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Development of a high technology curriculum for industrial technology at Keene State College.

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DEVELOPMENT OF A HIGH TECHNOLOGY
CURRICULUM FOR INDUSTRIAL TECHNOLOGY
AT KEENE STATE COLLEGE

A Dissertation Presented

by

DELMAR R. OGG

Submitted to the Graduate School of the
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Education

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ABSTRACT

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CURRICULUM FOR INDUSTRIAL TECHNOLOGY
AT KEENE STATE COLLEGE

SEPTEMBER, 1987

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"High technology" has significantly changed manufacturing technology in the world and created a lag between the career demands imposed on industrial technologists and their educational preparation in Industrial Technology programs.

This research project identified and ranked technical competencies judged by industrial personnel to be essential in the education of graduates of Keene State College's Industrial Technology program to enter and effectively participate in industrial careers affected by the impact of high technology. The following questions were answered:

1. What technical competencies should be acquired by Industrial Technology students in consideration of the impact of high technology on industry?
2. Will company size significantly affect the importance of each technical competency as reported by industrial personnel?

A survey instrument consisting of 61 technical competencies was developed, scrutinized by a panel of industrial consultants and KSC

Industrial Technology faculty, and distributed to 548 "Managers of Manufacturing" of companies throughout six New England states. Companies were randomly selected from the Duns Market Identifiers computer data base using limitors of state (ME, NH, VT, RI, CT, and MA), SIC CODE (Division D, Groups 30, 34, 36, 36, 37, and 38), and company size by number of employees. The collected data were analyzed using the latest version of the Statistical Package for the Social Sciences on a VAX computer. The results were displayed in tabular form showing frequency distributions, percents, and crosstabulations. Two lists of technical competencies presented in rank order of importance were developed based upon two different statistical measures.

Results of the study emphasize the magnitude of importance of particular competencies, relationship among competencies, and implications for curriculum considerations derived from the analysis of research data.

Based upon the results of this study, it was concluded that: (1) New England Industrial Technology programs should consider the implementation of important technical competencies identified by this study. (2) High tech competencies must be strong components in programs, but traditional and fundamental competencies must be maintained. (3) Broad technical education emphasizing concepts is preferred to skill development. (4) Design is not considered an appropriate task for the industrial technologist. (5) Computer application should be stressed rather than programming. (6) Planning and control of manufacturing are important competencies for industrial technologists. (7) Company size was not an important factor.

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CHAPTER I

ORIENTATION TO THE STUDY

Introduction and Background to the Problem

The increasing number of high tech industries and the presence of high tech equipment and processes in existing industries is forcing Industrial Technology program faculty members to critically analyze course content and curriculum offerings. To continue technology education focusing on "traditional" technology and to ignore the impact of the silicon chip present in the form of computer systems like CAD, CNC, and robotics is seriously limiting the employability of technology program graduates. Curriculum revision, faculty competency, and equipment acquisition are major concerns faced by educational institutions because of the impact of high technology.

Unfortunately, many technology educators distinguish high tech as the "good" and traditional tech as the "bad". Edward E. David, Jr. states:

> ...we are in the midst of a momentous change toward what has been called the post-industrial society. But this change must not be allowed to induce a systematic bias against presumed "sunset" industries in favor of supposed "sunrise" industries. It must not produce a strategy of reindustrialization that pits our basic industries against high technology corporations. These two sectors are not

adversarial; in fact, they have essential common interests.[1]

Technology educators need to modify curriculum, but changes need to be made that reflect the integration of high tech with traditionaltech, not the replacement of one by the other. Virtually all industries must adopt aspects of high tech to one degree or another to survive in the fiercely competetive world economy of today and the future.

Close working relationships between education and industry can result in a pool of technically competent prospective employees who have been educated through programs designed to meet the needs of industry. Without this relationship change will occur slowly, inefficiently, and inaccurately jeprodizing the credibility of technical programs and the efficiency and productivity of industry. Technically sophisticated graduates who understand high tech subjects like computer programming, electronics, robotics, and telecommunications as well as traditional technical subjects such as machine shop, drafting, welding, foundry, etc. are valuable additions to any industry. These individuals possess knowledge and skills allowing them to function in high tech industries or to assist traditional industries in their transistion to the utilization of high tech processes and techniques.

Historically, technology programs typically lag industry in technical currency, and strategies must be utilized to minimize the discrepancy. Internships, cooperative education, plant tours, workshops and seminars, and the use of adjunct faculty from local industry are several means used to solve this problem, but these techniques are not substitutes for a strong and current curriculum. By using these techniques combined with a technically current curriculum, quality technical education is not only possible, but it is beneficial to students, industry, and, ultimately, society.

DuVall wrote that the gap between what is happening in the industrial world and what is taking place in most technical programs must be eliminated.[2] The emergence of many four-year postsecondary technical education programs in the United States resulted from the development of programs utilizing the courses, faculty, and facilities of former Industrial Arts and Vocational Education teacher education programs according to Banister.[3] In many cases new technology programs were actually different groupings of existing "shop" courses with a new title like "Industrial Technology" added. Supposedly, these graduates were being prepared for industry instead of an I.A./Voc. Ed. teaching position in secondary schools. Many programs were established in the 60's and early 70's. Increasing industry salaries and low, unchanging teaching salaries were partially responsible for the increased interest by students to major in technology programs and the decreased interest to major in teacher education.

Programs have grown and been improved by the adoption of more industry oriented courses such as quality control, methods and time study, and plant layout while decreasing the emphasis on laboratory skill development. The degree of this evolution varies significantly from program to program, but even the best programs, as well as the worst programs, are facing the need for revision because of the high tech impact. Graduates must experience sophisticated technology education, not simply the "make and take" project oriented shop classes of the past. Computers, microprocessors, servos, CNC, CAD, and digital electronics are terms in the vocabulary of today's and tomorrow's technologists, and accurate identification of the competencies needed in these areas is absolutely necessary through education/industry relationships.

History of Industrial Technology at Keene State College

An Industrial Technology Curriculum Development Committee consisting of four industrial education department faculty was established in 1973 for the purpose of writing a proposal for the implementation of an Industrial Technology program at Keene State College. The efforts of this group resulted in Industrial Technology being added to the curriculum offerings of KSC in the Fall of 1975.

Throughout the history of KSC, Industrial Arts Teacher Education has been the singular program in the Industrial Education Department until the development and implementation of three two-year technical programs in 1969. These programs were in Machine Processes, Drafting and Design, and Industrial Electronics. Adams Technology Building was added to the campus to support the new programs with laboratories, lecture rooms, and faculty offices. The I.A. Teacher Education program benefited enormously by this department addition since labs were shared by all programs, supply budgets increased, and new faulty members were hired.

Realizing a need for an appropriate bachelor's degree program that would fulfill two specific needs as well as serve industry better, Industrial Technology was developed at KSC. The needs this new program intended to meet were:

1. to provide an extension of KSC's two-year technical program so interested and qualified graduates could pursue a four-year degree.
2. to provide an alternative for teacher education students who decide at some point in their college years not to continue to prepare for a career in teaching and prefer pursuit of a career in industry.

These practical, in-house objectives motivated the departmental faculty to develop Industrial Technology and, since existing faculty, facilities, and equipment were to be utilized, the proposal was expediently passed through the various college curriculum committees and the college senate and accepted in 1975.

Efforts extended by the IET Department faculty, the Technical Advisory Committee consisting of local industrialists, and consultants from other Industrial Technology programs culminated in a program strong in technology, management, math and science, and general education. Since the program's inception, numerous revisions and modifications have been made to improve program requirements and course contents. Motivation for change has been through faculty perception of changing technology, enrollment trends signifying student interest, and administrative pressure to increase cost effectiveness. Most of the changes that have occurred have had the scrutiny and approval of an industrial advisory or craft committee.

Current literature regarding the impact and scope of high technology suggests that it is crucial that the IET Department look to sources of input other than its own faculty and local industry for future direction of the Industrial Technology program. A wider perspective of goals for the I.T. program will help assure that graduates will be prepared for industrial careers regardless of the location of their industrial career position.

Industrial Technology Program Structure and Requirements

Industrial Technology students at KSC are required to complete coursework as follows:

Technical Education - 48 credits

Management - 15 credits

General Education - 59 credits including;

Math/Science - 29 credits

Social Sciences - 12 credits

Arts and Humanities - 18 credits

This array of subjects is designed to produce liberally educated graduates with strong technical education backgrounds coupled with principles of management and strong math and science preparation.

Within the "technical education" of the Industrial Technology program, students must select one of four options for concentration. These options are: Manufacturing, Drafting and Design, Industrial Electronics, and General Technology. Each option consists of in-depth technical coursework in each respective concentration resulting in individuals with skills and knowledge of a high proficiency level.

Recent faculty discussions have suggested the need for curriculum revision in the following areas:

1. More management/supervision/control types of courses are

needed. Quality control, cost estimation, plant layout, and production and inventory control courses are examples.

2. Less concentration and depth in a single technical area is favored to provide more opportunity for students to obtain a broader overview of all important aspects of technology. A specific example of this is an Industrial Technology major who is concentrating in the Drafting and Design option. This person would have not experienced important and common technical experiences in electronics, robotics, or hydraulics, but the person is labled as a technologist. Relating to this issue have been discussions suggesting the development of a "technology core" of courses that would be required in all I.T. options. Several department meetings have been devoted to discussing the concept of a common core. An investigation of other school's program requirements and the National Association of Industrial Technology certification requirements is being conducted to determine if this approach is being used in some programs and what courses comprise this core.

3. Latest high tech theory and applications should be incorporated in the curriculum wherever possible. The need to accurately identify this content was the primary motivation behind this research project.

Statement of the Problem

This research project identified and ranked technical competencies judged to be essential in the education of graduates of Keene State College's Industrial Technology program to enter and effectively participate in industrial careers affected by the impact of high technology. These competencies will be evaluated by the Industrial Education Department faculty and compared to existing I.T. course contents to identify areas for change. The following questions were answered:

1. What technical competencies should be acquired by Industrial Technology students in consideration of the impact of high technology on industry?
2. Will company size significantly affect the importance of each technical competency as reported by industrial personnel?

Purpose of the Study

This study was conducted to provide critical data for the evaluation of the Industrial Technology curriculum at Keene State College and to establish future directions for the program. Information was acquired from various industries throughout the New England region to provide a perspective much broader than previous input which has been limited to industries in the Keene, NH area. In addition to curriculum revisions that will undoubtedly result from this study, implications for faculty retraining, equipment purchases, and facility modifications or additions have been realized. The study could be the basis for the most extensive departmental transition in its history.

Now that this study has been completed, the results will be distributed to all faculty, administrators, and advisory committee members involved in the development and operation of the IET Department. Special advisory committee and departmental meetings will be devoted to comparing the results of this study to the content of the existing technology curriculum. Once discrepancies have been identified and the faculty have decided to implement change to correct these discrepancies, the established KSC curriculum development process will begin. This involves the writing of proposals and submission of these proposals for discussion and approval to the IET Department, the Divisional Curriculum Committee, the College Senate Curriculum Committee, and finally, the College Senate.

Significance of the Study

This study is critical for the maintenance of the quality, currency, and continuance of the Industrial Technology program at Keene State College. Curriculum modification to insure contemporary content that matches industrial practices results in appropriately prepared graduates with abilities allowing them to succeed in their careers.

The project also resulted in the acquisition of data from a population that has not been previously surveyed. The use of advisory and craft committees from industries within the Monadnock Region has been past practice at KSC. Selected industries from New England were used to gather input, thus providing a much broader perspective of current industrial practices which added credibility to the study. Sixty percent of the students at KSC are out-of-state students from various New England states, and the majority of these students return to their home state for employment after graduation.

The primary objective of this study was to identify technical competencies industry perceives as necessary for graduates of KSC's Industrial Technology program.

Delimitations

This study was conducted assuming the following factors:

1. The survey instrument developed included technical competencies representative of those perceived as critical for I.T. graduates with input from KSC Industrial Technology faculty, current literature, and the author of this research project.
2. The population surveyed was "Managers of Manufacturing" (or similar personnel) from randomly selected manufacturing industries in New England.
3. Input from KSC Industrial Technology faculty and participating industrialists was complete and accurate and submitted within identified time parameters.
4. This research project resulted in a source of information to be used for future curriculum modification within the Industrial Technology program at Keene State College.

Definition of Terms

For purposes of this research project the following terms were utilized as defined below:

Industrial Technology:

Industrial Technology consists of degree programs of study designed to prepare management-oriented technical professionals in the economic-enterprise system.

Industrial Technology degree programs and professionals in Industrial Technology careers typically will be involved with:

1. the application of significant knowledge of theories, concepts, and principles founded in the humanities and the social and behavioral sciences, including a thorough grounding in communication skills;
2. the understanding and ability to apply principles and concepts of mathematical and physical sciences;
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, and may include;
4. a field of specialization, for example: electronic data processing, computer integrated design and manufacturing, construction, energy, polymers, printing, safety, and transportation.[4]

<u>High Technology</u>

The technology influenced by the computer on engineering and design, planning and scheduling, fabrication and assembly, and marketing and distribution.[5]

An Ohio Task Force on High Technology has proposed that:

The term "high technology' characterizes: processes, products, and applications stemming from the latest scientific and technical development; utilization of high levels of artificial or machine intelligence and information decision capabilities; and extension of human manual and intellectual capacities through the use of computer technology and the application of sophisticated physical principles.[6]

Technical Competency:

Demonstrated performance of knowledge or skills relating to career oriented tasks of the Industrial Technologist.

Manufacturing Industry:

An organization which uses the resources of machinery, materials, and people to produce a product.

CHAPTER II

REVIEW OF THE LITERATURE

This review of literature examines studies pertaining to current curriculum development in industrial technology programs, and, in particular, includes studies that involve the survey technique of obtaining information for decision making regarding modification of industrial technology curricula.

Curriculum revision in technology program typically occurs as a result of input from three sources:

1. Faculty knowledge and perception of changing technology acquired through study or personal experiences in industry.
2. Utilization of advisory or craft committees of industrial personnel to recommend change or new direction for technology curricula.
3. Surveys of technology program graduates, industrial personnel, and/or faculty and administrators of other technology programs.

This study involved surveying industrial personnel so, therefore, the review of literature focuses on studies of that kind.

Curriculum Studies

In a study done by Douglas Pickle identification of essential high technology course offerings within the curricula of industrial technology was accomplished. This study was conducted by using two surveys: one survey was sent to high technology industries, and the other was sent to post-secondary institutions with Industrial Technology or Technology Education Departments. Industrial personnel were asked to identify specific courses they believed to be most beneficial to high technology, and schools were asked to provide information about courses that incorporate the computer as a teaching tool or as a controlling device for machines. Responses from the two groups were compared to identify a high technology curriculum.

The following conclusions were drawn:

1. The degree most preferred by industry for college graduates in high technology was the Bachelor of Science in Electrical Engineering.

2. Most Industrial Technology and Technology Education Departments offer four to six courses in high technology.

3. Most industries plan to expand their facilities to include high technology equipment.

4. Most Industrial Technology Departments and Technology Education Departments plan to expand the number of courses offered to include courses in high technology.

5. Colleges and universities believe that Computer-Aided Design is the most conducive course for implementing a high technology program in the curricula of Industrial Technology and Technology Education Departments.

6. Industrial needs for high technology courses and current course offerings of Industrial Technology and Technology Education Departments differ significantly.

7. Industry believes that Computer Electronics and Digital Electronics are the most beneficial electricity/electronics courses for high technology.

8. General Electricity and Statics are seen by industry as the least desirable electricity/electronics courses for high technology.

9. Electronics Drafting, Computer Graphics, and Computer Plotting are the most beneficial drafting courses for

high technology in industry.

10. Descriptive Geometry is the least desirable drafting course for high technology in industry.

11. Fortran IV is the most beneficial computer programming course for high technology in industry.

12. ALGOL and ASCII are the least desirable computer programming courses for high technology in industry.

13. Computer-Aided Manufacturing and Manufacturing Processes are the most beneficial manufacturing courses for high technology in industry.

14. Welding and Metal Casting Processes are the least desirable manufacturing courses for high technology in industry.

15. Differential Equations is the most beneficial science and mathematics course for high technology in industry.

16. Atomic and Nuclear Physics is the least desirable science and mathematics course for high technology in industry.

17. Other courses identified by industry as beneficial to high technology are Operations Research, Communications, Computer Organization, and Computer Architecture.

18. With regard to other courses that utilize the computer as a teaching tool, Principles of Numeric Controls and Graphics are the most frequently offered on the college or university level.

Mr. Pickle offered the following recommendations based upon the results of his study:

1. Industrial Technology and Technology Education Departments should include in their curricula such advanced electricity/electronics courses as Computer Electronics and Digital Electronics.

2. Industrial Technology and Technology Education Departments should include in their curricula such drafting courses as Electronics Drafting, Computer Graphics, and Computer Plotting.

3. Industrial Technology and Technology Education Departments should include the computer programming course entitled Fortran IV in their requirements for bachelor's degrees in

industrial technology and technology education.

4. Industrial Technology and Technology Education Departments should include in their curricula such manufacturing courses as Computer-Aided Manufacturing, Manufacturing Processes, and Quality Control.

5. Industrial Technology and Technology Education Departments should include an advanced mathematics course entitled Differential Equations as part of their curricular requirements for bachelor's degrees in industrial technology and technology education.

6. Other courses that should be considered as additions to the curricula of Industrial Technology and Technology Education Departments are Operations Research Communications, Computer Organization, and Computer Architecture.

7. Industrial Technology and Technology Education Departments need to evaluate their curricula and implement those courses most beneficial to the high technology industry located within the service area of the college or university.

8. Industrial Technology and Technology Education Departments should expand their facilities and curricula to include technology equipment and its applications.

9. Computer-Aided Design is the high technology course that should be incorporated into the curricula of Industrial Technology and Technology Education Departments for the purpose of implementing a high technology program.

10. At least four to six high technology courses should be offered by Industrial Technology and Technology Education Departments.[7]

Lambert studied the perceptions of Industry and Technology graduates of East Texas State University toward program requirements and used the findings to evaluate departmental offerings. Information was collected from graduates employed in industry and formed the basis for these conclusions:

1. The courses taken most frequently were metal manufacturing processes, accident prevention, and engineering graphics.

2. A need was established for more courses in industrial supervision, numerical control technology, and mechanics and strengths of construction materials.

3. A need was expressed with respect to increased assistance in job placement, upgrading objective grading practices of instructors, and creation of adequate classroom and laboratory facilities.[8]

A study by Kirchner and Blakeney at Northeastern University focused on the identification of factors that posed threats to the future of technical academic programs. The authors stated a concern for the future of high technology because of the perceived deterioriation of technical programs in the United States. The following factors contributing to this deteriorization were identified:

1. School budget constraints.

2. Teachers planning to leave the profession because of insufficient salaries.

3. Poor relations between teachers and high technology industries.

Although not specifically stated above, the impact of inappropriate curriculum content is implied in this study as it related to the decline of technical programs.[9]

At Southeastern University, Miller conducted a curriculum evaluation project involving graduates of the Industrial Technology Department. The study was performed to identify factors which could be used in decision making regarding the future of the department. 260 individuals responded to surveys sent to 294 graduates, and the following recommendations were based upon the data collected:

1. A periodic follow-up of graduates should be undertaken to serve as a basis for curriculum evaluation and revision and as a means for improving instruction.

2. An examination of the recruiting program of the Industrial Technology Department should be made in order to improve its effectiveness.

3. The University and the Industrial Technology Department should consider the feasibility of a graduate program in Industrial Arts Education and/or Industrial Technology in view of the small number of graduates who have achieved higher degrees and the large number of graduates who remain concentrated in the area.

4. Because of the high concentration of departmental graduates within the area, a survey of local industries should be undertaken to determine what these industries require of the graduates of the Industrial Technology Department at Southeastern Louisiana University.

5. Additional course work in specific technical areas should be offered to provide greater depth in all curricula.

6. The mathematics requirement should be increased, based on the expressed need in each curricular area.

7. The physical science requirement should be increased in the curriculum of industrial technology.

8. A technical writing course should be a curriculum requirement for industrial management technology and industrial technology majors.[10]

In response to the problem of continually updating technical curriculum to reflect technological changes in industries, Wieking developed a model to identify technological trends for use in industrial curriculum planning. Weiking's goal was to provide educators with a means of forecasting future trends so they would have adequate time to modify curiculum, alter facilities, purchase equipment, and train faculty. The accelerated rate of technological change has made it exceedingly difficult for technology programs to remain current. Weiking's study was for the purposes of:

1. To develop a conceptual model for identifying technological trends in industry and quantifying the impact of these trends would have on seven curriculum

planning elements.

2. To test the conceptual model with respect to its usability by putting it to use in an automotive power plant manufacturing industry located in the United States.

3. To forecast and describe technological changes in the automobile plant manufacturing industry of the United States, and

4. To identify the impact which these technological trends would have on industrial education curricula.

The instruments developed and used by Weiking were applied to his study in the automotive industry, but the model is generalizable to other technologies as well. The findings of this study are as follows:

1. The model for identifying technological trends was generally usable. Changes in the method for rating the amount of growth or decline in the use of a technology will have to be modified to make possible the forecasting of technologies which do not now exist.

2. Fifty automotive power plants' technologies were rated according to the amount of growth or decline in anticipated usage. Thirty-one technologies were identified as emerging, while nineteen were identified as declining.

3. Curriculum impact data, consisting of complexity weighting factor and curriculum impact ratings, were established for the effect the fifty automotive trends would have on seven curriculum planning elements.[11]

To determine core curriculum needs of students in industrial technology programs, Porchia surveyed industrial personnel and administrators of Industrial Technology programs to find answers to these problems:

1. The identification of functional characteristics of the technologists in industry;

2. The determination of a general educational core curriculum that would most nearly meet the needs of four-year technology programs in the areas of building and construction, drafting and design, machine tools,

automotive, electronics, printing, and metal fabrication;

3. The comparison of industry's values of specific general educational subjects with the values of personnel of colleges and universities offering four-year technology programs; and

4. The procurement of recommendations from areas of general education regarding the most desirable general subject matter content.

Porcia's findings are as follows:

1. The technologist's major job function in industry is working with data; the second most important job function of the technologist is working with people.

2. The technologist is most concerned with analyzing and synthesizing data.

3. The technologist's <u>Dictionary of Occupational Titles</u> code number should be .250.

4. A gap seemed to exist between educators' perceptions of the technologist's job functions and industrial employers' expressions of the job functions of the technologist in industry. Significant differences of opinions (at the .05 level) existing between school personnel and industrial representatives as to the frequency of performance of three of the twenty-one tasks listed.

5. The curriculum for the baccalaureate degree industrial technology program should be relevant to required job functions as indicated by industrial employers.

6. Courses that would prepare students to analyze and synthesize data should be included along with courses in human behavior and the practical application of material processes.

7. The technologist should possess a strong background in the areas of communications, science and mathematics, human relations, and business administration.

8. A high level of agreement was evident between industry and education regarding the overall value of courses offered to the technologist. Of the eighty-three courses listed within the study, only ten yielded significant differences in value when data from the two groups were compared.[12]

In 1982, Parrish conducted a follow-up study to evaluate present curriculum and to determine future directions and objectives for the Industrial Techhology Department at Southeastern Louisiana University. Input from graduates and local industrial personnel was obtained to assess overall program effectiveness. Specific questions to be answered were as follows:

1. Were the Industrial Technology Department graduates benefiting from their education?

2. What types of positions did they hold?

3. How did the Industrial Technology Department graduates from Southeastern Louisiana University rate their educational preparation for employment in their respective fields?

4. Did these graduates need such additional education as a graduate degree?

5. How did area industries rate the Industrial Technology curriculum at Southeastern Lousiana University?

6. How could area industries assist the Industrial Technology Department in fulfilling its objectives?

The results of this study provided a large quantity of data upon which decisions regarding programmatic revision could be made and future departmental directions could be established.[13]

In a recent study, Parrish and Pickle surveyed high technology industries to determine which industrial technology courses would most benefit their industries. The survey instrument was divided into the following major course areas: Electricity/Electronics, Drafting/Design, Computer Science, Manufacturing, and Science/Mathematics. Under each major area specific industrial technology courses were listed for ranking by participants. The conclusions and recommendations resulting from an analysis of the collected data are:

1. Industrial Technology Departments should place high emphasis on electronics and related courses.

2. In the next few years, the majority of industries surveyed plan to expand their facilities to include high technology equipment thus providing a demand for highly trained and educated personnel for high technology.

3. Drafting courses should include computer oriented coursework such as graphics and plotting.

4. High level programming courses should be required as part of Industrial Technology Degree programs.

5. Manufacturing courses should include computer applications, manufacturing processes and quality control.

6. The majority of high technology companies require advanced science and mathematics skills.

7. Industrial Technology Departments need to evaluate their curricula and implement those courses most beneficial to the high technology industry located within the service area of the college or university.

8. Industrial Technology Departments should expand their facilities and curricula to include high technology equipment and its applications.[14]

Soska reviewed Kimbrell's study at Washington State University which surveyed industry to gain impressions of recent engineering and technology graduates and reported:

1. Most graduates are unaware of available products.

2. They cannot interpret manufacturers' catalogues and are unable to select components for the design of an assembly.

3. They are largely unfamiliar with modern manufacturing processes, and have no appreciation of the influences of manufacturing processes on design.

4. They are not well-versed in codes and standards, and know little about reliability.

5. They are well-trained in the theories of material science, but poorly so in the application of the theories of materials specification or selection of a material for a given operation.

6. They are markedly deficient in their knowledge of the basic hardware normally used in industrial applications.

7. They have little or no understanding of the fact that time and cost are related.

8. They are weak in programming ability in high-level languages - not a serious deficiency but nonetheless a hindrance when it comes to using a computer or interpreting its output.

9. They are deficient in both oral and written communication skills.[15]

Summary

This chapter included studies of related research devoted to curriculum development in industrial technology programs. It is apparent that industrial technology graduates, industrial technology program administrators, and industrial personnel have been surveyed by many researchers seeking input about what the "best" industrial technology curriculum should be. Many of the studies address future direction, courses to be included, or problems affecting programs, but none answer the question about what specific technical competencies industrial technology students should acquire through participation and completion of an Industrial Technology program.

This study is an extension of previous research in Industrial Technology and provides valuable information to assist technology faculty in selecting appropriate content for their technology curricula.

CHAPTER III

RESEARCH METHOD

To obtain the data necessary to answer the research questions associated with this study, the use of a regional survey of managers of manufacturing industries was employed.

This chapter describes the population surveyed, the nature of the survey instrument, the distribution and collection procedures, and the analysis and reporting techniques used to report and interpret the data.

Description of the Population

The population from which the surveyed samples was selected consisted of small (25-149 employees) and large (150 or more employees) manufacturing companies from the New England states of Maine, New Hampshire, Vermont, Rhode Island, Massachusetts, and Connecticut. These companies were restricted by SIC (Standard Industrial Classification) numbers to kinds of companies in which Keene State College Industrial Technology graduates are employed or are qualified for employment by virtue of the Industrial Technology curriculum options available at KSC. SIC categories used were Machinery, Fabricated Metal, Rubber and Plastics, Electrical Machinery, Transportation, and Instruments.

Identification of the total numbers of small and large manufacturing companies within each state was done by conducting a computer data base search at the Keene State College Library. The data base searched was the Duns Market Identifiers (December, 1986 version) available from Dialog Information Services, Inc. of Palo Alto, California. This process was relatively simple to perform and extremely fast.

Once the total numbers of small and large companies in each state had been obtained, the use of a computer program designed to select random numbers was utilized in the KSC Computer Center. Entered into the program was the number of companies of each size and state as well as the desired sample size. The resulting output was randomly selected lists of specific numbers which identified companies to be included in the sample.

Having acquired the random numbered lists, the Duns data base was searched again with the specific numbers used as identifiers of companies. The result of this process was mailing labels for each company to be surveyed including company name and address. The data base search and the mailing labels were moderately expensive, but the process was fast and easy to do. Unfortunately, the search did not identify the Manager of Manufacturing for each company. To obtain this "field" of information from the data base, the cost was prohibitive so a long and laborious manual search of various industrial directories for each state was conducted.

The ideal sample size was established by calculation in consideration of the total population size and the statistical analysis to be performed on the acquired data. It was decided that 548 surveys would be mailed with anticipated returns of 240 completed surveys (120 small companies and 120 large companies) to be the maximum number needed.

The following data describe the populations and samples used in this study:

Populations

	ME	NH	VT	MA	CT	RI	TOTAL
Number of Small Manufacturing Companies	51	129	36	757	514	135	1622
Number of Large Manufacturing Companies	37	109	32	501	347	71	1097
						TOTAL:	2719

Samples

	ME	NH	VT	MA	CT	RI	TOTAL
Number of Small Companies Surveyed	10	26	7	152	104	28	327
Percentage	20	20	20	20	20	20	20
* *							
Number of Large Companies Surveyed	8	22	7	100	70	14	221
Percentage	20	20	20	20	20	20	20
						TOTAL:	548

The decision to survey personnel who possess the "Manager of Manufacturing" title is based upon the need for input from individuals who are familiar with the total scope of industrial operations that typically employ the graduates of industrial technology programs. Positions in industrial or manufacturing engineering, quality control, production planning, and methods analysis and time study are some of those positions filled by industrial technologists and are positions under the responsibility of the Manager of Manufacturing in industry.

The study was limited to the New England region because this is the geographic area in which the majority of graduates of KSC's Industrial Technology program are employed. This has been determined from information available in the Alumni Office at KSC. It appears that KSC attracts students from the New England area and provides an educational program for these students, and then the students seek and find employment at or nearby their home.

One objective of this study was to gain input from industry outside of the Keene, N. H. area which is already represented by advisory committees of local industrialists. Expanding this study to the New England region accomplished this objective, and limiting this study to this region insured that the findings are pertinent to KSC's Industrial Technology program and its graduates.

Development of Research Instrument

The following procedure was used to develop the research instrument used in this study:

1. A list of technical competencies typically included in technology programs was developed by the researcher. The sources of this information were other research projects, current literature, and information from other institutions having Industrial Technology programs. The list of competencies does not include work habits, communication skills, or "general education" competencies

for the purpose of limiting this study to a manageable size.

2. The first draft of the survey instrument was distributed to each faculty member of KSC's Industrial Technology Department with the request for each person to complete the survey and to note any omissions, errors, or inadequate statements - particularly with respect to their own technical specialties. This resulted in considerable modifications, and the process was repeated with the faculty. Minor revisions were made after the last examination.

3. The revised instrument was field tested by using a panel of consultants from local manufacturing companies. These six individuals (see Appexdix B) are "Manager of Manufacturing" of their respective companies thereby providing a perspective similar to that of the individuals surveyed in this study. Using personnel from local industry provided easy access and communication and greatly facilitated this phase of the study. Minor revisions were made after the panel of consultants completed and critiqued the survey.

4. The final instrument was typed, reduced to fit on the front and back of one page, and professionally printed to insure highest quality of appearance.

5. The necessary letters of introduction and explanation were written as well as appropriate followup and thank

you letters.

Research Procedure

Once the final research instrument was completed, the following procedure was implemented:

1. The survey instrument, a business reply envelope, and a letter of introduction and explanation was mailed to 548 participants. Also, a letter endorsing the study and encouraging cooperation was prepared by Keene State College's Dean of Program Development, Dr. Robert C. Andrews, and was included to add additional credibility to the study and to increase the number of returns. All companies surveyed were identified by a number, and corresponding numbers were written on all return envelopes so respondents could be omitted from followup procedures.
2. Two weeks after the initial mailing, the followup letter, another copy of the survey, and another business reply envelope was sent to all nonrespondents. Approximately 120 completed surveys had been received prior to this followup activity. To further encourage participation the reward of a New Hampshire Instant Sweepstakes Ticket for completed and returned surveys was offered as an enticement to respond. This action generated approximately another 80 completed surveys. The sweepstakes ticket and a thank you letter was sent immediately upon receipt.

3. One week after the first followup was initiated, post cards were sent to remaining nonrespondents with a plea for urgency and a deadline date. Approximately twenty-five additional responses were received.
4. During the last phase of this survey process, the researcher telephoned approximately fifty nonrespondents to personally encourage participation. This activity was discontinued because of the costs involved and the awareness that adequate returns had been received to insure valid statistical analysis of the data.
5. A letter of thanks was sent to all survey respondents once it was apparent that all returns had been received.

Data Analysis

The collected data were analyzed using the latest version of the Statistical Package for the Social Sciences (SPSS-X) on the VAX computer at Keene State College. This permitted the data to be displayed in the form of frequency distributions, percents, and crosstabulations to best describe the data and various relationships within the data. Each survey instrument included responses to 61 items rated on a four point Likert-like scale ranking from "Strongly Disagree" to "Strongly Agree." When these data were entered into the computer for analysis, the following numerical values were attached: Strongly Disagree - 1; Disagree - 2; Agree - 3; Strongly Agree - 4.

After the computer analysis of the data had been accomplished, the data were presented in tabular form. The purpose of this data presentation is, of course, to answer the research questions which were the basis for this study:

1. What technical competencies should be acquired by Industrial Technology students in consideration of the impact of high technology on industry?

2. Will company size significantly affect the importance of each competency as reported by industrial personnel?

CHAPTER IV

PRESENTATION AND INTERPRETATION OF DATA

The purpose of this chapter is to report the results of this research project. Four extensive tables are displayed showing the exact responses of study participants supplemented with various statistical measures to depict the relationships existing among the data. The narrative portions of this chapter clarify the contents of tables presented and interpret the included data.

Data Collected from the Survey Instrument

The data collected in this research project were from 236 "Managers of Manufacturing" of companies in six New England states. The survey instrument was distributed to a total of 548 companies and resulted in a forty-three percent rate of return. Of the 236 respondents, 135 completed surveys (57 percent) were received from managers of small companies (25 to 149 employees), and 101 completed surveys (43 percent) were received from managers of large companies (150 or more employees). All individuals who returned the survey instrument responded to all items in the document.

The distribution of responses by state was as follows: Maine, 5 percent; New Hampshire, 9 percent; Vermont, 4 percent; Connecticut, 29 percent; Rhode Island, 10 percent; and Massachusetts, 43 percent. This distribution is consistent with the total number of manufacturing companies in each state compared to the total number of manufacturing companies in New England included in this study thereby adding further credibility to the study.

The data collection procedure was conducted for a period of four weeks beginning with the initial mailing followed by two followup mailings and a final thank you letter sent when the collection process was considered complete. Copies of the various letters are included in Appendices B, D, and E. Particular attention was given to recording respondent's completion and return of the survey instrument so that proper recognition could be given in the form of a thank you letter and additional survey instruments would not be sent in followup letters. This insured each company was represented in the study only once.

Tables presented in this chapter attempt to show the total data reported by each respondent so that each research question will be answered completely.

Answering Research Questions

As stated in Chapter III, to answer the research questions which served as the basis for this study, each technical competency in the survey instrument was rated by industrial personnel based upon their agreement or disagreement with the importance of each competency in the educational preparation of Industrial Technology students in consideration of the impact of high technology on industry. To facilitate the analysis of responses to these competencies, each response was assigned a value of 1 to 4, based on the four possible responses of Strongly Disagree (SD), Disagree (D), Agree (A), or Strongly Agree (SA). The value of 4 was given to a response indicating greatest agreement (SA) with the importance of each competency.

Research Question 1:

What technical competencies should be acquired by Industrial Technology students in consideration of the impact of high technology on industry?

To answer Research Question 1, TABLE 1, TABLE 2, and TABLE 3 were constructed to present industrial personnel's ratings of the importance of each technical competency using two different statistical measures. Individual tables show each competency in the rank order established by the particular technique used. These presentations of data permit a comparison of the ranking of each competency on each table and assist in establishing a reasonable expectation of the importance of each competency. Modal and median responses were not reported because the recurring duplicate values of these statistics provided an inadequate basis for ranking the competencies.

TABLE 1 presents each competency in rank order by mean response established by analyzing the data for each of 61 items on 236 completed surveys. In several cases, the mean response of one competency was the same value as the mean response of another competency. These competencies are ranked at the same level and result in a list of 61 competencies being ranked from 1 to 55 rather than 1 to 61.

TABLE 1
RANK ORDER OF COMPETENCIES BY MEAN RESPONSE
(Large and Small Companies Combined)
(N=236)

Rank Order	Item	Competency	Mean Response
1	31	Can interpret and understand engineering drawings.	3.750
2	7	Understands the function and use of typical manufacturing machine tools.	3.665
3	55	Can effectively use algebra and trigonometry to solve technical problems.	3.419
4	10	Understands the principles of Computer Numerical Control (CNC) programming.	3.411
5	24	Can analyze and improve manufacturing work stations.	3.386
6	21	Can apply statistical quality control concepts to manufacturing situations.	3.381
7	60	Can operate a computer to use available software packages.	3.343
8	9	Can plan the production of a machined part.	3.331
9	39	Is familiar with properties of common manufacturing materials.	3.314
10	61	Understands geometric and true position tolerancing.	3.284
11	27	Can coordinate materials, machines, and workers effectively.	3.280
12	18	Understands process control systems.	3.263
13	14	Understands fundamental concepts and terminology of electronics.	3.258
14	53	Can determine accurate cost estimates for manufactured products and activities.	3.212
15	25	Can utilize various work analysis charts.	3.199

table continues

TABLE 1 - Continued

Rank Order	Item	Competency	Mean Response
15	47	Is familiar with OSHA safety regulations.	3.199
16	57	Understands concepts of physics.	3.186
16	50	Understands concepts of computer aided manufacturing (CAM).	3.186
17	23	Can develop a system of quality control for a manufacturing situation.	3.153
18	40	Can select appropriate manufacturing materials for use in products.	3.136
19	22	Can operate quality control measuring equipment.	3.131
20	15	Can use electronic test equipment.	3.123
20	48	Is familiar with flexible manufacturing systems.	3.123
21	1	Understands applications of robots in industry.	3.093
22	32	Can generate drawings with good drafting technique.	3.085
23	54	Can perform technical research to solve industrial problems.	3.047
24	26	Can perform time study analysis.	3.021
25	16	Understands digital logic.	3.013
26	58	Understands concepts of chemistry.	3.008
27	20	Understands digital electronic devices.	2.992
28	51	Understands concepts of energy conservation and technology.	2.987
28	3	Understands electronic, pneumatic, and hydraulic systems used in robotics.	2.987

table continues

TABLE 1 - Continued

Rank Order	Item	Competency	Mean Response
29	8	Can set-up and operate typical manufacturing machine tools.	2.979
30	19	Understands analog electronic devices.	2.958
31	42	Understands welding processes.	2.932
32	34	Can use a Computer-Aided Drafting (CAD) system.	2.919
33	56	Can effectively use calculus to solve technical problems.	2.907
34	43	Understands sheet metal fabrication techniques.	2.903
35	33	Can solve problems by graphical analysis techniques.	2.898
36	28	Understands fluid power concepts.	2.894
37	44	Understands plastics molding processes.	2.890
38	17	Understands microcomputer circuit operation and appliction.	2.877
39	36	Understands concepts and applications of lasers.	2.860
40	11	Can write CNC programs for machine tools.	2.831
41	41	Understands techniques of metal casting.	2.814
42	45	Understands the powder metallurgy process.	2.775
43	35	Understands concepts and applications of fiber optics.	2.771
44	38	Understands technqiues of packaging industrial products and use of available equipment.	2.750
45	52	Is familiar with heat and power generation for industrial use.	2.665

table continues

TABLE 1 - Continued

Rank Order	Item	Competency	Mean Response
45	46	Understands glass and ceramic molding processes.	2.665
45	4	Can program robots.	2.665
46	2	Can recommend purchases of robots based upon advantages of commercially available robots.	2.640
47	59	Can write computer programs in one or more languages.	2.619
48	49	Can design a flexible manufacturing system.	2.564
49	12	Can troubleshoot and repair electronic equipment.	2.559
50	30	Can troubleshoot fluid power circuits.	2.458
51	6	Can troubleshoot and repair robots.	2.436
52	13	Can design electronic circuitry.	2.318
53	29	Can design fluid power circuits.	2.305
54	37	Understands printing production systems of the graphic arts industry.	2.267
55	5	Can design robots.	2.005

Examination of TABLE 1 shows the mean response of 55 competencies to be greater than the midpoint (2.5) of the scale of values (1 to 4) assigned to the survey responses indicated by study participants. Only competencies 5, 6, 13, 29, 30, and 37 were rated below 2.5 and, therefore, were assigned values by industrial personnel indicating disagreement with the importance of these competencies in this research project. The relative agreement with the importance of the 55 competencies rated above 2.5 is clearly displayed in TABLE 1 by the rank order listed of those competencies by mean response. Also, the relative disagreement with the importance of the six competencies rated below 2.5 is apparent by inspection of the rank order of the mean responses of those competencies.

Additional data supporting the answer to Research Question 1 is presented in TABLE 2. This table shows the rank order of technical competency classifications by mean response. This structuring of the data further exemplifies the importance or lack of importance of particular competencies when considered in conjunction with the data presented in TABLE 1. Competency classifications, competency item numbers, mean responses, and rank order are displayed in this table.

TABLE 2
RANK ORDER OF COMPETENCY CLASSIFICATIONS
BY MEAN RESPONSE
(Large and Small Companies Combined)
(N=236)

Rank Order	Competency Classification	Competencies Included	Mean Response
1	Machine Tools	7, 8, 9	3.325
2	Traditional Drafting	31, 32, 33, 61	3.254
3	Materials	39, 40	3.225
4	Quality Control	21, 22, 23	3,222
5	Methods Analysis	24, 25, 26, 27	3.221
6	Cost Estimating	53	3.212
7	Safety (OSHA)	47	3.199

table continues

TABLE 2 Continued

Rank Order	Competency Classification	Competencies Included	Mean Response
8	Computer Aided Manufacturing	50	3.186
9	Math	55, 56	3.163
10	Computer Numerical Control	10, 11	3.121
11	Physical Sciences	57. 58	3.097
12	Research	54	3.047
13	Computers	59, 60	2.981
14	Electronics	12, 13, 14, 15, 16, 17, 18, 19, 20	2.929
15	Computer Aided Drafting	34	2.919
16	Plastics Molding	44	2.890
17	Metalworking	41, 42, 43	2.833
18	Lasers	36	2.860
19	FMS	48, 49	2.844
20	Energy	51, 52	2.826
21	Powder Metallurgy	45	2.775
22	Fiber Optics	35	2.771
23	Packaging	38	2.750
24	Glass/Ceramics	46	2.665
25	Robotics	1, 2, 3, 4, 5, 6	2.640
26	Fluid Power	28, 29, 30	2.552
27	Printing	37	2.267

TABLE 2 shows the relative ranking of groups of similar competencies on the basis of the mean response for each competency of all competencies in a particular group. Considering the midpoint (2.5) of the scale of values (1 to 4) used in this research project, the mean responses reported in TABLE 2 show only one competency classification, entitled "Printing", to be below this level. All of the other twenty-six competency classifications were rated above the 2.5 mean response level indicating the agreement of industrial personnel with the importance of these groups.

The use of the information reported in TABLE 2 should be used only as additional and supportive data to TABLE 1 and TABLE 3. In many cases, competencies within a particular competency classification are rated very low in TABLE 1 and TABLE 3, but they are included in classifications that are ranked very high in TABLE 2. The opposite of this situation is also present in the tables. Data presented in TABLE 2 is intended to be additional reinforcement for decision making regarding the inclusion or exclusion of competencies after consideration of information presented in TABLE 1 and TABLE 3.

To present another perspective of the importance of each competency, TABLE 3 presents the disagreement and agreement industrial personnel have indicated for each survey item. The table shows the total percentage of Strongly Disagree plus Disagree responses and the total percentage of Agree and Strongly Agree responses. These percentages were used to rank the competencies assuming the highest ranking competency to be that which had the highest percentage value of Agree plus Strongly Disagree.

The results of the development of TABLE 3 is another list of competencies which may be compared to TABLE 1 and TABLE 2 for the purpose of answering Research Question 1.

TABLE 3
RANK ORDER OF COMPETENCIES BY
ADJUSTED PERCENT RESPONSE
(Large and Small Companies Combined)
(N - 236)

Rank Order	Item	Competency	%SD&D	%A&SA
1	7	Understands the function and use of typical manufacturing machine tools.	0.4	99.6
2	31	Can interpret and understand engineering drawings.	0.8	99.2
3	39	Is familiar with properties of common manufacturing materials.	3.0	97.0
4	60	Can operate a computer to use available software packages.	3.4	96.6
5	18	Understands process control systems.	3.8	96.2
5	55	Can effectively use algebra and trigonometry to solve technical problems.	3.8	96.2
6	50	Understands concepts of Computer Aided Manufacturing (CAM).	4.2	95.8
6	14	Understands fundamental concepts and terminology of electronics.	4.2	95.8
6	10	Understands the principles of Computer Numerical Control (CNC) programming.	4.2	95.8
7	57	Understands concepts of physics.	4.7	95.3
8	24	Can analyze and improve manufacturing work stations.	5.1	94.9

table continues

TABLE 3 - Continued

Rank Order	Item	Competency	%SD&D	%A&SA
9	9	Can plan the production of a machined part.	5.9	94.1
10	61	Understands geometric and true position tolerancing.	6.8	93.3
11	21	Can apply statistical quality control concepts to manufacturing situations.	7.6	92.4
12	25	Can utilize various work analysis charts.	7.7	92.3
13	48	Is familiar with flexible manufacturing systems.	8.5	91.5
14	15	Can use electronic test equipment.	9.3	90.7
15	20	Understands digital electronic devices.	10.2	89.8
16	1	Understands applications of robots in industry.	10.6	89.4
17	47	Is familiar with OSHA safety regulations.	11.0	89.0
18	27	Can coordinate materials, machines, and workers effectively.	11.8	88.2
19	22	Can operate quality control measuring equipment.	12.2	87.8
20	51	Understands concepts of energy conservation and technology.	12.7	87.3
21	58	Understands concepts of chemistry.	13.1	86.9
22	19	Understands analog electronic devices.	13.5	86.5
23	23	Can develop a system of quality control for a manufacturing situation.	14.0	86.0
24	53	Can determine accurate cost estimates for manufactured products and activities.	14.8	85.2

table continues

TABLE 3 - Continued

Rank Order	Item	Competency	%SD&D	%A&SA
24	42	Understands welding processes.	14.8	85.2
25	40	Can select appropriate manufacturing materials for use in products.	15.3	84.7
26	32	Can generate drawings with good drafting technique.	15.7	84.3
27	54	Can perform technical research to solve industrial problems.	16.9	83.1
28	26	Can perform time study analysis.	17.3	82.7
29	43	Understands sheet metal fabrication techniques.	17.8	82.2
30	3	Understands electronic, pneumatic, and hydraulic systems used in robotics.	18.6	81.3
31	44	Understands plastics molding processes.	19.5	80.5
31	36	Understands concepts and applications of lasers.	19.5	80.5
31	28	Understands fluid power concepts.	19.5	80.5
32	17	Understands microcomputer circuit operation and application.	21.2	78.8
32	33	Can solve problems by graphical analysis techniques.	21.2	78.8
33	8	Can set-up and operate typical manufacturing machine tools.	22.4	77.6
34	41	Understands techniques of metal casting.	24.2	75.8
35	16	Understands digital logic.	22.7	77.3
36	34	Can use a Computer Aided Drafting (CAD) system.	25.0	75.0

table continues

TABLE 3 - Continued

Rank Order	Item	Competency	%SD&D	%A&SA
37	56	Can effectively use calculus to solve technical problems.	25.8	74.2
38	45	Understands the powder metallurgy process.	26.2	73.8
39	35	Understands concepts and applications of fiber optics.	26.7	73.3
40	11	Can write CNC programs for machine tools.	30.1	69.9
41	38	Understands techniques of packaging industrial products and use of available equipment.	30.9	69.1
42	46	Understands glass and ceramic molding processes.	36.5	63.5
43	2	Can recommend purchases of robots based upon advantages of commercially available robots.	38.6	61.4
43	52	Is familiar with heat and power generation for industrial use.	38.5	61.5
44	4	Can program robots.	39.0	61.0
45	59	Can write computer programs in one or more languages.	44.9	55.1
46	49	Can design a flexible manufacturing system.	47.0	53.0
47	12	Can troubleshoot and repair electronic equipment.	48.3	51.7
48	6	Can troubleshoot and repair robots.	53.0	47.0
49	30	Can troubleshoot fluid power circuits.	54.2	45.8
50	13	Can design electronic circuitry.	64.4	35.6

table continues

TABLE 3 - Continued

Rank Order	Item	Competency	%SD&D	%A&SA
51	37	Understands printing production systems of the graphic arts industry.	66.1	33.9
52	29	Can design fluid power circuits.	68.6	31.4
53	5	Can design robots.	80.5	19.5

Adjusted percentage responses of 50 percent or higher indicate that the majority of industrial personnel agreed with the importance of competencies listed in TABLE 3. On this basis it is observed that 55 competencies are considered important by survey participants. Only six competencies (5, 6, 13, 29, 30, and 37) were not rated as important.

The competencies identified as important in TABLE 1 and TABLE 3 are the same, but the rank order established by the statistical analysis employed varies from table to table for each competency. The agreement between TABLE 1 and TABLE 3 reinforces the argument for the inclusion of particular competencies in Industrial Technology programs.

Using TABLE 2 to support the agreement or disagreement with the importance of each competency as identified in TABLE 1 and TABLE 3, all competencies identified as important in TABLE 1 and TABLE 3 are also contained in competency classifications identified as important. The only competency that is identified on all three tables as unimportant is competency 37.

Data gathered and analyzed in this research project suggest that the competencies of rank order 1 to 55 from either TABLE 1 or TABLE 3 be included in Industrial Technology programs so that students may acquire these competencies in preparation for a career in industry.

Research Question 2

Will company size significantly affect the importance of each technical competency as reported by industrial personnel?

Research Question 2 is addressed by the data presented in TABLE 4. Frequencies of each response for each competency have been displayed in tabular form. Statistical values for Chi-Square and significance level are also included in the table and were the results of a statistical analysis using crosstabulation on the VAX computer in the Keene State College Computer Center.

Examination of the significance level of the 61 technical competencies included in TABLE 4 shows that only items 8, 18, and 50 are statistically significant at the .01 level. Responses reported on the remaining 58 competencies (95 percent) conform to expectations and imply that company size did not affect the responses reported by industrial personnel.

TABLE 4
RELATIONSHIPS AMONG SMALL AND LARGE COMPANY RESPONSES
(Number of Small Companies = 135 [57 percent])
(Number of Large Companies = 101 [43 percent])
(N = 236)

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
1	Understands applications of robots in industry.	Small	4	14	90	27	4.258	0.2349
		Large	3	4	67	27		
2	Can recommend purchases of robots based upon advantages of commercially available robots.	Small	9	45	69	12	0.778	0.8547
		Large	8	29	53	11		
3	Understands electronic, pneumatic, and hydraulic systems used in robotics.	Small	5	20	80	30	3.085	0.3787
		Large	1	18	65	17		
4	Can program robots.	Small	8	42	69	16	.0904	0.8245
		Large	5	37	49	10		
5	Can design robots.	Small	20	86	23	6	2.411	0.4917
		Large	21	63	15	2		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
6	Can troubleshoot and repair robots.	Small	13	47	59	16	10.772	0.0130
		Large	15	50	32	4		
7	Understands the function and use of typical manufacturing machine tools.	Small	0	1	43	91	0.816	0.6649
		Large	0	0	34	67		
8	Can set-up and operate typical manufacturing machine tools.	Small	3	26	64	42	12.569	0.0057
		Large	3	21	65	12		
9	Can plan the production of a machined part.	Small	1	7	72	55	0.162	0.9835
		Large	1	5	56	39		
10	Understands the principles of Computer Numerical Control (CNC) programming.	Small	1	8	69	57	5.381	0.1459
		Large	0	1	49	51		
11	Can write CNC programs for machine tools.	Small	3	42	66	24	4.371	0.2241
		Large	2	24	63	12		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
12	Can troubleshoot and repair electronic equipment.	Small	8	50	57	20	6.184	0.1030
		Large	8	48	39	6		
13	Can design electronic circuitry.	Small	11	69	46	9	4.408	0.2207
		Large	13	59	23	6		
14	Understands fundamental concepts and terminology of electronics.	Small	1	4	92	38	1.538	0.6735
		Large	1	4	61	35		
15	Can use electronic test equipment.	Small	0	9	93	33	3.937	0.2684
		Large	1	12	69	19		
16	Understands digital logic.	Small	2	14	99	20	2.123	0.5472
		Large	0	14	72	15		
17	Understands microcomputer circuit operation and application.	Small	4	27	92	12	3.899	0.2725
		Large	0	19	69	13		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
18	Understands process control systems.	Small	0	6	99	30	9.307	0.0095
		Large	0	3	57	41		
19	Understands analog electronic devices.	Small	1	18	102	14	0.172	0.9820
		Large	1	12	78	10		
20	Understands digital electronic devices.	Small	0	14	108	13	0.055	0.9730
		Large	0	10	82	9		
21	Can apply statistical quality control concepts to manufacturing situations.	Small	1	14	65	55	7.429	0.0594
		Large	0	3	44	54		
22	Can operate quality control measuring equipment.	Small	0	12	81	42	7.388	0.0605
		Large	2	15	64	20		
23	Can develop a system of quality control for a manufacturing situation.	Small	0	21	76	38	2.507	0.4740
		Large	1	11	57	32		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
24	Can analyze and improve manufacturing work stations.	Small	0	9	71	55	2.270	0.3216
		Large	0	3	50	48		
25	Can utilize various work analysis charts.	Small	0	13	89	33	2.816	0.2446
		Large	0	5	64	32		
26	Can perform time study analysis.	Small	2	23	83	27	1.597	0.6601
		Large	0	16	64	21		
27	Can coordinate materials, machines, and workers effectively.	Small	0	17	63	55	3.426	0.3305
		Large	2	9	49	41		
28	Understands fluid power concepts.	Small	1	30	90	14	3.617	0.2992
		Large	0	15	78	8		
29	Can design fluid power circuits.	Small	5	88	37	5	0.702	0.8727
		Large	4	65	30	2		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
30	Can troubleshoot fluid power circuits.	Small	6	59	59	11	6.359	0.0954
		Large	8	55	35	3		
31	Can interpret and understand engineering drawings.	Small	0	0	36	99	5.626	0.0600
		Large	2	0	17	82		
32	Can generate drawings with good drafting technique.	Small	2	22	70	41	6.453	0.0915
		Large	3	10	67	21		
33	Can solve problems by graphical analysis techniques.	Small	1	30	91	13	1.930	0.5870
		Large	1	18	67	15		
34	Can use a Computer-Aided Drafting (CAD) system.	Small	2	37	74	22	3.428	0.3302
		Large	2	18	59	22		
35	Understands concepts and applications of fiber optics.	Small	3	35	90	7	0.745	0.8626
		Large	1	24	70	6		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
36	Understands concepts and applications of lasers.	Small	2	27	95	11	1.707	0.6354
		Large	2	15	78	6		
37	Understands printing production systems of the graphic arts industry.	Small	10	82	42	1	3.289	0.3491
		Large	11	53	34	3		
38	Understands techniques of packaging industrial products and use of available equipment.	Small	6	37	80	12	0.607	0.8947
		Large	4	26	59	12		
39	Is familiar with properties of common manufacturing materials.	Small	0	4	87	44	0.426	0.8082
		Large	0	3	61	37		
40	Can select appropriate manufacturing materials for use in products.	Small	0	18	74	43	1.844	0.3977
		Large	0	18	58	25		
41	Understands techniques of metal casting.	Small	2	28	98	7	2.492	0.4768
		Large	1	26	65	9		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
42	Understands welding processes.	Small	0	18	108	9	3.255	0.3540
		Large	1	16	73	11		
43	Understands sheet metal fabrication techniques.	Small	0	23	102	10	0.348	0.8402
		Large	0	19	73	9		
44	Understands plastics molding processes.	Small	1	30	94	10	3.355	0.3401
		Large	0	15	75	11		
45	Understands the powder metallurgy process.	Small	2	36	94	4	3.641	0.3029
		Large	0	24	70	7		
46	Understands glass and ceramic molding processes.	Small	3	52	75	5	4.217	0.2390
		Large	0	31	65	5		
47	Is familiar with OSHA safety standards.	Small	1	15	73	46	1.380	0.7102
		Large	1	9	62	29		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
48	Is familiar with flexible manufacturing systems.	Small	1	16	93	25	7.563	0.0560
		Large	0	3	73	25		
49	Can design a flexible manufacturing system.	Small	5	57	65	8	1.189	0.7555
		Large	4	45	43	9		
50	Understands concepts of Computer Aided Manufacturing (CAM).	Small	0	9	103	23	9.607	0.0082
		Large	0	1	69	31		
51	Understands concepts of energy conservation and technology.	Small	0	15	102	18	4.176	0.2431
		Large	3	12	74	12		
52	Is familiar with heat and power generation for industrial use.	Small	1	53	71	10	3.690	0.2969
		Large	4	33	57	7		
53	Can determine accurate cost estimates for manufactured products and activities.	Small	1	21	67	46	1.381	0.7100
		Large	1	12	47	41		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
54	Can perform technical research to solve industrial problems.	Small	0	23	86	26	1.071	0.5853
		Large	0	17	59	25		
55	Can effectively use algebra and trigonometry to solve technical problems.	Small	1	5	65	64	1.158	0.7631
		Large	0	3	53	45		
56	Can effectively use calculus to solve technical problems.	Small	4	29	77	25	1.868	0.6002
		Large	1	27	54	19		
57	Understands concepts of physics.	Small	0	9	94	32	2.997	0.2235
		Large	0	2	76	23		
58	Understands concepts of chemistry.	Small	1	19	97	18	1.477	0.6876
		Large	0	11	74	16		
59	Can write computer programs in one or more languages.	Small	9	62	52	12	10.030	0.0183
		Large	1	34	52	14		

table continues

TABLE 4 - Continued

ITEM	COMPETENCY		SD FREQ.	D FREQ.	A FREQ.	SA FREQ.	CHI SQUARE	LEVEL OF SIGNIFICANCE
60	Can operate a computer to use available software packages.	Small	1	5	84	45	3.992	0.2623
		Large	0	2	54	45		
61	Understands geometric and true position tolerancing.	Small	0	8	75	52	1.683	0.4310
		Large	0	8	62	31		

The data presented in TABLES 1, 2, 3, and 4 report the results of this research project focusing on the research questions originally formulated for this project. The following chapter discusses the conclusions and recommendations reached as a result of this study.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter includes (1) a summary of the purpose, methodology, and results of this research project; (2) conclusions derived from the presentation and interpretation of the data; and (3) recommendations for further study.

Summary

Purpose of the Study

This study was conducted for the purpose of identifying technical competencies which should be acquired by students preparing for a career as an Industrial Technologist in a manufacturing industry. The study was specifically directed at the Industrial Technology program at Keene State College in Keene, New Hampshire. The research project has provided a basis for extensive curriculum modifications and future direction of this program.

Data were collected from numerous companies from the six New England states to gain a wide perspective of industrial personnel's opinion regarding technical competencies needed by Industrial Technologists in industry. In consideration of the impact of high technology in the manufacturing industry, identification of contemporary technical competencies for inclusion in technical programs was considered a necessity for the maintenance and continuance of these programs. This research project has identified those technical competencies rated as important by industrial personnel in New England.

Methodology

A survey instrument consisting of 61 technical competencies was constructed utilizing input from faculty members of the Industrial Education and Technology Department at Keene State College and a panel of industrialists from industries in the Keene, New Hampshire area. This survey was sent to 548 "Managers of Manufacturing" (or similar titles) of manufacturing companies randomly selected from the six New England States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont. A twenty percent sample was taken from the total number of manufacturing companies in each state. In addition to state, the sample was restricted on the basis of company size and Standard Industrial Classification code identifying company manufacturing emphasis. A forty-three percent survey response was realized.

The data were analyzed using a VAX computer and the Statistical Package for the Social Sciences software. Relationships among the data were displayed in tabular form showing mean responses, frequency distributions, and Chi-square statistics. Technical competencies identified as important by survey participants appear in rank order in two tables based on two different statistical measures.

Results

The results of this study are based upon the responses of industrial personnel representing 236 New England manufacturing companies.

1. Fifty-five technical competencies included in the research instrument used in this study were ranked as important according to the responses of industrial personnel.
2. Six technical competencies were ranked not important by industrial personnel.
3. Competencies including the concept of design are ranked not important or of very low importance. Designing robots, electronic circuitry, or fluid power circuits are examples of this research result.
4. Troubleshooting and repair competencies are ranked not important or of very low importance. Troubleshooting and repair of electronic circuits represents this result.
5. Industrial technologists need to be able to write computer programs is ranked of moderate relative importance.
6. The ability to operate a computer for the purpose of using available software is considered very important. This coincides with a conclusion of a study by Parrish and Pickle reported in Chapter II:

   "Manufacturing courses should include computer applications,..."

7. Specific high tech competencies (like those associated with CAD, CAM, CNC, digital electronics, robotics, etc.) are distributed throughout the rank order list of competencies and do not rank as the most important competencies on the list.
8. Several traditional technical competencies (like those associated with machine tools, drafting, properties of materials, etc.) are ranked among the competencies of highest importance, and many other traditional competencies are distributed throughout the list among high tech and other competencies.
9. "Understanding" competencies are generally ranked higher in importance than "doing" competencies relating to the same technical subject. For instance, understanding the principles of CNC is rank order five by mean response, but writing CNC programs is rank order forty by the same statistical measure.
10. Other than understanding applications of robots in industry, competencies associated with robotics are ranked very low or the lowest of all competencies.
11. Algebra and trigonometry are more important than calculus for industrial technologists to solve industrial problems.
12. Physics is ranked higher than chemistry in importance for industrial technologists.
13. Competencies associated with the planning and control of manufacturing are ranked high in importance. Methods

analysis, quality control, and production planning kinds of competencies are examples.

14. Industrial technologists in manufacturing industries have little need for an understanding of graphic arts printing processes.

15. Survey participant's responses to each competency were not affected by the size of the company in which the participant is employed.

Conclusions and Interpretations

As a result of the data collected and analyzed for this research project, the following conclusions and interpretations are presented:

1. Industrial Technology programs in New England should be reviewed by faculty and administrators to determine if the 55 technical competencies identified as important in this study are included in their programs, and, if not, curriculum modification processes should be implemented. This action will undoubtedly involve complex decisions not only related to competencies and course content, but issues such as facilities, equipment, faculty training, and funding will have to be thoroughly addressed. Depending upon the number of competencies identified by this study already included in a particular program, the time involved to adequately revise a program could vary considerably in time and, in fact, take many

years to accomplish.

2. Competencies considered "high tech" should constitute a strong portion of all New England Industrial Technology programs, but it is important for programs to maintain an equal emphasis on traditional and fundamental technology competencies. In many applications of high tech in industry, the high tech process used is for the purpose of increasing production or simplifying an otherwise complex task, but the fundamental process being performed is the same whether high tech or traditional methods are used, and requires the technologist to have a knowledge of traditional concepts of technology in both cases.
3. Industrial Technology programs should provide students with a broad technical education that stresses understanding of concepts and principles rather than emphasizing skill development in specialized technical areas. The diversity and dispersion of technical competencies identified as important by study participants suggests that the Industrial Technology student should develop competencies addressing numerous technical subjects. Substantial changes in emphasis and content of technical courses in various Industrial Technology programs could result from the impact of this conclusion.
4. Competencies involving "designing" competencies should

not be emphasized in Industrial Technology programs. Design is generally considered the work of the engineer, and, is not considered an appropriate task for the industrial technologist.

5. Computer application competencies should be stressed rather than computer programming skills. Industrial technologists use computers as tools to perform industrial tasks more effectively and efficiently. This does not require a proficiency in computer programming.

6. Competencies relating to planning and control of manufacturing activities are important aspects of Industrial Technology and should be included in all programs. The ranking of planning and control kinds of competencies in this study reinforces one aspect of the National Association of Industrial Technology's definition of Industrial Technology as stated in Chapter I:

   "Industrial Technology consists of degree programs of study designed to prepare management-oriented technical professionals in the economic-enterprise system."

7. Future studies related to this research project do not need to differentiate among responses based upon company size. Industrial personnel agree on the importance or lack of importance of competencies that should comprise the technology education of Industrial Technology students regardless of the size of the company in which they are employed.

Recommendations for Further Study

This study was conducted for the purpose of curriculum modification within the Industrial Technology program at Keene State College and will serve as the basis of a very close examination of this program. In conducting this research project, the author has identified numerous questions that warrant additional consideration and further investigation. These suggested topics relate not only to the program at Keene State College but to Industrial Technology programs at other colleges and universities. Suggestions for further study include:

1. Identification of technical competencies presently included in Industrial Technology programs must take place so that a comparison with those competencies identified by this research project can occur. This project is necessary at Keene State college or any other institution where the results of this study are being considered for curriculum revision.
2. Since this study was limited to New England industries, it is necessary for institutions outside of New England to replicate this study within their geographical area to identify competencies appropriate for consideration within their programs.
3. This study should be modified and conducted focusing on populations of Industrial Technology graduates and Industrial Technology faculty members to gain additional perspectives of the importance of the technical

competencies in question.

4. Repetition of this study should occur every five to ten years to assess changing career demands on industrial technologists caused by changing technology in industry.
5. A similar study to identify "general education" competencies important for students of Industrial Technology programs would be advantageous to faculty members responsible for decisions regarding this aspect of programs.
6. Numerous studies to identify learning experiences and activities that would facilitate student accomplishment of the technical competencies identified by this project are necessary.

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APPENDIX A

RESEARCH QUESTIONNAIRE

A Questionnaire for the
Development of a High Technology
Curriculum for Industrial Technology
at Keene State College

Directions:

Each statement below represents a technical competency which could be acquired by an Industrial Technology student through an appropriately structured technology program. In consideration of the impact of high technology on industry, please indicate the extent to which you think each competency is important for an Industrial Technology program graduate to possess by circling one of the following for each competency:

SD	D	A	SA
Strongly Disagree	Disagree	Agree	Strongly Agree

Example:

Can develop photographic film.	SD	D	A	SA

****

1.	Understands applications of robots in industry.	SD	D	A	SA
2.	Can recommend purchases of robots based upon advantages of commercially available robots.	SD	D	A	SA
3.	Understands electronic, pneumatic, and hydraulic systems used in robotics.	SD	D	A	SA
4.	Can program robots.	SD	D	A	SA
5.	Can design robots.	SD	D	A	SA
6.	Can troubleshoot and repair robots.	SD	D	A	SA
7.	Understands the function and use of typical manufacturing machine tools.	SD	D	A	SA
8.	Can set-up and operate typical manufacturing machine tools.	SD	D	A	SA
9.	Can plan the production of a machined part.	SD	D	A	SA
10.	Understands the principles of Computer Numerical Control (CNC) programming.	SD	D	A	SA

11.	Can write CNC programs for machine tools.	SD	D	A	SA
12.	Can troubleshoot and repair electronic equipment.	SD	D	A	SA
13.	Can design electronic circuitry.	SD	D	A	SA
14.	Understands fundamental concepts and terminology of electronics.	SD	D	A	SA
15.	Can use electronic test equipment.	SD	D	A	SA
16.	Understands digital logic.	SD	D	A	SA
17.	Understands microcomputer circuit operation and application.	SD	D	A	SA
18.	Understands process control systems.	SD	D	A	SA
19.	Understands analog electronic devices.	SD	D	A	SA
20.	Understands digital electronic devices.	SD	D	A	SA
21.	Can apply statistical quality control concepts to manufacturing situations.	SD	D	A	SA
22.	Can operate quality control measuring equipment.	SD	D	A	SA
23.	Can develop a system of quality control for a manufacturing situation.	SD	D	A	SA
24.	Can analyze and improve manufacturing work stations.	SD	D	A	SA
25.	Can utilize various work analysis charts.	SD	D	A	SA
26.	Can perform time study analysis.	SD	D	A	SA
27.	Can coordinate materials, machines, and workers effectively.	SD	D	A	SA
28.	Understands fluid power concepts.	SD	D	A	SA
29.	Can design fluid power circuits.	SD	D	A	SA
30.	Can troubleshoot fluid power circuits.	SD	D	A	SA
31.	Can interpret and understand engineering drawings.	SD	D	A	SA

32. Can generate drawings with good drafting technique.	SD	D	A	SA
33. Can solve problems by graphical analysis techniques.	SD	D	A	SA
34. Can use a Computer-Aided Drafting (CAD) system.	SD	D	A	SA
35. Understands concepts and applications of fiber optics.	SD	D	A	SA
36. Understands concepts and applications of lasers.	SD	D	A	SA
37. Understands printing production systems of the graphic arts industry.	SD	D	A	SA
38. Understands techniques of packaging industrial products and use of available equipment.	SD	D	A	SA
39. Is familiar with properties of common manufacturing materials.	SD	D	A	SA
40. Can select appropriate manufacturing materials for use in products.	SD	D	A	SA
41. Understands techniques of metal casting.	SD	D	A	SA
42. Understands welding processes.	SD	D	A	SA
43. Understands sheet metal fabrication techniques.	SD	D	A	SA
44. Understands plastics molding processes.	SD	D	A	SA
45. Understands the powder metallurgy process.	SD	D	A	SA
46. Understands glass and ceramic molding processes.	SD	D	A	SA
47. Is familiar with OSHA safety regulations.	SD	D	A	SA
48. Is familiar with flexible manufacturing systems.	SD	D	A	SA
49. Can design a flexible manufacturing system.	SD	D	A	SA
50. Understands concepts of computer aided manufacturing (CAM).	SD	D	A	SA

51.	Understands concepts of energy conservation and technology.	SD	D	A	SA
52.	Is familiar with heat and power generation for industrial use.	SD	D	A	SA
53.	Can determine accurate cost estimates for manufactured products and activities.	SD	D	A	SA
54.	Can perform technical research to solve industrial problems.	SD	D	A	SA
55.	Can effectively use algebra and trigonometry to solve technical problems.	SD	D	A	SA
56.	Can effectively use calculus to solve technical problems.	SD	D	A	SA
57.	Understands concepts of physics.	SD	D	A	SA
58.	Understands concepts of chemistry.	SD	D	A	SA
59.	Can write computer programs in one or more languages.	SD	D	A	SA
60.	Can operate a computer to use available software packages.	SD	D	A	SA
61.	Understands geometric and true position tolerancing.	SD	D	A	SA

Please list additional technical competencies you think should be possessed by graduates of Industrial Technology programs.

____

____

____

____

Thank you.

APPENDIX B

QUESTIONNAIRE COVER LETTER

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

March 27, 1987

Mecon Manufacturing Inc.
PO Box 23
Orford, ME 04270

Attn: Manager of Manufacturing

Dear Manager of Manufacturing:

The faculty of the Industrial Education and Technology Department are involved in an extensive study of the department's curriculum and intend to modify this curriculum to reflect the impact of high technology on industry. Our goal is to have a technology program that will provide an up-to-date technical education for students who will graduate with the necessary competencies to enter and succeed in contemporary industrial careers. The enclosed survey is designed to identify technical competencies that Industrial Technology programs should provide for their graduates.

Industrial Technology programs typically combine technology courses with a core of management courses. General education components of programs focus on math and science with additional emphasis on social sicence and communication skills. Graduates are employable in various aspects of manufacturing and industrial engineering such as quality control, methods analysis, time study, production control, inventory control, scheduling, etc.

Your input in this important project is critical. Please complete the survey and return it in the addressed stamped envelope at your earliest convenience. Names of companies and respondents will not be associated with data reported in the results of this survey.

Thank you,

Del Ogg, Coordinator
Industrial Education and Technology Department

DO/b

APPENDIX C

LETTER OF ENDORSEMENT

Keene
State
College

229 Main Street
Keene, NH 03431
(603) 352-1909

March 9, 1987

Technology Survey Recipient:

This letter is sent to encourage your participation in a special study conducted by Professor Delmar Ogg of the Industrial Technology faculty at Keene State College. As a manager of industrial operations and manufacturing, your perspective will contribute substantially to the information base that must necessarily precede programmatic revision and refinement.

I cannot overemphasize the importance of your individual input in this matter. The results of the survey will lay the foundation for curriculum modification in the Industrial Technology programs here, and assist in insuring the technical competence of graduates who may even be fortunate enough to become future employees of your company.

Please complete and return the attached survey as soon as possible. Thank you very much.

Sincerely,

Robert C. Andrews
Dean of Graduate Studies
& Program Development

RCA/sl

APPENDIX D

FOLLOW-UP LETTER

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

May 13, 1987

Dear Technology Survey Respondent:

On behalf of the Keene State College Industrial Technology Department, I thank you for your cooperation in making our curriculum modification project a big success. Your effort and time to complete our survey is most appreciated and will certainly assist us in developing a strong Industrial Technology program reflecting the impact of "high tech" on industry.

Our present Industrial Technology Program is very strong and has produced numerous graduates who are fulfilling many responsible positions in companies such as yours. The study in which you participated will help to insure that our graduates will be even more qualified for the future challenges they will encounter in the field of manufacturing.

Sincerely,

Del Ogg,
IET Department Coordinator
603-352-1909 (X346)

DO/b

APPENDIX E

PANEL OF INDUSTRIAL CONSULTANTS

Panel of Industrial Consultants

Mr. Hank Brunjes
Kingsbury Machine Tool Corporation
80 Laurel Street
Keene, NH 03431

Mr. Neil Donegan
Hillyer Machining Center Division
Kingsbury Machine Tool Corporation
80 Laurel Street
Keene, NH 03431

Mr. Warner Naeck
MPB Corporation
Precision Park
Keene, NH 03431

Mr. Mike Tomacelli
Pneumo Precision, Inc.
Optical Avenue
Keene, NH 03431

Mr. Bob Nordburg
Markem Corporation
150 Congress Street
Keene, NH 03431

Mr. Carl A. Hurd
Bryant Grinder Corporation
Springfield, VT

APPENDIX F

THANK YOU LETTER

Keene
State
College

229 Main Street
Keene, NH 03431

(603) 352-1909

April, 1987

Dear

Thank you for your cooperation in assisting the Industrial Education and Technology Department in its curriculum project to reflect the impact of "high technology" in our Industrial Technology program. Your input will certainly help us develop a strong program for our students.

Please contact me now or in the future if you have a need for one of our I.T. graduates. I would be glad to provide names of individuals who may qualify for positions in your company. Summer employment and internships are encouraged at KSC, so if possibilities exist at your company, please give me a call. I'm sure you'll find our students to be quite well prepared.

Enclosed is your New Hampshire Instant Sweepstakes ticket. I certainly hope you are a big winner for the time and thought you put into our project.

Sincerely,

Del Ogg,
IET Department Coordinator
(603-352-1909 X346)

DO/b

Enc.

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VITA

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Delmar R. Ogg was born in Normal, Illinois on the thirteenth day of January in 1944.

His secondary school education was completed upon graduation from Normal Community High School in 1962. Following high school he completed a tool and die apprenticeship at General Electric Company in Bloomington, Illinois. This accomplishment was followed by five years of academic work at Illinois State University culminating in Bachelor of Science in Education (Industrial Arts Education) and Master of Science (Industrial Technology) degrees being awarded in 1970 and 1971 respectively. Full time employment at General Electric was maintained while attending ISU resulting in a total of nine years of industrial experience prior to entering the teaching profession.

Sixteen years of a career in education have been spent as a teacher and department coordinator in the Industrial Education and Technology Department at Keene State College in Keene, New Hampshire. Educational accomplishments during this time period include the completion of a Certificate of Advanced Graduate Study (Curriculum and Instruction) from the University of Connecticut in 1981 and the Doctor of Education Degree (Occupational Education) from the University of Massachusetts in 1987.

He has been married since 1962 to Karen Ann Ogg and is the father of two children, Rebecca and Michael.