DEVELOPING AN INSTRUMENT TO SURVEY THE PERCEPTIONS OF INDUSTRIAL REPRESENTATIVES CONCERNING THE EDUCATIONAL REQUIREMENTS OF INDUSTRIAL TECHNOLOGY MAJORS

By

DUANE ALAN RENFROW

Bachelor of Science in
Industrial Arts Education
Oklahoma State University
Stillwater, Oklahoma
1979

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1985

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
May, 1991

DEVELOPING AN INSTRUMENT TO SURVEY
THE PERCEPTIONS OF INDUSTRIAL
REPRESENTATIVES CONCERNING THE
EDUCATIONAL REQUIREMENTS OF
INDUSTRIAL TECHNOLOGY
MAJORS

Thesis Approved:

Robert C. Wicklein
Thesis Adviser

Gary R. Buie

Gerald R. McClain

Lewis W. Duggar

Kenneth St. Clair

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGEMENTS

The writer wishes to extend his sincere gratitude to all who have contributed to the completion of this study.

I praise God for giving me the strength and abillity to follow this course of study. Without faith in Him to help me in my many times of trial this course of study would not have been possible.

I would like to express my sincere appreciation to the members serving on my committee. Thank you for working with me as I was completing this study by long distance. I would like to express a special appreciation to Dr. Robert Wicklein for serving as my Dissertation advisor. Thank you for your ideas and commitment in helping me to complete this study.

I wish to express love and gratitude to all of my family members both natural and by marriage, for the support and encouragement they have given me throughout my education.

I wish to express my love and appreciation to my wife, Kathy, and my children, Clinton, Maggie, and Mark for the love and support they have given me through the completion of this study. Without their understanding during this time this study would not have been possible.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure

CHAPTER I

INTRODUCTION

The development of a relatively new career type "industrial technologist" has provided a needed service for America's industries. Bohn and McDonald (1983) indicated that the term technologist relates to a career type that is located mid-way between the technician and engineer. Typically, entering this career requires the completion of a four year college industrial technology program or additional on-the-job training. The technology, in the form of techniques, processes, materials, and machines, being used in industry today is rapidly changing and improving. This change has caused a separation between the technician, who services, sets up, and maintains equipment, and the engineer, who plans and designs. The technologist is a broadbased problem-solver (Lauda, 1988) and is taking a position of sharing some of the responsibilities of the engineer in certain areas. Some of these areas include building production models, modifying production operations, training workers, and troubleshooting and servicing complex equipment (Bohn & McDonald,1983).

The National Association of Industrial Technology, NAIT, (1988) defines Industrial Technology as "degree programs of study designed to prepare management-oriented technical professionals" (p. 1). NAIT (1988) lists four aspects that are typically included in the educational experiences of professionals in Industrial Technology. As indicated by NAIT they are:

1. The application of significant knowledge of theories, concepts and principles found in the humanities and the social and behavioral sciences, including a thorough grounding on communication skills.
2. The understanding of the theory and application of the principles and concepts of mathematical and physical sciences and computer fundamentals.
3. The application of concepts derived from, and current skills developed in, a variety of technical disciplines including, but not limited to, materials and production processes, industrial management and human relations, marketing, communications, electronics and graphics.
4. Field of specialization may be included, for example, electronic data processing, computer integrated design and manufacturing, construction, energy, polymers, printing, safety or transportation. (p. 1)

The need for this career type, and the parameters for the education needed to prepare individuals, have been established; however, with the rapid advancements of new technology in industry, educational institutions are often faced with a curriculum or program that is outdated before it is firmly established. The advancement in equipment used in industry can give a clue as to the rate at which technology is changing. A little over 20 years ago less than 200 companies, mainly in the aerospace and automotive fields, were using Computer-Aided Design/Drafting and Computer-Aided Manufacturing systems. By the end of 1979 approximately 12,000 systems were in use. Also, the memory capacity and circuit densities of the electronic components of CAD/CAM systems have quadrupled every four years since that time (Hawkins, 1989). Skaine (1985) indicated that this rapid change in technology is likened to a revolution rather than an evolution. During the 1950's industrial knowledge doubled every fifteen years, now it doubles every three years (Sherry, 1989). Technology does not stand still and neither should educational programs. Technology educators must continually work and strive to include new content for courses in order to stay current with new technologies being developoed in industry. It should be acknowledged that these programs are continually evolving and developing (Sprague & Bies, 1988). Institutions typically look to each other and to industry to determine what to include in an educational program; however, an effective system to keep abreast of new technology has not been established. Industry is the ideal place to gauge the pulse of changing technology. Industries utilizing and developing new technology should be surveyed on a regular basis to determine what changes should be made in the educational content to prepare industrial technologists.

Statement of the Problem

This study was conducted due to the effects of rapidly changing technology in industry and because this change affects the perceptions of industry concerning the educational needs of industrial technologists. Being able to determine what industrial representatives perceive as the current educational needs is vital for post-secondary institutions for the purpose of upgrading curriculum, facilities and faculty. Developing an instrument that can effectively ascertain the perceptions of industrial representatives as technology changes should be a means to help keep curriculums, facilities and faculty at post-secondary institutions more in tune with the needs of industry and students concerning industrial technology.

Statement of the Purpose

The purpose of the study was to develop a valid and reliable instrument to survey the perceptions of industrial representatives concerning the educational needs of industrial technology majors. An important aspect in developing the instrument was to prepare an instrument that was short, simple and convenient to complete thus promoting a quick turn around from the respondent. Developing the instrument should provide a means to examine current educational needs in industry for the purpose of updating curriculum, facilities and faculty at post-secondary institutions.

In order to accomplish the purpose, the following developmental strategy was incorporated:

1. Identify the educational subject areas or requirements of industrial technology majors as indicated in current literature.

2. Develop an instrument to survey the perception of industries concerning the educational needs of industrial technology majors.

3. Establish reliability and validity of the instrument through the use of testing of the instrument using a sample of high technology industries and industrial technology educators.

Assumptions

In order for this study to be considered valid the following assumptions were made:

1. The subject areas or requirements of industrial technology majors listed in the study did not exclude any subject area or requirement deemed important by industry.

2. The companies used in the study, representing high

technology industries, were typical of companies across the nation making use of industrial technology majors.

3. The perceptions expressed by the respondents were honest expressions of their knowledge of the requirements for industrial technologists in their company.

4. The instrument was routed to the person most qualified to complete the survey.

Definition of Terms

The following definitions of terms are furnished to provide, as nearly as possible, clear and concise meanings of terms as used in this study.

Engineer: A person who has received a minimum of a bachelors degree from a college engineering curriculum (Hauser, 1971).

Engineering Technologist: A person who is a graduate of a baccalaurate program in engineering technology program (ABET, 1989).

Engineering Technology: It is that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities. The main difference between engineering technology and industrial technology lies in the type of faculty, use of facilities, mathematics and science sequence content, and the degree of specialization (ABET, 1989)

General Education Courses/Areas: Courses or areas of study at the postsecondary level that relate to the general education of students seeking the bachelor's or higher degree. Course areas include english, mathematics, history, government, philosophy, fine arts and humanities, human behavior, and physical and biological sciences (Giachino and Gallington, 1977).

High Technology Industry: These are specific industries dealing with specialized, complex technology in the following specific product classifications: aerospace equipment systems, analytical/ measuring instruments, biotechnology (not elsewhere classified), broadcast equipment, communications equipment, components, computer graphics, computer peripherals/accessories, computer systems, consumer/non-industrial products, electronic production equipment, electronics R&D, energy, environmental, genetics, industrial equipment, laser/optics, material handling equipment, materials, medical electronics, microelectronics, military products, monitoring/controlling equipment, pharmaceuticals, power devices/systems, robotics/automation, software/systems, storage peripherals, test equipment, video. New technology is not restricted to the previous list (Rocky Mountain High Technology Directory, 1987).

Industrial Internship: A program that provides for alternation of study in school with a job in industry or business, the two experiences being so planned and supervised cooperatively by the school and the employer that each contributes significantly to the students development in his/her chosen occupation. It is also known as cooperative education, practicum, or industrial work experience (Hauser, 1971).

Industrial Technologist: A management-oriented technical professional that works at a mid-level between the technician and the engineer. Areas of work include research and development, production operations analysis, training, troubleshooting and servicing complex equipment (Bohn and MacDonald, 1983).

Industrial Technology: A branch of technology concerned primarily with technical, managerial and production supervisory functions associated with the use of tools, materials, techniques, and the application of scientific knowledge needed to carry out the plans for providing society with objects of material culture (Connor, 1986).

Industrial Technology Specialization Courses/Areas: Those courses or areas within an industrial technology/ education curriculum involving technical science and leading to a major/minor in technology. Technical science includes knowledge and skills taken from four established areas including communications, construction, manufacturing, power, energy, and transportation (Giachino and Gallington 1977).

Industry: A combination of organizations and facilities that, through the effective coordination of capital, management and labor, produce goods to meet the needs and desires of society (Hauser, 1971).

Interpersonal Skills: Skills that are developed to aid the interaction between people and increase productivity, topics include problem solving, communication, leadership, creative thinking, critical thinking, and analytical thinking (Connor, 1986).

Post-secondary Education: Education that is offered to students who have completed high school. The types of schools offering this type of education include technical institutes, community colleges, junior colleges, and four year colleges/universities (Giachino and Gallington, 1977).

Technician: A person who is qualified for entry into a technical position of industry as a result of successful completion of an educational program terminating in a certificate, associate of arts, or science degree in a technical curriculum (Hauser, 1971).

Technology: The study of the technical means the human has initiated and utilized for survival. A break down of the word technology refers to; (1) techniques which refers to the principle or method employed in making things, and (2) logos which refers to the study of those principles or methods (Lauda, 1988).

Scope

The subject areas used to conduct this study were chosen from the current literature. These subject areas were related to industrial technology specialization courses, general education courses, and interpersonal skills courses identified by postsecondary institutions and experts in the field as being important for the preparation of industrial technology majors.

In developing the instrument a sample was chosen to be used to test the instrument for reliability. The population chosen consisted of Rocky Mountain high technology corporations which included the industries of seven states and a representative sample of industrial technology educators from the same seven states. The Rocky Mountain high technology corporations were chosen due to the availability of the data and because of the diversity of the product classifications included in this listing. Thirty different product classifications were included. The educators were chosen to confirm the validity of the instrument and provide correlation data for reliability testing. The content validity of the instrument was established by the utilization of content taken from related studies and the literature concerning curriculum content of industrial technology programs as perceived by industrial representatives and college and university educators.

The major purpose of this study was to develop a useful tool to help educators at postsecondary institutions gain new insights from industry concerning the educational requirements for industrial technology majors. This was needed due to the rapid change in technology occurring in industry today. The study was not conducted to establish a list of courses and values that would satisfy the current educational needs of industrial technology majors of the world; rather, it was conducted to develop an instrument that educators could use to determine the current educational needs of industrial technology majors, as perceived by industrial representatives in their own areas of influence.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Industrial technology is a relatively new career (Bohn and McDonald, 1983). The same follows for educational programs at colleges and universities in industrial technology. Hauser (by Connor, 1986) indicates that the first program in industrial technology was developed at Bradley University in 1923. The most significant increase in the need for industrial technologists, however, came after World War II when the demand for workers with a greater educational background increased and engineering curriculums shifted from programs that included practical hands-on application to programs that were almost exclusively theoretical (Connor, 1986). This shift helped to produce a gap between the engineer and the technician. Bohn and McDonald (1983) stated that "as engineers began to work at a higher level, technologists took over some of their duties" (p. 363). Lauda (1988) reinforces that description of an industrial technologist by stating that "from its earliest conception, industrial technology was designed to be broadly based and heavily involved with a problem-solving approach" (p. 264).

Industrial technology, in a more broad sense, includes two types of programs. One, industrial technicians are trained in two year industrial technology programs at both technical schools and junior or community colleges. The training results in a certificate or associate degree. The industrial technician functions in a narrow field dealing with specific technical skills or application. Examples of common training programs include Electrical Technology, Chemical Technology, Automotive Technology, Computer Technology and the like (Giachino & Gallington, 1977).

The second program prepares the industrial technologist. By contrast, the industrial technologist completes a four year baccalaureate degree in industrial technoloogy at a college or university (Giachino & Gallington, 1977, and Bohn & McDonald, 1983). The National Association of Industrial Technology (NAIT, 1988) indicates that majors in industrial technology, industrial technologists, are described as management-oriented technical professionals that are employed in careers that involve the use of knowledge in the following subject areas: (1) humanities, social and behavioral sciences, (2) communication skills, (3) mathematical, physical, and computer sciences, (4) industrial materials and processes, (5) industrial management and human relations, (6) marketing, (7) communications, (8) electronics, and (9) graphics.

Closely related in nature to industrial technology is engineering technology. The Accreditation Board for Engineering and Technology (ABET,1989) describes engineering technologists as those who "work in many functional and responsive ways to execute the applications designed by the engineer" (p.2). The Accreditation Board for Engineering and Technology also indicates that the main differences between educational programs in engineering and industrial technology concern type of faculty, use of facilities, sequence and content in mathematics and science courses, and degree and type of specialization. Giachiano and Gallington (1977) indicate that engineering technologists are more involved in testing, developing, and operating engineering and scientific equipment and processes rather than actual production. Examples of typical curriculums in engineering technology include Mechanical Engineering Technology, Civil Engineering Technology, Electrical Engineering Technology and Metallurgical Engineering Technology (Giachiano & Gallington, 1977). Another distinguishing feature that contrasts the two different programs is the faculty involved. Engineering technology programs at colleges and universities typically draw faculty from engineering or technological backgrounds whereas industrial technology programs at colleges and universities typically draw faculty from professional educational backgrounds, (ABET, 1989).

The diversification of job titles or career types does not stop with the above types. Industry uses a number of different names for positions that are similar or closely related in nature. Fales, Sheets, Mervich, and Dinan (1986) state that typical career titles used in industrial line production include Manufacturing Engineers, Manufacturing Technologists and Production Engineers. This aspect of industry's use of terminology helps to confuse what an industrial technologist should be.

In summary, an industrial technologist is a graduate of a four year baccalaureate degree in industrial technology earned at a college or university. This person must be prepared to deal with people and the production of a product. The knowledge base should be general and must be designed to help the student to develop academic, technical, and interpersonal skills. In reviewing the literature, reoccuring themes appeared concerning the content/topic needs of industrial technology programs at four year colleges and universities. Content/topic needs appeared in the areas of general education, industrial technology specialization, and interpersonal skills. The remainder of the review of literature was made to focus on these three areas and also to examine similar studies.

General Education

Courses in general education are required by all attending four year colleges and universities who are seeking a baccalaurate degree; however, certain subjects were identified as important specifically for industrial technology majors. Mathematics, science, physics, and chemistry continued to surface as the most important general education subjects (Connor, 1986, Giachino & Gallington, 1977, & Hauser, 1971). Connor (1986) found that, in the specialized areas of mathematics, Algebra was the most often required subject with Geometry, Trigonometry, Calculus, and Statistics following. Basic computer programming and word processing were also found to be important skills needed in industry (Connor, 1986 and Schaetz, 1989).

Communications was another area where specific interest was given for the industrial technology major. Connor (1986) found that industry considers oral communications, written communications, technical writing, and speech as important subject areas for the industrial technology majors to master.

Topics from the business area were also found to be important areas of study for industrial technology majors. The following topics were indicated; economics (Savage, Kruppa, Palumbo, & Schwerkolkt, 1988), Basic accounting (Prewitt, 1973), management foundations, managerial accounting, cost accounts, management organization, and sales administration, (Connor, 1986). Following is a summary of the general education topics that the literature indicated to be the most important for industrial technology majors to include in their preparation for working in industry: Algebra, Geometry, Trigonometry, Calculus, Statistics, Chemistry, Physics, Natural Science, Basic Computer Programing and Word Processing, Oral Communication, Written Communication, Technical Writing, Speech, Economics, Basic Accounting, Management Foundations, Managerial Accounting, Cost Accounts, Management Organizations, and Sales Administration.

Industrial Technology Specialization

The industrial technology specialization area was found to be the largest source of information. Traditionally specialization areas have been grouped in categories known as clusters. These clusters are made up of groups of related topics. The typical four clusters, construction, communications, manufacturing, and power, energy & transportation, form the basis for many industrial arts and technology education programs. These four groups also form the basis for many industrial technology programs; however, the following variations were found. The National Association of Industrial Technology (1988) listed six groups: (1) Materials and Production Processes, (2) Industrial Management and Human Relations, (3) Marketing, (4) Communications, (5) Electronics, and (6) Graphics. In developing the Missouri industrial technology education guide, Dyrenfurth (1987) indicated the following collection, (1) Materials and Processing, (2) Energy and Power, and (3) Communications. Savage, Kruppa, Palumbo, and Schwerkolt (1988), in dealing with constructing a core curriculum for an industrial technology program, explored three different methods of developing instructional programing in industrial technology. The first method, termed the data based approach, consisted of the following five groups: (1) Design, (2) Manufacturing, (3) Construction, (4) Energy and Power, and (5) "other" (Yurjevic, 1986, by Savage et al., 1988). The second method was called the philosophical based approach; it consisted of the following three groups: (1) Production, (2) Communication, and (3) Automation (Savage et al., 1988). The third and final method was called the orientation based approach; it consisted of the following five groups: (1) Construction Technology, (2) Design Technology, (3) Electronic Technology, (4) Manufacturing Technology, and (5) Visual Communication or Graphics Technology (Savage et al., 1988). Connor (1986) categorized data obtained from industry concerning subject matter for industrial technology curriculums into four groups. These groups were very similar to the typical clusters identified earlier in this chapter. Following are the names of these groups: (1) Communications Technology, (2) Manufacturing Technology, (3) Power and Energy Technology, and (4) Construction Technology. Mussnug and Roberts (1987) used six clusters in arranging an instrument used to survey industry concerning the development of technical education program curricula at institutions of higher education. These clusters were: (1) Organizational Management, (2) Computer Application in Industry, (3) Industrial Materials and Fabrication Processes, (4) Industrial Engineering Functions, Quality Assurances, and (5) Graphic Communication and Drafting and Design.

To facilitate the organization of the different technical topics found in this review, the following cluster titles were chosen; Communications, Manufacturing, Power and Energy, and Construction. These group titles will be used to categorize those technical topics identified as most important into uniform listings arranged by specific authors.

Connor (1986) recommended topics from all four areas after surveying industry needs. The topics from each group are as follows: (1) Communications - Blueprint Reading, Drafting Technology, CAD Technology, Graphic Arts Technology, Geometric Dimensioning; (2) Manufacturing - Manufacturing Technololgy, Quality Control, Production Management, Production Techniques, Production Scheduling, Material Handling, Inspection, Strength of Materials, Metal Technology, Personnel Management, Time and Motion Study, Project Development, Quality Circles, CAM Technology, Government Regulations, Numerical Control Programing, Plastics Technology; (3) Power and Energy - Basic Electricity, Electronics Technology, Solid State Electronics, Digital Electronics, Power Technology, Basic Thermodynamics, Robotic Applications, Robotics Technology; (4) Construction - Basic First Aid, Construction Technology, Strength of Materials.

Savage et al. (1988) utilized a study that surveyed colleges and universities to determine core curriculum course topics for industrial technology programs at colleges and universities. The study listed 45 topics from design, manufacturing, construction, energy and power, and "other" courses. The "other" category consisted of courses which related to technology, interpersonal skills, business, and general education. Thirty-four per cent of the institutions surveyed responded. Only six topics of the 45 listed in the survey reached the median rank as core courses. Those topics listed after the appropriate cluster are as follows: (1) Communications - Drafting and Drawing; (2) Manufacturing - Material Processing, Industrial Safety, Introduction to Manufacturing; (3) Power and Energy - Power Systems; (4) Construction - 0; (5) "other" - Introduction to Technology. This is not to say that the other course topics were not important or not included in a comprehensive program, but that they were not often included in a core of courses that every student majoring in industrial technology must take.

Mussnug and Roberts (1987) developed a model for the development of technical education program curricula at the college and university level focusing on Computer Integrated Manufacturing as the future of technical education programs. In doing so the authors developed an instrument to survey industry. The instrument contained 85 topics gathered from a review of literature, regional and national seminars, and advisory committee meetings. Seven topics received the highest ratings using 550 industries in Kentucky and Tennessee. A list of those topics follow in the appropriate group: (1) Communications - Threads, Fasteners and Fits, CAD/CAM Data Base Communications and Integration, and CAD; (2) Manufacturing - Production Management, Computer-Aided Production Operations and Methods, Industrial Process Control; (3) Construction - 0; (4) Power and Energy - Robotics Applications in Industry. Construction was excluded due to the nature of the study being focused on the manufacturing industry.

There was one area of technical knowledge that cut across all cluster areas that was indicated quite often in the review of literature. This area is the industrial internship, also known as cooperative education, practicum, and industrial work experience. This program allows a student to work actively with and learn from the years of experience possessed by industrial personnel while industry benefits from the application of the student's technical skills (Fryda, 1989). Schaetz (1989) indicated that the industrial internship is one of the key factors that will influence the job market during the next five years. The National Association of Industrial Technology (1988) in the Industrial Technology Accreditation Handbook for the Baccalaureate level indicates that an industrial experience or internship is one of the major program requirements for students majoring in industrial technology. Connor (1986), Hauser (1971), Strom (1970), and Savage, et al. (1988) in concluding studies all indicated that it was important for industrial technology majors to complete industrial internships.

In summary, it was revealed that a wide variety of technical course titles or topics can be found in current literature describing what should be included in a curriculum for an industrial technology program at the college and university level.

Interpersonal Skills

Leadership and problem solving skills were indicated as the most important interpersonal skills needed by the industrial technologist. In the past these skills have received little attention as a part of an industrial technology program at colleges and universities. Creger (1989) stated that "the profession has been obsessed by acronyms such as CIM, CAM, CAD, CAM/CAD, NC, CNC, CADD, JIT, and MRP" (p.3). Conner (1986), Creger (1989), and Akinkuoye (1989) all indicate the need for industrial technology majors to have good leadership and problem solving skills. The following elements were identified to help define what could be taught to help produce leaders and problem solvers.

According to Tabor (1989) leadership amounts to teaching and assisting others to control their impending circumstances. To be able to do this a person must be able to work with people and be able to see how situations can be improved and also to know when improvement can be expected. Tabor (1989) indicates the key to leadership is not to ignore human needs and lead through criticism but to develop a close working relationship with subordinates. One way to develop a closer working relationship with subordinates is to develop peer groups known as "Quality Circles" where subordinates can constructively evaluate performance and relate this to the leader without concern of criticizism (Tabor 1989). Creger (1989) utilized a United States Army view on how to be a leader by using three attributes of a leader, which are; "Be", "Know" and "Do". These three attributes were taken from a historical analysis of successful leaders. The first attribute of leadership, "Be", relates to commitment and character traits. Descriptors of commitment and the character traits of a good leader are: selflessness, courage, competency, honesty, and integrity. The second attribute of leadership relates to what a leader must "Know". Four aspects falls under the "Know" attribute, they are: (1) A leader must know the characteristics of his followers so that he can develop a cohesive team and instill discipline by adjusting his leadership style to match their level of maturity and experience; (2) A leader must know how to deal with his own strengths and weaknesses; (3) A leader must know how to communicate to followers through written, verbal and body language; and (4) A leader must know the situation and have the skill and judgment necessary to respond to the situation. The final attribute, "Do", relates to accomplishing goals. A leader must possess the following skills to accomplish goals: (1) set goals, (2) solve problems, (3) make decisions, (4) plan ahead, (5) communicate with several groups and individuals, (6) coordinate activities, (7) supervise, (8) evaluate, and (9) motivate. Creger (1989) indicated the importance of developing all three key leadership attributes in stating that "without achieving goals, possessing the other characteristics only contributes to make one a nice person, which does not warrent a salary and position" (p.4).

In reviewing the literature, problem solving emerged frequently as another topic in industrial technology programs. Savage et al. (1988), Brown (1989), and Connors (1986) all indicated that problem solving should be included in an industrial technology program as a course. Kales (1988) indicated that gaining problem solving skills was one facet in the attempt at improving the productivity of industry. He indicated that productivity is the main goal of industry. He recommends that U.S. industry can retake productivity leadership from the Japanese through the use of better problem solving skills, communication and analytical capabilities at all levels of the industrial organization.

The literature reviewed indicated that most courses used a specific method to teach solving problems. Most were based on the scientific method which is sometimes used synonymously with research in educational discussions (Best, 1977). The scientific method consists of five steps: (1) problem identification, (2) hypothesis formulation, (3) observation, (4) analysis, and (5) conclusion (Best, 1977). The design method (Brown, 1984) is a variation of this concept. This method uses the following four steps: (1) problem definition which includes stating the problem, listing requirements, noting limitations or restrictions, and performing research, (2) identification of preliminary solutions, (3) refinement of the preliminary solution, and (4) decision and implementation of a solution. Lindbeck (1972) indicated another method of problem solving called the design analysis method which is similar to the design method. This method consists of the following five steps: (1) statement of the problem, (2) analysis and research, (3) possible solutions, (4) experimentation, and (5) final solution. The engineering method (Beakey and Chilton, 1974) of problem solving is similar to the previous methods except that this method stressed the need for feedback throughout the problem solving process. This method included seven steps: (1) identify problem, (2) gather data, (3) create ideas, (4) prepare model, (5) analyze and evaluate, (6) experiment, and (7) present solution.

It was also found that the process of problem solving by just using one of the methods alone is not adequate. Brown (1989) insisted that creative problem solving is an expansion of basic problem solving. Brown justified this by stating that problem solving, "is not always connected with creativity, and is often defined outside the realm of creative thought" (p.21). Creativity is basically defined as the ability to think in alternate modes, or as applied imagination. Therefore, adding creativity expands the basic process of problem solving.

In summary, leadership relates to knowing what kind of person to be, what kind of information to know, and what to do to accomplish a task. Problem solving concerns utilizing a method in a creative manner to come to the solution of a problem.

Related Research

Six similar studies were reviewed that related to industrial needs associated with curriculum content for higher education technology programs. Three of the studies, Prewitt (1973), Hauser (1971), and Mussnug and Roberts (1987), examined industrial needs associated with curriculum content in a narrow field of study choosing a specific industrial technology topic. The other three studies, Connor (1986), Lewis (1970), and Strom (1970), examined industrial needs associated with curriculum content in a broad field of study examining all industrial technology topics. Following are reviews of each of the studies.

Prewitt (1973)

Prewitt conducted research to determine the effectiveness of four year industrial technology programs in preparing industrial electronics technicians for employment in industry.

Procedures. Data were obtained through an opinionaire that was constructed by the author. It was validated by a jury selected by the author and was sent to thirteen higher education institutions which had four year electronic technician programs. Also it was sent to selected industries in Kentucky, Tennessee, North Carolina, South Carolina, Mississippi, Georgia, Alabama, and Florida. The sample of industries consisted of a two per cent stratified random sample. A 100 per cent return rate was obtained from the higher education institutions and a 25 per cent return rate was obtained from industry.

Findings & Conclusions. There was general agreement between industry and education as to what the content of a four year industrial electronic technician curriculum should contain. There were 61 statements in the opinionnaire with industrial personnel and educators agreeing on the importance of a majority of the instrument items. However, some exceptions existed with industry indicating the need for industrial electronic technicians to have a working knowledge of woodworking hand tools and education disagreeing. Education indicated the need for industrial electronics technicians to have a working knowledge of lasers and related equipment and industry was undecided. Industry was also undecided as to the importance of axonometric projection, human physiology, psychology, government, and managerial accounting in a four year industrial electronic technicial program where education indicated that these topics were important. Finally, industry indicated that industrial electronic technicians need a knowledge of basic cost accounts with education being undecided as to its importance.

Recommendations. This study made a number of recommendations concerning further studies. Following is a list of those recommendations: (1) Similar studies in other specialized areas; (2) Parallel studies in other geographic regions; (3) Continuing studies to help keep education up-to-date; (4) Studies to determine the exact position held in industry by four-year industrial electronic technicians; (5) Studies to determine what type of industries utilize the services of the four-year industiral electronic technicians.

Connor (1986)

Connor conducted research to derive subject matter from industry for use in curricular change in industrial technology programs at colleges and universitites. His inquiry was also conducted to gage industry's willingness to participate in industrial technology cooperative work experience programs.

Procedures. The study was limited to manufacturing industries and building and construction industries in the State of Kansas. Due to the listing differences of manufacturing industries and construction and building industries samples from each were chosen differently. Samples from manufacturing industries were chosen from industries with 50 or more employees and samples selected from the building and construction industry were those with a gross income of greater than $500,000.00 per year. The entire population representing the above critera consisted of 650 companies, with questionnaires being sent to all.

The instrument was a composite questionnaire developed from the results of four other studies. Ninety-eight responses were required to fill out the instrument. Ninety-five of the responses utilized a Likert-type scale. The other three responses required placing a check in the appropriate blank. There were 70 different areas of instruction/course topics in the instrument. Of the 650 instruments sent, 288 (44%) usable instruments were returned. Of the 288 usable instruments returned, 104 (36%) employed industrial technology program graduates. Companies employing industrial technology program graduates, 36 per cent of the usable instruments returned, were used for analysis.

Findings and Conclusions. The study indicated that industry approves of cooperative work experience. Also, industry indicated that an industrial advisory group should be formed or continued between education and industry. Out of the 70 different areas of instruction, 27 were indicated as important, 33 were indicated as neutral value, and 10 were indicated as unimportant for inclusion in an industrial technology curriculum.

Recommendations. Ten recommendations for implementation were made. Four of the recommendations were related to specific course topics for inclusion in industrial technology curriculums: (1) recommended 27 course topics as a core for all industrial technology students, (2) recommended 11 course topics relating to skills and abilities, (3) recommended 33 course topics that could be included as part of the required areas of instruction in an industrial technology program, (4) recommended two course topics relating to skills and abilities that could be included in an industrial technology program. One of the recommendations related to course topics that should not be included in an industrial technology program. The study determined that the following ten course topics should not be required or encouraged: (1) machine vision, (2) basic kinematics, (3) fortran, (4) government, (5) axionometric projection, (6) pascal, (7) production printing, (8) basic photography, (9) wood technology, (10) advanced photography. The final five recommendations were more general and related to the whole program: (1) need for advisory committee, (2) cooperative education required by all students, (3) industry involvement with education in specific topics, (4) common core courses with elective options for specialization, (5) the development a method for continual evaluation of the program.

Six recommendations for further studies were made. Following is a list of those recommendations: (1) The study should be replicated in other states to further validate the results and extend the range of implications; (2) A study results and extend the range of implications; (2) A study should be conducted to determine why industries do not employ industrial technology graduates; (3) Studies should be conducted to determine specific content of topics identified in this study; (4) A study should be conducted comparing a program with a common curricular core to a traditional program; (5) A study should be conducted to determine employer expectations of the initial placement of industrial technology graduates; (6) An analysis should be made of job placement rational and criteria for titles of employment.

Lewis (1970)

Lewis conducted research to determine the opinion of educators in higher education institutions offering industrial technology degrees and industrialists concerning critical areas of an industrial technologist's job and the commonality of curricula being offered in industrial technology programs nationally. The study was concerned with technically oriented management programs leading to a Bachelor's Degree with a major in industrial technology.

Procedure. Three major questions were posed to be researched. The questions were developed with the assistance of four educators and four industrialists, each prominent in their field, and each from a different region of the United States. The instrument was sent to an equal number of chairpersons of industrial technology departments and industrial excutives throughout the nation. Following are the three questions used in the instrument: (1) In what areas do people in industry and education agree as to what is critical in the industrial technologist's job? (2) In what areas do educators and industrialists disagree as to the critical aspects in the industrial technologist's job? (3) To what extent is there a commonality in curricula presently being offered in industrial technology programs nationally? The first two questions also included the following 12 areas that might be critical to industrial technology: (1) employment, (2) wage and salary (3) administration, (4) industrial relations, (5) organizational planning and development, (6) employee service, (7) external relations, (8) marketing, (9) general management, (10) research and development, (11) production systems, and (12) technical depth. These 12 areas were included as selections to be used to answer the questions. The third question was answered by the author through the review of the college catalogs of 48 institutions offering Baccalaurate Degrees in industrial technology and was limited to management and technical breadth areas of curricula.

Findings and Conclusions. For the first question an analysis resulted in an indication that there was a great deal of agreement between educators and industrialists on subdivisions: items (4), (9), and (11). The second question revealed that there was the greatest disagreement in items (7) and (10). It was determined by question two that educators and industrialists agree in three areas, disagree in two areas, and the results were indeterminate in seven areas. The third question determined that the following nine definable areas in industrial technology are being taught at colleges and universities: (1) courses related to production planning; (2) courses related primarily to the transformation of materials; (3) courses related to engineering design; (4) courses related to systems; (5) courses related to the physical properties of materials; (6) courses related to tools and tool design; (7) courses related to power and energy mechanisms; (8) miscellaneous courses, reliability and technical drawing; and (9) courses related to administrative and personnel relations.

Recommendations. Conclusions and recommendations were made to provide direction for future curricular development.

Strom (1970)

Strom conducted research to determine to what extent the existing four-year industrial technology programs in Minnesota colleges and universities were meeting the needs of selected Minnesota industries.

Procedures. Two questionnaires were used in this study. One instrument was sent to the chairpersons of four-year industrial technology programs and the other instrument was sent to Minnesota industries who employed graduates of industrial technology programs and who were willing to participate in the study. The instrument sent to the chairpersons requested information concerning the status of four-year industrial technology programs in Minnesota. The instrument sent to the selected Minnesota industries requested information concerning the type of background needed by industrial technologists.

Findings and Conclusions. One-hundred per cent of the questionnaires sent to college and university chairman were returned. Eighty per cent, or a total of 111 of the questionnaires sent to industries were returned. Following is a list of the findings that were common among colleges and universites: (1) Additional curricula were being developed in areas of aeronautics, packaging design, and synthetics; (2) Chairpersons were in favor of developing a state committee with the function of improving and coordinating four-year non-teaching programs; (3) Three student major options were found; (4) Projected numbers of graduates from industrial technology programs for the years 1970 and 1971 indicated a substantial increase in graduates from Minnesota institutions; (5) Chairpersons indicated support for a educational brochure stating the aims and objectives of the Minnesota technology curricula. The questionnaire sent to industrialists identified the following common findings: (1) Industrial technologists in industry were typically employed in management, industrial engineering, product development, and supervisory positions; (2) The Minnesota industries surveyed prefer industrial technology graduates with the general technical major student option; (3) Minnesota industries surveyed were willing to consider the possibility of providing resource instructors; (4) Seventy-three per cent of Minnesota industries surveyed were willing to consider establishing an industrial work experience with colleges and universities; (5) Seventy per cent of the industries surveyed were willing to serve in an advisory capacity to state industrial technology programs.

Recommendations. Based on the findings of the study the following recommendations were made: (1) There is a need for clarification and standardization of titles and technical terminology used in industrial technology programs; (2) There is a need for inter-departmental cooperation on an industrial technology brochure; (3) There is a need for a state institutional committee to govern four-year non-teaching industrial technology degree programs; (4) Consideration should be given to the elimination of required course work in woodworking; (5) The technical specialization option in wood technology should be de-emphasized; (6) All existing technical curricula areas in the industrial technology program should be continued; (7) Greater emphasis should be placed on the general technical major student option; (8) An industrial work experience program should be developed; (9) A state industrial advisory committee should be formed; (10) Minnesota industrial personnel should be used as resource instructors on a limited basis; (11) Course work stressing industrial psychology, time and motion study, quality control, research and experimentation, sales administration, in-plant training, supervision and management, production techniques, and the principles of industry should be required of industrial technology majors.

Hauser (1971)

Hauser conducted a research study to determine to what extent industrial technology programs were preparing graduates to work in the casting industry. The study basically had a two-fold purpose, one was to determine what type of industrial technology curriculum was needed to best prepare an individual to enter the casting industry and the second was to study industrial technology programs as they related to metalcasting.

Procedures. The data for this study were obtained by using an instrument sent to plant managers of casting industries and casting instructors at institutions offering a four-year technology program. The opinnionaire was constructed using information gathered from a review of literature including casting periodicals, texts on metalcasting, and college catalogs. Validity was determined with the use of 12 doctoral industrial technology students and a jury of eight professional foundrymen. The instrument was sent to 141 plant managers and 50 casting instructors. The responses were compared by using frequency responses, percentage of responses, and chi square statistical values.

Findings and Conclusions. Of the opinionnaires sent out 75.4 per cent usable opinionnaires were returned. Based on a study of the data received the following conclusions were made: (1) There needs to be more interaction between industry and education; (2) Schools should recognize the need for industrial technologists with a background in casting and identify where those positions are to be found in industry; (3) Instructors should have real work experience in casting and should return periodically to industry to update skills; (4) Seminars sponsored by industry and the American Foundryman Society are advantagous to instructors; (5) Curricula in casting should be updated to include modern technologies; (6) Industrial advisory councils should be utilized by education; (7) Industrial internships are vital aspects to industrial technology programs; (8) The areas of technical, buisness administration, and communication in that order should be given the most emphasis in the training of industrial technologists for the casting industry.

Recommendations. In conducting the study two problems were presented which reflected the need for further study. They are as follows: (1) Graduates of industrial technology programs that have entered the casting industry should be surveyed to determine their opinion on specific aspects of industrial technology programs; (2) Industries should be surveyed to determine the willingness of industry to participate in industrial internships and to find the most desirable position in the casting industry in which to place the student.

Mussnug and Roberts (1987)

Mussnug and Roberts conducted research to determine what course topics should be included in an educational program designed to prepare technicians for managerial and supervisory positions in the computer assisted factories of the future.

Procedures. In keeping with a data based approach a questionnaire was developed to survey industry concerning computer related course topics. The topics included in the instrument were obtained through reviewing literature, attending regional and national seminars, and meeting with advisory committees. Eighty-five topics were selected to be included in the instrument. The following major headings were used: Organizational Management, Computer Applications in Industry, Industrial Material and Fabrication Processes, Industrial Engineering Functions and Quality Assurances, and Graphic Communications, Drafting and Design. The population to be surveyed consisted of 550 industries in Kentucky and Tennessee. The population was identified as those industries employing 50 or more and producing a hard product.

Findings and Conclusions. The highest rated topic was chosen for each major heading. They are: (1) Organizational Management - Production Management, (2) Computer

Applications in Industry - Computer Aided Production Operations and Methods, (3) Industrial Material and Fabrication Processes - Robotics Applications in Industry, (4) Industrial Engineering Functions and Quality Assurances - Industrial Process Control, and (5) Graphic Communications, Drafting and Design - Threads, Fasteners and Fits, CAD/CAM data base, Communication and Integration, and CAD.

Recommendations. Five recommendations were made in this study. They are: (1) to develop faculty training in specialized areas, (2) replication of the survey at set intervals to determine new needs, (3) review of the quality of graduates and follow-up of graduates to determine effectiveness of program, (4) development of faculty self-evaluation to determine program effectiveness, (5) expand interaction between industrial technology programs and industry.

In summary, there have been a number of studies conducted concerning industry and curricular needs of industrial technology programs. All of which provided a great insight for the study this author proposes. The two most essential aspects that were not found in the reviewed studies were; (1) the attention to developing an instrument that was simple to complete and straight forward, and (2) the construction of an instrument that was purposely developed for future use at set intervals to help update curricula. The instruments found were either long and very specific concerning course topics or they were short with extensive open-ended questions.

Summary

An industrial technologist is usually a graduate of a four year baccalaureate degree in industrial technology earned at a college of university. This person must be prepared to deal with people and the production of a product. A review of the literature indicated that three distinct content areas, as indicated by industrial representatives and industrial technology educators, are utilized to construct the curriculum content of four-year industrial technology programs at colleges and universities. All majors of these programs were required to take courses concerning general education, industrial technology specialization, and interpersonal skills. Courses relating to general education were taken from course areas such as mathematics, science, chemistry, communications, and business. It was found that courses pertaining to industrial technology specialization could be arranged into the following four basic clusters: (1) man-ufacturing, (2) communications, (3) construction, and (4) power and energy. Two interpersonal skills areas, leadership and problem solving, were found to be important aspects of a four-year degree in industrial technology.

A review of related research revealed that studies conducted to determine curriculum content for industrial technology programs at colleges and universities utilized narrow approaches or broad approaches. Narrow approaches chose a specific topic such as electronics or casting technology on which to base the study. Broad approaches examined industrial technology as a whole not choosing any one specific topic. The broad approach studies also examined general education and interpersonal skills type topics as well as industrial technology specialization topics.

CHAPTER III

METHODOLOGY

Introduction

This chapter relates to the methodology used to conduct this study. The main aspects of this chapter include (1) the research design, (2) the population used, (3) the development of the instrument, (4) the process of data collection, and (5) the process of data analysis.

Research Design

The purpose of the study was to develop a valid and reliable instrument to survey the perceptions of industrial representatives concerning the needs of industrial technology majors. Care was taken to produce an instrument that was short, simple and convenient to complete which would promote a rapid return from the respondents. The development of this type of instrument was needed due to the rapid change in technology occurring in industry today. This study was conducted to produce an instrument that educators could use to determine trends, not probabilities, concerning the current educational needs of industrial technology majors, as perceived by industrial representatives, for use in their own areas of influence.

Therefore, the results of the pilot survey conducted in this study were used to test the instrument.

Population

Subjects chosen from two different groups were utilized as the sample of the study. One group consisted of corporation representatives selected from industry which served as the intended recipients of the survey instrument developed from the results of this study. The second group consisted of professors of college and university industrial technology programs. The two groups were used to test the reliability and validity of the instrument.

The corporations were chosen from the Rocky Mountain High Technology Directory (1987). Several factors made the directory beneficial for use in the study. A major cross section of the United States was represented by the seven states listed in the directory. The seven states listed include Arizona, Colorado, Montana, Nevada, New Mexico, Utah, and Wyoming. The directory listed corporations involved in 30 high tech product classifications. The high tech product classifications were listed previously in the definition of terms under high tech industry. The directory also listed the location, key management, founding date, specific products, gross sales, and number of employees. The directory was acquired from the San Luis Valley Regional Development and Planning Commission in Alamosa, Colorado. A sample of 65 corporation representstives was chosen from the directory to represent the group taken from industry. The sample represented all of the corporations in Arizona, Colorado, Nevada, New Mexico, and Utah that employed 600 or more employees and all of the corporations in Montana and Wyoming that employed from 100 to 249 employees. The corporations chosen from Montana and Wyoming represented the largest high tech corporations in those States. The following is a list of the number of corporations chosen from each of the seven states: (1) Arizona, 22; (2) Colorado, 22; (3) Montana, 3; (4) Nevada, 3; (5) New Mexico, 5; (6) Utah, 8; (7) Wyoming, 2. A list of the corporations selected was included in Appendix A. Out of the 30 high tech product classifications listed in the directory, 21 were represented by the 65 corporations selected for use in the study. Table I gives a summary of the percentage of corporations per product classification and state.

The college and university professors chosen as the second group for inclusion in this study were selected from the Industrial Teacher Education Directory (1989). The sample was taken from those schools in the same seven states from which the high tech industries were chosen. Only colleges and universities with industrial technology programs were considered for sample selection. The sample of college and university professors were selected from six of the seven target states. Nevada was not included in the sampling because no industrial technology programs were indicated in the directory. The sample taken was a proportional random sample that represented 50 per cent of

TABLE I

SUMMARY OF THE PERCENTAGES OF CORPORATIONS PER PRODUCT CLASSIFICATION AND STATE

PRODUCT CLASSIFICATION	STATES SURVEYED							TOTAL % PER PROD. CLASS.
	ARIZ	COLO	MONT	NEVA	NMEX	UTAH	WYOM	
Aerospace Equipment/Systems	12.0	6.4	0	0	3.1	3.1	0	24.2
Analytical/Measuring Inst.	0	1.5	0	0	0	0	0	1.5
Biotechnology	0	4.5	0	0	0	1.5	1.5	7.5
Broadcast Equipment	0	1.5	0	0	0	0	0	1.5
Communications Equipment	1.5	6.2	0	0	0	1.5	0	9.2
Components	4.5	0	0	0	1.5	1.5	0	7.5
Computer Graphics	0	0	0	0	0	1.5	0	1.5
Computer Peripherals	3.1	1.5	0	0	0	1.5	1.5	7.6
Computer/Systems	1.5	0	0	0	0	0	0	1.5
Consumer/Non-Ind.Prod.	0	0	0	1.5	0	0	0	1.5
Electronics Prod.Equip.	0	0	1.5	0	0	0	0	1.5
Electronics R&D	0	0	0	0	1.5	0	0	1.5
Energy	0	0	3.1	0	0	0	0	3.1
Industrial Equipment	1.5	1.5	0	1.5	0	0	0	4.5
Material Handling Equipment	0	0	0	0	0	1.5	0	1.5
Materials	3.1	6.2	0	0	0	0	0	9.3
Microelectronics	4.5	0	0	0	1.5	0	0	6.0
Military Products	0	0	0	1.5	0	0	0	1.5
Monitoring/Control Equip.	1.5	1.5	0	0	0	0	0	3.0
Power Devices/Systems	1.5	0	0	0	0	0	0	1.5
Storage Peripherals	0	3.1	0	0	0	0	0	3.1
TOTAL % PER STATE	34.7%	33.5%	4.6%	4.5%	7.6%	12.1%	3.0%	100%

NOTE: ALL PERCENTAGES ROUNDED TO THE NEAREST TENTH OF ONE PERCENT the total population of professors in the six States sampled. The total number of college/university professors surveyed equaled 28 individuals. Following is a list of the number of individuals taken from each state: (1) Arizona - 6; (2) Colorado - 19; (3) Montana - 8; (4) New Mexico - 3; (5) Utah - 10; (6) Wyoming - 2. A list of the professors selected was included in Appendix B. Table II indicates the number of professors chosen from each State and the percentage of the total sample group that each number represented.

Instrument Development

The topics used as the content in the survey instrument were obtained from a review of the related literature. The content validity of the instrument was based on these topics. Best (1977) indicated that validity can be assured by the judgement of recognized authorities. Forty topics, as indicated by industry and education, were found to be most important in preparing industrial technologists. The topics included subjects from industrial technology specialization areas, general education areas, and interpersonal skills areas. Some of the 40 topics, indicated as being most important, could be viewed as broad and not specific enough to be conclusive when used in a survey instrument; however, one of the main issues in this study was to develop an instrument that was short. Including every possible topic that could be derived from

TABLE II

NUMBER AND PROPORTION OF PROFESSORS CHOSEN PER STATE

STATE SURVEYED	NUMBER OF SUBJECTS	PERCENTAGE OF TOTAL SAMPLE
Arizona	6	12.5%
Colorado	19	39.6%
Montana	8	16.7%
Nevada	0	0
New Mexico	3	6.2%
Utah	10	20.8%
Wyoming	2	4.2%
TOTAL	48	100%

NOTE: ALL PERCENTAGES ROUNDED TO THE NEAREST TENTH OF ONE PERCENT these 40 topics would lead to an expansive instrument which in turn could affect a quick return or return rates in general. This instrument was viewed as a starting point for further studies. Once general topic categories are identified as being important subsequent studies could be conducted to gain specific topics.

Reliability was also a main issue of this study. The development of a reliable instrument should also play an important part in the design of the instrument. An instrument is said to be reliable if it measures accurately and consistently each time it is administered (Best, 1977). The format of the instrument was carefully designed to be as simple and easy to understand as possible. One statement directed the respondent in how to complete the survey. The ranking scale was made very evident and each component of the instrument was clearly identified. All of the aspects were included so that the instrument would read the same way no matter how many times the respondent filled it out.

Simplicity was one of the key concerns in the development of the instrument. The total survey instrument was designed to be placed on one sheet of 8.5" X 11" letter head paper. The return address and a stamp were placed on the back of the instrument so that after completion the instrument could be refolded, stapled or taped, and returned without the inconvenience of placing the instrument in a folded up return envelope. The instrument was printed on two colors of paper to add variety for the respondent and to make collation of returns easy.

The instrument was headed with a statement asking the respondent to rate the importance of the 40 listed topics. Respondents were instructed to check the boxes corresponding to their opinion of the relative importance of each topic. No open-ended questions or short answers were required; however, space was provided to allow the respondent to write in one additional topic and rank it. Also space for comments was provided at the bottom of the instrument. These two aspects were added to verify the content validity of the topics. Content validity refers to the appropriateness of the instrument material (Nisbet and Entwistle, 1970). Comments or additional topics that were common among respondents would indicate aspects of the instrument that were inappropriate which would cast doubt on the validity of the instrument. For those respondents from industry who did not view industrial technology programs as beneficial for employment in their industries a check box and disclaimer statement was provided to indicate this.

The 40 topics were arranged in groups of four to facilitate completion. The ten groups were arranged in two columns with five in each column. A five point Likert-type scale was used to rank each topic. The following ranking was used: (5) very important; (4) important; (3) neutral; (2) unimportant; (1) not needed. This type of ranking was used to facilitate the analysis of the results using raw scores.

A cover letter introducing the study and asking for the respondents' cooperation was included with the instrument. A copy of the letter and instruments was included in Appendix C and Appendix D.

Process for Collecting Data

Overall return rates and the amount of time allowed for the return of the instrument were the most important considerations in collecting data. A main feature of the study was to develop an instrument that would be returned quickly; however, acceptable return rates had to be decided upon first.

Establishing acceptable return rates proved to be more nebulous than previously assumed. Galfo and Miller (1970) indicated that there was no ready answer in determining an acceptable return rate. Mouly (1963) indicated that many accepted studies reported return rates from 20 to 40 per cent. Travers (1969) pointed out that a 20 per cent return rate is typical under favorable conditions and that second and third follow-ups typically only increase the overall return rate to 30 per cent. Nisbet and Entwistle (1970) reported that a 70 per cent return rate is very difficult to obtain especially from certain groups including managers in industry. The type of study being conducted also influenced the selection of an acceptable return rate. A large return from a sample would be needed to infer perceptions of a whole population. The samples chosen for this study represented specific populations and were not designed to be representative of all corporations and college/university professors across the nation. Utilizing this rationale, a return rate of 35 per cent was considered acceptable. In keeping with the aspect of an instrument that was designed to be quickly returned, if this return rate was achieved by the end of the cut-off date a follow-up on nonrespondents would not be conducted.

Two weeks were allowed for the return of the instrument. A statement in the cover letter indicated that the analysis of the returns would begin October 19th, 1990. The mailing was made on October 4th, 1990 which was 12 working days before the analysis of the returns were scheduled to begin. The two extra working days were included to allow the instrument to reach its destination by the beginning of the two week period. October 19, 1990 was considered the final cut-off date for returns; however, any instruments that were returned the following week would be utilized in the study.

Process for Data Analysis

Primarily, the purpose of the study was the development of an instrument not the gathering of data in order to make generalizations. Also, the analysis of the data was conducted to indicate the results of the pilot survey and assure the reliability and content validity of the instrument. The analysis of the data was conducted using the following four approaches: (1) demographics of the returns, (2) frequency distribution of data, (3) rank correlation coefficient, and (4) analysis of the additional comments.

Three pie charts were used to represent visually the demographics of the returns. One pie chart, Figure 1, was used to indicate the proportion of responding corporation representatives by project classification. Another pie chart, Figure 2, indicated the proportion of responding corporation representatives per state. The final pie chart, Figure 3, indicated the proportion of responding college/university professors per state.

A frequency distribution of the data, in the form of five bar graphs, was used to visually represent the average rank of the topic items of the survey instrument. Average rankings by the surveyed corporations and college/university professors are both included on the same graph. The first two graphs, Figure 4 and Figure 5, indicated the average rank of topics from the general education area. The next two graphs, Figure 6 and Figure 7, indicated the average rank of topics from the industrial technology specialization areas. The final graph, Figure 8, indicated the average rank of topics from industrial technology specialization areas and interpersonal skills areas.

An analysis was conducted, using a rank correlation coefficient, Spearman's rho, to determine reliability between groups and to confirm the content validity of the instrument. Best (1977) indicates that a correlation analysis can be used to qualify the reliability and validity of an instrument after a logical analysis of the relationship between the groups has been established. Best (1977) states that "a test is said to be valid to the degree that it measures what it claims to measure" (p. 257). This can be accomplished by correlating test scores of recognized authorities with test scores from a target group. Best (1977) also states that "a test is said to be reliable to the degree that it measures accurately and consistently, yielding comparable results when administered a number of times" (p. 258). A correlation analysis can be used to accomplish a reliability test by using equivalent forms given to groups of individuals then correlating the results.

Positive relationships indicated by correlation coefficients of varying degrees were used to confirm reliability and validity. The following is a list of the criteria for the evaluation of a coefficient: a high to very high relationship, +.80 to +1.00; a substantial relationship, +.60 to +.80; a moderate relationship, +.40 to +.60; a low relationship, +.20 to +.40; and a negligible relationship, .00 to +.20.

The comments made on the instrument were also analyzed to determine if any comments or additional topics were found to be common among all or a majority of the returned instruments. Nisbet and Entwistle (1970) indicated that content validity relates to the appropriateness of the instrument material. Critical comments or many added topics that were common among respondents would indicate an instrument that was not valid.

After reporting and analyzing the data using these methods, statements concerning the purpose of the study were made and conclusions and recommendations were stated.

CHAPTER IV

FINDINGS

Introduction

The purpose of the study was to develop a valid and reliable instrument to survey the perceptions of selected high tech industry representatives concerning the needs of industrial technology majors in four year college and university programs. The product of the study was the instrument, not the statistics produced by the pilot survey conducted.

The results of the study were determined by the analysis of data gathered from a pilot survey of 65 corporations in a seven State area in the Rocky Mountain region and 48 college/university professors from the same seven State area. The results are presented and analyzed in this chapter. The following five sections present and analyze the data from the survey instrument concerning the: (1) Demographics of Returns, (2) Frequency Distribution of Data, (3) Rank Correlation Coefficient, (4) Respondent Comments, and (5) Summary.

Demographics of Returns

The cover letter and survey instrument were mailed to 65 Rocky Mountain high tech corporations and 48 college/ university professors on October 4, 1990. At the end of the two week cut-off date, October 19, 1990, 41 (36.3%) of the 113 survey instruments were returned. After the cut-off date two more survey instruments were returned to increase the overall return rate to 38.1 per cent. All returned survey instruments were usable. Of the 65 corporations surveyed 15 (23.1%) returned the survey. Of the 50 college/university professors surveyed 28 (58.3%) returned the survey. Following the parameters set for adaquate return rates for this study no follow-up was conducted.

Further representation of the demographic information obtained by the survey was included in the form of three pie charts. Figure 1 represented the proportion of corporations that responded by product classification. The greatest number of responses, 39.7 per cent, came from corporations representing the aerospace equipment/systems product classification. The following list of nine product classifications each represented 6.7 per cent of the responses from corporations: (1) Analytical/Measuring Equipment, (2) Broadcasting Equipment, (3) Biotechnology, (4) Communications Equipment, (5) Components, (6) Computer Graphics, (7) Energy, (8) Industrial Equipment, and (9) Materials. Figure 2 represented the proportion of

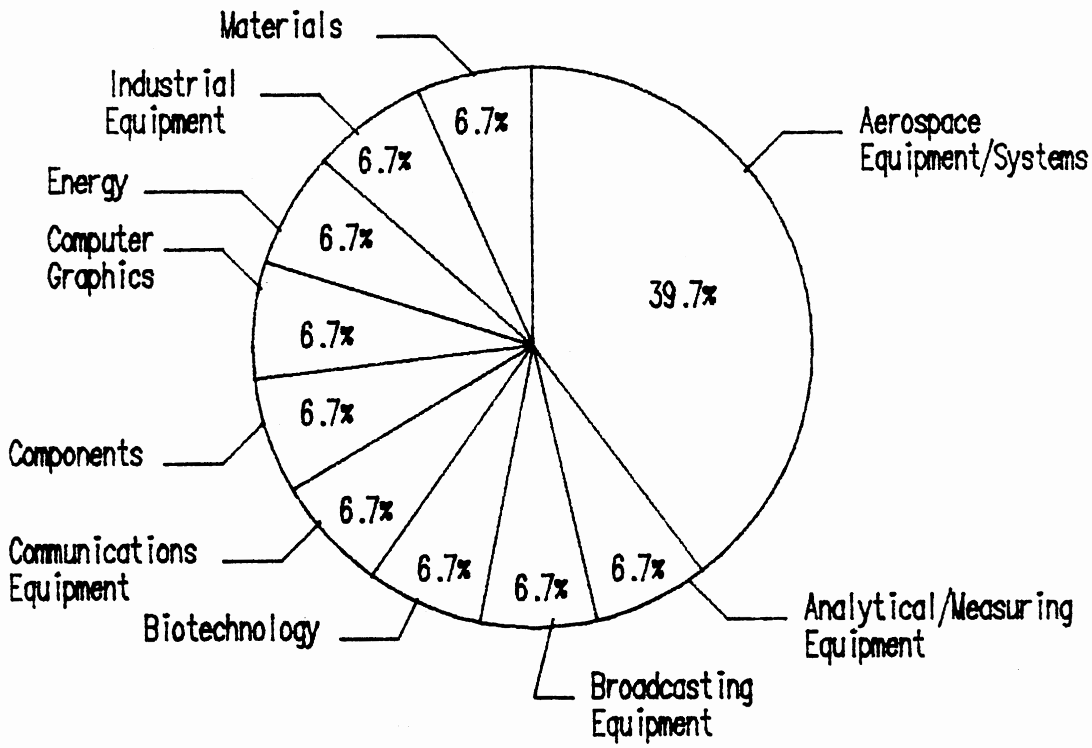


Figure 1. Proportion of Responding Corporations by Product Classification

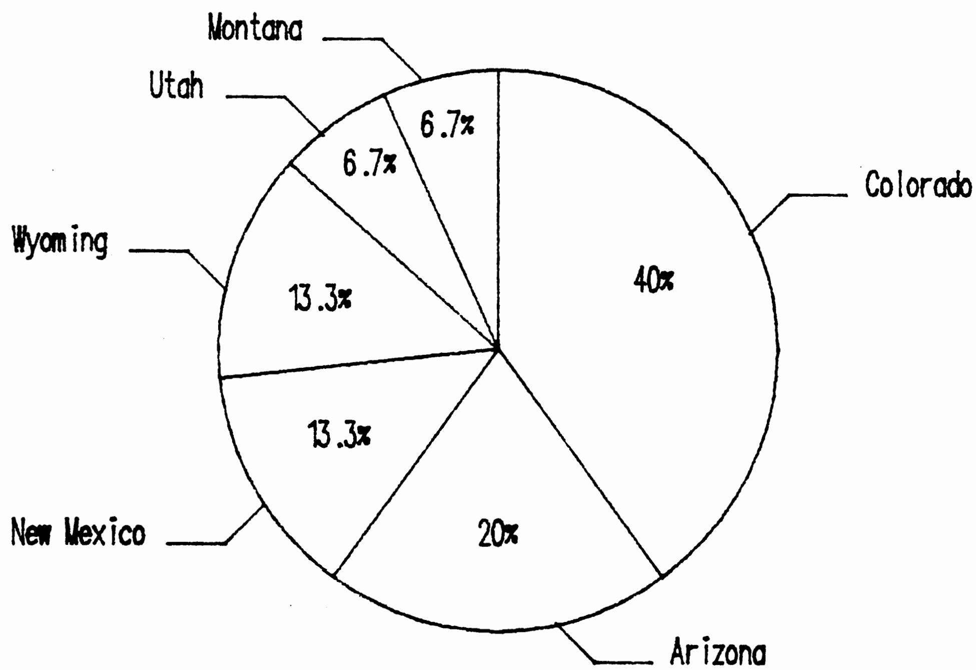


Figure 2. Proportion of Corporations Responding by State

corporations responding by State. Colorado represented 40 per cent of the returned survey instruments. Arizona represented 20 per cent of the returned instruments. Both New Mexico and Wyoming each represented 13.3 per cent of the returned survey instruments. Montana and Utah each represented 6.7 per cent of the returned instruments. No usable returns were obtained from Nevada. Figure 3 represented the proportion of college/university professors of the total sample, by state, that returned the survey instrument. Professors from Colorado responded with the largest percentage, 32.2 per cent. Utah was represented with a response rate of 28.5 per cent. Montana was represented with a response rate of 17.9 per cent. The response rate from the professors from Arizona was 10.7 per cent. Professors from New Mexico responded with a response rate of 7.1 per cent. Finally, professors from Wyoming responded with a response rate of 3.6 per cent. No response rate was listed for Nevada for the reason that no industrial technology programs were listed for that State. These findings correlated with the sample number taken from each state.

Frequency Distribution of Data

Five bar graphs were developed to visually compare the data obtained relating to the perceptions of the corporation representatives and the educators surveyed concerning the survey topics. Average ranks of each of the 40 topics from

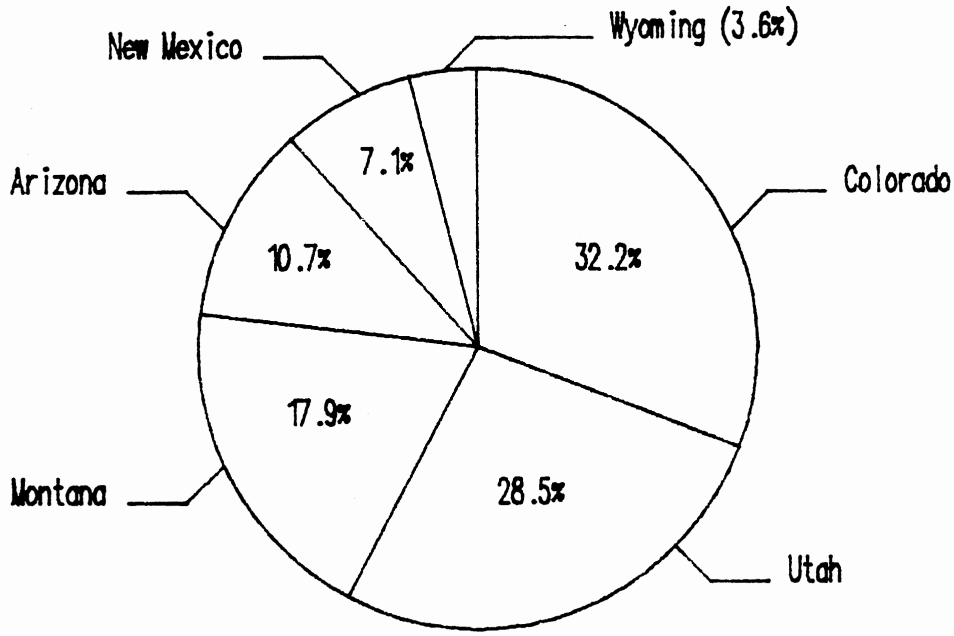


Figure 3. Proportion of Responding Colleges/ University Professors by State

both groups were plotted together on bar graphs. The ranking was based on a scale from five to one with five being the highest ranking. Eight topics were included on each graph primarily to make the construct of each graph acceptable to format stipulations. The first two graphs, Figure 4 and Figure 5, included topics from the general education area. The following is a list of the topics and the average rankings given by the representatives of industry and education, respectively, found on Figure 4: (1) Algebra, 4.6 - 4.6; (2) Geometry, 4.5 - 4.2; (3) Trigonometry, 4.1 - 4.4; (4) Calculus, 3.6 - 3.5; (5) Statistics, 4.5 - 4.1; (6) Biological Science, 2.2 - 2.9; (7) Physics, 4.3 - 4.3; (8) Chemistry, 3.6 - 4.1. In addition, the following is a list of the topics and the average rankings given by the representatives of industry and education, respectively, found on Figure 5: (9) Basic Computer Programing, 4.1 - 4.5; (10) Word Processing, 2.9 - 4.4; (11) Speech, 3.9 - 4.8; (12) Economics, 3.4 - 4.0; (13) Technical Writing, 4.2 - 4.6; (14) Accounting, 3.4 - 3.7; (15) Marketing, 3.2 - 3.9; (16) Management, 4.2 - 4.5. The third and fourth graphs, Figure 6 and Figure 7, were comprised of industrial technology specialization area topics. The following is a list of the topics and the average rankings given by the representativies of industry and education, respectively, found in Figure 6: (17) Drafting Technology, 3.1 - 4.3; (18) Graphic Arts Technology, 2.5 - 3.4; (19) Computer Aided Design, 3.7 -

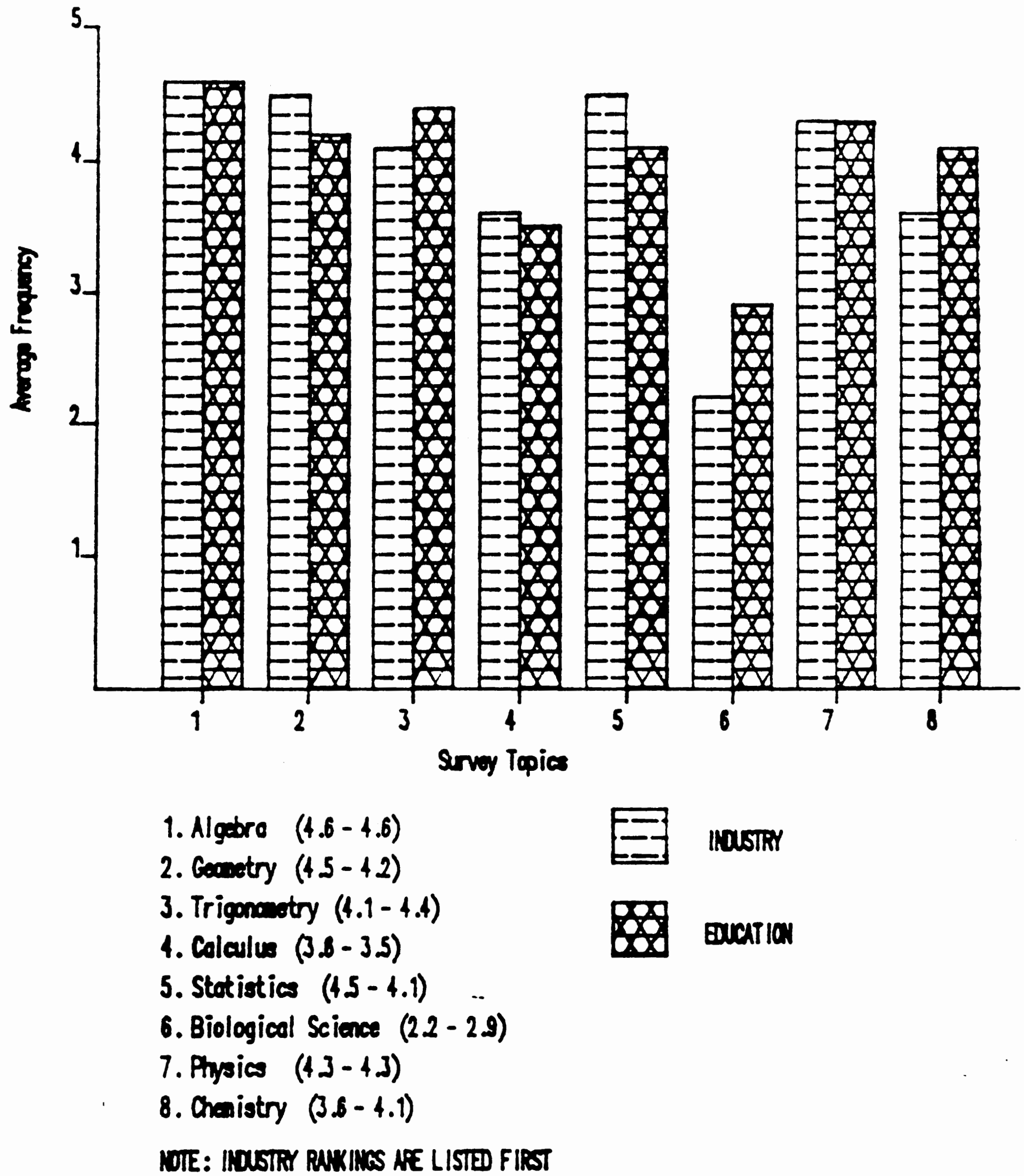


Figure 4. Average Ranks of General Education Topics (1-8)

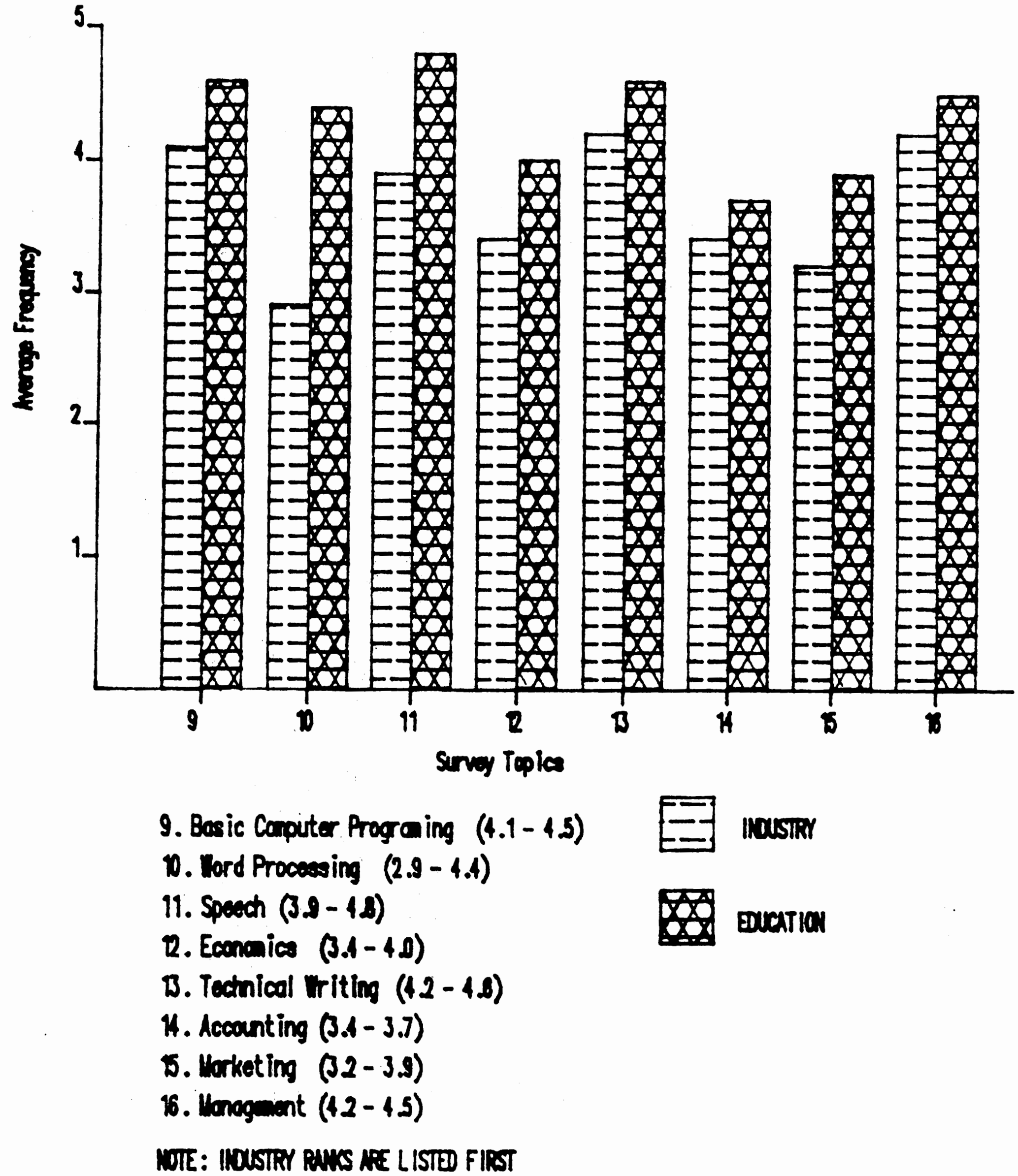


Figure 5. Average Ranks of General Education Topics (9-16)

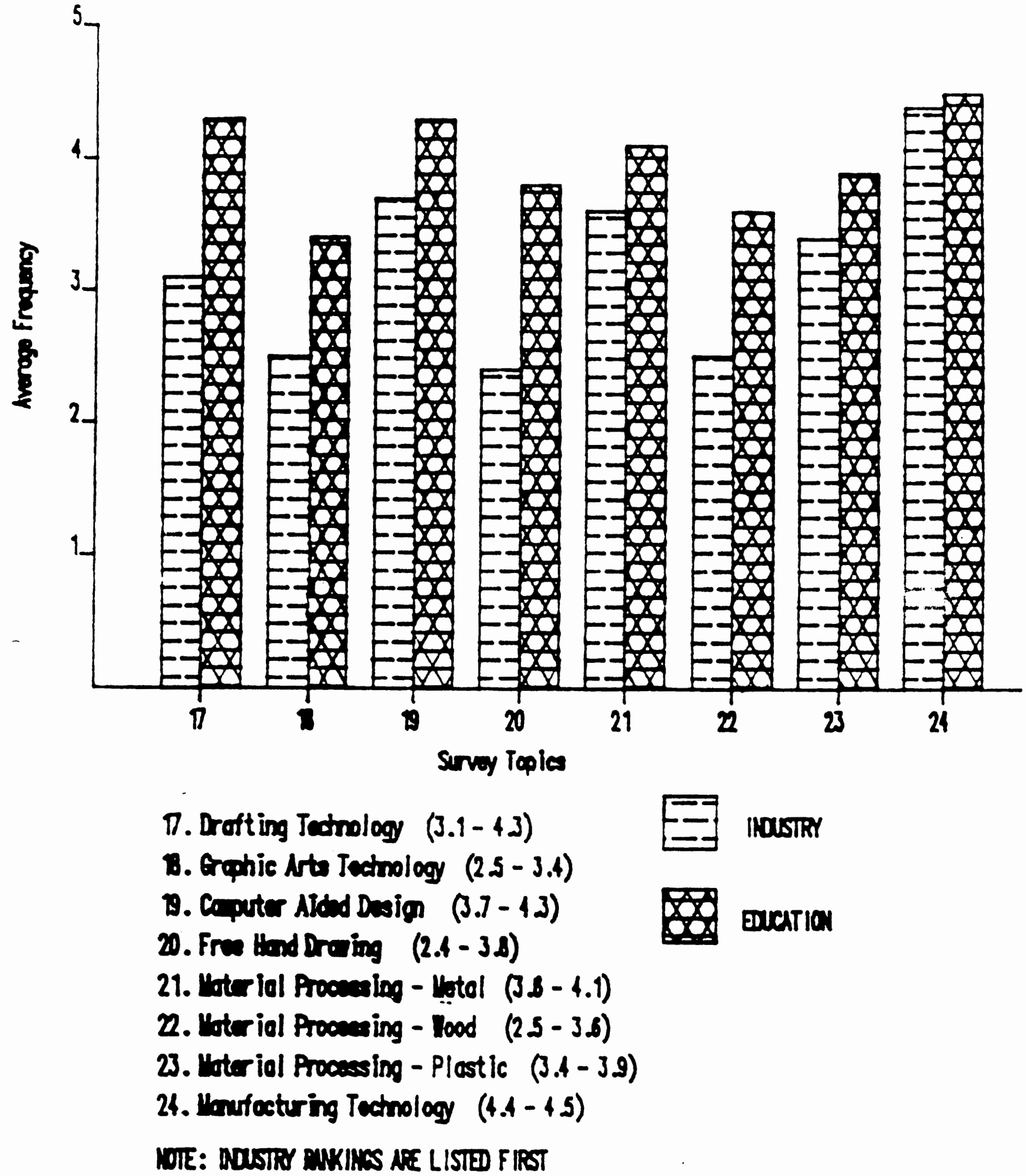
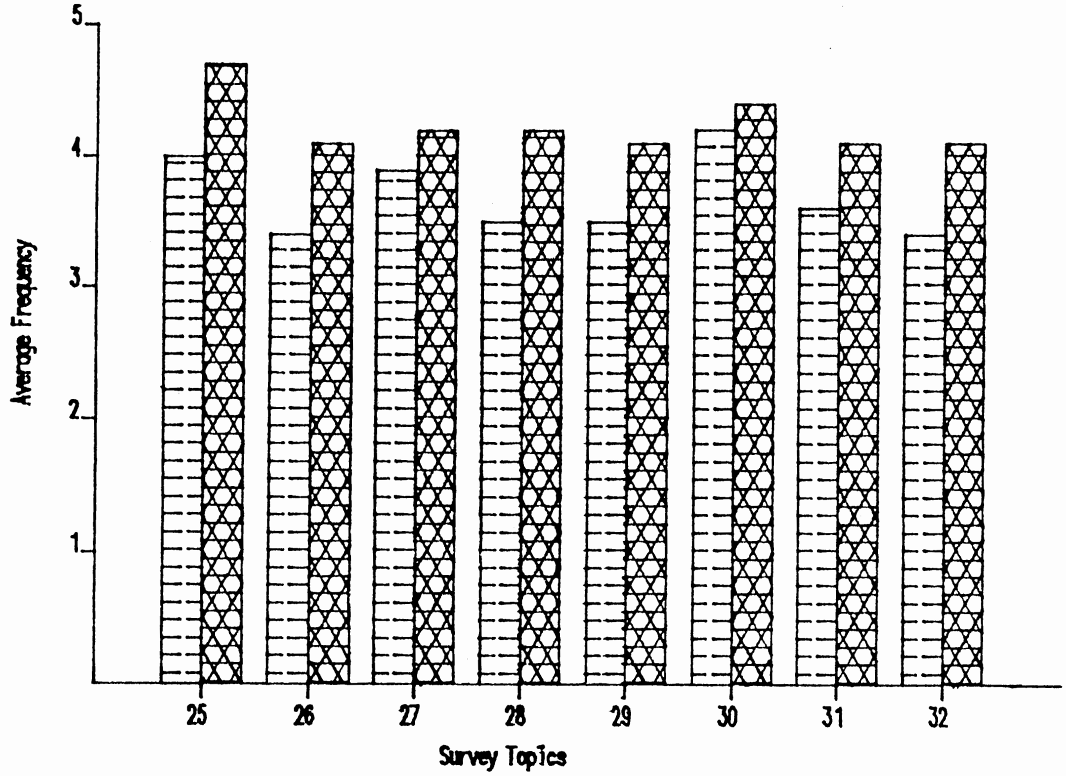


Figure 6. Average Ranks of Industrial Technology Specialization Topics (17-24)



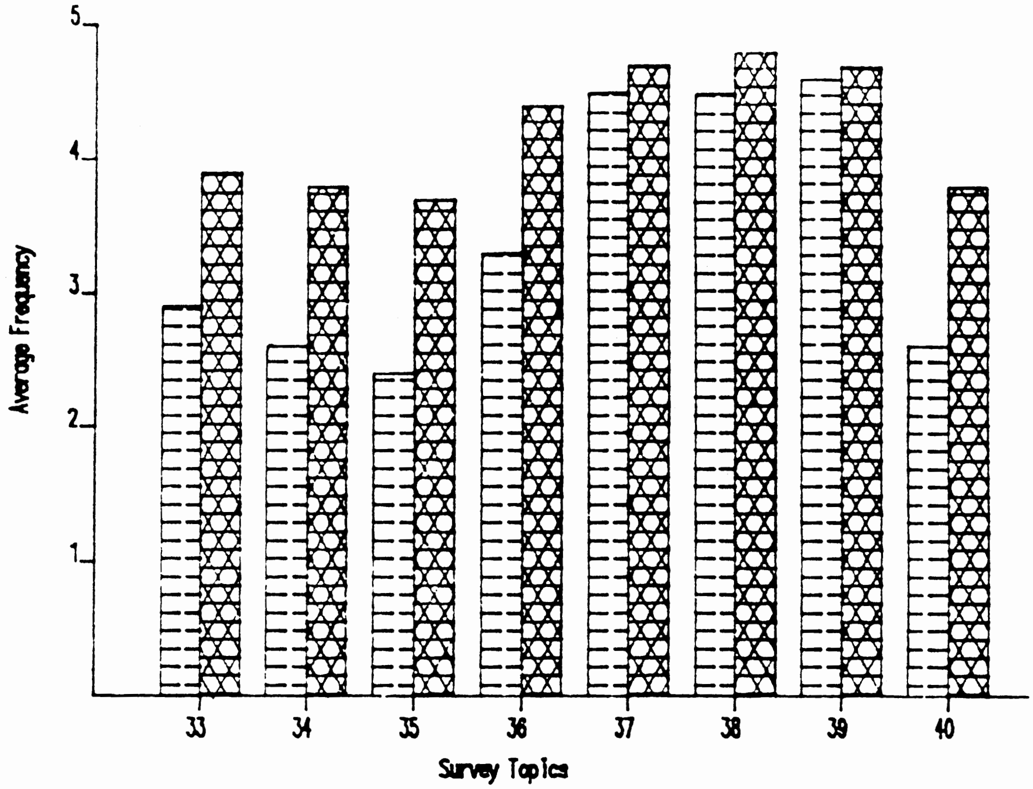
25. Industrial Safety (4.0 - 4.7)
26. Numerical Control Programing (3.4 - 4.1)
27. Computer Integrated Manufacturing (3.9 - 4.2)
28. Robotics Technology (3.5 - 4.2)
29. Electricity (3.5 - 4.1)
30. Electronics (4.2 - 4.2)
31. Power Systems (3.6 - 4.1)
32. Hydraulics & Pneumatics (3.4 - 4.1)

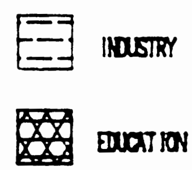
NOTE: INDUSTRY RANKINGS ARE LISTED FIRST

Figure 7. Average Ranks of Industrial Technology Specialization Topics (25-32)

4.3; (20) Free Hand Drawing, 2.4 - 3.8; (21) Material Processing - Metal, 3.6 - 4.1; (22) Material Processing - Wood, 2.5 - 3.6; (23) Material Processing - Plastic, 3.4 - 3.9; (24) Manufacturing Technology, 4.4 - 4.5. In addition, the following is a list of the topics and the average rankings given by the representatives of industry and education, respectively, found in Figure 7: (25) Industrial Safety, 4.0 - 4.7; (26) Numerical Control Programing, 3.4 - 4.1; (27) Computer Integrated Manufacturing, 3.9 - 4.2; (28) Robotics Technology, 3.5 - 4.2; (29) Electricity, 3.5 - 4.1; (30) Electronics, 4.2 - 4.2; (31) Power Systems, 3.6 - 4.1; (32) Hydraulics and Pneumatics, 3.4 - 4.1. The final graph, Figure 8, consisted of industrial technology specialization area and interpersonal skills area topics. The following is a list of the topics and the average rankings given by the representatives of industry and education, respectively, found in Figure 8: (33) Basic First Aid, 2.9 - 3.9; (34) Strength of Construction Materials, 2.6 - 3.8; (35) Constrtuction Technology, 2.4 - 3.7; (36) Industrial Internships, 3.3 - 4.4; (37) Leadership, 4.5 - 4.7; (38) Problem Solving, 4.5 -4.8; (39) Communications, 4.6 - 4.7; (40) Transportation Systems, 2.6 - 3.8.

In examining the graphs the following results were found. Three topics, Algebra, Physics, and Electronics, were equally ranked by the representatives of industry and education. The two survey groups ranked the following 17 topics within a difference of one half of one point:





33. Basic First Aid (2.9 - 3.9)
34. Strength of Construction Materials (2.6 - 3.8)
35. Construction Technology (2.4 - 3.7)
36. Industrial Internships (3.3 - 4.4)
37. Leadership (4.5 - 4.7)
38. Problem Solving (4.5 - 4.8)
39. Communications (4.6 - 4.7)
40. Transportation Systems (2.6 - 3.8)

NOTE: INDUSTRY RANKINGS ARE LISTED FIRST

Figure 8. Average Ranks of Industrial Technology Specialization and Interpersonal Skills Topics (33-40)

Geometry, Calculus, Statistics, Chemistry, Basic Computer Programing, Technical Writing, Accounting, Management, Material Processing - Metal, Material Processing - Plastic, Manufacturing Technology, Computer Integrated Manufacturing, Power Systems, Leadership, Problem Solving, and Communications. The following 12 topics were ranked by the two survey groups with a difference between .5 and 1 point: Biological Science, Speech, Economics, Marketing, Graphic Arts Technology, Computer Aided Design, Industrial Safety, Numerical Control Programming, Robotics Technology, Electricity, Hydraulics & Pneumatics, and Basic First Aid. The two survey groups ranked the following eight topics with a difference greater than one point: Word Processing, Drafting Technology, Free Hand Drawing, Material Processing - Wood, Strength of Construction Materials, Construction Technology, Industrial Internships, and Transportation Systems. The corporation representatives surveyed gave the highest average ranking, 4.6, to Algebra and Communications. The college/ university professors surveyed gave the highest average ranking, 4.8, to Problem Solving and Speech. Biological Science received the lowest average ranking from both groups. The corporation representatives surveyed gave an average ranking of 2.2 to Biological Science and college/university professors indicated a ranking of 2.9.

Rank Correlation Coefficient

Determining the content validity and determining the reliability of the survey instrument were major issues of the study. Best (1977) indicated that the content validity and reliability of an instrument could be determined through the use of an analysis using a rank correlation coefficient, Spearman's rho. Two analyses were performed to examine the correlation between the average ranking of topics between the two groups surveyed. The first analysis made use of all paired average ranks. The second analysis clustered the topics in logical groups. The software, "Statistics with Finesse", used to run the analysis was developed by James Bolding in 1984.

The first analysis made use of the paired average ranks of each of the survey instrument topics for an overall analysis. Each of the paired average rankings from the 40 survey instrument topics was keyboarded into a personal computer program designed to run the analysis. This analysis revealed a high positive correlation coefficient of .7525.

The second analysis was made concerning the paired average ranks of survey instrument topics arranged into groups related to the following major subject areas: Mathematics; Science; Computer Science; Business; Graphic Communications; Manufacturing; Power, Energy and Transportation; Construction; and Interpersonal skills.

These major subject areas were taken from the three overall subject areas, general education, industrial technology specialization, and interpersonal skills, examined earlier in the study. The following is a list of the topics grouped under the nine major subject areas: (1) Mathematics - Algebra, Geometry, Trigonometry, Calculus, Statistics; (2) Science - Biological Science, Physics, Chemistry; (3) Computer Science - Basic Computer Programing, Word Processing; (4) Business - Speech, Economics, Accounting, Marketing, Management; (5) Graphic Communications - Drafting Technology, Graphic Arts Technology, Computer Aided Design, Free Hand Drawing; (6) Manufacturing - Material Processing (Metals), Material Processing (Wood), Material Processing (Plastic), Manufacturing Technology, Industrial Saftey, Numerical Control Programming, Computer Integrated Manufacturing, Robotics Technology, Basic First Aid; (7) Power Energy and Transportation - Electricity, Electronics, Power Systems, Hydraulics and Pneumatics, Transportation Systems; (8) Construction - Strength of Construction Materials, Construction Technology; (9) Interpersonal Skills - Technical Writing, Industrial Internships, Leadership, Problem Solving, Communications. The second analysis also yielded substantial, high to very high positive correlation coefficients. The following is a list of the nine major subject areas and the corresponding correlation coefficient values: (1) Mathematics, .6750; (2) Science, 1.000; (3) Computer Science, 1.000; (4) Business, .7250; (5) Graphic

Communications, .7500; (6) Manufacturing, .9250; (7) Power, Energy and Transportation, .9000; (8) Construction, 1.000; and (9) Interpersonal Skills, .7750.

The analyses indicated that the instrument was both valid and reliable. Best (1977) indicated that validity could be determined by correlating the survey results of a target group with the survey results of recognized authorities. The target group utilized for this study were the representatives of the high tech corporations selected. The recognized authorities of this study were represented by the college/university professors selected. The group of college/university professors were determined to be the best qualified to judge the appropriateness of the topics included in the survey instrument. A correlation coefficient of +.7525, gained through the analysis of the 40 survey instrument topics of both groups, indicated that a substantial positive relationship existed between the average rankings of the two groups. Also substantial positive relationships were found to exist between the average rankings of the survey topics when they were grouped into nine major subject areas. These analyses indicate that the content of the instrument was valid or appropriate for the study population. As indicated by Best (1977) the same analyses can be used to test the reliability of the instrument. The same substantial positive relationship found to exist between the average rankings of the two surveyed groups also indicated that the instrument was completed in a consistent manner which indicates reliability. Finally, Best (1977) states that "a valid test is always reliable" (p.190); therefore, the analyses conducted proved that the instrument was both valid and reliable.

Respondent Comments

Another aspect of the survey instrument, that was added to help establish the content validity of the instrument, was the addition of a section which gave space for the addition of other topics and comments. This additional space was included to provide the respondents with room to include other topics that were appropriate for inclusion in the survey instrument or to indicate those topics that were inappropriate for inclusion in the survey instrument. Numerous comments or additional topics that were common among respondents would indicate that the instrument was soliciting responses that were not appropriate for the population surveyed which would indicate an instrument that was not valid.

Few comments and additional courses were added to the survey instruments. Four respondents from the corporations surveyed included comments. Four respondents from the college/university professors surveyed included comments.

Three of the four comments from the corporations surveyed were concerning courses specific to the type of industry that they were representing or courses concerning interpersonal skills. The fourth survey respondent checked the disclaimer box indicating that their company was only interested in persons with mechanical and electrical engineering degrees. There was no common theme in the list of additional courses. Following is a list of those courses: (1) nuclear engineering, (2) radiation health physics, (3) environmental restoration, (4) total quality management, (5) management/supervisory skills, (6) performance appraisal systems, and (7) motivation techniques

Two of the four comments from the responding college/university professors related to additional courses. One of the other two was a general comment stating the need for the National Association of Industrial Technology to be involved in this type of study. The final comment indicated that with out actual floor experience in industry an industrial technology degree was not beneficial. None of the additional courses was listed more than once. Following is a list of the additional courses listed in the comments from responding college/university professors: (1) research and development, (2) organizational management, (3) persuasive & organizational communications, (4) industrial psychology, (5) anthropology in Southwest culture, (6) industrial ethics, and (7) principles of law.

These findings helped to verify the instrument content validity. The respondents, through the lack of common comments or additional topics, indicated that the content of the survey instrument was appropriate for the group surveyed.

Summary

The results were reported using the demographics of returns, frequency distribution of data, rank correlation coefficient, and other courses and comments.

The returns indicated that the rate of return for the college/university professors, 58.3 per cent, was greater than the rate of return from the corporation representatives, 23.1 per cent, surveyed. The highest proportion of corporation respondents by product classification came from the aerospace equipment/systems classification, 39.7 per cent. The highest proportion of corporation respondents, 40 per cent, and college/university professor respondents, 32.2 per cent, by state came from Colorado.

A study of the frequency distribution indicated that the corporations surveyed ranked Algebra and Communications with the highest rank, 4.6. The ranking was based on a scale from five to one with five being the highest rank. College/university professors ranked Problem Solving and Speech with the highest rank, 4.8. Both groups ranked Biological Science with the lowest rank, 2.2 corporations and 2.9 professors. An examination of the frequency distribution of the representatives of the high tech corporations surveyed typically ranked industrial technology specialization topics slightly lower that the college/

university professors surveyed.

In conducting the statistical analysis using Spearman's rho an overall correlation coefficient of +.7525 was found. This coefficient was considered a substantial positive relationship. The analysis of the following nine groups yielded coefficients that indicated a range from substantial to very high positive relationships: (1) Mathematics, .675; (2) Science, 1.000; (3) Computer Science, 1.000; (4) Business, .725; (5) Graphic Communications, .750; (6) Manufacturing, .925; (7) Power, Energy and Transportation, .900; (8) Construction, 1.000; and (9) Interpersonal Skills, .775. The statistical analysis indicated that the instrument was valid and reliable.

Very few comments were included in the returns from both groups. Most comments related to specific courses; however, no common themes were evident. One respondent from the corporations surveyed checked the disclaimer indicating that the company being represented hired persons with mechanical and electrical engineering degrees for the positions indicated on the survey instrument. The lack of common comments and additional topics helped to verify the instrument content validity for the population surveyed.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to develop a valid and reliable instrument to survey the perceptions of industrial representatives concerning the educational needs of industrial technology majors. An important aspect in developing the instrument was to prepare an instrument that was brief in length, simple and convenient to complete thus promoting a rapid return from the respondents. The development of this instrument will provide a means to examine current educational needs in industry for the purpose of updating curriculum, facilities and faculty at post-secondary institutions.

In order to accomplish this a developmental strategy was incorporated. The strategy included the identification of content, development of an instrument, and a pilot survey.

The content to be used in the instrument was taken from a review of current literature addressing the content needs of four year industrial technology programs. Establishing the content validity of the instrument was accomplished by choosing those topics indicated by the authorities (Connor, the content validity of the instrument was accomplished by choosing those topics indicated by the authorities (Connor, 1986, Giachino and Gallington, 1977, Creger, 1989, Hauser, 1971, Savage et al., 1988, Schaetz, 1989) as being most important.

Using the works of Berdie and Anderson (1974) as a guide, an instrument was developed using 40 topics selected from three educational areas. The areas include general education, industrial technology specialization, and interpersonal skills. Great care was used in designing an instrument that was brief in length, simple and convenient to complete.

To test the validity and reliability of the instrument a pilot survey was conducted using two groups. The first group represented the intended recipients of the instrument and were chosen from Rocky Mountain high technology corporations. The region includes Arizona, Colorado, Montana, Nevada, New Mexico, Utah, and Wyoming. Sixty-five corporations represented a total population of corporations following a natural break comprised of those employing the most people from each state. The second group represented authorities in the field of industrial technology. The selected group consisted of 48 college/university professors from the same region from which the corporations were taken. The sample represented 50 per cent of the industrial technology college/university professors in the target region. The statistical analysis used to test the instrument consisted of a rank correlation coefficient, Spearman's rho. According to Best (1977) this test can be used to qualify the validity and reliability of an instrument. The data used in the test consisted of the average ranks of each group pertaining to the 40 survey topics.

The survey instrument was sent to representatives of the selected corporations and the selected college/ university professors on October 4, 1990. By the cut-off date, October 19, 1990, 41 (36.3%) of the survey instruments had been returned. Two survey instruments were returned after the cut-off date to increase the return rate to 38.1 per cent. All of the surveys returned were usable. As a proportion of the total surveys sent to each group the corporation representatives returned 23.1 per cent and the college/university professors returned 58.3 per cent. In view of the fact that a 35 per cent return rate was considered adequate for the purpose of the study a follow-up on non-respondents was not made.

After calculation of the average ranks, using a ranking scale from one to five with five being the highest, of the 40 topics, the representatives of the corporations surveyed ranked Algebra and Communications the highest (4.6) and the college/university professors surveyed ranked problem solving and speech the highest (4.8). Three topics were ranked the same by both groups. The topics were Algebra (4.6), Physics (4.3), and Electronics (4.2). Biological

Science was ranked the lowest by both the corporation representatives surveyed (2.2) and the college/university professors surveyed (2.9). After completion of the statistical analysis there was found to be an overall correlation coefficient of +.7525 between the two groups concerning the average ranking of the 40 survey instrument topics. Substantial to very high positive relationships were found to exist when the topics were grouped into nine major catagories. Both analyses indicates a substantial positive relationship between the two groups. Literature indicated that a substantial positive relationship indicated that the instrument was both valid and reliable.

Conclusions

After analyzing the data from the study the following conclusions were made concerning the purpose of the study.

The results of the study indicate that the instrument would be useful to survey the perceptions of industry, of all types, concerning the educational requirements of industrial technology majors.

Broad topics, such as the ones used in the instrument of the study, could be used to identify major topic areas in all areas of industrial technology. An instrument designed to survey the perceptions of industrial representatives does not need to be long and cumbersome. Once the major areas are identified further studies could be conducted to identify specific topics.

Greater attention should be placed on instrument development concerning validity and reliability. A review of past related research revealed superficial explanations of instrument development, which is of no great benefit to future researchers.

Recommendations

In view of the findings of this study the following recommendations were made.

1. Another study, utilizing the instrument developed in this study, should be conducted employing a larger sample of Rocky Mountain high technology corporations. This study should also make use of a follow-up of non-respondents to determine if response rate can be improved.

2. Another study, utilizing the instrument developed in this study, should be conducted making use of a more general selection of industry not limited to Rocky Mountain high technology corporations.

3. Future studies, utilizing the instrument developed in this study, should be conducted across the nation to help determine national perceptions of industrial representatives.

4. This study should be repeated every two years to help indicate perception change in industry and education.

5. Upon the identification of major topics in the industrial technology specialization area, through the use of the instrument developed in this study, further studies

should be conducted to gain specific information concerning the content in those major topics.

A SELECTED BIBLIOGRAPHY

Accreditation Board for Engineering and Technology. Criteria for Accrediting Programs in Engineering Technology. New York, New York, 1989.

Akinkuoye, Nicholas O. "Carving a Niche' for Industrial Technology in Business and Industry." Journal of Industrial Technology, Vol. 5 (Summer, 1989), pp. 15 -17.

Beakley, George C. and Chilton, Ernest G. Design: Serving the Needs of Man. New York: Macmillian Publishing Co., Inc., 1974.

Berdie, Douglas R. and Anderson, John F. Questionnaires: Design and Use. Metuchen: The Scarecrow Press, Inc., 1974.

Best, John W. Research in Education. 3rd Ed. Englewood Cliffs: Prentice-Hall Inc., 1977.

Bohn, Ralph C. and MacDonald, Angus J. Power: Mechanics of Energy Control. 2nd Ed. Encino: Glencoe Publishing Co., 1983.

Brown, Ryan K. "The Role of Creative Problem Solving in the Industrial Technology Curriculum." Journal of Industrial Technology, Vol. 5 (Spring, 1989), pp. 21 -23, 30.

Brown, Walter C. Drafting for Industry. South Holland: Goodheart-Willcox Co., Inc., 1984.

Connor, Sidney G. "Industrial Technology and Industry: A Derivation of Subject Matter From Industry with Implications for Curricular Change." (Unpub. Ed.D dissertation, Kansas State University, 1986.)

Creger, Donald W. "Leadership and Motivation: The Competitive Edge." Journal of Industrial Technology, Vol. 5 (Spring, 1989), pp. 3-5.

Dyrenfurth, Michael J. Missouri Industrial Technology Education Guide. Missouri: State Department of Education, 1987.

Fales, James F., Sheets, Everett G., Mervich, Gregg J., Dinan, John F. Manufacturing: A Basic Text. 2nd Ed. Encino: Glencoe Publishing Co., 1986.

Fryda, Lawrence J. "Role Reversal: Industry "Internships" with Students." Journal of Industrial Technology, Vol. 5 (Spring, 1989), pp. 11-12.

Galfo, Armand J. and Miller, Earl. Interpreting Educational Research. 2nd Ed. Dubuque: Wm. C. Brown Co. Pub., 1970.

Giachino, Joseph W. and Gallington, Ralph O. Course Construction in Industrial Arts, Vocational and Technical Education. 4th Ed. Homewood: American Technical Publishers, Inc., 1977.

Hauser, Emmett. "Analysis of Industrial Technology Curriculum and its Significance to the Casting Industry." (Unpub. Ed.D. dissertation, University of Northern Colorado, 1971.)

Hawkins, Richard C. "The Future of Computer Simulation in the Year 2000." Journal of Industrial Technology, Vol. 5 (Spring, 1989), pp. 24-26.

Industrial Teacher Education Directory 1989-90. South Holland, Illinois: Goodheart-Willcox Company, Inc., 1989.

Kales, Paul A. "The productivity Goal - Tracking a Moving Target." Journal of Industrial Technology, Vol. 5 (Winter, 1988/89), pp. 24-25, 35-36.

Lauda, Donald P. "Industrial Teacher Education, 1988-2000." Industrial Teacher Education in Transition - 75th Mississippi Valley Industrial Teacher Education Conference, Chapter 13 (1988), pp. 255-271.

Lewis, Myron E., Jr. "An Investigation of the Relevancy of Selected Areas of the Industrial Technology Curricula to the Expectations of Industry." (Unpub. Ed.D. dissertation, State University of New York at Buffalo, 1970.)

Lindbeck, John R. Designing Today's Manufactured Products. 2nd Ed. Bloomington: McKnight & McKnight Publishing Co., 1972.

Mouly, George J. The Science of Educational Research. New York: American Book Co., 1963.

Mussnug, Kenneth and Roberts, George. A Data Based Model for the Development of Technical Education Program Curricula at Institutions of Higher Education. Knoxville: University of Tennessee, Research Report, 1987.

National Association of Industrial Technology. Industrial Technology Accreditation Handbook Baccalaureate Level. Ypsilanti, Michigan: Eastern Michigan University, 1988.

Nisbet, J. D. and Entwistle, N. J. Educational Research Methods. New York: American Elsevier Pub. Co., Inc., 1970.

Prewitt, Roger W. "An Investigation of the Effectiveness of Four-year Industrial Technology Programs in Preparing Industrial Electronic Technicians to Meet the Requirements of Industry." (Unpub. Ed.D. dissertation, University of Northern Colorado, 1973.)

Rocky Mountain High Technology Directory. Boulder: Leading Edge Communications, Inc., 1987.

Savage, Ernest, Kruppa, Richard, Palumbo, Anthony, Schwerkolt. "Three Approaches to Establishing a Core Curriculum for Industrial Technology Programs." Journal of Industrial Technology. Vol. 5 (Winter, 1988 -89), pp. 9-11, 23.

Schaetz, Patrick L. Recruting Trends 1989-90 A Study of 479 Businesses, Industries, Governmental Agencies, and Educational Institutions Employing New College Graduates. East Lansing: Michigan State University, Research Report, 1989.

Sherry, Bob. "CIM Comes to America's Rescue." Industrial Education, Vol. 78 (December, 1989), pp. 16-17.

Skaine, James C. "Curricular Planning in the Midst of Technological Dynamism." Journal of Industrial Teacher Education, Vol. 23 (Fall, 1985), pp. 41-43.

Sprague, W. W., Bies, John H. "World Economy Affects Technology Education." Industrial Education, Vol. 77 (November, 1988), pp. 17-20.

Strom, Irving E. "A Comparative Analysis of Industrial Technology Education in Minnesota and the Requirements of Industry." (Unpub. Ed.D. dissertation, University of Northern Colorado, 1970.)

Tabor, Luther G. "Leadership for Success." _Journal of Industrial Technology_, Vol. 5 (Spring, 1989), pp. 17 -20.

Travers, Robert M. W. _An Introduction to Educational Research_. 3rd Ed. New York: The MacMillian Co., 1969

APPENDIXES

APPENDIX A

A LIST OF PROFESSORS SELECTED

1. MARIAN G. BARCHILON
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

2. MR. DONALD COLLINS
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

3. DR. RONALD D. DAHL
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

4. ZINDRA GAFFORD
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

5. DR. RENEE HOROWITZ
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

6. DR. GARY MICKOLAJAK
   ARIZONA STATE UNIVERSITY
   DIVISION OF TECHNOLOGY
   TEMPE, AZ 85287

7. MR. STEVEN L. SCHAEFFER
   ADAMS STATE COLLEGE
   DEPARTMENT OF INDUSTIRAL STUDIES
   ALAMOSA, CO 81102

8. DR. LEE D. CARTER
   COLORADO STATE UNIVERSITY
   DEPARTMENT OF INDUSTRIAL SCIENCES
   FORT COLLINS, CO 80523

9. MR. SCOTT CONDREAY
   COLORADO STATE UNIVERSITY
   DEPARTMENT OF INDUSTRIAL SCIENCES
   FORT COLLINS, CO 80523

10. MR. RICHARD G. DUNN
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

11. DR. GARY B. GEHRIG
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

12. REGINA M. GONZALES
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

13. B.D. LEE
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

14. DR. MARION MANESS
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

15. DR. JEAN M. MARCHAND
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

16. MR. CHARLES W. SMITH
    COLORADO STATE UNIVERSITY
    DEPARTMENT OF INDUSTRIAL SCIENCES
    FORT COLLINS, CO 80523

17. MR. JOHN M. BORTON
    UNIVERSITY OF SOUTHERN COLORADO
    AREA OF INDUSTRIAL TEACHER EDUCATION
    PUEBLO, CO 81001-4901 6/5

18. DR. FRANK T. CHEN
    UNIVERSITY OF SOUTHERN COLORADO
    AREA OF INDUSTRIAL TEACHER EDUCATION
    PUEBLO, CO 81001-4901 6/5

19. MR. RONALD DARBY
    UNIVERSITY OF SOUTHERN COLORADO
    AREA OF INDUSTRIAL TEACHER EDUCATION
    PUEBLO, CO 81001-4901 6/5

20. MR. ALAN M. HIRTH
    UNIVERSITY OF SOUTHERN COLORADO
    AREA OF INDUSTRIAL TEACHER EDUCATION
    PUEBLO, CO 81001-4901 6/5

21. MR. PAUL A. SEFCOVIC
    UNIVERSITY OF SOUTHERN COLORADO
    AREA OF INDUSTRIAL TEACHER EDUCATION
    PUEBLO, CO 81001-4901 6/5

22. MR. JERRY L. SWEET
UNIVERSITY OF SOUTHERN COLORADO
AREA OF INDUSTRIAL TEACHER EDUCATION
PUEBLO, CO 81001-4901 6/5

23. MR. CHARLES E. TEDROW
UNIVERSITY OF SOUTHERN COLORADO
AREA OF INDUSTRIAL TEACHER EDUCATION
PUEBLO, CO 81001-4901 6/5

24. MR. JAMES SEITZ
WESTERN STATE COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
GUNNISON, CO 81231

25. DR. CHARLES R. TUTOR
WESTERN STATE COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
GUNNISON, CO 81231

26. MR. JOHN HAWKINSON
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

27. MR. VIRGIL HAWKINSON
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

28. MR. GREGORY KEGEL
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

29. MR. STEPHAN KINHOLT
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

30. MR. LEIGH MORGAN
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

31. CLAIR NYSTROM
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

32. MR. CONRAD NYSTROM
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

33. DR. LYLE R. SCHROEDER
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

34. MR. LAWRENCE STRIZICH
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

35. VAL VALDEZ
NORTHERN MONTANA COLLEGE
DEPARTMENT OF INDUSTRIAL TECHNOLOGY
HAVRE, MT 59501

36. DR. DOUGLAS L. PICKLE
EASTERN NEW MEXICO UNIVERSITY
SCHOOL OF TECHNOLOGY
PORTALES, NM 88130

37. MR. BILL R. ZACHRY
EASTERN NEW MEXICO UNIVERSITY
SCHOOL OF TECHNOLOGY
PORTALES, NM 88130

38. DR. CHARLES O. TAYLOR
UNIVERSITY OF NEW MEXICO
INDUSTRIAL/TECHNOLOGY EDUCAITON DIVISION
ALBUQUERQUE, NM 87131

39. DR. DON L. BLANCHARD
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

40. MR. JERRY LAWRENCE
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

41. MR. LYMAN E. MUNFORD
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

42. MR. KENNETH S. MUNFORD
SOUTHERN UTAH STATE COLLEGE
INDUSTIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

43. JEAN NEWVILLE
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

44. DR. STEVE J. TAYLOR
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

45. MR. DAVID A. WARD
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

46. MR. RICHARD L. WITTWER
SOUTHERN UTAH STATE COLLEGE
INDUSTRIAL EDUCATION DEPARTMENT
CEDAR CITY, UT 84720

47. MR. REED M. NIELSEN JR.
UTAH STATE UNIVERSITY
INDUSTRIAL TECHNOLOGY & EDUCATION DEPT.
LOGAN, UT 84322

48. MR. JOEL W. TROXLER
UTAH STATE UNIVERSITY
INDUSTRIAL TECHNOLOGY & EDUCATION DEPT.
LOGAN, UT 84322

49. DR. LOWELL BARR
UNIVERSITY OF WYOMING
DEPARTMENT OF VOCATIONAL EDUCATION
LARAMIE, WY 82071

50. DR. NORM PETERSON
UNIVERSITY OF WYOMING
DEPARTMENT OF VOCATIONAL EDUCATION
LARAMIE, WY 82071

APPENDIX B

A LIST OF THE CORPORATIONS SELECTED

1. MR. ROBERT M. HANDLEY, DIV. MANAGER
   AIRESEARCH ELECTRONIC SYSTEMS DIVISION
   11100 NORTH ORACLE RD.
   TUCSON, AZ 0

2. MR. WILLIAM T. HICKS, VP MANUFACTURING
   AT&T TECHNOLOGIES
   505 N. 51ST
   PHOENIX, AZ 85043

3. MR. LARRY MOORE, VP/GM
   AVIONICS DIVISION/SPERRY CORPORATION
   5353 W.BELL ROAD
   GLENDALE, AZ 85308

4. MR. JAMES J. BURNS, PRESIDENT, CEO
   BURR-BROWN CORPORATION
   6730 SOUTH TUCSON BLVD.
   TUCSON, AZ 85734

5. MR. JOHN KERWAT, DIR. OF PERSONNEL
   COMPUGRAPHIC CORPORATION
   4621 N. 16TH ST.,SUITE E-509
   PHOENIX, AZ 85016

6. MR. KANE FLEDDERJOHN, VP/GM
   GARRETT FLUID SYSTEMS COMPANY
   P.O. BOX 22200
   TEMPE, AZ 85282

7. MR. MAL CRAIG, PRESIDENT
   GARRETT TURBINE ENGINE COMPANY
   111 S. 34TH ST.
   PHOENIX, AZ 85034

8. MR. E.R. MILLER, HUMAN RESOURCES
   GATES LEARJET CORPORATION
   1255 AERO PARK BLVD.
   TUCSON, AZ 85706

9. MR. GERALD MYERS, PRESIDENT
   GENERAL SEMICONDUCTOR INDUSTRIES INC.
   2001 W. 10TH PL.
   TEMPE, AZ 85281

10. MR. ROBERT W. CLARK, PRESIDENT/CEO
    GOODYEAR AEROSPACE CORPORATION
    GOODYEAR TIRE AND RUBBER
    LITCHFIELD PARK, AZ 85340

11. MR. EDWARD T HURD, GM
    HONEYWELL INC./IND. AUTOMATION SYS.DIV.
    16404 N. BLACK CANYON HIWAY
    PHOENIX, AZ 85023

12. MR. J.R. BLOOM, GM/VP
    HONEYWELL INC./LARGE COMPUTER PROD. DIV.
    P.O. BOX 8000
    PHOENIX, AZ 85021

13. MR. JOHN SWANE, PUBLIC SERVICE MANAGER
    INTEL CORP./PHOENIX OPERATION
    5000 W. CHANDLER BLVD.
    CHANDLER, AZ 85224

14. MR. DONALD E. LEMON, PRESIDENT
    ITT TERMINAL SYSTEMS
    1515 WEST 14TH ST.
    TEMPE, AZ 85038

15. MR. WILLIAM BROWN, PRESIDENT
    MC DONALD-DOUGLAS HELICOPTER CO. INC.
    5000 E. MC DOWEL
    MESA, AZ 85205

16. MR. LARRY HOWLE, OPERATIONS MANAGER
    MEMOREX CORP./TUCSON-MEXICO OPERATION
    6701 S. MIDVALE ST.
    TUCSON, AZ 85746

17. MR. MICHAEL STEVENS, VP/GM
    MICRO-REL
    2343 W. 10TH PLACE
    TEMPE, AZ 85281

18. MR. PHILIP FREY, JR., PRESIDENT
    MICROSEMI CORP./ARIZONA FACILITY
    P.O. BOX 4390
    SCOTTSDALE, AZ 85252

19. MR. BILL DIMITRO, DIR. OF PERSONNEL
    MOTOROLA INC./SEMICONDUCTOR PRODUCTS
    5005 EAST MCDOWELL ROAD
    PHOENIX, AZ 85008

20. MR. ARTURO AGUAYO, DIVISION MANAGER
    ROGERS CORP./CIRCUIT COMPONENTS DIVISION
    2400 S. ROOSEVELT ST.
    TEMPE, AZ 85282

21. MR. TERRY MILLER, MANAGER
    ROGERS CORP./MICROWAVE DIVISION
    P.O. BOX 3000
    CHANDLER, AZ 85244

22. MR. GARY SCHULKE, DIR. OF PERSONNEL
SPERRY CORP. AEROSPACE AND MARINE GROUP
2111 N. 19TH AV.
PHOENIX, AZ 85027

23. IBIS VALLES, DIR. OF PERSONNEL
SPERRY CORP.AEROSPACE AND MARINE GROUP
19019 N. 59TH AVE.
GLENDALE, AZ 85308

24. MR. TRYGVE MYHREN, CEO/CHAIRMAN
AMERICAN TELEVISION AND COMM. CORP.
160 INVERNESS DRIVE WEST
ENGLEWOOD, CO 80112

25. MR. FRANK CALETTI, GM
AMPEX CORP.
600 WOOTEN ROAD
COLORADO SPRINGS, CO 80915

26. MR. JAMES BRESLIN, GM/VP
AT&T DENVER WORKS
120TH & HURON
WESTMINSTER, CO 80234

27. MR. ED JEFFORDS, VP
AT&T NETWORK SYSTEMS
8300 E. MAPLEWOOD AVE.,RM 200N
ENGLEWOOD, CO 80111

28. MR. R.N. HERRING, PRESIDENT,B.A.S.D.
BALL AEROSPACE SYSTEMS DIVISION
P.O. BOX 1062
BOULDER, CO 80306

29. MR. ROBERT M. COLLINS, PRESIDENT
COBE LABORATORIES, INC.
1185 OAK ST.
LAKEWOOD, CO 80215

30. MR. JOE COORS JR., PRESIDENT
COORS CERAMIC CO.
600 9TH ST.
GOLDEN, CO 80401

31. MR. VERN DYKE, PLANT MANAGER
EASTMAN KODAK COMPANY/ COLORADO DIV.
WINDSOR, CO 80551

32. MR. ROBERT E. RANKIN, DIR. OF OPERATIONS
FORD AEROSPACE & COMMUNICATIONS CORP.
10440 STATE HIGHWAY 83
COLORADO SPRINGS, CO 80908

33. MR. BRIAN HEGARTY, VP/GM
HONEYWELL, INC./SOLID STATE ELECTRONICS DIV.
1150 E. CHEYENNE MTN BLVD.
COLORADO SPRINGS, CO 80906

34. MR. IRA LANGENTHAL, VP/GM
HONEYWELL, INC./TEST INSTRUMENTS DIV.
P.O. BOX 5227
DENVER, CO 80217

35. MR. GEORGE L. CORSILIA, GM
IBM CORP.
6300 DIAGONAL HIGHWAY
BOULDER, CO 80301

36. MR. W.T. STEPHENS, PRESIDENT/CEO
MANVILLE CORP.
P.O. BOX 5108
DENVER, CO 80217

37. MR. R.E. WEBER, VP PERSONNEL
MARTIN MARIETTA DENVER AEROSPACE
PO BOX 179
DENVER, CO 80201

38. MR. BRUCE W. VALORIS, DIR. OF PERSONNEL
MARTIN MARIETTA INFO. AND COMM. SYS.
P.O. BOX 1260
DENVER, CO 80201-1260

39. MR. GERALD W. GOODMAN, PRESIDENT
MINISCRIBE CORPORATION
1861 LEFTHAND CIRCLE
LONGMONT, CO 80501

40. MR. JOHN C. MEYER, VP HUMAN RESOURCES
NBI, INC.
3450 MITCHELL LANE
BOULDER, CO 80301

41. FRANCINE HAMMER, DIR. OF PERSONNEL
NORGREN (CA) COMPANY
5400 S DELAWARE
LITTLETON, CO 80120

42. MR. CECILE BARKER, PRESIDENT
OAO CORPORATION
1250 ACADEMY PARK LOOP, SUITE 110
COLORADO SPRINGS, CO 80910

43. MR. E.A. TOWNE, MANAGER, EXT. COMMUNICATIONS
ROCKWELL INTERNATIONAL/ROCKY FLATS FACILITY
P.O. BOX 464
GOLDEN, CO 80401

44. MR. RUDY J. KRASOVEC, MANAGER OF HUMAN RES.
SPERRY CORPORATION/PUEBLO OPERATIONS
1 WILLIAM WHITE BLVD.
PUEBLO, CO 81001

45. MR. J.N. MCLAGAN, VP GENERAL TECH. DIV.
STEARNS CATALYTIC CORPORATION/GEN. TECH. DIV.
P.O. BOX 5888
DENVER, CO 80217

46. MR. WILLIAM M. YOUNG, VP HUMAN RESOURCES
STORAGE TECHNOLOGY CORPORATION
2270 SOUTH 88TH ST.
LOUISVILLE, CO 80028

47. MR. GARY RILEY, PRESIDENT
TELEDYNE WATER-PIK
1730 EAST PROSPECT ST.
FORT COLLINS, CO 80525

48. MR. GARY RAWSON, DIR. HUMAN RELATIONS
TRW ELECTRONIC PRODUCTS, INC.
2650 N. NEVADA AVE.
COLORADO SPRINGS, CO 80907

49. MR. JOHN JESTER, PRESIDENT
US WEST INFORMATION SYSTEMS
6200 SOUTH QUEBEC
ENGLEWOOD, CO 80111

50. MR. JOHN DYNES, VP HUMAN RESOURCES
VALLEYLAB, INC.
P.O. BOX 9015
BOULDER, CO 80301

51. MR. ANDY MARFAT, PRESIDENT
VTM MICROWAVES, INC.
4975 W. 80TH AVE.
WESTMINSTER, CO 80030

52. MR. BOB POPE, PRESIDENT
WOODWARD GOVERNOR COMPANY
P.O. BOX 1519
FORT COLLINS, CO 80522

53. MR. W. BERMINGHAM, INDUST. RELATIONS MANAGER
MSE, INC.
INDUSTRIAL PARK P.O.BOX 3767
BUTTE, MT 59702

54. MR. JACK SCERICK, PRESIDENT
MULTITECH
BOX 4078
BUTTE, MT 59702

55. MR. KEN SELZER, PRESIDENT
SEMITOOL
655 W. RESERVE DRIVE
KALISPELL, MT 59901

56. MR. DONALD E. BENTLY, CEO
BENTLY NEVADA
BOX 157
MINDEN, NV 89423

57. MR. FRANK THATCHER, DIR. OF HUMAN RESOURCES
INTERNATIONAL GAME TECHNOLOGY
520 S. ROCK
RENO, NV 89502

58. MR. CARL NAUGLE, DIR. OF PERSONNEL
EG&G ENERGY MANAGEMENT INC.
2621 LOSEE RD.
N. LAS VEGAS, NV 89030

59. MR. DAVE P. BAILEY, SR. VP OPERATIONS
BDM CORPORATION
1801 RANDOLPH ROAD, SE
ALBUQUERQUE, NM 87106

60. ROSAURA CEPEDA, PERSONNEL
DIGITAL EQUIPMENT COPORATION
5600 KIRCHER BLVD.
ALBUQUERQUE, NM 87109

61. MR. JIM HARTMAN, PLANT MANAGER
INTEL CORPORATION/N. MEXICO OPERATIONS
4100 SARA RD.
RIO RANCHO, NM 87124

62. MR. RANDY S. NUNNALLY, PRESIDENT/GM
DYNAELECTRON CORPORATION
8500 MENAUL NE - A321
ALBUQUERQUE, NM 87112

63. MR. DON BORWHAT, PERSONNEL DIRECTOR
GENERAL ELECTRIC/AIRCRAFT ENGINES
336 WOODWARD RD. SE
ALBUQUERQUE, NM 87102

64. MR. BOB SMITH, DIR. OF PERSONNEL
SPERRY CORP. AEROSPACE & MARINE GROUP/ DEFENSE SYSTEMS
9201 SAN MATEO BLVD. N.E.
ALBUQUERQUE, NM 87113

65. MR. C.R. KRAUSE, PRESIDENT
DESERET MEDICAL INC.
9450 SOUTH STATE ST.
SANDY, UT 84070

66. DR. JULES MIRABAL, PRESIDENT
    EATON-KENWAY
    515 EAST 100 SOUTH
    SALT LAKE CITY, UT 84102

67. MR. DAVID C. EVANS, PRESIDENT/CEO
    EVANS & SUTHERLAND COMPUTER CORPORATION
    P.O. BOX 8700
    SALT LAKE CITY, UT 84108

68. MR. JON DEVAULT, VP
    HERCULES CORPORATION/AEROSPACE PRODUCTS GROUP
    528 SOUTH 320 WEST, SUITE 258
    MURRAY, UT 84107

69. MR. GABE SUSCO, PRESIDENT/CEO
    IOMEGA CORPORATION
    1821 WEST 4000 SOUTH
    ROY, UT 84067

70. MR. PAUL TIMOTHY, MANAGER OF INDUSTRIAL RELATIONS
    LITTON SYSTEMS, INC.
    2211 WEST NORTH TEMPLE
    SALT LAKE CITY, UT 84116

71. MR. GILBERT MOORE, DIR. OF EXTERNAL AFFAIRS
    MORTON THIOKOL INC.
    P.O. BOX 524
    BRIGHAM, UT 84302

72. MR. G.T. ENTWISTLE, PERSONNEL DIRECTOR
    SPERRY CORPORATION/SALT LAKE CITY
    322 NORTH SPERRY WAY
    SALT LAKE CITY, UT 84116

73. MR. JOHN GRAY, HUMAN RESOURCES MANAGER
    VARIAN EIMAC
    1678 S. PIONEER RD.
    SALT LAKE CITY, UT 84104

74. MR. JOHN DENNIS, PLANT MANAGER
    EATON PRINTER PRODUCTS
    TECHNICAL RESEARCH PARK
    RIVERTON, WY 82501

75. MR. JERRY V. PAYNE, PRESIDENT
    Y-TEX CORPORATION
    1825 BIG HORN AVE. BOX 1450
    CODY, WY 82414

APPENDIX C

LETTER OF REQUEST

Adams State College
ALAMOSA COLORADO 81102

School of Science, Mathematics, and Technology / (719) 589-7256

October 3, 1990

The Adams State College Department of Industrial Studies in Alamosa, Colorado needs your help. You have been selected to participate in a brief survey to recieve information concerning important curriculum content for majors in four-year Industrial Technology programs. The graduates from these programs seek employment in manufacturing industries leading to supervisory/management positions. The results from this survey will be used to help develop an instrument that will be used in a continual evaluation process to help upgrade Industrial Technology curriculums.

Please assist us by completing the inclosed survey. The survey takes approximately two minutes to fill out. For your convenience the survey has a return address and a stamp placed on it so that it can be refolded, stapled or taped and returned. Responses will be kept confidential. Please complete and return this survey as soon as possible. Analysis of the returned surveys will begin on October 19, 1990.

Your individual contribution and time are greatly needed and appreciated. As the department head of the Department of Industrial Studies I personally want to thank you for your response. If you have any questions or concerns regarding this survey, please feel free to contact me at (719) 589-7381.

Sincerely,

Duane A. Renfrow, Head
Department of Industrial Studies

enclosure

Adams State College
ALAMOSA, COLORADO 81102
School of Science, Mathematics, and Technology / (719) 589-7256

October 3, 1990

The Adams State College Department of Industrial Studies in Alamosa, Colorado needs your help. Your company has been selected to participate in a brief survey to recieve information from employers concerning what they deem as important curriculum content for majors in four-year Industrial Technology programs. The graduates from these programs seek employment in manufacturing industries leading to supervisory/management positions. The results from this survey will be used to help develop an instrument that will be used in a continual evaluation process to help upgrade the Industrial Technology curriculum.

Please assist us by completing the inclosed survey or routing it to the appropriate individual in your company and encourage their participation. The survey takes approximately two minutes to fill out. For your convenience the survey has a return address and a stamp placed on it so that it can be refolded, stapled or taped and returned. Responses will be kept confidential. Please complete and return this survey as soon as possible. Analysis of the returned surveys will begin on October 19, 1990.

Your individual contribution and time are greatly needed. As the department head of the Department of Industrial Studies I personally want to thank you for your response. If you have any questions or concerns regarding this survey, please feel free to contact me at (719) 589-7381.

Sincerely,

Duane A. Renfrow, Head
Department of Industrial Studies

enclosure

APPENDIX D

INSTRUMENTS

Adams State College
ALAMOSA, COLORADO 81102

Industrial Technology Educational Requirements Survey

School of Science, Mathematics, and Technology / (719) 589-7256

Which of the following topics would be beneficial to four year program Industrial Technology majors seeking supervisory/management positions in industry? Please place a check in the appropriate blank according to the degree of importance.

(5) VERY IMPORTANT, (4) IMPORTANT, (3) NEUTRAL, (2) UNIMPORTANT, (1) NOT NEEDED

	(1)	(2)	(3)	(4)	(5)
1. ALGEBRA					
2. GEOMETRY					
3. TRIGONOMETRY					
4. CALCULUS					
5. STATISTICS					
6. BIOLOGICAL SCIENCE					
7. PHYSICS					
8. CHEMISTRY					
9. BASIC COMPUTER PROGRAMMING					
10. WORD PROCESSING					
11. SPEECH					
12. ECONOMICS					
13. TECHNICAL WRITING					
14. ACCOUNTING					
15. MARKETING					
16. MANAGEMENT					
17. DRAFTING TECHNOLOGY					
18. GRAPHIC ARTS TECHNOLOGY					
19. COMPUTER AIDED DESIGN					
20. FREE HAND DRAWING					

	(1)	(2)	(3)	(4)	(5)
21. MAT PROCESSING-METAL					
22. MAT PROCESSING-WOOD					
23. MAT PROCESSING-PLASTIC					
24. MANUFACTURING TECH.					
25. INDUSTRIAL SAFETY					
26. NUMERICAL CONTROL PROG.					
27. COMPUTER INTEG MANUF.					
28. ROBOTICS TECHNOLOGY					
29. ELECTRICITY					
30. ELECTRONICS					
31. POWER SYSTEMS					
32. HYDRAULICS & PNEUMATICS					
33. BASIC FIRST AID					
34. STRENGTH OF CONST MAT.					
35. CONSTRUCTION TECHNOLOGY					
36. INDUSTRIAL INTERNSHIPS					
37. LEADERSHIP					
38. PROBLEM SOLVING					
39. COMMUNICATIONS					
40. TRANSPORTATION SYSTEMS					
41. OTHER ____________________					

COMMENTS: ____

____

____

____

____

Adams State College
ALAMOSA, COLORADO 81102

Industrial Technology Educational Requirements Survey

School of Science, Mathematics, and Technology / (719) 589-7256

Which of the following topics would be beneficial to four year program Industrial Technology majors seeking supervisory/management positions in your industry? Please place a check in the appropriate blank according to the degree of importance. If you feel that supervisory/management personnel in the industry that you represent do not benefit from a four-year Industrial Technology degree indicate by checking the box below.

☐ *Supervisory/management personnel in the industry that I represent do not benefit from a four-year or higher Industrial Technology degree.*

(5) VERY IMPORTANT, (4) IMPORTANT, (3) NEUTRAL, (2) UNIMPORTANT, (1) NOT NEEDED

	(1)	(2)	(3)	(4)	(5)		(1)	(2)	(3)	(4)	(5)
1. ALGEBRA						21. MAT PROCESSING-METAL					
2. GEOMETRY						22. MAT PROCESSING-WOOD					
3. TRIGONOMETRY						23. MAT PROCESSING-PLASTIC					
4. CALCULUS						24. MANUFACTURING TECH.					
5. STATISTICS						25. INDUSTRIAL SAFETY					
6. BIOLOGICAL SCIENCE						26. NUMERICAL CONTROL PROG.					
7. PHYSICS						27. COMPUTER INTEG MANUF.					
8. CHEMISTRY						28. ROBOTICS TECHNOLOGY					
9. BASIC COMPUTER PROGRAMMING						29. ELECTRICITY					
10. WORD PROCESSING						30. ELECTRONICS					
11. SPEECH						31. POWER SYSTEMS					
12. ECONOMICS						32. HYDRAULICS & PNEUMATICS					
13. TECHNICAL WRITING						33. BASIC FIRST AID					
14. ACCOUNTING						34. STRENGTH OF CONST MAT.					
15. MARKETING						35. CONSTRUCTION TECHNOLOGY					
16. MANAGEMENT						36. INDUSTRIAL INTERNSHIPS					
17. DRAFTING TECHNOLOGY						37. LEADERSHIP					
18. GRAPHIC ARTS TECHNOLOGY						38. PROBLEM SOLVING					
19. COMPUTER AIDED DESIGN						39. COMMUNICATIONS					
20. FREE HAND DRAWING						40. TRANSPORTATION SYSTEMS					
						41. OTHER ____________					

COMMENTS: ____

____

____

____

2

VITA

Duane Alan Renfrow

Candidate of the Degree of

Doctor of Education

Thesis: DEVELOPING AN INSTRUMENT TO SURVEY THE PERCEPTIONS OF INDUSTRIAL REPRESENTATIVES CONCERNING THE EDUCATIONAL REQUIREMENTS OF INDUSTRIAL TECHNOLOGY MAJORS

Major Field: Occupational and Adult Education

Biographical:

Personal Data: Born in Pawhuska, Oklahoma, April 9, 1955, the son of Mr. and Mrs. Oscar L. Renfrow.

Education: Graduated from Pawhuska High School, Pawhuska, Oklahoma in May, 1973; received the Bachelor of Science degree in Industrial Arts Education from Oklahoma State University in May, 1979; completed requirements for the Master of Science degree in July, 1985; completed requirements for the Doctor of Education degree in May, 1991.

Professional Experience: Student teaching, fall semester, 1978, Pawnee High School, Pawnee, Oklahoma; industrial arts teacher, fall 1979 through spring 1982, Sharon Public Schools, Sharon, Kansas; industrial arts teacher, fall 1982 through spring 1984, Sallisaw High School, Sallisaw, Oklahoma; graduate teaching assistant, fall 1984 through summer 1986, Oklahoma State University, Stillwater, Oklahoma; assistant professor/department head, fall 1986 to present, Adams State College, Alamosa, Colorado.

Professional Organizations: Colorado Technology Education Association