident as having been an effective performance is largely a matter of the subjective judgment of the reporter. The objectivity of these judgments depended upon the clarity with which the objectives of the functional areas of employ-

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[20]The reporters were not informed that that they had been identified as high achievers by the Company. Furthermore, the reporters did not know exactly how the data collected were to be used and therefore did not have any reason to "slant" the information for personal gain and it was believed that the "ego factors" were minimized.

ment had been defined and the competence of the reporter in interpreting these objectives with respect to the incident performed. The statement of purpose which was developed for the respective functional area of employment of the reporter was discussed with the reporter prior to its use as a "standard" for the selection of the critical incidents. The persons utilized as reporters in this study were individuals who had been classified as having been high achievers by the Company. These individuals had been designated as "most effective individuals". Logically then, they must have interpreted the Company's objectives correctly and must have significantly contributed toward achieving these objectives to have received this distinction. On this basis, the reporters were considered to have been qualified to make the subjective judgments necessary to select "effective" critical incidents.

The critical incident technique also provided an internal check on the reporter's selection of the "effective" critical incident. The procedure forced the reporter to specify the results of the actions which had been described in the critical incident report and to explain how they had contributed toward achieving the agreed upon stated objective.

The Pilot Studies

The procedures and instruments used for conducting the personal interviews were tested in a pre-pilot study conducted at the John Bean Division of the FMC Corporation in Lansing, Michigan in November, 1964. Minor revisions were made and a section containing questions structured to obtain additional information was added.

A pilot study was conducted in February, 1965 at the Midland, Michigan location of the cooperating company. Fourteen people were included in this pilot study. The original design of the study made the assumption that the Company personnel were qualified to make the judgment as to whether a position might be staffed by an industrial technologist as defined in this study. The pilot study indicated that this assumption could not be supported and the procedures which have been described above (cf. p. 56) were developed to identify the appropriate level of employment. After deleting one person from the pilot study group because he was staffing a position inappropriate to an industrial technologist as defined in this study, the data obtained from these interviews were included in the final tabulations of the study because the remainder of the pilot study group met the established criteria.

Information Sought From the Personal Interviews

Each interviewee was requested to report three effective critical incidents which they had personally performed. In addition to the three effective job-related critical incidents, each subject was requested to: (1) complete the "Interview Control Data Form"; (2) identify the behavior which best illustrated his effectiveness if the reported incident involved more than one functional act;[21] (3) identify the principal medium involved in each incident reported on the basis of the "key" functional act identified in (2) above; and (4) attempt to identify the course (or courses) in his educational

[21]Nearly all of the effective critical incidents reported did involve more than one functional act.

background which had been beneficial to his performance of the effective act.[22]

Conducting the Interviews

The high achievers were first contacted by telephone by Company personnel for the purpose of scheduling an appointment for an interview.

Immediately following the scheduling of an appointment for an interview, a cover letter was sent to the individual under a Company letterhead (see Appendix H). This letter was designed to: (1) confirm the appointment; (2) provide the interviewee with a description of the critical incident technique prior to the interview; (3) provide the interviewee an opportunity to identify and select effective critical incidents;[23] and (4) serve as an introduction of the interviewer.

VI. RECORDING AND CODING THE DATA

The critical incident reports were recorded on a questionnaire form (see Appendix A) and coded to protect the anonymity of the reporter. The questionnaire included the three basic questions found in the classic formulation of the critical incident technique: (1) What were the circumstances leading up to the critical incident? (2) What specifically did you do that was effective? and (3) Why did

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[22]A selected list of cost titles was made available to the reporter to aid his recall and assist him in this task (see Appendix L).

[23]This procedure proved to provide a great deal of efficiency with respect to the length of time necessary to conduct the interviews and there was some indication that it improved the quality of the reports.

you judge this incident to have been an example of effectiveness?

A discussion of the composition and characteristics of the high achievement group that was interviewed is included in the following chapter. The analysis and handling of the critical incident data is presented in Chapter V.

CHAPTER IV

DESCRIPTION OF THE POPULATION

The composition of the population studied and the biographical data pertaining to the high achievement group are presented in this chapter. These data are of a descriptive nature and are not intended for predictive purposes.

I. DESCRIPTION OF THE HIGH ACHIEVEMENT GROUP

The high achievement group was composed of all those individuals identified by the Company as having been their most effective employees in the general area of employment investigated by this study on the basis of established criteria.[1]

The identified high achievers were employed in the following functional areas of employment: (1) technical service and development (commercial utilization), (2) technical sales, (3) research, and (4) production.

The original high achievement group investigated was composed of forty-two persons. All forty-two of these individuals were investigated through personal interviews conducted by the investigator, and their personal records were studied. As a result of these investigations seven persons were deleted from the sample because they did not meet the established criteria.[2]

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[1] cf. Chapter III, pp. 55-58 , "Identification of the High Achievers."

[2] Five of the persons deleted from the population had earned doctorate degrees and the level of technical qualifications required

The Technical Service and Development Group

The largest number of high achievers meeting the established criteria was identified in the technical service and development functional area of employment. Seventeen persons were identified as having been most effective in their work in this functional area of employment.[3]

The purpose of the technical service and development functional area of employment was to identify and develop new uses for existing as well as new products; to render technical assistance to customers; and to keep abreast of the changing technology of the customer's field.

The technical service and development group provided information to the research departments concerning the marketability of products and materials which had been developed by the research people. The technical service and development group evaluates products from the research departments much the same as customers do and makes the research departments aware of opportunities for products or technology in the field.

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of their respective positions fell above the established stanines.

One person deleted from the study was staffing a position which was by definition a technician classification involving the conducting of routine analytical tests for the quality control department.

The remaining person was deleted from the population because of the degree of specialization required and the fact that the job description of the position which he was staffing did not fit the pattern of a postion which might be staffed by an industrial technologist as defined in this study.

These persons were undoubtedly very successful employees and certain information collected from these individuals provided the investigator some insights into the technical manpower situation.

[3]One person was deleted from the technical service and development group because of the degree of technical specialization demanded of his position.

The demands of positions within this functional area were such that personnel in this group drew upon a variety of educational disciplines. Employment in this area demanded application of technical knowledge to the solution of customer problems and emphasized the business and human relations aspects; therefore, the educational background provided by an industrial technology curriculum which places considerable emphasis on these same aspects should be well suited for qualifying individuals for employment in the technical service and development area of employment.

The educational backgrounds represented by this group of high achievers were somewhat varied. All of the undergraduate degrees were technical in nature, but some individuals had combined a technical undergraduate degree with a master's degree in business administration. One person had received both a technical graduate as well as a technical undergraduate degree.

The educational backgrounds and the composition of the technical service and development group of high achievers are presented in Table I.

The Technical Sales Group

The responsibilities of the five individuals identified as having been high achievers in the technical sales area were found to differ from the commonly held concept of "salesman". These salesmen were charged with the responsibility of servicing their customers on a long-range basis by searching out and identifying areas of need and problem areas in the customer's business operation, and with the coordination of the technical and marketing assistance necessary to solve

TABLE I

POSITIONS STAFFED BY HIGH ACHIEVERS FROM THE FUNCTIONAL AREA OF TECHNICAL SERVICES AND DEVELOPMENT AND THE EDUCATIONAL DEGREES REPRESENTED

Technical Services and Development Group		
Position Staffed	Product Area	Degree Represented
Packaging Development Engineer	Wire and Cable	B.S. Chemical Engineering
Packaging Engineer	Packaging	B.S. Packaging Engineering B.S. Chemistry
Section Head Tech. Serv. & Dev.	Cleaning Systems	B.S. Chemical Engineering
Section Head Tech. Serv. & Dev.	Cleaning Formulations	B.S. Chemical Engineering
Civil Engineer Plastics Dev. & Serv.	Fabricated Constr. Mat'ls	B.S. Civil Engineering M.S. Soil Mechanics
Packaging Engineer	Packaging	B.S. Packaging Engineering
Chemical Engineer	Plastics	B.S. Chemical Engineering
Coatings Engineer	Coatings	B.S. Chemical Engineering
Plastics Engineer	Plastics	B.S. Mechanical Engineering
Chemical Engineer	Plastics	B.S. Chemical Engineering
Plastics Chemist	Plastics	B.S. Chemistry
Coatings Chemist	Coatings	B.S. Chemistry
Packaging Specialist	Packaging	B.S. Chemistry
Plastics Development Engineer	Plastics	B.S. Chemical Engineering M.B.A. Management
Chemist Plastics Dev. & Serv.	Plastics	Associate Pre-engineering B.S. Chemistry-Mathematics

these problems and to supply these demands.

The high achievement group in the technical sales area represented a variety of different educational backgrounds as is evidenced in Table II. In fact, no two individuals had the same undergraduate major. The sales area was the one area of employment studied where the Company was hiring graduates from a variety of different backgrounds to perform the same or similar types of work.

The Research Group

Thirteen individuals were identified as high achievers within the functional area of research. This functional area of employment differed from the technical service and development functional area in that its purpose was to develop and refine new products from basic materials, whereas the technical service and development functional area of employment was charged with the responsibility of developing new product applications and finding ways to utilize the products and processes which had been developed by the research personnel.

The primary purpose of the research group was to discover new products and processes which would maintain the Company's economic position in the field.

Of the thirteen persons identified[4] as high achievers by the Company in this area, it was necessary to delete six persons on the basis of either the degree of specialization required of the respective position or because the requirements of the position were not appropriate to the qualifications of an industrial technologist as

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[4]This does not imply that there were only thirteen high achievers employed in this area, but that only thirteen were originally considered to meet all of the criteria established by this investigation.

TABLE II

POSITIONS STAFFED BY HIGH ACHIEVERS FROM THE FUNCTIONAL AREA OF TECHNICAL SALES AND THE EDUCATIONAL DEGREES REPRESENTED

Technical Sales Group		
Position Staffed	Product Area	Degree Represented
Salesman	Coating Products	B.S. Packaging Engineering
Packaging Sales Engineer	Packaging Products	B.S. Mechanical Engineering M.B.A. Personnel Management
Assistant Product Sales Manager	Industrial Chemical Sales	A.B. Chemistry M.B.A. Business Administration
Field Salesman	Industrial Chemical Sales	B.A. Psychology
Assistant Brand Manager	Consumer Product Sales	A.B. Economics M.B.A. Business Administration

defined in this study.

The educational backgrounds represented by the research group were somewhat varied, but all the undergraduate degrees were of a technical nature. The undergraduate degrees represented were in either chemistry, chemical engineering or mechanical engineering. Three of the four master's degrees represented by this group were technical in nature and the fourth degree was in economics. It should be noted that one person held a bachelor's degree in both mathematics and chemistry.

The composition of the research group and the educational degrees represented by the identified high achievers from this functional area of employment are presented in Table III.

The Production Group

The purpose of the functional area of employment termed "production" was to utilize efficiently the existing processes and personnel to: (1) produce quality materials and products; (2) improve the existing facilities, processes, and operating conditions; and (3) achieve greater efficiency in producing better materials and products.

The seven individuals identified as having effectively contributed toward meeting the objective stated above in an outstanding manner were in positions of leadership as production supervisors.

The composition of the production group of high achievers is presented in Table IV.

Educational Institutions Represented by the High Achievers

An investigation of the hiring practices of the Company revealed that employees were recruited from small, medium and large

TABLE III

POSITIONS STAFFED BY HIGH ACHIEVERS FROM THE FUNCTIONAL AREA OF RESEARCH AND THE EDUCATIONAL DEGREES REPRESENTED

Position Staffed	Product Area	Degree Represented
Product Specialist	Saran Products Laboratory	B.S. Chem. Engineering M.S. Economics
Process Engineer	Process Engineering	B.S. Mech. Engineering M.S. Mech. Engineering
Chemist	Saran Products Laboratory	B.S. Chemistry B.S. Mathematics
Project Leader	Halogen Research Laboratory	B.S. Chem. Engineering M.S. Chem. Engineering
Project Leader	Halogen Research Laboratory	B.S. Chem. Engineering M.S. Chem. Engineering
Project Leader	Fabricated Plastic Products	B.S. Chemistry
Research Product Specialist	Saran Products Laboratory	B.S. Chemistry Working toward M.S. in Chemistry

TABLE IV

POSITIONS STAFFED BY HIGH ACHIEVERS FROM THE FUNCTIONAL AREA OF PRODUCTION AND THE EDUCATIONAL DEGREES REPRESENTED

	Production Group	
Position Staffed	Product Area	Degree Represented
Assistant Superintendent	Bromine Products	B.S. Chemical Engineering
Assistant Superintendent	Bromide Products	B.S. Chemical Engineering
Assistant Superintendent	Propylene Oxide Production	B.S. Chemical Engineering
Assiatant Superintendent	Chlorobenzol Production	B.S. Chemical Engineering Working toward M.B.A.
Assistant Superintendent	Ethanolamine Production	B.S. Chemical Engineering
Production Development Engineer	Process Section	B.S. Chemical Engineering
Development Engineer	Process Section	B.S. Chemical Engineering

colleges and universities located in all parts of the United States and in some foreign countries. The educational institutions represented by the high achievement group studied reflected this hiring practice. The Midwestern institutions were more heavily represented in both the sample and the population from which the sample was drawn. Due to the proximity of Midwestern institutions to the Midland, Michigan location and the tendency for graduates to locate in the geographic section of the country in which they have been reared, this finding was as might have been expected.

Only eight educational institutions were represented by more than one high achiever. Eighteen undergraduate and four graduate degrees were obtained from these eight institutions: Michigan State University four undergraduate degrees; Purdue University and Michigan Technological University three undergraduate degrees; and the University of Detroit, University of Minnesota, and Central Michigan University each two undergraduate degrees. Two of three persons holding undergraduate degrees from Purdue University had also earned masters' degrees from Purdue University. The only other institution represented by two masters' degrees in the high achievement group investigated was the University of Michigan.

Because a wide variety of types and sizes of higher educational institutions was represented by the persons classified as having been high achievers, the evidence does not particularly favor any one group or type of institution.

The educational institutions represented by the high achievement group studied are presented in Table V.

TABLE V

INSTITUTIONS REPRESENTED BY THE HIGH ACHIEVERS STUDIED

Name of the Institution	Degree Level*			
	A	B	C	D
Michigan State University	1	0	4	0
Michigan Technological University	0	0	3	0
Purdue University	0	0	3	2
University of Detroit	0	0	2	0
University of Minnesota	0	0	2	0
Central Michigan University	0	0	2	0
Alma College	0	0	1	0
University of Michigan	0	0	1	2
Illinois Institute of Technology	0	0	1	0
Missouri University at Rollo	0	0	1	0
Missouri Valley College	0	1	0	0
University of Delaware	0	0	1	0
University of Cincinnati	1	0	1	0
Northwestern University	0	0	1	0
University of Maryland	0	0	1	0
Tri State College	0	0	1	0
Indiana University	0	0	1	1
Dickenson College	0	0	1	0
South Dakota School of Mines	0	0	1	0
Louisiana State University	0	0	1	0
Southeastern Missouri State College	0	0	1	0
Arkansas Polytechnic College	0	0	1	0
Cornell University	0	0	1	0
Indiana State University	0	0	0	1
George Washington University	0	0	0	1
Wooster College	1	0	0	0
Loyola of Chicago	0	0	0	1
Port Huron Junior College	0	1	0	0
Bay City Junior College	0	1	0	0
Westminster College (Pa.)	0	0	1	0
Carnegie Institute of Technology	0	1	0	0
Fenn College	1	0	0	0
Mount Union College	0	0	1	0
John Carroll College	1	0	0	0
Calvin College	1	0	0	0
University of Wisconsin	0	0	1	0

*A—Transfer work; B—Associate Degree; C—Bachelor's Degree; and D—Master's Degree.

Note: Those persons having had dual majors and who received two degress were only counted once.

Types of Academic Majors Represented

An investigation of the types of academic majors represented by the persons employed by the Company during the six-year period investigated revealed that a variety of academic majors was utilized.[5] However, the Company was basically a chemical company and had employed a majority of individuals holding either a degree in chemistry or chemical engineering. This hiring practice was reflected in the sample studied as is evidenced in Table VI.

It must be noted that in several cases the degree earned did not necessarily reflect the nature of the individual's educational experiences while in college. Several persons had transferred into the technical curriculums from which they graduated after having received non-technical orientations. In contrast, one individual received a degree in psychology after having transferred out of a technical curriculum.

Because the industrial technology degree has been referred to at times as a hybrid degree, it is interesting to note that some of the educational backgrounds represented by some high achievers approximated a similar combination of educational experiences as those which might have been obtained from an industrial technology curriculum.

The only academic major which was disproportionately represented in the high achievement group studied was the degree in packaging received from Michigan State University's School of Packaging.

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[5]See Appendix J. As has been noted previously, the Company was not employing graduates of degree-level industrial technology curriculums of the type defined in this study at the time of this investigation.

TABLE VI.

ACADEMIC MAJORS REPRESENTED BY THE HIGH ACHIEVERS*

Academic Major	Number Bachelor	Master
Chemical Engineering	16	2
Chemistry	10**	0
Mechanical Engineering	3	1
Packaging Engineering	3[a]	0
Civil Engineering	1	1
Economics	1	1
Marketing	0	1
Psychology	1	0
Management	0	1
Personnel Management	0	1
Business Administration	0	2
Soil Mechanics	0	1
Mathematics	3**	0

*See Appendix J for the types of degrees represented in the universe.

**Three persons had had dual majors and received degrees in all three cases in both chemistry and mathematics.

[a]One person had a dual major and received degrees in both packaging engineering and chemistry.

Five graduates of this packaging curriculum were employed by the Company during the six-year period under investigation by this study. Three of these five graduates were designated as having been high achievers.[6]

An investigation of the packaging curriculum at Michigan State University revealed that this curriculum placed more emphasis on application and was less theoretically-oriented than, for example, current engineering curriculums at many institutions. This packaging curriculum pattern was found to be very similar in nature to the industrial technology curriculum patterns described in this study. This evidence tends to support the assumption that graduates of an industrial technology curriculum might be utilized to staff positions within the area of employment delineated in this study.

Advanced Degrees

Six hundred and eighty-eight persons employed by the Company during the six-year period studied had earned bachelors' degrees, and one hundred and eighty-one persons who had entered continuous employment during the same six-year period had earned masters' degrees.

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[6]It may be that this unique curriculum is especially suited to the demands of the Plastics Development and Service Department of the Company. However, only two of the graduates of this packaging curriculum were employed in this area. The third graduate of the packaging curriculum included in the sample studied was employed in the area of technical sales.

An investigation was made to determine if these three graduates had earned outstanding academic records, but this was not found to have been the case. The mean grade point average of these three high achievers was found to be 2.54 and well below the 2.81 mean grade point average for the total high achievement group. Only one of the three packaging curriculum graduates had a cumulative grade point average above the mean for the group and it exceeded the mean for the group by only .11.

Nine of the the thirty-five persons classified as having been high achievers had earned masters' degrees at the time of this investigation. A chi-square test of statistical significance was performed to determine whether individuals holding masters' degrees were disproportionately represented in the high achievement group. No statistically significant difference was found.

An investigation of the rate of advancement of those persons in the high achievement group who held masters' degrees was conducted to determine whether persons with masters' degrees had advanced more rapidly than those persons who did not hold masters' degrees, and no difference was noted. The findings of this study did not indicate that a master's degree facilitated more rapid advancement during the limited time span investigated.[7] Thus, with regard to the cooperating company, the promotional practices appear to have been dependent on performance and merit and factors other than academic credentials.[8]

Intercollegiate Athletics

Six of the thirty-five high achievers had participated in

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[7]It did appear that the advantage of holding a master's degree was that additional opportunities and better salaries are provided the master's degree holder at the time of the person's initial employment. However, the additional advantages of holding a master's degree were not clear and need to be investigated.

[8]This statement must be qualified as a bias was recognized with respect to the advancement of persons not holding bachelor's degrees. Three persons classified as high achievers had been employed by the Company at one time as technicians. In all three cases it was noted that these individuals did not advance beyond this classification until after (or immediately prior to) the completion of their baccalaureate degrees. This point is of particular significance to this study which is concerned with degree-level industrial technical curricula.

varsity athletics while in college. This figure represented slightly more than one-sixth of the group studied. The statistical significance of having participated in intercollegiate athletics as a factor associated with effectiveness has not been tested in this study. Because, however, one-sixth of the high achievement group had participated in intercollegiate athletics, this factor might merit consideration in conjunction with other factors in the selection of employees.[9]

II. ACADEMIC ACHIEVEMENT

Academic achievement has been used as a selection criterion by many companies.[10] The Bell Telephone Study[11] found that the single most reliable predictive indicator of a college graduate's success in the Bell Telephone system was his rank in his graduating class.

The academic records of the high achievement group in this study were determined both on the basis of cumulative grade point averages and on the basis of rank within the individual's academic major. Even though grade point averages are quantitative, it was realized that grading practices vary from institution to institution and from one academic major to another. In addition, it has been

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[9] A man's success in extracurricular activities may be significant as a factor in predicting future on-the-job success by the fact that it may be an indicator of drive and motivation.

[10] e.g., "Grades Top Criteria," Senior Scholastic, LXXVIII (February 8, 1961), p. 2T; and "Top Grads Swamped by Good Job Offers," Business Week, (April 14, 1962), p. 76.

[11] Frederick R. Kappel, "From the World of College to the World of Work," John Findley Green Foundation Lecture, Westminster College, Fulton, Missouri, April 5, 1962. (Reprinted from the Bell Telephone Company for Spring 1962.), p. 8.

generally recognized that it is often more difficult to maintain a high over-all grade point average in some academic majors than in others. Therefore, the high achievers were requested to indicate their rank within the graduating class of their academic majors.

All grade point averages were computed on the basis of a four point honor system.[12] As Table XVII shows,[13] the cumulative grade point averages were found to range from 2.27 to 3.68. The mean grade point average of the high achievement group was 2.81 which would represent a B- letter grade average on the basis of a four honor point system. The median grade point average was 2.80 and the mode interval was between 2.75 and 2.99 for the group studied. Eight high achievers (22.8%) had earned a cumulative grade point average of less than 2.50 (C+ letter grade) and nine high achievers (25.7%) had earned a cumulative grade point average above 3.00 (B letter grade).

Twenty of the thirty-five high achievers (57.1%) ranked in the top twenty-five per cent of their graduating class within their academic majors. All thirty-five individuals had graduated in the upper half of their graduating classes within their respective academic majors.

The rank difference correlation coefficient for the variables of cumulative grade point average and rank within the graduating class of the high achiever's academic major was .73 (N=35).[14]

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[12]"A"—four honor points; "B"—three honor points; "C"—two honor points; and "D"—one honor point.

[13]See Appendix K. The data are summarized in Tables VII and VIII.

[14]It should be noted that this is not a particularly high positive correlation.

TABLE VII

SUMMARY OF THE CUMULATIVE GRADE POINT AVERAGES OF THE HIGH ACHIEVERS*

INTERVAL	Below 2.24	2.25-249	2.50-2.74	2.75-2.99	3.00-3.24	3.25-3.49	Above 3.50
NUMBER OF SUBJECTS	0	8	5	13	5	4	0

*All cumulative grade point averages were computed on the basis of a four honor point system: "A"—four honor points; "B"—three honor points; "C"—two honor points; and "D"—one honor point.

TABLE VIII

SUMMARY OF THE QUARTILE RANKS OF THE HIGH ACHIEVERS WITHIN ACADEMIC MAJOR[a]

QUARTILE	FIRST	SECOND	THIRD	FOURTH
NUMBER OF SUBJECTS	0	0	20	15

[a]When ranking by quartiles it is customary for the first quartile to be the lowest and for the fourth quartile to be the highest.

Because 57.1 per cent of the high achievers ranked within the upper twenty-five per cent of the graduating class within their academic majors, and whereas only nine individuals had earned cumulative grade point averages of 3.00 (B letter grade) or better, it would appear that with regard to the population studied that "rank within major" was a more discriminating criterion than cumulative grade point average for the selection of effective employees.

III. WORK EXPERIENCE

An investigation of the work experience records of the high achievers was conducted. Work experience were obtained through: (1) full or part-time employment before, during and after their college experiences; (2) summer employment; (3) cooperative training programs as a part of their college training; (4) military tours of duty; (5) Company work experience; or (6) research or teaching assistantships while attending college.

Personal comments and several of the critical incidents reported reflected the value of these experiences to the high achiever's effective performance. The important factor to note is not whether the individual had had work experience, but the type and pattern of work experiences he had on his qualifications record. In some cases the work experience merely provided a source of income and provided few experiences pertinent to their present employment. However, fourteen persons (40%) had had work experience of a technical nature which was related to their present employment. Five persons had received technical training as a part of their military experience

and six reported having received valuable leadership experience while on their military tours of duty. Five persons had had experience and training in skilled occupations and thirteen persons had had some form of sales experience. The structured work experiences which were obtained by some individuals through their participation in college cooperative work experience curriculums are discussed in the following section. For the complete tabulations of the work experiences of the high achievement group studied see Appendix I.

College Cooperative Curriculums

Eight of the high achievers (23%) had participated in college cooperative work experience curriculums as a part of their college education. Twenty-three per cent is a high percentage considering the fact that ten subjects majored in curriculums such as chemistry, psychology, and economics which are traditionally not offered on a cooperative basis. This finding becomes even more significant considering the fact that several of the engineering schools represented by the high achievement group did not offer a cooperative training option.

Research and Teaching Assistantships

Ten (28.6%) of the persons classified as having been high achievers had held either teaching or research assistantships during their college experience. The fact that over one-fourth of the high achievers studied had held research or teaching assistantships while in college would indicate that the advantages of having had such an experience would merit further investigation as a prognosticator of future on-the-job success.

IV. DEGREE OF SELF SUPPORT

If a man earns part or all of his college expenses, this may be used as an indicator of drive and motivation. Therefore, it might be expected that a large percentage of the persons classified as high achievers in this study would have assumed a high degree of self support in meeting their college expenses. This contention has been supported in that it was found that twelve subjects, or over one-third of the sample, had earned eighty to one hundred per cent of their college expenses. Twenty-two high achievers (63%) had earned over fifty per cent of their college expenses, while an additional four subjects had earned over thirty per cent of their college expenses. One person had earned only ten per cent of his college expenses, but he had earned one of the highest cumulative grade point averages (3.46) and ninety per cent of his expenses were met through scholarship aid.[15] Fifty-one per cent (18 individuals) had received some degree of scholarship aid and four individuals received financial assistance through the G. I. Bill.

The complete tabulations of the financing of the college education of the identified high achievement group are presented in Table IX.

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[15]Because only three high achievers who had earned eighty per cent or more of their college expenses had a cumulative grade point average above the mean of the sample, it would appear that self support through college might be considered somewhat compensatory for lower academic achievement.

TABLE IX

THE ANALYSIS OF THE SOURCES UTILIZED BY HIGH ACHIEVERS TO FINANCE THEIR COLLEGE EXPENSES

Code No.	Self-support	Scholarships	Family	G.I. Bill
21890	100%	0%	0%	0%
21801	90%	0%	0%	10%
21815	60%	30%	10%	0%
21840	50%	15%	35%	0%
21825	85%	15%	0%	0%
21990	80%	0%	20%	0%
21910	25%	10%	65%	0%
21920	20%	20%	60%	0%
21940	100%	0%	0%	0%
22309	75%	0%	25%	0%
22310	20%	5%	75%	0%
22315	65%	5%	30%	0%
22330	75%	15%	10%	0%
56009	95%	5%	0%	0%
56010	100%	0%	0%	0%
56015	70%	25%	5%	0%
56030	25%	0%	75%	0%
57009	50%	0%	50%	0%
57010	20%	0%	80%	0%
57015	75%	10%	15%	0%
57025	100%	0%	0%	0%
57035	30%	50%	20%	0%
52408	100%	0%	0%	0%
52409	20%	50%	30%	0%
61409	30%	20%	50%	0%
52410	50%	0%	50%	0%
61401	70%	0%	30%	0%
61425	100%	0%	0%	0%
61435	100%	0%	0%	0%
61511	90%	0%	10%	0%
62111	60%	0%	40%	0%
62115	60%	15%	25%	0%
70909	50%	0%	0%	50%
70901	90%	10%	0%	0%
70911	10%	90%	0%	0%

NOTE: All percentages are rounded off to nearest five per cent.

V. SUMMARY OF THE CHAPTER

The findings of this study with respect to the data descriptive of the high achievement group investigated may be summarized as follows:

1. The educational backgrounds of the persons classified as having been high achievers were concentrated in technical degrees in either chemistry or chemical engineering which was consistent with the hiring practices of the Company. The only curriculum which was disproportionately represented was the packaging curriculum of the School of Packaging at Michigan State University. This curriculum, although not classified as such, closely approximated the curriculum patterns of industrial technology curriculums as they have been defined in this study.

2. Academic rank order in major was found to have been a more discriminating criterion for identifying high achievers than was cumulative grade point average. The mean and median grade point averages of the high achievement group investigated were 2.81 and 2.80 respectively on the basis of a four honor point system. This mean grade point average was above the all-University grade point averages for the seniors of a major institution such as Michigan State University (2.65 for the class of 1965), but it was not considered to have been exceptionally high. All of the individuals classified as high achievers did rank in the upper one-half of the graduating class of their respective academic majors and twenty of the thirty-five (57%) ranked in the upper twenty-five per cent of the graduating class of their respective academic majors.

3. Persons holding masters' degrees were not disproportionately represented in the high achievement group. The advantages of holding a master's degree, with regard to the area of employment and the period of time under investigation, were not clear and further research was recommended.

4. One-third of the high achievement group earned from eighty to one hundred per cent of their college expenses. Twenty-two of the thirty-five (63%) had earned fifty per cent or more of their college expenses.

5. Eight of the thirty-five (23%) high achievers had participated in cooperative work experience curriculums, which is a high percentage considering the fact that many of the institutions represented by the sample did not offer this curricular option.

CHAPTER V

FINDINGS REGARDING EFFECTIVENESS OF ON THE JOB PERFORMANCE

This chapter reports the collection, analysis and classification of the data received in the form of critical incident reports which were descriptions of effective on-the-job performance. The chapter is divided into the following sections: (1) the critical incident reports; (2) the formulation of the classification systems; (3) the analysis and classification of the critical incident data; and (4) the summary of the findings.

I. THE CRITICAL INCIDENT REPORTS

A total of 106 usable critical incidents of effective on-the-job performance was collected from the thirty-five high achievers who staffed positions within the area of employment investigated by this study. All of the subjects supplied three or more usable critical incidents with three exceptions where only two critical incidents were obtained per reporter.[1]

Collection of the Critical Incident Reports

Of the total of 110 critical incidents reported by the thirty-five high achievers only four of those reported did not meet the cri-

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[1]Three critical incidents were to have been solicited from each of the thirty-five individuals classified as having been high achievers and the 106 critical incidents collected were one more than was expected. This total was due to the fact that in several cases the situation which was described by the reporter included more than one critical incident.

teria of usable critical incidents.[2] In two cases, the results of the incidents were not clear at the time that the incidents were reported. In the other two cases, the critical incidents were not job related.[3]

From a procedural standpoint, the technique of providing the interviewee with information about the critical incident technique prior to the interview proved to have been an efficient means of minimizing the time necessary to conduct the interviews.[4] It was also found that this procedure improved the quality of the reports by permitting the interviewee to have reconstructed mentally the incident prior to the interview.

Backgrounds Utilized in the Performance of the Critical Incidents

In an attempt to relate the high achiever's effective performance to his educational background, the reporter was requested to attempt to identify a course, or courses, which he had had while in college which was (were) valuable to him in the performance of the effective functional activity which had been described in the critical incident report and which had contributed toward his effectiveness in the reported situation.[5] If the reporter could not identify any col-

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[2]cf. Chapter III, pp. 61-62.

[3]In both of the latter cases, the reports were accepted as a means of establishing rapport with the interviewee and were used as a means of clarifying what type of information was desired.

[4]In two cases, scheduling difficulties prevented the interviewees from thoroughly studying the material describing the critical incident technique prior to the interviews. In both cases, the interviews were lenghthened by twenty minutes and in one case only two usable critical incidents were obtained during the scheduled interview period.

[5]A list of selected course titles was provided to aid the reporter's recall and to assist him in this task. See Appendix L.

lege educational experience which was considered to have been a contributing factor to his effectiveness, he was then asked to identify any other factor which he considered to have been valuable to him and a contributing factor in the performance of the reported effective behavior.

It was found that in those incidents which described the solution of technical problems the reporter was able to identify specific courses in his educational background which had been useful to him in the performance of the critical incident which he had described. In thirty-four instances the reporter identified specific technical coursework which had been beneficial to his effectiveness. The one specific technical course title which was mentioned most frequently was a course commonly called "unit operations".[6] This finding provides evidence of the value of the applied educational courses which are a significant part of industrial technology curriculums.

It should be noted that Company job experience was mentioned in more reports as having been valuable in the performance of effective critical incidents than any other factor. In seventeen incidents the reporters were unable to attribute their effectiveness to any factor. The following factors were identified as having contributed to the effective behavior of the high achievers:

1. Company job experience, thirty-five incidents;
2. Technical coursework, thirty-four incidents;
3. Previous work experience, nine incidents;
4. "A matter of common sense," six incidents;
5. Business and management courses, five incidents; and
6. Human relations courses, two incidents.[7]

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[6]This is an applied course (or courses) usually offered on the upper division level which deals with the application of methods and procedures for processing or manufacturing materials.

[7]This finding points up the difficulty in relating effective-

The factors reported to have been associated with effective performance are summarized in Table X. It is interesting to note that in one incident the reporter attributed his effectiveness to a particular college professor and to a particular lecture which he had given. The conclusions which may be drawn from this phase of the study are that regardless of the recency of the reporters' contact with their college educational experiences it was difficult for the high achievers to identify those educational experiences which may have been a factor in their effectiveness in given situations. Technical backgrounds were utilized and essential to effective performance in approximately one-third (34 of 106) of the effective critical incidents reported, but considering the fact that the majority of the high achievers were from highly technical curriculums, they were not utilizing their technical backgrounds to the extent that might have been expected.[8]

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ness to specific human relations courses. The reporters repeatedly remarked that they may have utilized knowledge gained from social science courses, but that they could not identify any specific course titles. The very nature of the critical incident technique is such that it is likely that the high achiever related effectiveness primarily to techniques of performance and therefore identifies "doing" courses as having been most helpful.

[8]This evidence points out the need for an investigation of the degree of specialization that is essential and appropriate for persons staffing positions in the general area of employment investigated by this study. An investigation of this topic would be particularly pertinent to the development of industrial technology curriculums which sacrifice some degree of technical specialization in order to provide the student more educational experiences in the areas of management and human relations.

TABLE X

FACTORS REPORTED TO HAVE BEEN ASSOCIATED WITH THE EFFECTIVE PERFORMANCE OF THE CRITICAL INCIDENTS

FACTORS ASSOCIATED WITH EFFECTIVE PERFORMANCE

COLLEGE EXPERIENCE			WORK EXPERIENCE		MILITARY EXPERIENCE		OTHER		
Human Relations Courses	Technical Courses	Business or Management Courses	Company Experience	Non-Company Experience	Leadership	Technical	Not Identifiable	Common Sense	Miscellaneous
2	34	6	35	9	1	3	17	6	5*

*Scientific method-1; college professor-1; master's thesis-1; sense of logic-1, and; creativity-1.

II. FORMULATION OF THE CLASSIFICATION SYSTEMS

The establishment of suitable classification systems proved to have been one of the most troublesome problems encountered in this study. An appropriate system of classification was sought which could be used for analyzing the critical incident data and which would be useful in the development and selection of educational experiences to be included in industrial technology curriculums. Various dimensions were investigated and classification systems found in the literature were experimented with in an attempt to locate an appropriate classification system for analyzing the critical incident data.

Any selection of a dimensional system of classification to be used for the analysis and description of effective performance must be arbitrary, the criterion of choice being the assumed relevance of the dimension to the selection of specific courses and the development of curriculum patterns which are appropriate to our dynamic technological culture. In order to be a functional system of classification the system must meet the tests of relevance, comprehensiveness of all types of effective performance, and be definable operationally for classification purposes.

After extensive experimentation, it was decided that the critical incident data would be most useful if it were analyzed on the basis of three separate dimensions, namely: (1) functional task performed; (2) primary medium of involvement; and (3) type of skill utilized. This decision was reached on the basis of the following reasoning. If the critical incident data were analyzed only on the basis of the functional activity exhibited by the high achiever in a particular

situation, the resulting information would be of limited value to curriculum designers. This information would be of greater value if the "medium" in which the functional task was performed was identified and the general types of skills which were utilized were identified. Thus, the first system of classification was established to identify the "functional task" which had been performed; the second system was established to identify the principal "medium" which was involved in the functional task which was the "key" to the high achiever's effectiveness, and the third was designed to identify the general types of skills which had been utilized. The development, selection, and use of these classification systems are presented in the following sections.

Functional Task Classification System

Because this study was concerned with the investigation of management-oriented and/or technically-oriented personnel, the literature related to the analyses of management performance was investigated as a possible source of an appropriate classification system. Management theory has tended to focus upon a functional system of classification. Various researchers have emphasized the specific activities which managers perform to accomplish their responsibilities.[9]

The set of functional dimensions discussed in classical management theory are: (1) planning, (2) investigating, (3) coordinating, (4) evaluating, (5) supervising, (6) staffing, (7) negotiating, and (8) representing. George R. Terry in Principles of Management lists

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[9]Thomas A. Mahoney, Thomas H. Judee, and Stephen J. Carroll, Development of Managerial Performance. . . A Research Approach, (Chicago: South-Western Publishing Company, Monograph C-9, January 1963), p. 14.

only four categories: (1) planning, (2) organizing, (3) actuating, and (4) evaluating.[10]

Stogdill and Shartle list fourteen categories of types of managerial behavior:

1. Inspection and organization;
2. Investigation and research;
3. Planning;
4. Preparation of procedures and methods;
5. Coordination;
6. Evaluation;
7. Interpretation of plans and procedures;
8. Supervision of technical operations;
9. Public relations;
10. Professional consultation;
11. Negotiation;
12. Scheduling, routing, and dispatching;
13. Personal activities; and
14. Technical and professional activities.[11]

The selection of the specific categories within a functional classification system must be based upon pragmatic considerations. Whether four or fourteen dimensions are identified, they must be defined so that they are not overlapping and yet be comprehensive enough to include the entire range of elements of performance. The categories must be mutually exclusive to the extent that they provide an unambiguous system of classification, but as Domas has pointed out it is questionable whether a completely mutually exclusive set of human behaviors can be achieved.

> In any classification procedure, it is generally desirable that all the categories be mutually exclusive with respect to all other categories. This type of

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[10]George R. Terry, Principles of Management, (Homewood, Ill.: Richard D. Irwin, Inc., 1956), p. 29.

[11]Ralph M. Stogdill and Carroll L. Shartle, Methods in the Study of Administrative Leadership, Business Monograph No. 80, (Columbus: Bureau of Business Research, The Ohio State University, 1955), pp. 52-53.

> mutual exclusion may be possible in some physical sciences or mathematics. It is questionable, however, whether a completely mutually exclusive set of human behaviors can be achieved. Reading the accounts of classification procedures, one cannot but be struck by the fact that classifications follow a logical pattern up to a point beyond which the logic of the pattern is broken in order to assure completeness of coverage. These experiences may be accounted for by the fact that human beings, unlike mathematical symbols, do not behave logically.[12]

Selecting the specific categories. No system of classification was located in the literature which could be used in its complete form. Therefore, categories from several existing systems were integrated and additions and deletions were made and a system of classification was evolved which proved to meet the tests of relevance and comprehensiveness and the established categories were found to have been defined operationally in order to permit the judges to make the classifications with consistency.

The following nine categories were used in this study to classify the functional tasks described in the critical incident reports: (1) planning, (2) coordinating, (3) investigating, (4) evaluating, (5) consulting, (6) negotiating, (7) initiating, (8) organizing, and (9) promoting.

Definitions of the functional tasks. Defining the nine categories used to classify functional behavior in this study to the satisfaction of all management and psychology people would be a difficult, if not impossible, task. As a practical consideration, therefore, each term has been defined arbitrarily in a manner which provided a

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[12]Domas, op. cit., p. 38.

functional definition which would allow its use in this study. Thus, for example, the definition of the term "negotiating" must be considered on the basis of the definition given in this study.

> Planning. Determining goals and deciding what activities are necessary to achieve a particular goal. It involves thinking and critical analysis of a given situation. It may involve conferences and exchange of information with others.
>
> Coordinating. Exchanging information and providing services designed to integrate and adjust the activities of units within the organization or of persons within the units. It may involve expediting, liason with other personnel, arranging personal contacts and informing the effected parties as well as the chain of command of the actions taken.
>
> Investigating. Performing acts involving the accumulation and preparation of information and data about some topic. Usually it involves the preparation of some type of written report. It may involve inventorying, measuring output or performance, preparing cost analyses, doing formal research, or analyzing markets.
>
> Evaluating. Assessment and appraisal of procedures, methods suggestions, materials, products, tests, services, customer relations, and personnel to determine the remedial action which is required in the event a malfunction is discovered.
>
> Consulting. Providing technical advice and services and specialized assistance on problems of a specific technical nature to persons or units within, or outside, the organization designed to directly or indirectly contribute to stated company goals.
>
> Negotiating. Purchasing, selling, or contracting agreements for goods or services. It may involve contacting suppliers, dealing with Company representatives, obtaining contracts and agreements, settling claims, or mediating personnel problems.
>
> Initiating. Beginning action, or causing action to come to pass, through personal initiative. To introduce a new measure, idea, procedure, policy, or course of action.
>
> Organizing. Directing and controlling action through management. The skillful manuevering of resources to obtain a desired objective.

Promoting. Advancing the general interests o the organization through speeches, consultation and contacts with individuals or groups outside the organization. It may involve the sponsoring and fostering of an idea within the organization.

Media of Involvement

A system of classification was used to identify and analyze the type of media which was involved in the performance of the key functional or behavioral act which was described in a particular effective critical incident report. It was assumed that the performance of a functional task of "planning", for example, would have different implications with respect to the type of educational experience demanded dependent upon the medium with which the functional task dealt. The four "media" (or what might be termed subject dimensions) used in this study were: (1) people or human relations; (2) concrete physical things; (3) theoretical abstractions; and (4) business and economic media.[13]

In nearly all of the critical incidents reported the high achievers had performed more than one behavioral act. Some of these functional tasks were of secondary importance to the individual's effectiveness and only the key functional act which had been identified by the reporter as the one which best illustrated his effectiveness in the respective critical incident was used to identify the principal medium of involvement. Thus, the actual classifications of the media of involvement were made by the reporters at the time that the critical incidents were obtained.

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[13]This system of classification was adapted from a system of analysis used by John C. Mills who designated four fundamental types of human involvement and interest. The four terms used by Mills were: people, ideas, things, and money. cf. John C. Mills, The Engineer in Society, (New York: D. Van Nostrand Co., Inc., 1946), p. 17.

Skills Dimension Classification System

A system for classifying the general types of human skills was evolved as a means of identifying those broad categories of human abilities which were factors associated with the effectiveness of the high achievers in the reported situations.

Previous attempts to identify personal factors associated with effectiveness have experienced considerable difficulty. When a system of personal traits is used, the problem of definition is critical as individuals have widely differing concepts of the same terms. Secondly, there is the problem of overlapping terms. In an attempt to overcome these problems, this study utilized a classification system based upon general classifications of skills or abilities. These "skills" were defined as the summation of the interaction of various personality traits and were found to have been complimentary in nature rather than overlapping in nature.

The categories of "skills" used in this study were: (1) conceptual skills, (2) human relations skills, (3) technical skills, (4) communications skills, and (5) business and organizational skills. These categories were defined as the composite of several personality traits or specific human skills. The use of the more comprehensive classifications was considered to have been consistent with the objectives of this study than other similar concepts found in the literature.

The four skill classifications—human relations, technical, conceptual, and communication— used in this study were based upon the system of classification evolved by Robert D. Hay of the University

of Arkansas.[14] The fifth "skill actegory" — "business and organizational" — addded in the interest of comprehensiveness. The use of these five categories was considered to have been more comprehensive and relevant to this study than the "skill mix", for example, suggested by Davis which included only "conceptual skill, human skill, and technical skill."[15]

In an attempt to determine the relative importance of a given skill category the critical incidents were analyzed and three judges[16] made independent ratings with regard to each particular skill category. Each critical incident, with respect to each skill category, was assigned a rating of: (1) most important, (2) contributing, or (3) non-contributing. Ratings agreed upon by at least two of the three judges were included in the final tabulations of the study.

The definitions of the skill categories used in this study are as follows:

Conceptual skills. "The creative and analytical ability of

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[14]cf. Robert D. Hay, Management Staffing Needs in Arkansas Sawmills, Small Business Management Research Report No. 46, (Little Rock, Arkansas: Industrial Research and Extension Center, 1961). In the Hay study a fifth category of "drive" was used. Drive may be a vital factor associated with effective performance, but it was not considered to have been appropriate to the classification system used in this study as "drive" is more of a personal "characteristic" than a "skill". Furthermore, "initiative" which is closely related to drive was specifically considered as one of the functional task categories previously established. Drive was also implied in several other functional task classification categories.

[15]cf. Keith Davis, Human Relations at Work, (New York: McGraw-Hill Book Company, Inc., 1962), pp. 116-117.

[16]The three judges included: A doctoral candidate with a major in speech science and a minor in psychology; an associate professor of industrial technical education; and the investigator.

the mind; the actions of the mind that create new knowledge and analyze information. 'Original thinking' is used synonymously with 'creative thinking', and 'critical thinking' is used synonymously with 'analytical thinking'."[17]

Human relations skills. The ability to interact favorably with other people and to motivate them. Tactfulness, consideration, sensitivity, cautiousness, emotional stability, cheerfulness, sociability, and cooperation in interacting and working with people.[18]

Communication skills. Competencies in the transfer of information. These skills have been defined as "the ability to use words meaningfully in communication,"[19] and to understand and be understood in both oral and written media.

Technical skills. The abilities to use technical knowledge about the physical process of producing and distributing goods and services. Technical skills include a knowledge of equipment, processes, products, materials, methods, and supporting theory. It is purposeful human activity— the art of applying this technical information to the solution of technical problems.

Business and organizational skills. The art of planning, directing, and controlling human, physical and economic resources to obtain a desired objective. Competencies in the use of business, economic, and managerial principles and methods.

III. THE CLASSIFICATION OF THE CRITICAL INCIDENT DATA

Analysis of the Functional Task Data

A total of 359 behavioral acts were abstracted from the 106 effective critical incidents reported by the thirty-five individuals classified as having been high achievers. These behavioral acts (or functional tasks) were identified and classified by three judges

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[17]Hal B. Pickle, Personality and Success, Small Business Research Series No. 4, Small Business Administration (Washington: U. S. Government Printing Office, 1964), p. 4.

[18]Ibid., pp. 4-5.

[19]Western Psychological Services, Catalog of the Professions, p. 48.

who independently analyzed and classified the data. Any functional task which was identified in a particular critical incident by two of the three judges[20] was included in the final tabulations. Two of the three judges did not agree on thirty-one of the 954 classification decisions and these thirty-one items were deleted from the tabulations. Complete agreement among the three judges was obtained in eighty-four per cent of the classification decisions. On this basis, the classifications which were made were considered to have been accurate to the extent that their use in the final tabulations was justifiable.

The planning function. Twenty-eight critical incidents (26%) were classified as having involved the "planning" function. The distribution of the percentages of incidents reported by each of the four groups studied were as follows: Technical Service and Development group—21%; Technical Sales group—33%; Research group—33%, and; Production group—29%. Therefore, the "planning" function was factor associated with the effective performance of high achievers in all four areas of employment studied and to approximately the same degree.

The coordinating function. Forty-five critical incidents (71%) were classified as having involved the "coordinating" function. The distribution of the percentages reported by each of the four groups studied were as follows: Technical Service and Development group—39%; Technical Sales group—47%; Research group—50%, and; Production group—43%. Therefore, the "coordinating" function was a factor associated with the effective performance of the high achievers in thirty-nine per cent or more of the incidents reported from all of

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[20] cf. footnote number 16 page 104.

the four areas of employment studied. The range of percentages (39% to 50%) indicated that "coordinating" was involved to approximately the same degree regardless of the functional area of employment of the reporter on the basis of the data analyzed.

The investigating function. Fifty-four critical incidents (51%) were classified as having involved the "investigating" function. The distribution of the percentages of incidents reported by each of the four groups studied was as follows: Technical Service and Development group--68%; Technical Sales group--47%; Research group--17%, and; Production group--52%. Three groups, therefore, reported from forty-seven per cent to sixty-eight per cent of their incidents that involved the "investigating" function; however, the Research group whose primary function is usually considered to be closely associated with "investigating" reported only seventeen per cent of their incidents which were judged to have involved the "investigating" function. This was an unexpected finding in that one might have expected the Research group to have reported one of the highest percentages of incidents involving the "investigating" function. This finding may have been caused by the fact that the majority of the high achievers identified in this area were staffing supervisory positions and were therefore involved less in so-called "bench" research.

The evaluating function. Forty-four critical incidents (41%) were classified as having involved the "evaluating" function. The distribution of the percentages of incidents reported by each of the four groups was as follows: Technical Service and Development group--

66%; Technical Sales group—47%; Research group—33%, and; Production group—38%. Therefore, "evaluating" was a factor associated with one-third or more of the effective critical incidents reported by each of the four respective groups. The highest percentage (66%) reported by the Technical Service and Development group may reflect the fact that this functional area of employment is a "problem-oriented" group whose work involves considerable testing and feasibility studies of ideas and products.

The consulting function. Forty-one critical incidents (39%) were identified as having involved "consulting". The distribution of the percentages of incidents reported by each of the four groups studied that involved "consulting" was as follows: Technical Service and Development group— 42%; Technical Sales group—33%; Research group—44%, and; Production group—29%. Therefore, the range of the percentages (29% to 44%) of the incidents reported involving the "consulting" function would indicate that this function was a factor associated with the effective performance of high achievers in all areas of employment studied and to approximately the same degree.

The negotiating function. Forty-nine critical incidents (46%) were identified as having involved the "negotiating" function. The highest percentage (73%) of incidents classified as having involved this category was reported by the Technical Sales group.[21] The percentages of incidents classified as having involved "negotiating"

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[21] This finding was as might have been expected considering the purposes of the Technical Sales group. cf. "The Technical Sales group", Chapter IV, p. 70-71.

reported by the other three employment groups was as follows: Technical Service and Development group—42%; Research group—50%, and; Production group—33%. The fact that one-third or more of the incidents reported by any one group involved the "negotiating" function indicates that it was a factor associated with the effective performance of high achievers in the areas and levels of employment studied.

The initiating function. Thirty-nine critical incidents (37%) were classified as having involved some initiating action which was judged to have been an effective performance. The distribution of the percentages of incidents that involved "initiating" reported by each of the four respective groups studied was as follows: Technical Service and Development group—36%; Technical Sales group—47%; Research group—0%, and; Production group—62%. Drive and motivation factors are closely related to the "initiating" function and it might have been expected that the high achievers would have reported a high percentage of incidents involving initiating action. This assumption was supported by the percentage of incidents classified in this category by the Production group (62%) and to some extent by the percentage reported by the Technical Sales group (47%) and the Technical Service and Development group (36%). The fact that the Research group failed to report any effective critical incidents which were classified as having involved "initiating" action was unexpected and the reasons for this void were not apparent.

The organizing function. Twenty-two critical incidents (21%) were classified as having involved "organizing". The distribution of the percentages of incidents classified as having involved

"organizing" reported by the four groups was as follows: Technical Service and Development group—17%; Technical Sales group—13%; Research group—28%, and; Production group—14%. On the basis of the data studied, the organizing function was the least reported factor associated with effective performance. The range of percentages (13% to 29%) reported was also one of the smallest and indicated that "organizing" was a factor in fewer incidents regardless of the functional area of employment of the reporter.

The promoting function. Twenty-six critical incidents (25%) were classified as having involved "promoting". The distribution of the percentages of incidents reported by the four respective groups that involved "promoting" was as follows: Technical Service and Development group—23%; Technical Sales group—40%; Research group—28%, and; Production group—14%. The fact that this functional task was more closely related to the responsibilities of the sales group was reflected in the higher percentage of incidents reported by the sales group which were classified as having involved "promoting". The percentages reported by the other three groups were considerably less and were grouped within a range of nine per cent variation as may be evidenced in Table XI.

Principal Medium of Involvement

At the time that each effective critical incident was reported, the reporter was given a working definition of each of the four media of involvement which were being used and was requested to identify the medium which he considered was primarily involved in the critical incident which he had just reported.

TABLE XI

ANALYSIS OF THE CRITICAL INCIDENT REPORTS ON THE BASIS OF THE FUNCTIONAL AREA OF EMPLOYMENT OF THE HIGH ACHIEVER AND THE TASK PERFORMED

FUNCTIONAL AREA OF EMPLOYMENT	Number of incidents Reported by Each Group	TYPE OF FUNCTIONAL TASK PERFORMED																	
		Planning		Coordinating		Investigating		Evaluating		Consulting		Negotiating		Initiating		Organizing		Promoting	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Technical Service and Development	52	11	21%	20	39%	34	68%	33	66%	22	42%	22	42%	19	36%	9	17%	12	23%
Technical Sales	15	5	33%	7	47%	7	47%	7	47%	5	33%	11	73%	7	47%	2	13%	6	40%
Research and Development	18	6	33%	9	50%	3	17%	6	33%	8	44%	9	50%	0	0%	5	28%	5	28%
Production	21	6	29%	9	43%	11	52%	8	38%	6	29%	7	33%	13	62%	6	29%	3	14%
TOTALS FOR ALL GROUPS	108	28	26%	45	42%	55	52%	54	51%	41	39%	49	46%	39	37%	22	21%	26	24%

NOTE: Percentages do not total 100% because each critical incident may have involved more than one functional task.

It was realized that a subjective judgment was requested, but it was found that in most case the reporter had little difficulty in making this judgment as the principal medium associated with the key effective behavioral act which best illustrated his effectiveness was often self-evident.[22] In those cases where difficulty was encountered, the reporter was asked to rank order the media of involvement according to their importance. Where this was necessary only the medium ranked highest was used in the final tabulations. There were only a few cases where this procedure was necessary.

Of the 106 usable effective critical incidents, the reporters identified forty-nine (46%) effective critical incidents as having dealt principally with people and the human relations aspect. Twenty-five critical incidents (23%) were considered to have dealt principally with concrete physical things such as materials, products, or equipment. Nineteen critical incidents (18%) were judged to have dealt principally with business, organizational or economic factors; and nine critical incidents (8%) were identified as having dealt principally with theoretical concepts, formulas, or abstractions.

These findings point up the importance of the human relations aspect as a factor associated with the effective performances of management-oriented technical personnel. Human relations are involved to some degree in almost all functional activities in a work environment, but the important point to note in these findings is that the

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[22]These judgments were later supported by the classifications made with respect to the type of skill utilized. For example, where "people" were identified as the principal medium of involvement the skill category ranked highest was "human relations skill". Likewise, where "theoretical abstractions" were identified as the principal medium of involvement "conceptual" might have been identified as the principal skill utilized.

behavioral act which was identified by the reporter as the "key" to the respective high achiever's success or effectiveness in forty-nine (46%) of the one hundred and six critical incidents reported were judged to have been centered around effectively working with people to achieve a desired objective.

The interviews revealed that the high achievers who had moved into management positions were concerned about the lack of educational experiences in their college training which would have helped them in their relations with subordinates, superiors, and non-Company personnel. The concern of the need for additional education in the area of human relations was also evidenced by the fact that nearly all of the Company sponsored courses and workshops in which the high achievers had participated were in the area of human relations.

The highest percentage of incidents reported by each of the four respective groups from the various functional areas of employment investigated were those which were considered to have dealt primarily with the human relations aspect.

The Technical Services and Development group reported incidents which were the most uniformly distributed among the four medias of primary involvement with a distribution range of from thirteen to thirty-three per cent. The Technical Sales group classified seventy-three per cent of their reported incidents as having dealt primarily with "people" and twenty per cent as having dealt primarily with "business and organizational" factors. The sales group reported only one critical incident which was classified as having dealt primarily with "things" and did not identify any critical incidents which they considered to have dealt primarily with theoretical "abstractions".

The Production group reported the highest percentage (33 1/3 %) of incidents judged to have been concerned primarily with concrete physical "things". The Research group classified the highest percentage (22%) of any group as having dealt primarily with theoretical "abstractions". These findings are as might have been expected considering the nature and purposes of the respective functional areas of employment studied.

The complete tabulations of the analysis of the critical incident reports on the basis of the functional areas of employment of the high achiever and the principal medium of involvement are presented in Table XII.

The Classification of the Skill Data

The classification of the skills utilized in the performance of effective critical incidents was made by three judges who made independent decisions. If a particular skill was identified by two of the three judges as having been utilized in the performance of the effective critical incident, it was included in the final tabulations. The judges did not agree on twelve of the 530 classification decisions (2.3%). On this basis, the classifications were considered to have been made accurately and consistently.

Analysis of the skill data. The four functional groups studied varied somewhat in the extent to which they reported effective critical incidents which utilized skills within each of the five respective categories.

The skills utilized by the Technical Services and Development group on the basis of the analysis of the reported effective critical

TABLE XII

ANALYSIS OF THE CRITICAL INCIDENT REPORTS ON THE BASIS OF THE FUNCTIONAL AREA OF EMPLOYMENT OF THE REPORTER AND THE PRIMARY MEDIUM OF INVOLVEMENT

FUNCTIONAL GROUP	Total No. of Incidents Reported by Group	MEDIA OF INVOLVEMENT							
		PEOPLE		THINGS		BUSINESS		THEORY	
		Number Reported	Per Cent Reported	Number Reported	Per Cent Reported	Number Reported	Per Cent Reported	Number Reported	Per Cent Reported
Technical Service and Development	52	17	32.7	16	30.7	12	23.0	7	13.5
Technical Sales	15	11	73.4	1	6.7	3	20.0	0	0
Research	18	9	50.0	2	11.1	3	17.1	4	22.2
Production	21	12	56.0	7	23.3	1	4.7	1	4.7
Totals—all groups	106	49		26		19		12	

NOTE: The values in the "total number reported" column include those in which a particular skill was identified as having been the "critical skill" associated with the effective performance.

incidents were distributed fairly uniformly among the five established categories. The percentages for the Technical Services and Development group were: (1) communication skills—60%; (2) business and organizational skills—67%; (3) human relations skills—75%; (4) conceptual skills—81%; and (5) technical skills—83%.

In contrast, twenty per cent of the incidents reported by the Technical Sales group were considered to have demanded technical skills. This was the lowest percentage classified in any given skill category by any one of the four functional groups studied. The Technical Sales group also reported the highest percentage (100%) of incidents utilizing a given skill. All of the incidents reported by the Technical Sales group were considered to have utilized: (1) human relations skills; (2) communication skills; and (3) business and organizational skills. Due to the nature of the technical sales function this was not an unexpected finding.

The Research group reported the lowest percentage (39%) of incidents which were classified as having utilized conceptual skills. This percentage was lower than might have been expected even considering the fact that this functional area of employment was engaged in "applied research" rather than "basic research" which traditionally draws heavily upon conceptual skills. A summary of the skill data is presented in Table XIII.

The skills which were identified as having been utilized in the performance of the effective critical incidents reported by the Production group were also distributed fairly uniformly among the five skill categories. The percentages reported by the Production group were: (1) communication skills—52%; (2) technical skills—57%;

TABLE XIII

ANALYSIS OF THE CRITICAL INCIDENT REPORTS ON THE BASIS OF THE FUNCTIONAL AREA OF EMPLOYMENT OF THE HIGH ACHIEVERS AND THE SKILLS UTILIZED

FUNCTIONAL AREA OF EMPLOYMENT	Total No. of Incidents Reported by Group	TYPE OF SKILL UTILIZED									
		CONCEPTUAL		HUMAN RELATIONS		COMMUNICATION		TECHNICAL		BUSINESS AND ORGANIZATIONAL	
		Number Reported	Per Cent Reported	Number Reported	Per Cent Reported	Number Reported	Per Cent Reported	Number Reported	Per Cent Reported	Number Reported	Per Cent Reported
Technical Service and Development	52	39	75%	38	74%	35	67%	41	78%	40	76%
Technical Sales	15	7	47%	15	100%	15	100%	3	20%	15	100%
Research	18	7	39%	13	72%	13	72%	11	61%	14	78%
Production	21	12	57%	14	67%	12	57%	13	62%	16	76%
Totals—All Groups	106	65		80		75		68		85	

NOTE: Percentages do not total 100% because each critical incident may have utilized more than one skill.

(3) business and organizational skills--57%; (4) conceptual skills--62%; and (5) human relations skills--67%.

With regard to the importance of a given skill, the judges rated each skill utilized in a particular critical incident as having been "most important" or "contributing" toward the high achiever's effectiveness. Human relations skills were classified as "most important" in twenty-nine incidents; technical skills as "most important" in twenty-six incidents; business and organizational skills as "most important" in thirty-two critical incidents; conceptual skills as "most important" in ten incidents; and, communication skills as "most important" in nine effective critical incidents. The comparison of the frequencies which a particular skill was identified as a "contributing" skill and the frequencies which the same skill was classified as having been the "most important" skill is presented in Table XIV.

On the basis of the critical incident data studied, the findings revealed that human relations, business and organizational, and technical skills were more frequently classified as the "critical" (most important) skills associated with the performance of the key effective behavioral acts which best illustrated the high achiever's effectiveness. Conceptual and communication skills were classified less frequently as having been the "critical skills" associated with the effective performance of the individuals classified by the Company as having been high achievers.

The inventory of skills utilized by high achievers in the performance of the reported effective critical incidents revealed that a variety of skills was associated with effective performance. The totals for the composite of the four groups studied were more uniformly

distributed among the five skill categories than the total for any one group separately as is evidenced in Table XIV. These findings indicate that persons effectively staffing positions in the general area of employment investigated by this study had a variety of skill qualifications and that no single given skill was dominant. Therefore, the educational curriculums which are designed to prepare individuals for employment in this general area must include a variety of educational experiences designed to foster the development of the five general types of skills investigated by this phase of the study.

IV. SUMMARY OF THE CHAPTER

The findings reported in this chapter were in the form of 106 critical incident reports solicited from thirty-five individuals classified as having been high achievers in four functional areas of employment. The findings of this phase of the study may be summarized as follows:

1. Company job experience and specific technical courses taken while in college were the two most frequently cited factors identified by the high achievers as having contributed to their effective performance of the respective critical incidents. The most frequently mentioned technical course was an applied course in chemical engineering commonly called "unit operations".

2. The six functional tasks of investigating, evaluating, coordinating, negotiating, consulting, and initiating were identified as having been factors associated with the effective performance of high achievers in thirty-seven per cent or more of the critical incidents reported. All of the 106 critical incidents reported

TABLE XIV

ANALYSIS OF THE CRITICAL INCIDENT DATA ON THE BASIS OF THE IMPORTANCE OF THE SKILL UTILIZED AND THE FUNCTIONAL AREA OF EMPLOYMENT OF THE REPORTER

FUNCTIONAL AREA OF EMPLOYMENT	Total No. of Incidents Reported by Group	IMPORTANCE OF THE SKILL UTILIZED									
		CONCEPTUAL		HUMAN RELATIONS		COMMUNICATION		TECHNICAL		BUSINESS AND ORGANIZATIONAL	
		Total Number Classified	Number Classified Critical	Total Number Classified	Number Classified Critical	Total Number Classified	Number Classified Critical	Total Number Classifid	Number Classified Critical	Total Number Classified	Number Classified Critical
Technical Service and Development	52	36	6	38	10	35	2	41	15	40	19
Technical Sales	15	7	1	15	5	15	4	3	1	15	4
Research	18	7	0	13	8	13	2	11	4	14	4
Production	21	12	2	14	6	12	1	13	6	16	6
Totals—All Groups	106		9		29		9		26		33

NOTE: The "total all groups" column includes those incidents in which a particular skill was identified as having been the "critical skill" associated with effective performance.

involved the performance of one or more of these six functional tasks. The functional tasks of planning, organizing, and promoting were less frequently identified as having been a contributing factor in the performance of the reported critical incidents. These three functional tasks were identified in lower percentages (21% to 26%) of the incidents than the six previously mentioned functional tasks.

3. Of the four media of involvement— things, people, business and economic, and theoretical— the "people" or human relations medium was most frequently (49 of the 106 incidents) judged to have been the principal medium of involvement associated with the key behavioral act which best illustrated the effective performance. All four of the groups studied identified the human relation medium most frequently, thus emphasizing the importance of the human relations aspect to the effective performance of management-oriented technical personnel at the levels of employment investigated by this study.

4. The five types of skills—conceptual, human relations, communication, technical, and business and organizational— were all represented in a high percentage (65% to 85%) of the incidents reported by each respective group. The percentages of incidents reported by the four respective groups studied which utilized a given skill varied to some degree, but in all but three cases a percentage of more than fifty per cent was reported.

On the basis of the data studied, effective performance was associated with a variety of skills of both a technical and non-technical nature.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

I. THE PROBLEM AND SUMMARY OF THE FINDINGS

The problem investigated by this study was the idenitification of those factors associated with the effectiveness of management-oriented and/or technically-oriented personnel employed by a major chemical company during a six-year period of time in a delineated area of employment.

An exploratory investigation was conducted of a defined area of employment at the intermediate ranges of technical employment where graduates of baccalaurate degree-level industrial technology curriculums offered by divisions or departments of industrial education might be employed. A body of descriptive information was built by investigating the nature of the types of behavioral tasks which persons classified by the cooperating company as effective employees from four functional areas of employment had performed which were considered to have contributed to their effectiveness in on-the-job performances. It was intended that the identified behavioral data would be useful as a basis for selecting and developing educational experiences which might be incorporated into industrial technology curriculums.

The Company personnel records of the identified high achievers were investigated and the critical incident technique was used to collect descriptions of specific incidents of effective on-the-job performances of the individuals classified as having been effective employees. These critical incident reports were analyzed, systems of

of classification were established, and the data were categorized on the basis of the established dimensions.

It must be emphasized that during the present era of rapid technological and sociological change, the findings of this study must be considered with respect to the point in time in which they were obtained. Furthermore, it must be pointed out that a study of this nature could not account for all of the variables associated with effectiveness *per se* as it is a complex phenomenon with many obscure and undetermined variables which have not all been investigated.

The thirty-five individuals identified as having been high achievers investigated in this study were employed by a nationally recognized chemical company in the management-oriented and/or technically-oriented positions which were considered to have been appropriate for the employment of graduates of degree-level industrial technology curriculums. These thirty-five high achievers reported one hundred and six effective critical incidents which they had personally performed.

The identified high achievers were staffing positions in the following functional areas of employment: (1) technical service and development (product utilization), (2) technical sales, (3) research, and (4) production.

The educational backgrounds of the high achievers may be summarized as follows: The seven individuals identified as high achievers in the production group were in positions of leadership as production supervisors and all held bachelors' degrees in chemical engineering. The technical sales group of high achievers represented a variety of educational backgrounds of both a technical and non-

technical nature. The technical sales area was the one functional area of employment investigated where the Company had hired graduates from a variety of different educational backgrounds to do the same or a similar type of work. The educational backgrounds of the technical service and development group were somewhat varied, but all of the undergraduate degrees were of a technical nature. The research group was composed of seven individuals identified as having been high achievers. All of the undergraduate degrees were of a technical nature. Four of the nine persons in the high achievement group studied who had earned masters' degrees were included in this research group. All four of these advanced degrees were technical in nature, however, four of the five other advanced degrees were masters of business administration degrees.

The educational institutions represented by the high achievement group reflected the Company's practice of hiring from small, medium, and large colleges and universities widely distributed geographically. Only eight educational institutions were represented by more than one graduate. These eight insitutions had granted twenty degrees to individuals classified in the high achievement group. Only one institution (Michigan State University) was represented by as many as four graduates. Of the four degrees obtained from Michigan State University, three of the degrees were granted by that institution's School of Packaging. The degree in packaging engineering was the only curriculum disproportionately represented (but not necessarily significantly disproportionately represented) in the sample studied, and it was noted that this curriculum, although not identified as such, closely approximated the curriculum patterns of industrial technology

curriculums as defined in this study.

One of the interesting findings of this study was that six of the identified high achievers had participated in varsity athletics while in college.

The academic records were investigated and studied both on the basis of cumulative grade point average and rank within the graduating class of the respective academic majors. Academic rank in major was found to have been a more discriminating criterion for identifying potential high achievers than was cumulative grade point average. The mean and median cumulative grade point averages were 2.80 and 2.81 respectively on the basis of a four honor point system. This mean grade point average was above the all-university average (approximately 2.65 for the senior class of 1965) of Michigan State University, but it was not considered to have been exceptionally high.

Persons holding masters' degrees were not disproportionately represented in the high achievement group on the basis of a chi-square test of statistical significance.

Eight (23%) of the thirty-five high achievers had participated in college cooperative work experience curriculums and ten (29%) had held teaching or research assistantships during their college experiences.

One-third of the high achievement group studied had earned eighty to one hundred per cent of their college expenses. Twenty-two (63%) of the thirty-five high achievers had earned fifty per cent or more of their college expenses.

Company job experience and specific technical courses were the two factors most frequently identified by the high achievers as having

contributed to their effective performance of the respective critical incidents which they reported. An applied chemical engineering course (or courses) commonly entitled "unit operations" was the most frequently mentioned technical course.

The six functional tasks of "investgating", "evaluating", "coordinating", "negotiating", "consulting", and "initiating" were identified as having been factors associated with the effective performance of the high achievers in thirty-seven per cent or more (from 37% to 52%) of the critical incidents reported. All of the 106 critical incidents reported involved one or more of these six functional tasks. The three other established categories of functional tasks—"planning", "organizing", and "promoting"—were identified in lower percentages (21% to 26%) of the effective critical incidents reported than were the six previously mentioned functional tasks. Although each of the four functional groups reported some critical incidents which were classified into each functional task category,[1] there was no identifiable pattern of behaviors common to all four groups on the basis of the available critical incident data. The findings revealed a considerable variance between the percentages reported by each respective group studied.

The "people" or human relations media was most frequently (49 of the 106 critical incidents) judged to have been the principal medium of involvement associated with the key behavioral act which best illustrated the effective performance. The importance of the

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[1]There was one exception as the research group did not report any incidents which were classified as having involved the "initiating" function.

human relations aspect to the effective performance of technically-oriented personnel was also emphasized by the fact that all four functional groups studied identified the human relations medium the most frequently of any of the four established categories (people, concrete physical things, abstractions, and business and economic).

The five established skill categories--conceptual, human relations, technical, communication, and business and organizational--investigated by this study were all utilized in a high percentage (65% to 85%) of the 106 effective critical incidents analyzed. The degree of utilization of a given skill by the four respective high achievement groups studied varied somewhat, but in all but three cases a percentage of more than fifty per cent was recorded. Human relations skills, technical skills, and business and organizational skills were most frequently classified as the "most important" skill utilized in the performance of the respective effective critical incidents. Conceptual skills and communication skills were both classified in only nine critical incidents as having been the "most important" skill utilized.

II. CONCLUSIONS

It must be emphasized that this study was of an exploratory nature and the findings must be interpreted with regard to the nature of the cooperating chemical company and the composition of its work force. Rapid technological and sociological changes demand that these findings must also be considered with regard to the point in time in which they were obtained. On this basis the following conclusions have been made.

It was concluded that a variety of technical and non-technical skills were factors associated with the effective performance of management-oriented technical personnel employed by the Company at the levels and in the functional areas investigated by this study. In view of the fact that most of the high achievers indicated that they had received adequate technical preparation from their college experiences, but also indicated the need for additional human relations and managerial skills, it would appear that more educational courses designed to foster the development of these human relations and managerial skills should be included in the technical curriculums designed to prepare individuals to staff positions within the general area of employment investigated by this study.

It was concluded that the degree-level industrial technology curriculums were better qualified than the two-year technician curriculums to supply both an adequate technical background and the necessary human relations, business, and managerial skills due to the limitations of time imposed upon the two-year curriculums.

The fact that forty-nine of the one hundred and six effective critical incidents reported were classified as having involved the human relations medium in the key behavioral act which best illustrated the effective performance in the resepective critical incidents, and the fact that eighty of the one hundred and six effective critical incidents were judged to have demanded a utilization of human relations skills, lead to the conclusion that additional educational experiences designed to foster the development of these skills should be emphasized more in the curriculums which are designed to prepare individuals for employment in the intermediate ranges of management-oriented technical

employment investigated by this study.

In view of the fact that the six established functional tasks of: (1) "investigating", (2) "evaluating", (3) "coordinating", (4) "negotiating", (5) "consulting", and (6) "initiating" were reported more frequently than the functional tasks of: (1) "planning", (2) "organizing", and (3) "promoting", it would appear that with regard to the types of responsibilities of the identified high achievers studied the first six functional tasks were associated more frequently with effective performance than the latter three functional tasks on the basis of the critical incident data studied.

In view of the fact that eight (23%) of the identified high achievers had participated in college cooperative work experience curriculums and ten (29%) of the high achievers had held either teaching or research assistantships while in college indicated that these kinds of experiences might be considered as factors in the selection of potential effective employees.

It was concluded that work experience was a factor associated with effective performance on the basis of the investigation of the work experience records of the high achievers and the fact that Company work experience was identified in thirty-five (approximately one-third) of the effective critical incidents reported as a factor associated with effective performance. Non-Company work experience was identified in nine (8%) of the effective critical incidents, and technical and leadership experience gained through military tours of duty was credited as a contributing factor in four effective critical incidents. Therefore, in forty-eight (45%) of the critical incidents reported work experience was identified as a factor contributing

toward effective performance. The important point to note is not whether the identified high achiever had had work experience, but the type and pattern of work experiences the high achiever had on his qualifications record.

The fact that fifty-seven per cent of the identified high achievers had graduated in the upper twenty-five per cent of the graduating class within their academic major, and the fact that all thirty-five high achievers had graduated in the upper half of their respective classes within their academic majors, and whereas only nine (26%) had earned a cumulative grade point average of 3.00 (B letter grade) or better, it would appear that with regard to the population studied that "rank within major" was a more discriminating criterion than cumulative grade point average for the selection of effective employees.

The fact that the Company was not employing graduates of industrial technology curriculums as defined in this study and there appeared to have been a lack of understanding of the nature and purposes of this type of educational preparation and the qualifications and abilities of the graduates of these curriculums on the part of Company personnel, lead to the conclusion that those institutions offering industrial technology curriculums need to devote more attention to publicizing their respective curriculums.

III. RECOMMENDATIONS

The following recommendations were considered appropriate on the basis of the findings of this study.

The fact that this was an exploratory study which investigated

a particular type of industry implies the need for similar studies of this nature which are conducted on a broader scale which will investigate other types of industries with regard to the topic of degree-level industrial technology curriculums as defined in this study.

The finding that nine (26%) of the high achievement group had earned masters' degrees suggested that holding an advanced degree might be a factor associated with effective performance, but the evidence was not sufficient to permit reaching any conclusions and the advantages of holding advanced degrees were not clear. It is recommended that this topic be investigated. Likewise, there is need for a comparison of the advantages of the degree-level curriculums and the two-year technician curriculums. The traditional issue of a "technical" versus a "non-technical" degree was also in evidence in this study and continued efforts need to be made to resolve this issue.

At the present time there are no known degree-level industrial technology curriculums of the type investigated in this study which permit students to concentrate in the area of chemical technology. Two-year chemical technology curriculums are available, but these curriculums are of the technical institute type. Thus, it is recommended that institutions offering, or considering offering, degree-level industrial technology curriculums investigate the possibility of providing a chemical technology option.

The findings of this study emphasize the need for an investigation of the degree of technical specialization required to effectively staff the types of positions investigated by this study. This type of investigation would be particularly pertinent to degree-level industrial technology curriculums which sacrifice some degree of

technical specialization in order to provide additional educational experiences in the areas of human relations and the managerial sciences.

It is recommended on the basis of the technical courses which the high achievers identified as having been essential for employment in their respective positions and the nature of the critical incidents reported, that the Company and other companies with similar technical manpower needs might consider graduates of industrial technology curriculums for staffing positions within the general area of employment investigated by this study.

LITERATURE CITED

LITERATURE CITED

A. BOOKS

Arizona State University General Catalog. Tempe, Arizona: Arizona State University, May, 1963, Vol. LXXVIII, No. 2.

Dauwalder, Donal D., Education and Training for Technical Occupations. Los Angeles: The Los Angeles City Junior College District, June 1961.

Davis, Keith. Human Relations at Work. New York: McGraw-Hill Book Company, inc., 1962.

Domas, Simeon J. Report of an Exploratory Study of Teacher Competence. Cambridge, Mass.: The New England School Development Council, 1950.

Henninger, G. Ross. The Technical Institute in America. New York: McGraw-Hill Book Company, Inc., 1959.

Kast, Fremont E. and James E. Rosensweig. Management in the Space Age. New York: Exposition Press, Inc., 1962.

Lindsay, Robert Bruce. The Role of Science in Civilization. New York: Harper and Row Publishers, 1963.

Mahoney, Thomas A., Thomas H. Judee, and Stephen J. Carroll. Development of Managerial Performance. . . A Research Approach. Chicago: South-Western Publishing Company, Monograph C-9, January 1963.

Mills, John C. The Engineer in Society. New York: D. Van Nostrand Co., Inc., 1946.

Massachuetts Institute of Technology. A Proposal for Experimental Developments in Engineering Education. A Report Prepared by the Faculty of the School of Engineering at the Massachuetts Institute of Technology. Cambridge, Mass.: Massachuetts Institute of Technology, March 1959.

Purdue University Bulletin. School of Technology: Announcements 1965-1966, LXV (February 22, 1965), No. 14.

Terry, George R. Principles of Management. Homewood, Ill.: Richard D. Irwin, Inc., 1956.

The University of Maryland Bulletin. College Park: The University of Maryland, Vol. XIX (April 24, 1964).

Wickenden, William E. and Robert E. Spahr. A Study of Technical Institutes. Lancaster, Pa.: Society for the Promotion of Engineering Education, 1931.

B. PUBLICATIONS OF THE GOVERNMENT, LEARNED SOCIETIES, AND OTHER ORGANIZATIONS

American Institute for Research. Technical Appendices for Critical Requirements for Research Personnel. Pittsburgh: American Institute for Research, March 1949.

Catalog of the Professions: (1951-62). Los Angeles: Western Psychological Services, 1962.

Emerson, Lynn A. Education for a Changing World of Work. Appendix I: Technical Training in the United States. Washington: Government Printing Office, 1963.

Hay, Robert D. Management Staffing Needs of Arknasas Sawmills. Small Business Administration Research Report No. 46. Little Rock, Ark.: Industrial Research and Extension Center, 1961.

National Science Foundation. Federal Funds for Research, Development, and Other Scientific Activities. Washington: Government Printing Office, 1964, Vol. XII.

Pickle, Hal B. Personality and Success. Small Business Research Series No. 4. Small Business Administration. Washington: Government Printing Office, 1964.

President's Science Advisory Committee. Education for the Age of Science. Washington: Government Printing Office, 1959.

Stogdill, Ralph M. and Carroll L. Shartle. Methods in the Study of Administrative Leadership. Business Monograph No. 80. Columbus: Bureau of Business Research. The Ohio State University, 1955.

United States Bureau of Census. Statistical Abstracts of the United States: 85th Annual Edition. Washington: Government Printing Office, 1965, Table 751, p. 546.

United States Congress, Joint Economic Committee of the Congress of the United States of America. Current Economic Situation and Short-Run Outlook. Hearings Before the Joint Economic Committee of Congress, Second Session, December 7-8, 1960.

Wolfbein, Seymour L. "Manpower in the United States With Projection to 1970," Study of Population and Immigration Problems. Washington: Government Printing Office, 1962.

C. PERIODICALS

Flanagan, John C. "The Critical Incident Technique," Offprinted From the Psychological Bulletin, LI (July 1954), No. 4, pp. 327-358.

"Grades Top Criteria," Senior Scholastic, LXXVIII (February 8, 1961), p. 2T.

Hollister, S. C. "A Goal for American Engineering Education," Journal of Engineering Education, XLIII (September 1952), p. 8.

Kappel, Frederick R. "From the World of College to the World of Work," John Findley Green Foundation Lecture, Westminster College, Fulton, Missouri, April 5, 1962. Reprinted from the Bell Telephone Magazine for Spring 1962.

Mayhew, Lewis B. "The Critical Incident Technique in Educational Evaluation," Journal of Educational Research, XLIX (April 1960), p. 594.

Nelson, Hilding E. "Prospectus for a Graphic Arts Technology Curriculum," Industrial Arts and Vocational Education, LII (February 1964), pp. 18-19.

Spaulding, George E., Jr. "The 'Executive' Executive: What Qualities Make the Difference?" Management Review, LIII (November 1964), No. 11, 4-15.

"Top Grads Swamped by Good Job Offers," Business Week (April 14, 1962), p. 76.

D. RESEARCH STUDIES

Boaz, Holland E. "Degree-Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance." Unpublished Doctoral dissertation, The University of Missouri, Columbia, 1965.

Keith, Charles William. "The Industrial Technology Program at Kent State University: An Appraisal and Recommendations," Unpublished Doctoral dissertation, The Ohio State University, Columbus, 1964. (Microfilm.)

Weber, Earl M. "A Comparative Study of Industrial Technology Programs in American Colleges and Universities With Industrial Arts Teacher Education and Technical Institute Programs." Unpublished Doctoral dissertation, The Pennsylvania State University, University Park, 1961. (Microfilm.)

E. UNPUBLISHED MATERIALS

Barnhart, E. L. "Industrial Technology Programs: Curriculum Patterns." Paper read at the Fifieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963.

Cunningham, Beryl M. "Applied Sciences in Education and Industry," Peoria, Illinois: College of Applied Sciences, Bradley University, 1964. (Mimeographed.)

"Dow . . . at a Glance." Midland, Michigan: The Dow Chemical Company, 1963.

Gallington, R. O. "Industrial Technology Programs: Questions and Comments." Paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, November 7, 1963.

Garner, Roy G. "Psychological Test Results and Success on Technical Jobs." Paper prepared by Roy G. Garner, Psychology Department, The Dow Chemical Company, August 10, 1965.

Keil, Raymond L. "Literature Related to the Critical Incident Technique: A Survey and Bibliography." Unpublished paper deposited in the Bradley University Library, Peoria, Illinois, July 1965. (Mimeographed.)

Haurer, Nelson A. "Degree Programs of Industrial Technology: Observations and Comments." Baton Rouge: Louisiana State University, February 1963. (Mimeographed.)

Haurer, Nelson A. and others. "Industrial Technology Programs." Paper read at the Fiftieth Mississippi Valley Industrial Arts Conference, Chicago, Illinois, February 21, 1964.

"Objectives: The Dow Chemical Company." Midland, Michigan: Public Relations Department, The Dow Chemical Company, April 1965.

E. MISCELLANEOUS

Boaz, Holland E. "Degree-Level Technology Programs Offered in Industrial Education Departments: Their Status, Accreditation and Acceptance—Summary, Conclusions and Recommendations." A summary of the findings of a doctoral study conducted at the University of Missouri and received in a personal letter from Holland E. Boaz dated June 24, 1965.

Sommers, Wesley S. Chairman Industrial Technology Department, Stout State College, Menomonie, Wisconsin. Personal letter to Raymond L. Keil dated May 18, 1965.

APPENDIXES

APPENDIX A

DEVELOPMENT OF A STATEMENT OF PURPOSE

A study is being conducted in cooperation with the Technical Placement Services Office for the purpose of determining the nature of the requirements of certain positions within the functional area of activity known as Technical Service and Development.

The procedure to be used for collecting the data requires a statement of the general purpose or aim of the activity to be investigated. It is necessary that all persons to be interviewed have a common understanding of this purpose.

At this time an attempt is being made to develop such a statement of purpose for the area of Technical Service and Development.

A review of company literature has been made and a tentative statement of purpose has been developed. We have attempted to make the tentative statement specific enough so as to be meaningful and yet sufficiently general so as to be commonly acceptable.

It is believed that you are especially well qualified to provide an evaluation of this statement. The present form of the statement is as follows:

> The primary purpose of the technical service and development function is to develop applications for new and existing products; to render technical assistance to customers; and to keep abreast of the changing technology of the customer's field.

Do you agree with this statement? _____

If you do not agree with this statement what are your specific points of disagreement? What changes would you recommend for improving this statement?

Thank you for your cooperation.

Code _____

Type 1 INCIDENT

Before beginning I would like for you to read this statement of purpose (hand card). Do you agree with this statement?

Now—keeping this statement of purpose in mind—would you please recall a recent thing which you remember doing which struck you as having been effective in contributing, directly or indirectly, toward meeting the objective embodied in the statement of purpose and made you feel satisfied with your accomplishment?

a. Approximately when did this incident occur? Date _____
b. What were the circumstances leading up to this incident?

c. What, specifically, did you do that was effective?

d. Why did you judge this incident to have been effective?

e. If the incident reported above includes more than one thing that you did, please identify the action which you believe <u>best</u> illustrates your effectiveness.
f. Can you identify a course,or courses, which you have had in your educational background which was (were) valuable to you in this situation and contributed to your effectiveness? If so, please identify it (them). Here is a selected list of course titles (hand list) to assist your recall.

g. The critical incident reported above is an example of effectiveness in dealing primarily with:

☐ economic factors ☐ people ☐ things ☐ economic factors

Type 2 INCIDENT

Statement of Operating Criteria:

T-2 Now would you try to recall an incident which occurred within the last six months where you remember doing something which struck you as having been effective in contributing, directly or indirectly, toward meeting the objective stated above?

a. Approximately when did this incident occur? Date _____

b. What were the circumstances leading up to this incident?

c. What, specifically, did you do that was effective?

d. Why did you judge this incident to have been effective?

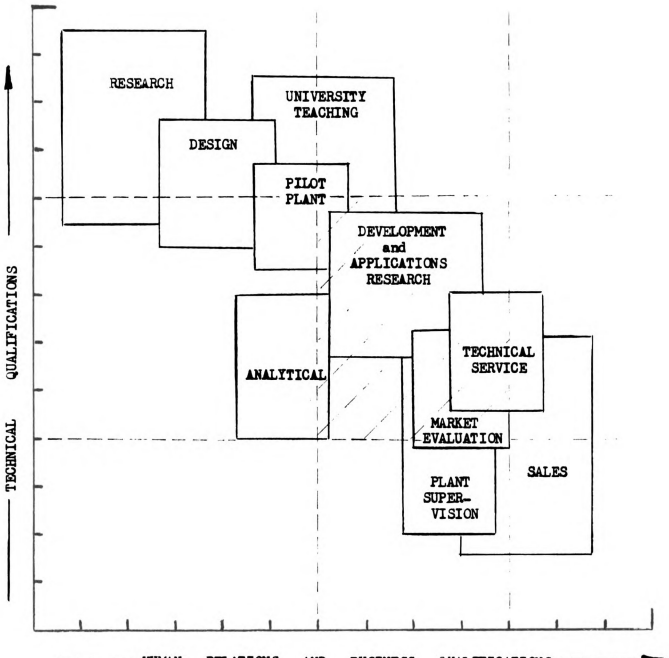
e. If the incident reported above includes more than one thing that you did, please identify the action which best illustrates your effectiveness.

f. Can you identify a course, or courses, which you have had in your educational background which was (were) valuable to you in this situation and contributed to your effectiveness? If so, please identify it (them).

g. The critical incident reported above is an example of effectiveness in dealing primarily with:

☐ people ☐ things ☐ abstractions ☐ economic factors ☐ organizational factors

APPENDIX B



GRAPHIC ANALYSIS CHART OF THE AREAS OF EMPLOYMENT

APPENDIX C

THE COOPERATING COMPANY

Since the founding of the Dow Chemical Company in 1897, the enterprise has expanded and diversified on the strength of numerous pioneering discoveries in the field of chemistry and other related fields. From common materials—brine, petroleum, salt and air—came a growing line of products. The company roster of products numbered more than eight hundred items in 1963[1] and the corporate enterprise was one of the eight chemical companies whose annual sales exceeded one billion dollars.[2]

Company personnel ascribed the company's growth and success to its traditional "will to progress."[3]

> . . . Teamwork involving personnel in research, production, technical service and development, sales and finance has been a significant factor in Dow's prominence as a leader among the chemical companies of the world.[4]

The organizational philosophy of the company appeared to have been flexible as it attempted to provide responsible individuals maximum freedom in their work. The company objectives express a willingness to reorganize and redefine jobs when necessary to break down calcified organizational lines.[5]

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[1] "Dow . . . at a Glance" (Midland, Michigan: The Dow Chemical Company), 1963O, p. 2.

[2] "Dow Annual Report:1964" (Midland, Michigan: The Dow Chemical Company, March 1965), p. 4.

[3] "Dow . . . at a Glance", op. cit., p. 3.

[4] Ibid.

[5] "Objectives: The Dow Chemical Company" (Midland, Michigan: Public Relations Department, Dow Chemical Company, April 1965).

The Midland Division

The firm's corporate headquarters and the company's oldest and most diversified production facility were located at Midland, Michigan. The company's marketing organization—the product sales groups as well as the market-support services—were also based at the Midland location.

Company Personnel Policies and Practices

The company utilized "practically every type of skill and training for the effective conduct of its business."[6]

> . . . Nearly as varied as the disciplines represented by the technical and professional employees of Dow are the differing assignments in which those trained in any specific field achieve both success and satisfaction. As examples, mechanical engineers have made their individual marks not only in equipement design and maintenance shop operations but also in economic evaluation and industrial relations; many chemists work in basic research and product development, while others find their careers in patent work, marketing, or production. . .[7]

The company's philosophy of management "starts with the belief that each individual employee is a vital asset, that the company's capability arises from the talents and skills and abilities of those individuals, that a company is what the hearts and minds of those individuals make it."[8]

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[6]"Dow . . . at a Glance," op. cit., p.1.

[7]Ibid.

[8]Ibid., introduction by H. D. Doan, President Dow Chemical Company

> . . . Every effort is made to provide each Dow employee both opportunity and challenge in his work--opportunity to develop and use his capabilities to the full extent of his capacity and desire, and challenge to apply his own thinking and creative ability for the solution of any scientific, technical, or business problem.[9]

The company appeared to be determined to maintain and improve its position in today's dynamic industrial culture. In order to do this the company must "continue to attract individuals of the same type that brought it to its present position. . ."[10]

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[9] Ibid.

[10] Ibid., p.1.

APPENDIX D

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February 22, 1965

Dr. Peter Haines
316 Erickson Hall
Michigan State University
East Lansing, Michigan

Dear Dr. Haines:

SUBJECT: Ray Kell, Research Project at The Dow Chemical Company.

This letter is in response to your request for formal approval of Dow's willingness to participate in Ray Kell's research project with Michigan State University.

We are very happy to do so. I have read Ray's research proposal, as well as has my supervisor, and we have also made formal checks with executive management and they have given their blessing to the project.

We see this research as being highly valuable and should be of great interest to:

1. Educational Administrators
2. Deans of Engineering Colleges
3. College Placement People
4. Industrial Placement Departments.

We are very happy to cooperate with Michigan State University, The College of Education and Ray in providing the industrial situation for the research.

Cordially yours,

Carl Shafer, Manager
Technical Services and
Business Department Placement

gk

cc: Ray Kell
1618 A. Spartan Village
East Lansing, Michigan

APPENDIX E

THE DOW CHEMICAL COMPANY

MIDLAND

This letter will confirm your scheduled discussion with Ray Keil, Ph.D. student, Michigan State University. The letter will also provide you with some information concerning the nature of this scheduled interview.

The purpose of the interview is to obtain detailed descriptions or accounts of what you did in particular situations where you considered yourself to have been effective.

The method of gathering this data is called the "critical incident technique". In order to acquaint you with this procedure prior to the interview, a brief description of the technique along with an example of a critical incident has been enclosed. The procedure will be explained to you more thoroughly at the time of the interview and any further questions which you may have will be answered at that time.

It should be emphasized that every effort will be made to keep all the information reported confidential. You will be asked to report only "effective" incidents. You will not be asked to use any names within the reports themselves.

Your thoughtful consideration and cooperation is greatly appreciated.

Carl Shafer
Technical Placement

Enclosure

gk

Date_____

Interview Time_____

Place_____

WHAT IS THE CRITICAL INCIDENT TECHNIQUE?

The critical incident technique is a procedure used to collect descriptions of direct observations of human behavior in such a way as to facilitate their potential usefulness in determining the requirements of a particular activity or job classification.[1]

It would be relatively simple to ask you to list the qualities or traits which you consider most vital to effective performance in your type of work; however, investigators in the past have found it difficult to get agreement from person to person on just what these traits mean in terms of on-the-job behaviors using this approach. Research has shown that more objective data can be obtained by collecting descriptions of actions which actually occurred and were reported by someone in the best position to know the demands of their particular situation, rather than from lists of traits which were inferred from these actions by "outsiders".[2]

In other words, the "critical incident technique" will be used to collect a large number of specific behaviors which you and others have performed in actual situations which demonstrated effective performance. When a large number of such incidents have been collected, analyses should reveal the on-the-job behaviors which discriminate between effective and ineffective performance.[3]

WHAT IS AN INCIDENT?

John C. Flanagan, Director of the American Institute for Research and the person recognized for the development and refinement of the critical incident technique, describes an incident as follows: "By an incident is meant any observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the person performing the act".[4] For example, a father returning home from work and greeting his child could be an incident. The incident beginning when the two first saw each other and ending when one or the other turned his attention to another matter which was not of interest to the other--such as a newspaper or favorite toy. Therefore, when you are asked to describe an incident you are not being asked to describe a complete, or long-range, project which may have extended over weeks or even months. You are being asked to describe specific incidents (which may, or may not, have been a part of a larger project) which in your judgment are examples of effective performance.

WHAT IS A CRITICAL INCIDENT?

The above example of a father greeting his child may, or may not, have been a "critical" incident depending upon what actually took place, the circumstances prior to the father's arrival home and upon what criteria were operating. If it were a "routine" greeting under normal day-to-day circumstances, it would be considered a part of the normal day-to-day expectations of a father role and would NOT be "critical". If, in another situation, a father came home and discovered that his son had received a poor grade on a high school mathematics test, and then proceeded to initiate or perform some

plan of action which resulted in the son's improvement in the subject, it could be a "critical" incident. A description of this action would be a critical incident report if the description of the consequences of the action were sufficient to leave little doubt that it had contributed to the family's stated objective of having their son maintain the grades necessary "to go to college". It is not necessary for an incident to be an "earth-shaking event" to be considered "critical". It should be something important enough to stand out in the reporter's mind as the sort of thing that people in the reporter's area of work should do to be effective.

AN EXAMPLE OF A CRITICAL INCIDENT

STATEMENT OF PURPOSE--(Vocational Rehabilitation Counselor): The general purpose of a vocational rehabilitation counselor is to improve the welfare of the people that come to the agency for help.

> "A woman with a limited physical handicap contacted my office and explained her problem to me. She was very pessimistic about her future. I investigated her background, arranged for her to have a medical examination to determine her eligibility status and thoroughly explored all the possibilities which might be available. I finally located an agency which the client did not know existed, but from which she was eligible to receive assistance. I made arrangements for her to contact the people at the agency. A later follow-up of the case revealed that the client had received assistance from the agency that I had located. The client was in good spirits at the time of this visit and she expressed her gratitude to me for making the suggestion."
>
> "I considered myself to have been effective in this case on the basis of the follow-up call. My suggestion had proved to be helpful as the client's situation and mental attitude were improved. I wish more of my cases would work out as well as this one!"

YOUR PART IN THE STUDY

In this investigation, you are being asked to provide descriptions of three effective critical incidents:

1. A recent incident in which you judged your behavior or actions to be effective;
2. Another recent incident in which you judged your behavior or actions to be effective; and,
3. An incident which occurred within the last six months in which you judged your behavior or actions to be effective.

---

1. Flanagan, John C., "The Critical Incident Technique", Psychological Bulletin, Vol. 51, No. 4, July 1954, pp. 327, 355.
2. _____, Technical Appendices for Critical Requirements for Research Personnel, Pittsburg: American Institute for Research, March 1949, p. 27 (p. B-1 of Appendix B).
3. Ibid.
4. Flanagan, Op. Cit., p. 327.

CRITERIA FOR A GOOD CRITICAL INCIDENT[1]

A Critical Incident Should Be:

1. An accurate, detailed description of behavior;
2. An objective, unbiased description of behavior;
3. Observed or performed by the reporter in a specific situation;
4. Judged by the reporter to be effective on the basis of established criteria.

A Critical Incident Should NOT Be:

1. A generalized list of ambiguous traits, inferences, or interpretations of behavior;
2. Unduly affected by personal biases;
3. A vague recollection or hearsay of details;
4. Judged by standards other than those stated as to its effectiveness;
5. Selected only because of its dramatic qualities (this does not exclude unusual or dramatic incidents when they are in fact the most recent incident which has occurred).

RAY KEIL

MICHIGAN STATE UNIVERSITY

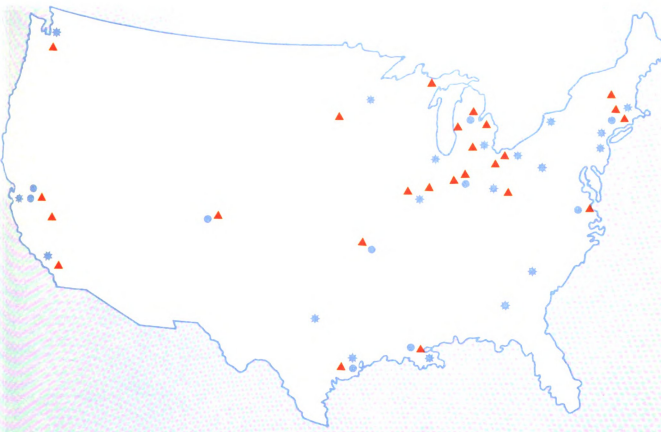
1. _____, Technical Appendices for Critical Requirements for Research Personnel, Pittsburg: American Institute for Research, March 1949, p. 30 (p. B-4 of Appendix B).

APPENDIX F

Please return to:

TECHNICAL PLACEMENT
P.O. BOX 468
MIDLAND, MICHIGAN 48641

THE DOW CHEMICAL COMPANY



SALES OFFICES

Atlanta, Georgia
Boston, Massachusetts
Buffalo, New York
Camden, New Jersey
Chicago, Illinois
Cincinnati, Ohio
Charlotte, N. C.
Cleveland, Ohio
Dallas, Texas
Detroit, Michigan
Houston, Texas
Los Angeles, California
Minneapolis, Minnesota
New Orleans, Louisiana
New York, New York
Pittsburgh, Pennsylvania
St. Louis, Missouri
San Francisco, California
Seattle, Washington

MANUFACTURING LOCATIONS

Fresno, California
Pittsburg, California
Torrance, California
Rocky Flats, Colorado
Allyn's Point, Connecticut
Honolulu, Hawaii
Madison, Illinois
Indianapolis, Indiana
Zionsville, Indiana
Plaquemine, Louisiana
Bay City, Michigan
Jackson, Michigan
Ludington, Michigan
Marquette, Michigan
Midland, Michigan
Riverside, Missouri
Cleveland, Ohio
Findlay, Ohio
Hanging Rock, Ohio
Tulsa, Oklahoma
Sioux Falls, South Dakota
Freeport, Texas
Bennington, Vermont
Wells River, Vermont
Williamsburg, Virginia
Kalama, Washington

RESEARCH FACILITIES

Framingham, Massachusetts
Freeport, Texas
Golden, Colorado
Indianapolis, Indiana
Midland, Michigan
Plaquemine, Louisiana
Pittsburg, California
Tulsa, Oklahoma
Walnut Creek, California
Williamsburg, Virginia

QUALIFICATION RECORD

DATE THIS FORM COMPLETED _____

TYPE OF WORK DESIRED?	☐ PERMANENT	☐ PART TIME
	☐ SUMMER	☐ TEMPORARY

PERSONAL

NAME	LAST NAME	FIRST NAME		MIDDLE NAME
PRESENT ADDRESS	STREET	CITY	STATE	AREA CODE-PHONE
PERMANENT ADDRESS	STREET	CITY	STATE	AREA CODE-PHONE

DATE AVAILABLE FOR EMPLOYMENT

☐ MALE ☐ FEMALE	AGE	BIRTH DATE: MONTH DAY YEAR	HEIGHT	WEIGHT

ARE YOU A CITIZEN OF THE U.S.?	IF NOT, DO YOU INTEND TO BECOME A CITIZEN?	IF NOT A CITIZEN, WHAT TYPE OF VISA DO YOU NOW HAVE?
☐ YES ☐ NO	☐ YES ☐ NO	☐ STUDENT ☐ EXCHANGE ☐ PERMANENT

MARITAL STATUS	AGES OF CHILDREN	RELATIONSHIP OF OTHER DEPENDENTS
	BOYS: GIRLS:	

FAMILY DATA

RELATION	NAME	ADDRESS	PRESENT OR MOST RECENT OCCUPATION
WIFE OR HUSBAND			
FATHER			
MOTHER			

NUMBER OF OLDER BROTHERS AND SISTERS — NUMBER OF YOUNGER BROTHERS AND SISTERS

EDUCATION

SCHOOLS ATTENDED — NAME AND LOCATION	DATES FROM	DATES TO	ACADEMIC YEARS CREDIT	DEGREES RECEIVED OR EXPECTED (BS, MS, PHD, ETC.)	DATE	MAJOR SUBJECT	MINOR SUBJECT
LAST ELEMENTARY SCHOOL							
HIGH SCHOOL							
COLLEGES							

SCHOLASTIC RECORD	ACCUMULATIVE GRADE POINT AVERAGE	MAXIMUM OBTAINABLE GRADE POINT AVE.	RANK IN CLASS (EX. 10/126)	THESIS SUBJECT	NAME OF SUPERVISING PROFESSOR OR FACULTY ADVISOR, AND HIS TELEPHONE NUMBER
UNDER GRADUATE					
MASTER'S					
DOCTORATE					

* IMPORTANT: ATTACH A TRANSCRIPT OR LIST OF ALL COLLEGE COURSES, CREDIT HOURS AND GRADES

HONORS		WHAT PART OF YOUR COLLEGE CAREER DID YOU MOST ENJOY?

PERCENT OF COLLEGE EXPENSE FURNISHED BY:	YOURSELF %	SCHOLARSHIPS %	FAMILY %	G. I. BILL %

MILITARY

LIST ALL UNITED STATES MILITARY SERVICE. INCLUDE R.O.T.C., NATIONAL GUARD SERVICE AND PRESENT RESERVE STATUS.

BRANCH	FROM MO. YR.	TO MO. YR.	HIGHEST RANK	ACTIVE DUTY	TYPE OF DISCHARGE	REASON FOR DISCHARGE

DUTIES PERFORMED IN ACTIVE MILITARY SERVICE

PRESENT DRAFT CLASSIFICATION	WHEN EXPIRES?	DO YOU EXPECT TO SERVE?	WHEN?

COMPLETE INFORMATION ON THIS FORM WILL FACILITATE PROPER EVALUATION OF YOUR APPLICATION

GIVE PAST EMPLOYMENT RECORD AS COMPLETELY AS POSSIBLE STARTING WITH MOST RECENT EMPLOYER— USE LAST PAGE TO ELABORATE, IF NECESSARY

EMPLOYMENT DATA

ORGANIZATION NAME AND ADDRESS	DATE FROM	DATE TO	FULL, PART-TIME OR SUMMER?	MONTHLY EARNINGS	NATURE OF WORK AND NAME OF YOUR IMMEDIATE SUPERVISOR	REASON FOR LEAVING
	MO. YR.	MO. YR.		FIRST LAST		
	MO. YR.	MO. YR.		FIRST LAST		
	MO. YR.	MO. YR.		FIRST LAST		
	MO. YR.	MO. YR.		FIRST LAST		

WORK PREFERENCE

BRIEFLY DESCRIBE THE TYPE OF WORK YOU PREFER AND GIVE YOUR INTERPRETATION OF WHAT IT INVOLVES:
USE LAST PAGE TO ELABORATE IF NECESSARY.

ARE YOU WILLING TO TRAVEL? ☐ **YES** ☐ **NO**

NUMBER OF WORKING NIGHTS PER WEEK YOU WOULD BE WILLING TO BE AWAY FROM HOME?

LIST ANY STRONG LOCATION PREFERENCE AND REASONS

WILL YOU ACCEPT EMPLOYMENT ANYWHERE IN THE U.S.A.? ☐ **YES** ☐ **NO**

SALARY RANGE WITHIN WHICH YOU WOULD ACCEPT A POSITION **$** **PER MONTH**

HAVE YOU EVER APPLIED AT ANY DOW OFFICE BEFORE? ☐ **YES** ☐ **NO**

AT WHICH DOW LOCATION? **WHAT YEAR?**

ACTIVITIES

CAMPUS AND/OR PRESENT ACTIVITIES NAME OF ORGANIZATION	TYPE OF ORGANIZATION	OFFICES HELD
OTHER ACTIVITIES (DRAMATICS, ATHLETICS, ETC.)		

INTERESTS

LEISURE TIME ACTIVITIES

HEALTH

ALL NEW EMPLOYEES MUST PASS A PHYSICAL EXAMINATION BY A COMPANY PHYSICIAN. PLEASE LIST ANY PAST SERIOUS ILLNESSES OR KNOWN LIMITATIONS, HAS ANY ILLNESS SPECIFICALLY AFFECTED YOUR COLLEGE ACHIEVEMENT OR PREVIOUS WORK PERFORMANCE?

DO YOU WEAR GLASSES? ☐ **YES** ☐ **NO** **REASON**

REFERENCES

LIST THREE REFERENCES, NOT RELATED TO YOU

NAME	ADDRESS	OCCUPATION	YEARS KNOWN

IT IS CUSTOMARY TO INVESTIGATE THE INFORMATION GIVEN ABOVE. IF YOU DO NOT WISH TO HAVE YOUR PRESENT EMPLOYER CONTACTED, PLEASE CHECK BOX AT RIGHT. ☐

SIGNATURE_____

THE REMAINING PART OF THIS APPLICATION IS FOR YOUR CONVENIENCE IN FURNISHING ADDITIONAL INFORMATION, OR EXPANDING UPON ANY INFORMATION REQUESTED IN OTHER SECTIONS OF THE APPLICATION. WE ARE INTERESTED IN ANY JOBS, SPECIAL TRAINING OR WORK EXPERIENCES YOU MIGHT HAVE HAD. LIST PATENTS AND PUBLICATIONS. LIST ANY OUTSTANDING ACHIEVEMENT EVEN THOUGH NOT DIRECTLY RELATED TO THE POSITION FOR WHICH YOU ARE NOW APPLYING. INCLUDE REASONS WHY YOU FEEL YOU WOULD MAKE A GOOD EMPLOYEE OF OUR COMPANY, OR WHY YOU ARE ESPECIALLY INTERESTED IN THE DOW CHEMICAL COMPANY.

STOCK FORM 8890 PRINTED IN U.S.A. R3-64

APPENDIX G

Code _____

I N T E R V I E W C O N T R O L D A T A

What is your current job title? _____

How long have you been working in your present position? Yrs. __ Months ____

List any other job titles formerly held at the Dow Chemical Company:

1. _____ 4. _____
2. _____ 5. _____
3. _____ 6. _____

Did you participate in Dow's Special Assignment Program? ____. Have you received any other company training since your initial employment with the Dow organization? If so, describe _____

_____

EDUCATION:

SCHOOLS ATTENDED Name Location	Degree type	Degree date	Major Area	Rank in Major
High School				
College or other post high school				

Were you in a college cooperative training program? _____
Did you have any summer technical employment? _____
Are you married? _____ Do you have any children? _____

DISTRIBUTION OF YOUR WORK TIME:

Please indicate the percentage of time that you believe you devote to each of the following four types of activity during the course of the last six months. Those activities dealing primarily with:

_____ 1. concrete physical things;

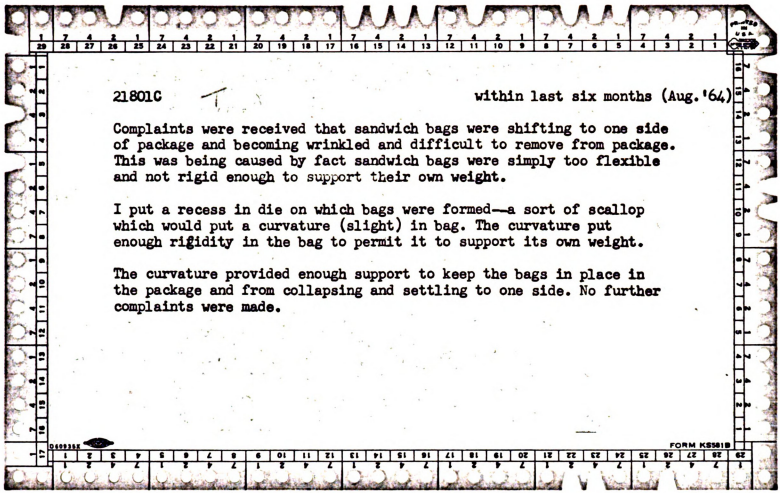
_____ 2. people and human relations;

_____ 3. theoretical abstractions; and,

_____ 4. economic factors and the business aspects.
100%

APPENDIX H

ROYAL McBEE KEYSORT CARD



21801C within last six months (Aug.'64)

Complaints were received that sandwich bags were shifting to one side of package and becoming wrinkled and difficult to remove from package. This was being caused by fact sandwich bags were simply too flexible and not rigid enough to support their own weight.

I put a recess in die on which bags were formed—a sort of scallop which would put a curvature (slight) in bag. The curvature put enough rigidity in the bag to permit it to support its own weight.

The curvature provided enough support to keep the bags in place in the package and from collapsing and settling to one side. No further complaints were made.

FORM KS501B

APPENDIX I

TABLE XV

WORK EXPERIENCE OF THE IDENTIFIED HIGH ACHIEVERS

	COLLEGE		COMPANY		TECHNICAL			MILITARY			OTHER				
Code Number	Cooperative Curriculum	Research or Teaching Assistant	Special Assignments Program	Other Formal Company Training	Summer	Part-time	Full-time	Technical	Leadership	Skilled	Semi-skilled	Laborer	Clerical	Sales	Miscellaneous
21825	4 yrs.														
21815				yes								1 S[a]			
21990				yes								2 S			2 S
22315	4 yrs.														
56009	2 yrs.							2 yr.	2 yr					3 F	
21840	2 yrs.	1 yr.									1 S				
56010						8 yr.									
22310		2 S												1 S	
21890													2½ F		
21910					2									5 F	
22330		3 yrs.			2							1 S		4 S	
21801											2 S	1 F		2 Pc	
21940					2					1 S				1 S	
22309		2 yrs.	yes					3 yr.	3yr.			4 S			
21920		3 yrs.	yes									1 S		4 S	
61511					1				2yr.			4 P			2 P
57035		1 yr.	yes	yes	1							2 S			
57009		1 yr.		yes								1S/2P			
57010				yes					2 yr.			4 S			
56030				yes	2								1 P		
57025		2 yrs.		yes						2 P					

[a]Summer employment.

[b]Full-time employment

[c]Part-time employment

TABLE XV (continued)

WORK EXPERIENCE OF THE IDENTIFIED HIGH ACHIEVERS

	COLLEGE COMPANY				TECHNICAL			MILITARY		OTHER					
Code Number	Cooperative Program	Research or Teaching Assistant	Special Assignments Program	Other Formal Company Training	Summer	Part-Time	Full-Time	Technical	Leadership	Skilled	Semi-Skilled	Laborer	Clerical	Sales	Miscellaneous
57015	3 yrs.			yes								1 S		4 S	
56015	2 yrs.		yes	yes								2 S			
62111			yes		1							1 S		1 S	
52410	5 yrs.			yes										3 P	
52408	2 yrs.			yes	4									2 F	
52409		1 yr.		yes								6S/2P			
70909		3 yrs.						3yr.	3yr.			2S/1P			
61409					2		5yrs.	2yr.	2yr.						
61401				yes						*					
61425							6yrs.					4 P			
61435				yes		1 yr.		2 yr.				1 S	3 S		
62115			yes	yes	4										
70911				yes		4 yrs.				5yrs.				1 F	
70901				yes		1 yr.	5yrs.					2yr. F		3 F	

*One year full-time; three summers; and two years part-time.

APPENDIX J

TYPES OF DEGREES REPRESENTED IN THE POPULATION*

	TYPE OF DEGREE			
Major Area	Associate	Bachelor	Master	Doctorate
Chemistry	26	267	24	17
Chemical Engineering	1	214	37	12
Chemical Technology	0	3	0	0
Organic Chemistry	0	3	28	32
Mathematics	2	26	2	0
Mechanical Engineering	0	46	3	0
Civil Engineering	0	23	2	0
Industrial Engineering	0	12	0	0
Engineering	10	5	0	0
Packaging Engineering	0	5	0	0
Petroleum Engineering	0	1	0	0
Mining Engineering	0	1	0	0
Electrical Engineering	1	12	0	0
Industrial Chemistry	2	1	0	0
Pharmacology	1	0	0	0
Agronomy	0	7	0	0
Commerce	8	4	0	0
Marketing	0	21	18	0
Journalism	0	5	0	0
English	0	12	0	0
Psychology	0	3	0	0
Clinical Psychology	0	1	0	0
Industrial Psychology	0	1	0	0
Fish and Wildlife	0	1	0	0
Marine Biology	0	0	1	0
Business Administration	5	28	14	0
Geology	0	2	0	0
Pre-Medical	9	1	0	0
Pre-Dental	0	2	0	0
Economics	0	30	6	0
Microbiology	0	0	1	1
Miscellaneous	11	1	0	0
Agricultural Education	0	3	0	0
Liberal Arts	6	5	0	0
Transportation and Traffic	0	1	1	0

*"Population" refers to all persons employed by the Company between January 1, 1958 and January 1, 1964.

Major Area	TYPE OF DEGREE			
	Associate	Bachelor	Master	Doctorate
Forestry	0	2	1	0
Agricultural Science	1	8	0	0
Plant Physiology	0	0	2	1
Physics	0	0	2	1
Nursing	0	1	0	0
Engineering Science	0	1	0	0
Library Science	0	1	0	0
Auditing	0	1	0	0
Foreign Trade	0	1	0	0
Sanitary Engineering	0	0	6	1
Biochemistry	0	0	4	5
Agriculture	0	2	0	0
Biology	0	14	1	0
Dyes and Inks	0	1	0	0
Business and Economics	3	5	3	0
Agricultural Chemistry	0	0	2	0
Management	1	12	8	0
Accounting	4	14	2	0
Education	0	1	0	0
Secondary Education	0	1	0	0
Physical Education	0	3	1	0
Educational Administration	0	0	0	1
Soil Science	0	2	1	2
Soil Mechanics	0	0	1	0
Plant Pathology	0	1	1	1
Physical Chemistry	0	1	6	14
Military Engineering	0	1	0	0
Military Science	0	1	0	0
Sales Administration	0	1	0	0
Theology-Religion	0	1	1	0
Linguistics	0	1	1	0
Ceramic Engineering	0	2	2	0
Medical Technology	3	8	0	0
Sociology	0	4	0	0
Production Engineering	1	0	0	0
Classical Methods	1	0	0	0
Statics	0	0	1	0
Bacteriology	0	1	2	0
Agricultural Engineering	0	2	0	0
Industrial Relations	0	0	4	0
Range Management	0	0	1	0

	TYPE OF DEGREE			
Major Area	Associate	Bachelor	Master	Doctorate
Personnel Management	0	2	1	0
Science	3	4	1	0
Law	0	14	0	0
Political Science	0	5	1	0
Sales Technical Service	0	1	0	0
Analytical Chemistry	0	0	9	6
Metallurgical Engineering	0	11	3	1
Agricultural Economics	0	5	3	1
Animal Husbandry	2	10	1	1
Pharmacy	2	0	0	1
Engineering Administration	0	2	3	0
History	0	7	0	0
Social Science	0	2	0	0
Bio-Physics	0	1	0	0
Pulp-Paper Engineering	0	1	0	0
Pulp-Paper Chemistry	0	1	1	0
Geography	0	2	0	0
Entomology	0	1	2	2
Animal Production	0	1	0	0
Animal Nutrition	0	0	3	2
Animal Physiology	0	0	1	0
Communications	0	1	1	0
Anatomy	0	0	0	1
Research in Engineering	0	0	1	0
Zoology	0	9	0	0
Physiology	0	1	0	0
Plant Science	0	1	0	0
Horticulture	1	4	1	0
Botany	0	1	0	1
Physiological Chemistry	0	1	1	0
Public Relations	0	1	0	0
Government	0	2	0	0
Finance	0	3	1	0
Mortuary Science	1	0	0	0
Industrial Education	0	2	2	1
Medicine	0	0	0	1
Floriculture	0	0	1	0
Inorganic Chemistry	0	0	0	6
Distribution	0	2	1	0
Advertising	0	3	1	0
Textile Technology	0	1	1	0

	TYPE OF DEGREE			
Major Area	Associate	Bachelor	Master	Doctorate
Engineering Chemistry	0	1	0	0
Engineering Geology	0	1	0	0
Aeronautical Engineering	0	1	0	0
Philosophy	0	1	0	0
Music	0	1	0	0
Art	0	1	0	0
Economic Geology, Metals	0	1	1	0
Labor Relations	0	1	1	0
Labor-Management Relations	0	1	0	0
Methods Analysis	0	0	1	0
Veterinary Medicine	0	0	0	1
Market Research	0	0	1	0
Operations Research	0	0	1	0
Pomology	0	1	0	0
Languages	0	0	1	0
Polymer Chemistry	0	0	0	1
Weed Control Chemistry	0	0	1	0
Poultry Science	0	1	0	0
Nutrition and Methods	0	0	1	0

APPENDIX K

TABLE XVII

ACADEMIC ACHIEVEMENT

Code Number	Grade Point Average	Percentile Rank in Major
70911	3.68	96
21920	3.60	100
70901	3.46	90
61401	3.29	80
62115	3.17	80
22310	3.05	87
56009	3.05	90
22330	3.00	90
56015	3.00	80
61410	2.99	74
62111	2.94	78
56030	2.94	80
52408	2.92	75
57015	2.90	66
57009	2.89	92
61425	2.81	60
21910	2.80	74
70909	2.80	90
57010	2.80	69
22309	2.79	85
52409	2.79	75
21815	2.75	75
21890	2.62	67
21990	2.60	65
57025	2.60	88
21940	2.60	67
21825	2.50	75
22315	2.49	75
61435	2.41	50
61511	2.40	73**
57035	2.40	55
52410	2.40	65
56010	2.30	50
21801	2.30	67
21840	2.27	56

[a]All grade point averages were computed on the basis of a four point honor system.

**This person had a dual major in packaging engineering and chemistry. The percentile rank in the chemistry major was fifty-eight.

APPENDIX L

A SELECTED LIST OF COURSE TITLES

COMMUNICATION ARTS

8141 English Composition
8710 Library science & bibliography
8180 Archival science & philology
8315 Technical report writing
6127 Commun. research & info. theory
6148 Mass media & communication
8410 Radio & TV arts
8320 Journalism
8311 Biography
8160 Etymology
8150 Basic speech
8151 Busn. & professional speech
8155 Group discussion
8156 Group discussion leadership
6159 Speech pathology
8142 Foreign languages

ART

8210 Art composition
8220 Painting
8225 Commercial art
8230 Sculpture
8250 Music
8330 Photography
6260 Interior design
8361 Graphic arts
8400 Entertainment

HUMAN RELATIONS & BEHAVIOR

6100 PSYCHOLOGY
6102 Psych. theories & systems
6110 Developmental psychology
6120 Experimental & physiological psychology
6140 Social psychology
6143 Surveys & polls
6144 Group interaction
6146 Leadership
6147 Role differentiation
6149 Social attitudes
6150 Clinical psychology
6166 Personality theory
6170 INDUSTRIAL PSYCHOLOGY
6171 Performance evaluation & criterion development
6172 Employee morale & attitudes
6180 Psychometrics
6181 Experimental design
6182 Factor analysis
6185 Test constr. & evaluation
6190 Counseling & guidance
6195 Rehabilitation

6200 EDUCATION
6220 Educational methods
6225 Science education
6230 Industrial education
6240 Agricultural education
6250 Art education
6260 Music education
6270 Physical education
6275 Business education
6295 Special education
6280 Educational administration
6292 Educational measurement
6201 Higher education
6220 Secondary education
6210 Elementary education
6290 Educational psychology

6300 SOCIAL SCIENCE
6330 Sociology
6340 Anthropology
6350 Criminology
6370 Family relations
8120 HISTORY
8122 American history
8123 European history
8124 World history
8125 Economic & social history
8130 Archeology
3800 GEOGRAPHY
3801 Physical geography
3802 Economic geography
3803 Human geography
3804 Urban geography
3805 Regional geography
3806 Military geography
6510 Military science

6400 POLITICAL SCIENCE
6410 Government
6420 Political systems (the isms)

HUMANITIES
6310 Philosophy
6320 Theology & religion
6360 Ethics
6121 Aesthetics
8110 Literature
8111 Classics
8112 Value theory
8113 Philosophy of science
4300 Logic

7000 BUSINESS & ECONOMICS

7100 Business management
7101 Industrial management
7110 Finance
7112 Public finance
7111 Corporate finance
7113 Money & banking
7114 Taxes
7118 Accounting
7114 Corporate accounting
7115 Public accounting
7116 Governmental accounting
7117 Auditing
7120 MARKETING & DISTRIBUTION
7121 Sales administration
7122 Salesmanship
7123 Market research
7124 Distribution & warehousing
7125 Transportation
7127 Traffic management
7128 Sales technical service
7129 Pricing
7160 PURCHASING

7130 INDUSTRIAL RELATIONS
7131 Personnel Management
7132 Labor relations
7133 Recruiting, selection & placement
7134 Salary & wage administration
7135 Employee & executive training & development
7136 Job analysis & position classification
7140 OFFICE MANAGEMENT
7141 Methods analysis
7142 Records management
7144 Office equipment
7170 INSURANCE
7180 SMALL BUSINESS MANAGEMENT
7190 CLERICAL & SECRETARIAL
7200 PUBLIC ADMINISTRATION
7220 FOREIGN SERVICE
7230 PUBLIC UTILITIES

7300 LAW
7310 Patent law
7320 Labor law
7330 Tax law
734C Pre-law

7400 ECONOMICS
7410 Business economics
7420 Agricultural economics
7430 Governmental economics
7440 Labor economics
7450 Economic statistics
7460 Foreign trade
7470 Foreign areas studies
7480 Home economics

1000 TECHNOLOGY & ENGINEERING
0100 Research in science &/or engr.
0110 Research supervision
0120 Pilot plant operation
0200 Production & supervision
0250 Foremanship
1030 FUEL TECHNOLOGY
1040 CORROSION
1050 HEAT TRANSFER

1100 CHEMICAL ENGINEERING
1101 Adsorption & absorption
1102 Electrochemical processes
1103 Extraction & solvent recovery
1104 Heat transmission
1105 Measurement & control of process variables
1106 Fluid dynamics
1107 Mechanical separation
1108 Mixing, kneeding & agitating
1109 Phase change separating (crystallization)
1111 Size reduction processes
1112 Process design & development
1113 Materials handling
1114 Product packaging
1115 Distillation
1116 Drying
1117 Filtration

1120 NUCLEAR ENGINEERING
1130 PETROLEUM ENGINEERING
1131 Petroleum processing
1132 Petroleum production
1134 Natural gas production & transportation
1140 Engineering chemistry

1150 CHEMICAL TECHNOLOGY
1160 PULP & PAPER MANUFACTURE
1170 BIOCHEMICAL ENGINEERING

1200 MECHANICAL ENGINEERING
1201 Power engineering
1202 Automotive engineering
1203 Lubrication

1204 Construction & assembly
1205 Welding
1207 Pipe design
1208 Models (physical)
1210 ENGINE DESIGN
1211 Internal combustion engines
1212 Diesel engines
1213 Steam engines & turbines
1214 Boilers & steam engineering
1215 Gas turbines
1220 MARINE ENGINEERING
1230 HEATING & AIR CONDITIONING
1240 TEXTILE ENGINEERING
1241 Textile technology
1250 APPLIED SCIENCES
1251 Applied mechanics
1252 Statics
1253 Dynamics
1254 Thermodynamics
1255 Properties of materials
1256 Plasticity
1257 Elasticity
1258 Fluid dynamics
1259 Kinematics
1260 MACHINE DESIGN-Equipment design
1261 Machine tools
1262 Tool design
1270 Properties of plastics
1280 Drafting
1285 Descriptive drafting
1281 Technical illustration
1282 Graphic reproduction
1290 Cost estimating
1291 Specification writing
1292 Inspection

1300 ELECTRICAL ENGINEERING
1301 Power generation
1302 Power transmission & distribution
1305 Illumination
1306 Wire communication
1307 Servo mechanisms

1310 ELECTRONICS
1311 Radio communication
1312 Television
1313 Computers
1314 Electron tubes
1315 Electronics circuitry
1316 Semiconductor applications
1317 Telemetering
1318 Circuit theory

1400 CIVIL ENGINEERING
1404 Construction, light
1405 Construction, heavy
1412 SANITARY ENGINEERING
1421 Water supply
1422 Sewage & industrial wastes
1423 Water pollution and control
1426 Air pollution
1427 Refuse disposal
1428 Industrial hygiene & occupational health
1430 ARCHITECTURAL ENGINEERING
1440 SURVEYING, MAPPING & PHOTOGRAMMETRY
1442 Cartography
1444 Engr. surveys for construction

1500 AERONAUTICAL ENGINEERING

1600 INDUSTRIAL ENGINEERING
1601 Engr. economics & econ. eval.
1602 Maintenance engineering
1603 Time & motion study
1604 Operational analysis
1605 Procurement & accounting
1606 Production planning
1607 Statistical engr., quality control
1608 Stds. & testing of materials
1609 Safety engineering
1612 Product engineering
1623 Process engineering
1614 Instrumentation and control
1615 Engineering materials
1617 Industrial testing
1618 Packaging & labeling

1700 AGRICULTURAL ENGINEERING

1800 CERAMIC ENGINEERING
1801 Abrasives
1802 Clay products
2203 Cement & related bldg. products
1804 Protective & refractory coatings for metals
1806 Glass
1807 Kilns, furnaces

1900 METALLURGICAL ENGINEERING
1901 Metallurgy
1904 Electro metallurgy
1905 Powder metallurgy
1906 Physical metallurgy

1907 Foundry practice
1908 Metal treatment & fabrication

2000 CHEMISTRY
2001 Textile chemistry
2002 Industrial chemistry
2003 Cellulose chemistry
2004 Pulp & paper chemistry
2006 Electrochemistry
2008 Petroleum chemistry
2009 Colloid chemistry

2100 ORGANIC CHEMISTRY
2103 Organic synthesis
2104 Theoretical chemistry (incl. reaction mech. & struct. chem.)
2105 OrganicMetallic components
2106 Silicon compounds
2107 Adhesives, glue & sizes
2108 Resins
2109 Paints, enamels & varnishes
2111 Rubber: Natural & Synthetic & related products
2112 Oils, fats & waxes
2113 Dyes & inks
2114 Coal & coal products
2115 Explosives & rocket fuels
2116 Soaps & detergents
2117 Synthetic alcohols & solvents
2119 Leather, tanning materials; collegen
2131 Carbohydrates
2122 Halogen compounds
2123 Proteins & amino acids
2124 Coatings

2200 INORGANIC CHEMISTRY
2204 Florescent minerals
2205 Industrial & other gases
2207 Metals
2208 Pigments (incl. carbon black)
2209 Radioactive mat'ls (purification & separation)
2211 Theoretical inorganic chemistry
2212 Rare earths

2300 PHYSICAL CHEMISTRY
2302 Atomic & nuclear structure & radio chemistry
2303 Photochemistry
2305 Theoretical (incl. reaction mechanisms & kinetics)
2306 Thermodynamics & thermochemistry
2307 Ion exchange & applications
2308 Catalysts; catalytic materials
2309 Corrosion & inhibition
2311 Vacuum techniques
2312 Crystallography
2313 Physical organic chemistry
2314 Molecular structure
2400 POLYMER CHEMISTRY
2410 LATEX CHEMISTRY
2500 FOOD CHEMISTRY
2600 ANALYTICAL CHEMISTRY
2610 Assaying
2620 Classical methods
2630 Electrochemical methods
2650 Micro chemistry
2651 Trace methods
2660 Tracer methods
2670 Instrumental & optical methods
2700 PHARMACEUTICAL CHEMISTRY
2800 AGRICULTURAL CHEMISTRY

3000 OTHER PHYSICAL SCIENCES
3100 PHYSICS
3110 THEORETICAL PHYSICS
3120 SOLID STATE
3121 Physics of metals
3122 Semiconductors
3123 Crystalline state
3124 Dielectrics (incl. fluid)
3125 Magnetism
3128 Glasses & high ploymers
3130 NUCLEAR PHYSICS
3140 ATOMIC & MOLECULAR STRUCTURES
3150 MECHANICS & HEAT
3160 ELECTRICITY & MAGNETISM
3161 Electromagnetic fields
3162 Microwaves
3163 Radiowaves
3164 Electron dynamics
3170 ACOUSTICS
3180 OPTICS
3190 SPECTROSCOPY
3200 Astronomy
3300 GEOLOGY
3400 HYDROLOGY
3500 OCEANOGRAPHY
3600 GEO-PHYSICS
3700 GEO-CHEMISTRY
3900 METEOROLOGY

4000 MATHEMATICS
4010 Actuarial mathematics
4040 Biometrics & biostatistics
4100 Algebra
4115 Trigonometry
4120 Linear algebra & matrix theory
4130 Polynom'ls, invariants, theory of equations
4140 Lattices, Boolean algebra