ENGINEERING TRAINING NEEDS
IN A MANUFACTURING
COMPANY

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PREFACE

This study is concerned with the identification of the training needs of engineers employed in a specific manufacturing company. The research questions with which this study deals are:

1. What subject areas would meet the training needs of the engineers?
2. Do perceived training needs vary according to academic preparation?
3. Do perceived training needs vary according to years of experience?

Responses regarding employees' desire for training in 22 job-related areas are analyzed according to the employee's academic preparation, and years of engineering experience.

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CHAPTER I

INTRODUCTION

Because of rapidly changing technology in engineering, it is difficult for engineers to maintain their effectiveness in their job without ongoing training. If employees are not knowledgeable of the latest engineering techniques and research and development in their area of speciality, they will not be able to make the best decisions and perform their job with maximum efficiency. They must possess certain skills in order to provide the most effective solutions to the customers' problems. In order to provide appropriate training, these skills areas must be specified and individual engineer's perception of training needs identified.

Statement of Problem

The specific problem with which this study dealt was the identification of engineering employees' training needs in a specific manufacturing company.

Purpose of the Study

The purpose of this study was to determine what skills areas engineers in a specific company needed to develop in order to perform their jobs efficiently.

Research Questions

The specific questions which this study was intended to answer were:

1. What subject areas would meet the training needs of the engineers?
2. Do perceived training needs vary according to academic preparation?
3. Do perceived training needs vary according to years of experience?

Scope of the Study

The scope of this study was:

1. The study dealt only with employees of a large engineering and manufacturing company in Tulsa, Oklahoma, whose primary duties were engineering related.
2. The study did not include engineers who were Division Directors or Executives.

Limitations of the Study

Since the skills areas identified in this study were obtained through a specific job description for a particular company, these skills were necessary to perform a specific job. These same skills may not be required in other engineering positions. Therefore, the various skills listed on the Training Needs Analysis Form would need to be evaluated for applicability if used for other postions and in other companies.

Assumptions

It was assumed that since the employee was performing an engineering function, he would be able to determine whether he possessed adequate knowledge in the specific subject areas to perform his job effectively. Also, he would be able to determine the applicability of the subject areas to his specific job.

Definitions

The following definitions are provided to clarify terms used in this study:

1. Self-Directed Learning - the process of gaining knowledge about a specific subject in which the individual provides the impetus for his learning, deciding what, when, and how he will learn.
2. Training Needs Analysis Form - a document designed to obtain information regarding the applicability of subject areas to current engineering jobs and the desire of incumbents for training in those areas.
3. Engineer - a person employed in a position in which he designs controls or equipment, reviews customer specifications and determines process requirements, coordinates the scheduling and fabrication of equipment, or provides mechanical and electrical services for field installations.

Organization of Study

Chapter I introduces the study, presenting the problem of the study along with purpose, objectives, scope, limitations, assumptions and definition of terms. Included in Chapter II is a review of related literature concerning the impact of high technology and the cost of technical change. The roles of professional organizations, employers, educational institutions, communities, and the individual engineer are discussed. Chapter III discusses the procedures utilized, including the creation of the instrument, selection of the sample, collection and analysis of data. In Chapter IV, the responses to each question in the survey are discussed. Chapter V summarizes the study, makes conclusions, and provides recommendations for future practices and further studies.

CHAPTER II

A REVIEW OF RELATED LITERATURE

The review of literature was conducted to determine what information was available that related to the continuing training needs of engineers. In this chapter, the review of literature is organized into the following categories:

1. Impact of High Technology
2. Cost of Technological Change
3. Role of Professional Organizations in the Training of Engineers
4. Role of Employers in the Training of Engineers
5. Role of Educational Institutions in the Training of Engineers
6. Role of Communities in the Training of Engineers
7. Role of the Engineer in Continuing Training
8. Summary.

Impact of High Technology

Just in the past 40 years such technical industries as nuclear energy, jet aircraft, computers, and space technology have come into existence as significant industrial manufacturing activities (Thompson, 1980). These industries require highly trained employees to design, control, monitor and manage the results of the engineering innovations.

Lack of up-to-date knowledge can result in loss of business opportunity or physical hazard. For example, unfamiliarity with the proper handling procedures for toxic chemicals needed in refinery processes could cause physical injury or even death. Also, a company could become unable to compete in a technical market if its employees were not familiar with the most recent technology in their speciality. If the company could not design the most efficient and cost effective systems or products, customers would purchase from another source which could provide the most progressive applications to meet their specific needs.

Cost of Technological Change

To develop and maintain a high level of technology requires substantial investments. Not only is there the cost for design, materials, and fabrication of more intricate and precise equipment and controls, but also there is a cost for training employees to operate and utilize the new equipment and controls.

Both business and industry invest substantial amounts of money in providing employees up-to-date knowledge of the latest innovations. It is estimated that over $100 billion annually is spent to train employees (Thompson, 1980).

Role of Professional Organizations in the Training of Engineers

Professional organizations and societies recognize the need for ongoing training of engineers. Through such means as technical seminars, professional newsletters and journals, society meetings, and honorary academies, they promote training and excellence in innovations of individual engineers.

At the August, 1981, American Institute of Chemical Engineers Annual Meeting, there were 65 technical sessions offered to participants (Fogler, 1981). These training sessions represented ten areas of engineering that had experienced rapid technological advances. They were food, pharmaceuticals, bioengineering, engineering fundamentals, energy, computing, synthetic fuels, materials, nuclear energy, and engineering management.

In the food, pharmaceuticals and bioengineering fields, technological advances to meet the needs of a growing population required the engineering of facilities and equipment to accommodate large-scale operations. In order to provide these systems, automated and computer-controlled equipment must be developed, creating a need for continual training to keep abreast of the latest advances.

Included in the sessions on engineering fundamentals were such topics as turbulence, turbulent structure and its role, and chemical reactions in turbulent flow. Although these areas represent fundamentals to the chemical engineer, the development of new instrumentation to measure properties requires the engineer to continue training in order to maintain up-to-date knowledge in the field.

The energy sessions included the areas of hydrogen, oil shale, and the electric-powered car. These were supplemented by panel discussions and workshops to promote exchange of ideas and relate the most current knowledge on the subjects.

Computing was another area of emphasis at the annual meeting. It included the latest innovations in telecommunications technology, industrial trends in scientific computing, the impact of computing on engineering and research work, and the effects on the manufacturing process.

In the sessions on synthetic fuels, the latest technologies for the production of synthetic motor fuels from coal to shale were discussed. Another subject for consideration in these sessions was the environmental acceptability of wastes from synfuel plants. Both the development of efficient alternate fuels and the resulting problem of waste disposal create the need for an ongoing awareness of the "state-of-the-art".

Concern for safety and public awareness after the Three-Mile Island accident created a strong interest in the sessions on nuclear energy. Not only was it necessary for engineers to be aware of developments in their specific area, they also needed to learn to prevent certain hazards as experienced at Three Mile Island. The focus was on uranium mining and milling operations and radium operations.

Advances in materials was another topic for the technical sessions. This included injection molding, engineering aspects of process, and mechanical properties of polymers. All of these areas represent modern engineering applications developed to accommodate the needs that have evolved due to the design of more complex materials that perform more efficiently under specific circumstances.

The final category of training dealt with engineering management. Panel discussions were used to bring together ideas from managers in industry. As not all engineers have emphasized management in their training, these sessions provided the newly promoted manager and experienced engineer with the expertise of successful managers throughout the various industries involved with engineering.

Besides providing technical sessions for its members, the American Institute of Chemical Engineers furnishes free data services. Through the monthly publication, Chemical Engineering Progress, information on acquiring the most recent data on various products, materials, and services is made available to members.

To recognize the continued technological advancements made by engineers, the National Academy of Engineering elects individuals for their contributions in engineering. The Academy is a private organization that works with the National Academy of Sciences and advises the federal government about engineering progress and sponsors engineering programs to promote research. Through such honorary societies as this, engineering advancement is encouraged.

Role of Employers in the Training of Engineers

Employers also share in the training of engineers through such means as in-company library facilities, research and development facilities, computer-based education systems, and simulation training. Implementation of specific systems is dependent on the training requirements, physical limitations of space, capabilities of the system and amount of funding available to individual firms.

According to Bowman, patent literature is the most valuable information source to the engineer. In his company, computerized patent information searches are constantly made to keep the technical staff aware of the latest innovations (Bowman, 1978).

Some companies that are limited in space availability and cannot maintain an extensive in-house library are using online computer searches to obtain information promptly. Following are examples of data bases currently used by engineering companies:

°World Patent Index produced by Derwent Publications

°American Petroleum Institute Patent File produced by the American Petroleum Institute (Stanley, 1981)

For those companies that have the necessary staff and space available to provide and maintain an up-to-date technical library, an in-house library is an excellent source for employees to use as a reference for various engineering specialities. If the library includes access to data through the additional means of a computer, engineers can acquire valuable information needed to stay up-to-date in their area of expertise and provide the latest in engineering techniques for their customers.

At Control Data Corporation, in Minneapolis, Minnesota, employees are provided training through a computer-based education system called PLATO. There are 100 learning centers throughout the United States where employees can use terminals to take specific courses. The company has found the computer-based system to be very beneficial in meeting individual training needs when they occur (Berg, 1981).

Another appropriate training tool used by industry to train its employees is the simulator. Such a system is offered by Ford Motor Company to simulate faults of equipment that can be anticipated in troubleshooting. Malfunctions are encountered through setting random selection and the trainee demonstrates the procedure used to correct the situation (Mallory, 1981).

Role of Educational Institutions in the Training of Engineers

Universities and facilities offering continuing education cooperate with employers to offer technical courses, both credit and noncredit, to provide the engineer with necessary skills to perform a job. These courses are offered after work hours in some instances. Others are conducted at company locations by university professors or experts in specific disciplines for the convenience of the engineers and to insure attendance. Since not all companies are located close to universities, educational services are provided at a lower cost by bringing the courses to the engineers, rather than the engineers traveling to the university. By making their services more accessible, educational institutions provide necessary training for the engineers.

Through cooperation with engineering professionals and the National Science Foundation, MIT developed a program to identify engineering skills and provide self-administered learning materials to acquire the necessary skills. The importance of this program was emphasized by the $772,000 grant to establish the program (Evans and Tribus, 1975).

In every educational institution that is dedicated to providing engineering training, the changing needs of industry that are brought about by the advancements in technology dictate the areas where training is needed. Through cooperation with practicing engineers, specific areas are identified to provide the content of training programs.

Role of Communities in the Training of Engineers

Communities that are dependent upon engineering jobs to provide employment for a large number of people have been very innovative in providing necessary training to ensure needed skills. In response to such a need, the Quad-Cities Technical Advisory Council was formed by industries, universities, and local agencies of the Federal Government. Davenport, Iowa; Rock Island, Moline, and East Moline, Illinois, are the cities served by the Council. Credit courses, symposia and seminars are held to meet the needs of engineers in the community (Dray, Keller, Moriarty, 1969).

Other types of instruction offered through communities are video-tape classroom instruction and talk-back television courses. These methods can be very effective when it is not practical for trainees to travel to a university. When a community has a large number of people dependent on an industry that must remain technically up-to-date, programs are developed to meet the specific needs of the community.

Role of the Engineer in Continuing Training

Through research reported in recent professional journals, such as, *Engineering Education*, *Professional Engineer*, *Chemical Engineering*, and *Training and Development Journal*, it is evident that engineers continue training in order to remain effective in their jobs. Much of this training is self-initiated and is dependent on a variety of resources as identified by the individual engineer.

In a survey conducted in 1981, by Robert Rymell, Director of the

Center for Human Resources Research and Professional Development Programs at Texas Christian University, it was determined that 100 percent of the engineers questioned participated in training. Rymell randomly selected 30 engineers from one high-technology employer for his survey. All 30 engineers participated in some form of learning activity or training in order to perform their present jobs more efficiently. These learning activities were self-initiated by the engineer when he identified certain areas in which he felt his knowledge was inadequate to perform his job at his desired level of competency. Although the learning activity in which the engineer participated was not always a formalized training course it did represent a form of training which the engineer undertook to obtain up-to-date knowledge.

In a recent survey conducted by the Chemical Engineering magazine, 4,300 engineers responded indicating their need to keep up with technology (Greene, 1981). According to the engineers who responded, reading magazines and books, taking continuing education courses, attending meetings, taking company courses, and getting advanced degrees all were methods used to keep abreast with the rapid changes in technology.

Summary of Review

Through exposure to recent literature regarding technical progress and training in business and industry, it is very evident that change is rapidly taking place affecting the ability of engineering employees to remain up-to-date regarding the "state-of-the-art". To respond to the ongoing need for training, professional organizations, employers, educational institutions, communities, and individual engineers have shared the responsibility of providing appropriate training. Since it is important for the engineer to feel confident in his abilities to perform a specific function, he has frequently initiated self-directed learning when he perceives a difference between the amount of knowledge he possesses and the amount of knowledge he needs to perform his job.

CHAPTER III

PROCEDURES

This chapter outlines the procedures used to develop and implement the questionnaire to obtain information regarding the training needs of engineers. The procedures used are presented as follows:

1. Selection of the Method
2. Description and Selection of Subjects
3. Collection of Data
4. Analysis of Data.

Selection of the Method

Since responses were intended to reflect the employee's desire for training and not indicate any deficiency or individual lack of knowledge which might provide a negative connotation with regard to job performance, it was necessary to ensure anonymity and confidentiality. It was assumed that employees would feel free to express interest in training if they did not feel threatened by the possibility that their supervisor might think they lacked adequate technical knowledge to perform their job. Therefore, a form was developed with simple "check off" questions that enabled the respondent to indicate whether he wanted training, was satisfied with his current knowledge, or if the subject was not applicable to his current job. Such a form had the advantages of keeping a person's handwriting from being identified and required a minimum of time to complete.

Through discussions with managers, supervisors, and employees in engineering positions, 22 training areas were identified as needed to perform specific engineering jobs. These areas were:

1. Interpreting Customer Specifications
2. Performing Energy and Materials Balance Calculations
3. Specifying Appropriate Equipment, Size and Type for the Customer's Needs
4. Determining Optimum Configuration of Equipment
5. Determining Manufacturing Requirements for Customer Specifications
6. Selecting Valves and Instruments for Control Systems
7. Specification of Appropriate Parts
8. Preparation of Flow, Wiring, and Logic Diagrams
9. Preparation of Specification Sheets
10. Preparation of Cost Estimates for Control Systems
11. Determining Profit Margin on Bid Proposals
12. Certifying Customer and Shop Drawings
13. Preparing Shop Orders
14. Developing Job Schedules
15. Coordinating Production with Appropriate Departments
16. Determing Applicable Materials
17. Handling Customer Problems by Telephone and Written Correspondence
18. Functional Checkout of Control Panels
19. Start-Up of Equipment
20. Troubleshooting Equipment Problems in the Field

21. Familiarization with All Industrial Product Lines Sold by the Company

22. Familiarization with Departments and Their Functions

See the Appendix for a copy of the Training Needs Analysis Form.

Description and Selection of Subjects

The training needs of engineering employees at a large engineering and manufacturing firm in Tulsa, Oklahoma, had not been studied prior to this research. Since the study was designed to determine specific areas in which there was a need for training, the population selected was all the employees who were performing in engineering positions. Those engineers who were in positions as Division Directors or Company Officers were not included since the majority of their time was not spent performing actual engineering functions.

Included in the population were 27 employees with Mechanical Engineering Degrees, 22 with Chemical Engineering Degrees, and 9 with Electrical Engineering Degrees. Also, there were 12 employees in engineering positions who had degrees in disciplines other than engineering, and 14 who did not have degrees. The experience level of employees performing engineering functions ranged from 32 participants with less than 6 years to 13 with over 15 years. There were 24 employees with 6 to 10 years experience and 15 with 11 to 15 years experience.

Collection of Data

It was decided that the survey would be conducted in-plant in order to ensure a high degree of response. The researcher distributed the forms during working hours and the employees were asked not to sign them, but to complete and return the survey at the time of distribution. Surveys were conducted the first and second week of November, 1981. The distribution of questionnaires was made twice in order to include participants who were out of the office at the time of the first distribution.

Analysis of Data

Responses to the 22 subject areas were summarized in 22 tables. Data shown in each table included the number and percentage of employees who wanted more training, was satisfied with their current knowledge, or who did not feel the subject area was applicable to their current position. Responses were categorized by academic preparation and years of experience.

CHAPTER IV

PRESENTATION OF FINDINGS

The purpose of this study was to determine the training needs of engineering employees of a large engineering and manufacturing company located in Tulsa, Oklahoma. This chapter presents the findings of the study in this order:

1. Identified Subject Areas
2. Characteristics of the Population
3. Responses to the Need for Training in Selected Subject Areas.

Identified Subject Areas

Though discussions with engineers and their managers and supervisors, 22 subject areas were identified that related to engineering positions in the company. These areas were as follows:

1. Interpreting Customer Specifications
2. Performing Energy and Materials Balance Calculations
3. Specifying Appropriate Equipment, Size and Type for the Customer's Needs
4. Determining Optimum Configuration of Equipment
5. Determining Manufacturing Requirements for Customer Specifications
6. Selecting Valves and Instruments for Control Systems
7. Specification of Appropriate Parts

8. Preparation of Flow, Wiring, and Logic Diagrams
9. Preparation of Specification Sheets
10. Preparation of Cost Estimates for Control Systems
11. Determining Profit Margin on Bid Proposals
12. Certifying Customer and Shop Drawings
13. Preparing Shop Orders
14. Developing Job Schedules
15. Coordinating Production with Appropriate Departments
16. Determing Applicable Materials
17. Handling Customer Problems by Telephone and Written Correspondence
18. Functional Checkout of Control Panels
19. Start-Up of Equipment
20. Troubleshooting Equipment Problems in the Field
21. Familiarization with All Industrial Product Lines Sold by the Company
22. Familiarization with Departments and Their Functions

Characteristics of the Population

There were 84 people surveyed, which represented the total engineering workforce in the Industrial Divisions of the company. Academic preparation of incumbents of engineering positions was varied, consisting of 22 employees with Chemical, nine with Electrical, and 27 with Mechanical Engineering Degrees. Also, there were 12 employees who had degrees in disciplines other than engineering and 14 who had no degree.

The number of years experience in an engineering position was categorized as either less than six, six to ten, 11 to 15, or over 15. These categories were divided into two groups, those employees with engineering degrees and those without engineering degrees.

Responses to the Need for Training
in Selected Subject Areas

Responses to the need for training in 22 subject areas were represented by 22 tables. Each table was designed to show the number and percentage of employees who wanted more information, were satisfied with their current knowledge, or felt the subject was not applicable to their present job. Employee responses were grouped according to the academic preparation of the employees. Also, responses were grouped by the number of years experience the employees had in engineering positions and whether or not they had an engineering degree.

Data shown in Table I included 51.9 percent of the mechanical engineers and 50 percent of the employees with non-engineering degrees who desired more information regarding the interpretation of customer specifications. Those employees with less than six years of experience, both with and without engineering degrees, showed the greatest desire for more information. Of those groups, 52.4 percent of employees with engineering degrees and 63.6 percent without engineering degrees wanted more information. Electrical engineers showed the least desire for more information, with only 22.2 percent wanting more information. None of the employees without engineering degrees who had over 15 years of experience wanted more information.

TABLE I

RESPONSES TO "INTERPRETING CUSTOMER SPECIFICATIONS"
BY ACADEMIC PREPARATION AND
YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	8	36.4	11	50.0	3	13.6
Electrical Engineering	2	22.2	5	55.6	2	22.2
Mechanical Engineering	14	51.9	11	40.7	2	7.4
Non-Engineering Degree	6	50.0	5	41.7	1	8.3
No Degree	4	28.6	7	50.0	3	21.4
Years of Experience With Engineering Degree						
Less than 6	11	52.4	5	23.8	5	23.8
6 - 10	6	33.3	11	61.1	1	5.6
11 - 15	4	40.0	5	50.0	1	10.0
Over 15	3	33.3	6	66.7	0	0
Years of Experience - No Engineering Degree						
Less than 6	7	63.6	2	18.2	2	18.2
6 - 10	2	33.3	3	50.0	1	16.7
11 - 15	1	20.0	4	80.0	0	0
Over 15	0	0	3	75.0	1	25.0

Again, mechanical engineers and employees with non-engineering degrees showed the greatest desire for more information about performing energy and materials balance calculations as reflected in Table II. The greatest desire for information according to years of experience was expressed by those people with engineering degrees, 77.8 percent with from 11 to 15 years experience. Those employees without engineering degrees who expressed the greatest desire for more information were those with six to ten years of experience.

The data shown in Table III represents responses to specifying appropriate equipment, size and type, for the customer's needs. The employees with mechanical engineering degrees and non-engineering degrees also showed the strongest desire for more information about this area, with 74.1 percent and 75 percent respectively. According to years of experience, those with less than six showed the greatest desire for information, 80.9 percent with engineering degrees and 81.8 percent without engineering degrees.

Data shown in Table IV regards responses to determining optimum configuration of equipment. To this question, 88.9 percent of the electrical engineers responded that they wanted more information. Those employees with less than six years of experience showed the greatest desire for more information. Within that group, there were 90.5 percent of those with engineering degrees and 72.7 percent of those without engineering degrees who wanted more information.

Data reflected in Table V are the responses to the desire for training in the area of determining manufacturing requirements for customer specifications. Electrical engineers and employees with non-engineering degrees showed the strongest desire for training, with 77.8

TABLE II

RESPONSES TO "PERFORMING ENERGY AND MATERIALS BALANCE CALCULATIONS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	3	13.6	18	81.9	1	4.5
Electrical Engineering	5	55.6	1	11.1	3	33.3
Mechanical Engineering	16	59.3	8	29.7	3	11.1
Non-Engineering Degree	8	66.7	3	25.0	1	8.3
No Degree	7	50.0	1	71.1	6	42.9
Years of Experience With Engineering Degree						
Less than 6	10	47.6	9	42.9	2	9.5
6 - 10	6	33.3	7	38.9	5	27.8
11 - 15	1	10.0	9	90.0	0	0
Over 15	7	77.8	2	22.2	0	0
Years of Experience - No Engineering Degree						
Less than 6	7	63.6	1	9.1	3	27.3
6 - 10	4	66.7	0	0	2	33.3
11 - 15	2	40.0	1	20.0	2	40.0
Over 15	2	50.0	2	50.0	0	0

TABLE III

RESPONSES TO "SPECIFYING APPROPRIATE EQUIPMENT, SIZE AND TYPE, FOR THE CUSTOMER'S NEEDS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	11	50.0	9	41.0	2	9.0
Electrical Engineering	6	66.7	2	22.2	1	11.1
Mechanical Engineering	20	74.1	7	25.9	0	0
Non-Engineering Degree	9	75.0	3	25.0	0	0
No Degree	7	50.0	5	35.7	2	14.3
Years of Experience With Engineering Degree						
Less than 6	17	80.9	2	9.5	2	9.5
6 - 10	10	55.6	7	38.9	1	5.6
11 - 15	5	50.0	5	50.0	0	0
Over 15	4	44.4	5	55.6	0	0
Years of Experience - No Engineering Degree						
Less than 6	9	81.8	1	9.1	1	9.1
6 - 10	3	50.0	2	33.3	1	16.7
11 - 15	2	40.0	3	60.0	0	0
Over 15	2	50.0	2	50.0	0	0

TABLE IV

RESPONSES TO "DETERMINING OPTIMUM CONFIGURATION OF EQUIPMENT" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	13	59.1	8	36.4	1	4.5
Electrical Engineering	8	88.9	1	11.1	0	0
Mechanical Engineering	19	70.4	7	25.9	1	3.7
Non-Engineering Degree	7	58.3	5	41.7	0	0
No Degree	9	64.3	4	28.6	1	7.1
Years of Experience With Engineering Degree						
Less than 6	19	90.5	1	4.8	1	4.8
6 - 10	12	66.7	5	27.8	1	5.6
11 - 15	4	40.0	6	60.0	0	0
Over 15	6	66.7	3	33.3	0	0
Years of Experience - No Engineering Degree						
Less than 6	8	72.7	2	18.2	1	9.1
6 - 10	4	66.7	2	33.3	0	0
11 - 15	2	40.0	3	60.0	0	0
Over 15	2	50.0	2	50.0	0	0

TABLE V

RESPONSES TO "DETERMINING MANUFACTURING REQUIREMENTS FOR CUSTOMER SPECIFICATIONS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	12	54.6	5	22.7	5	22.7
Electrical Engineering	7	77.8	2	22.2	0	0
Mechanical Engineering	19	70.4	5	18.5	3	11.1
Non-Engineering Degree	9	75.0	3	25.0	0	0
No Degree	8	57.1	4	28.6	2	14.3
Years of Experience With Engineering Degree						
Less than 6	14	66.7	2	9.5	5	23.8
6 - 10	13	72.2	2	11.1	3	16.7
11 - 15	3	30.0	7	70.0	0	0
Over 15	8	88.9	1	11.1	0	0
Years of Experience - No Engineering Degree						
Less than 6	9	81.8	1	9.1	1	9.1
6 - 10	4	66.7	1	16.7	1	16.7
11 - 15	1	20.0	4	80.0	0	0
Over 15	3	75.0	1	25.0	0	0

and 75 percent of those groups respectively desiring more information in the specific subject area. The least desire for training was expressed by those employees with from 11 to 15 years of experience. Of those with engineering degrees, 30 percent with from 11 to 15 years of experience and 20 percent with no engineering degrees and comparable experience wanted more information.

Responses to gaining knowledge in the area of selecting valve and instruments for control systems are data shown on Table VI. It shows that 77.8 percent of the electrical engineers and 83.3 percent of employees without engineering degrees who have from six to ten years of experience wanted more information in this area. According to academic preparation, at least 50 percent of all groups wanted to know more about the subject.

Data in Table VII concern responses to the desire for training in the specification of appropriate parts. Mechanical engineers showed the strongest desire for knowledge and employees with no degrees the least. Percentages of these groups desiring more information were 55.5 and 35.7 respectively. Of those employees with engineering degrees those with less than six years experience had 66.7 percent of their group desiring more information. Also, there were 66.7 percent of the employees without engineering degrees and with six to ten years of experience who wanted training.

Data in Table VIII shows employees desire for training in the preparation of flow, wiring, and logic diagrams is shown. There were 62.9 percent of the mechanical engineers and only 25.0 percent of employees with non-engineering degrees who wanted training in this area. Of those employees without engineering degrees, none with from 11 to 15

TABLE VI

RESPONSES TO "SELECTING VALVES AND INSTRUMENTS FOR CONTROL SYSTEMS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	11	50.0	6	27.3	5	22.7
Electrical Engineering	7	77.8	2	22.2	0	0
Mechanical Engineering	16	59.3	4	14.8	7	25.9
Non-Engineering Degree	6	50.0	3	25.0	3	25.0
No Degree	8	57.1	3	21.4	3	21.4
Years of Experience With Engineering Degree						
Less than 6	13	61.9	4	19.0	4	19.0
6 - 10	8	44.4	3	16.7	7	38.9
11 - 15	7	70.0	2	20.0	1	10.0
Over 15	6	66.7	3	33.3	0	0
Years of Experience - No Engineering Degree						
Less than 6	7	63.6	2	18.2	2	18.2
6 - 10	5	83.3	0	0	1	16.7
11 - 15	1	20.0	3	60.0	1	20.0
Over 15	1	25.0	1	25.0	2	50.0

TABLE VII

RESPONSES TO "SPECIFICATION OF APPROPRIATE PARTS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	8	36.4	9	41.0	5	22.7
Electrical Engineering	4	44.4	4	44.4	1	11.1
Mechanical Engineering	15	55.5	4	14.8	8	29.7
Non-Engineering Degree	5	41.7	5	41.7	2	16.7
No Degree	5	35.7	7	50.0	2	14.3
Years of Experience With Engineering Degree						
Less than 6	14	66.7	1	4.8	6	28.6
6 - 10	7	38.9	5	27.8	6	33.3
11 - 15	3	30.0	5	50.0	2	20.0
Over 15	3	33.3	6	66.7	0	0
Years of Experience - No Engineering Degree						
Less than 6	4	36.4	4	36.4	3	27.3
6 - 10	4	66.7	2	33.3	0	0
11 - 15	1	20.0	4	80.0	0	0
Over 15	1	25.0	2	50.0	1	25.0

TABLE VIII

RESPONSES TO "PREPARATION OF FLOW, WIRING, AND LOGIC DIAGRAMS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	7	31.8	8	36.4	7	31.8
Electrical Engineering	4	44.4	5	55.6	0	0
Mechanical Engineering	17	62.9	2	7.4	8	29.7
Non-Engineering Degree	3	25.0	4	33.3	5	41.7
No Degree	7	50.0	5	35.7	2	14.3
Years of Experience With Engineering Degree						
Less than 6	12	57.1	4	19.0	5	23.8
6 - 10	8	44.4	4	22.2	6	33.3
11 - 15	3	30.0	4	30.0	4	40.0
Over 15	5	55.6	4	44.4	0	0
Years of Experience - No Engineering Degree						
Less than 6	6	54.5	2	18.2	3	27.3
6 - 10	3	50.0	1	16.7	2	33.3
11 - 15	0	0	4	80.0	1	20.0
Over 15	1	25.0	2	50.0	1	25.0

years of experience wanted more training; however, 54.5 percent of the group who had less than six years desired training.

Responses to the desire for training in the preparation of specification sheets are reflected by data in Table IX. It shows that only 8.3 percent of the employees with non-engineering degrees wanted training, while 55.6 percent of the electrical engineers desired training. Of the employees without engineering degrees, none wanted training who had at least 11 years of experience. This is in contrast to those employees with engineering degrees of which 22.2 percent with over 15 years experience wanted more information regarding the preparation of specification sheets.

Data in Table X show the responses to the desire for training in the preparation of cost estimates for control systems. The highest degree of interest in training was shown by electrical engineers, with 55.6 percent of that group wanting more information. None of the employees without engineering degrees and with 11 to 15 years experience wanted training, while 40.0 percent of the degreed engineers with the same years of experience wanted training.

Data shown in Table XI concern responses to the desire for training in the determination of profit margin on bid proposals. The highest response for training, 55.6 percent, was again expressed by the electrical engineers. Only 18.2 percent of the chemical engineers wanted more information about this subject.

Data in Table XII show the responses to training in certifying customer and shop drawings. Only 4.5 percent of the chemical engineers desired training as compared to 44.4 percent of electrical and mechanical engineers. Considering years of experience, responses ranged

TABLE IX

RESPONSES TO "PREPARATION OF SPECIFICATION SHEETS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	3	13.6	13	59.1	6	27.3
Electrical Engineering	5	55.6	3	33.3	1	11.1
Mechanical Engineering	7	25.9	10	37.0	10	37.0
Non-Engineering Degree	1	8.3	8	66.7	3	25.0
No Degree	3	21.4	6	42.9	5	35.7
Years of Experience With Engineering Degree						
Less than 6	5	23.8	9	42.9	7	33.3
6 - 10	7	38.9	3	16.7	8	44.4
11 - 15	1	10.0	8	80.0	1	10.0
Over 15	2	22.2	6	66.7	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	3	27.3	5	45.5	3	27.3
6 - 10	1	16.7	3	50.0	2	33.3
11 - 15	0	0	4	80.0	1	20.0
Over 15	0	0	2	50.0	2	50.0

TABLE X

RESPONSES TO "PREPARATION OF COST ESTIMATES FOR CONTROL SYSTEMS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	7	31.8	6	27.3	9	41.0
Electrical Engineering	5	55.6	3	33.3	1	11.1
Mechanical Engineering	12	44.4	4	14.8	11	40.7
Non-Engineering Degree	2	16.7	2	16.7	8	66.7
No Degree	3	21.4	6	42.9	5	35.7
Years of Experience With Engineering Degree						
Less than 6	5	23.8	9	42.9	7	33.3
6 - 10	7	38.9	3	16.7	8	44.4
11 - 15	4	40.0	3	30.0	3	30.0
Over 15	3	33.3	5	55.6	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	2	18.2	2	18.2	7	63.6
6 - 10	2	33.3	1	16.7	3	50.0
11 - 15	0	0	4	80.0	1	20.0
Over 15	1	25.0	1	25.0	2	50.0

TABLE XI

RESPONSES TO "DETERMINING PROFIT MARGIN ON BID PROPOSALS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	4	18.2	12	54.6	6	27.3
Electrical Engineering	5	55.6	2	22.2	2	22.2
Mechanical Engineering	14	51.9	6	22.2	7	25.9
Non-Engineering Degree	4	33.3	4	33.3	4	33.3
No Degree	5	35.7	3	21.4	6	42.9
Years of Experience With Engineering Degree						
Less than 6	9	42.9	2	9.5	10	47.6
6 - 10	8	44.4	6	33.3	4	22.2
11 - 15	3	30.0	6	60.0	1	10.0
Over 15	3	33.3	6	66.7	0	0
Years of Experience - No Engineering Degree						
Less than 6	3	27.3	3	27.3	5	45.5
6 - 10	3	50.0	1	16.7	2	33.3
11 - 15	1	20.0	2	40.0	2	40.0
Over 15	2	50.0	1	25.0	1	25.0

TABLE XII

RESPONSES TO "CERTIFYING CUSTOMER AND SHOP DRAWINGS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	1	4.5	9	41.0	12	54.6
Electrical Engineering	4	44.4	5	55.6	0	0
Mechanical Engineering	12	44.4	8	29.7	7	25.9
Non-Engineering Degree	4	33.3	5	41.7	3	25.0
No Degree	5	35.7	6	42.9	3	21.4
Years of Experience With Engineering Degree						
Less than 6	9	42.9	3	14.3	9	42.9
6 - 10	3	16.7	10	55.6	5	27.8
11 - 15	2	20.0	6	60.0	2	20.0
Over 15	3	33.3	3	33.3	3	33.3
Years of Experience - No Engineering Degree						
Less than 6	6	54.5	3	27.3	2	18.2
6 - 10	1	16.7	4	66.7	1	16.7
11 - 15	1	20.0	3	60.0	1	20.0
Over 15	1	25.0	1	25.0	2	50.0

from 54.5 percent of employees without engineering degrees and less than six years of experience to 20 percent of employees with 11 to 15 years of experience desiring training.

Responses to preparing shop orders varied widely as shown in Table XIII. Only 8.3 percent of those employees with non-engineering degrees and 44.4 percent of the electrical engineers wanted training. None of the employees without engineering degrees and over 15 years experience wanted training, while 38.1 percent of the degreed engineers with less than six years experience wanted more knowledge concerning the preparation of shop orders.

Data in Table XIV concern responses to developing job schedules. Of the employees who had degrees in disciplines other than engineering, 16.7 percent wanted training, with 55.6 percent of the electrical engineers wanting to know more about the area. In the case of employees without engineering degrees and over 15 years experience, 100 percent felt that developing job schedules was not applicable to their current job. In contrast, 50 percent of employees with the same academic preparation but with six to ten years experience wanted training.

The question regarding coordinating production with appropriate departments was the subject of Table XV. As data in that table indicate, 100 percent of the non-degreed engineers with over 15 years experience did not think the question was applicable to their jobs. But, 66.7 percent of the employees without engineering degrees and with from six to ten years experience wanted training in the area. Responses by academic preparation ranged from 25 percent of employees with degrees other than engineering to 77.8 percent of the electrical engineers wanting training.

TABLE XIII

RESPONSES TO "PREPARING SHOP ORDERS" BY
ACADEMIC PREPARATION AND
YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	7	31.8	10	45.5	5	22.7
Electrical Engineering	4	44.4	1	11.1	4	44.4
Mechanical Engineering	6	22.2	15	55.5	6	22.2
Non-Engineering Degree	1	8.3	7	58.3	4	33.3
No Degree	3	21.4	7	50.0	4	28.6
Years of Experience With Engineering Degree						
Less than 6	8	38.1	6	28.6	7	33.3
6 - 10	5	27.8	8	44.4	5	27.8
11 - 15	2	20.0	6	60.0	2	20.0
Over 15	2	22.2	6	66.7	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	1	9.1	7	63.6	3	27.3
6 - 10	1	16.7	4	66.7	1	16.7
11 - 15	2	40.0	2	40.0	1	20.0
Over 15	0	0	1	25.0	3	75.0

TABLE XIV

RESPONSES TO "DEVELOPING JOB SCHEDULES"
BY ACADEMIC PREPARATION AND
YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	4	18.2	11	50.0	7	31.8
Electrical Engineering	5	55.6	1	11.1	3	33.3
Mechanical Engineering	8	29.7	11	40.7	8	29.7
Non-Engineering Degree	2	16.7	5	41.7	5	41.7
No Degree	5	35.7	5	35.7	4	28.6
Years of Experience With Engineering Degree						
Less than 6	7	33.3	6	28.6	8	38.1
6 - 10	7	38.9	6	33.3	5	27.8
11 - 15	1	10.0	5	50.0	4	40.0
Over 15	2	22.2	6	66.7	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	3	27.3	5	45.5	3	27.3
6 - 10	3	50.0	2	33.3	1	16.7
11 - 15	1	20.0	3	60.0	1	20.0
Over 15	0	0	0	0	4	100.0

TABLE XV

RESPONSES TO "COORDINATING PRODUCTION WITH APPROPRIATE DEPARTMENTS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	7	31.8	6	27.3	9	41.0
Electrical Engineering	7	77.8	0	0	2	22.2
Mechanical Engineering	13	48.1	7	25.9	7	25.9
Non-Engineering Degree	3	25.0	5	41.7	4	33.3
No Degree	5	35.7	4	28.6	5	35.7
Years of Experience With Engineering Degree						
Less than 6	10	47.6	4	19.0	7	33.3
6 - 10	10	55.6	3	16.7	5	27.8
11 - 15	2	20.0	3	30.0	5	50.0
Over 15	5	55.6	3	33.3	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	3	27.3	5	45.5	3	27.3
6 - 10	4	66.7	2	33.3	0	0
11 - 15	1	20.0	2	40.0	2	40.0
Over 15	0	0	0	0	4	100.0

Data in Table XVI show the interest in training in the area of determining applicable materials. Responses were very high in favor of training, with 54.6 percent of chemical engineers being the lowest when considering academic preparation.

A lower degree of interest in training is shown by data in Table XVII, which deals with handling customer problems by telephone and written correspondence. The lowest degree of interest was expressed by 9.1 percent of the non-degreed engineers with less than six years experience. Considering academic preparation, responses in favor of more training ranged from 25 percent of the non-engineering degreed employees to 36.4 percent of the chemical engineers.

Data in Table XVIII indicate the desire for training in the functional checkout of control panels. There were 83.3 percent of the non-degreed engineers with six to ten years experience who wanted training. By academic preparation, the non-engineering degreed employees showed the highest degree of interest in training, 58.3 percent.

Interest in learning more about the start-up of equipment data is shown in Table XIX. The data indicate that 66.7 percent of the mechanical engineers wanted training. The lowest degree of interest was expressed by the chemical engineers, with 41 percent of that group wanting training. All of the employees without engineering degrees and over 15 years experience felt satisfied with their current knowledge or thought that the start-up of equipment was not applicable to their jobs.

Data in Table XX show the responses to training in the troubleshooting of equipment problems in the field. A very high interest in training was expressed ranging from 50 percent of the chemical engineers and 75 percent of the non-engineering degreed employees wanting to know

TABLE XVI

RESPONSES TO "DETERMINING APPLICABLE MATERIALS"
BY ACADEMIC PREPARATION AND
YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	12	54.6	5	22.7	5	22.7
Electrical Engineering	6	66.7	3	33.3	0	0
Mechanical Engineering	17	62.9	9	33.3	1	3.7
Non-Engineering Degree	9	75.0	3	25.0	0	0
No Degree	8	57.1	5	35.7	1	7.1
Years of Experience With Engineering Degree						
Less than 6	15	71.4	2	9.5	4	19.0
6 - 10	13	72.2	4	22.2	1	5.6
11 - 15	3	30.0	6	60.0	1	10.0
Over 15	4	44.4	5	55.6	0	0
Years of Experience - No Engineering Degree						
Less than 6	7	63.6	3	27.3	1	9.1
6 - 10	4	66.7	2	33.3	0	0
11 - 15	3	60.0	2	40.0	0	0
Over 15	3	75.0	1	25.0	0	0

TABLE XVII

RESPONSES TO "HANDLING CUSTOMER PROBLEMS BY TELEPHONE AND WRITTEN CORRESPONDENCE" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	8	36.4	14	63.6	0	0
Electrical Engineering	3	33.3	6	66.7	0	0
Mechanical Engineering	8	29.7	19	70.4	0	0
Non-Engineering Degree	3	25.0	8	66.7	1	8.3
No Degree	4	28.6	9	64.3	1	7.1
Years of Experience With Engineering Degree						
Less than 6	10	47.6	11	52.4	0	0
6 - 10	4	22.2	14	77.8	0	0
11 - 15	3	30.0	7	70.0	0	0
Over 15	2	22.2	7	77.8	0	0
Years of Experience - No Engineering Degree						
Less than 6	1	9.1	9	81.8	1	9.1
6 - 10	3	50.0	3	50.0	0	0
11 - 15	2	40.0	3	60.0	0	0
Over 15	1	25.0	2	50.0	1	25.0

TABLE XVIII

RESPONSES TO "FUNCTIONAL CHECKOUT OF CONTROL PANELS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	8	36.4	3	13.6	11	50.0
Electrical Engineering	3	33.3	5	55.6	1	11.1
Mechanical Engineering	13	48.1	4	14.8	10	37.0
Non-Engineering Degree	7	58.3	2	16.7	3	25.0
No Degree	7	50.0	5	35.7	2	14.3
Years of Experience With Engineering Degree						
Less than 6	9	42.9	5	23.8	7	33.3
6 - 10	7	38.9	4	22.2	7	38.9
11 - 15	4	40.0	2	20.0	4	40.0
Over 15	4	44.4	1	11.1	4	44.4
Years of Experience - No Engineering Degree						
Less than 6	6	54.5	3	27.3	2	18.2
6 - 10	5	83.3	0	0	1	16.7
11 - 15	2	40.0	3	60.0	0	0
Over 15	1	25.0	1	25.0	2	50.0

TABLE XIX

RESPONSES TO "START-UP OF EQUIPMENT"
BY ACADEMIC PREPARATION AND
YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	9	41.0	11	50.0	2	9.0
Electrical Engineering	4	44.4	4	44.4	1	11.1
Mechanical Engineering	18	66.7	6	22.2	3	11.1
Non-Engineering Degree	7	58.3	3	25.0	2	16.7
No Degree	9	64.3	4	28.6	1	7.1
Years of Experience With Engineering Degree						
Less than 6	14	66.7	6	28.6	1	4.8
6 - 10	11	61.1	6	33.3	1	5.6
11 - 15	2	20.0	6	60.0	2	20.0
Over 15	4	44.4	3	33.3	2	22.2
Years of Experience - No Engineering Degree						
Less than 6	7	63.6	3	27.3	1	9.1
6 - 10	6	100.0	0	0	0	0
11 - 15	3	60.0	2	40.0	0	0
Over 15	0	0	2	50.0	2	50.0

TABLE XX

RESPONSES TO "TROUBLESHOOTING EQUIPMENT PROBLEMS IN THE FIELD" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	11	50.0	9	41.0	2	9.0
Electrical Engineering	4	44.4	4	44.4	1	11.1
Mechanical Engineering	19	70.4	6	22.2	2	7.4
Non-Engineering Degree	9	75.0	3	25.0	0	0
No Degree	9	64.3	5	35.7	0	0
Years of Experience With Engineering Degree						
Less than 6	14	66.7	6	28.6	1	4.8
6 - 10	11	61.1	6	33.3	1	5.6
11 - 15	4	40.0	4	40.0	2	20.0
Over 15	5	55.6	3	33.3	1	11.1
Years of Experience - No Engineering Degree						
Less than 6	8	72.7	3	27.3	0	0
6 - 10	6	100.0	0	0	0	0
11 - 15	2	40.0	3	60.0	0	0
Over 15	2	50.0	2	50.0	0	0

more about this specific area. All of the employees without engineering degrees and with six to ten years experience wanted more training.

In Table XXI data is shown regarding interest in training to familiarize the employee with all the industrial product lines sold by the company. There were 100 percent of the degreed engineers with over 15 years experience who wanted training. According to academic preparation responses favorable to training ranged from 71.4 percent of the employees without degrees to 96.3 percent of the mechanical engineers expressing their interest.

Data in Table XXII indicate the interest for training to familiarize the employee with departments and their functions. Again, there was a strong desire for training, with 100 percent of the electrical engineers wanting to know more about that specific training area. The lowest desire for training by group according to academic preparation was expressed by the chemical engineers. Their percentage of favorable responses was 68.2. Considering experience levels, responses ranged from 60 percent of the engineers with from 11 to 15 years experience to 88.9 percent of the engineers with six to ten years experience wanting training.

Responses by engineers to the 22 training areas identified in this study indicates that the strongest desire for training by the Chemical and Mechanical Engineers was in the area of familiarization with all industrial product lines sold by the Company. This same training area was the most favored by both degreed and non-degreed engineers with less than six years experience, and degreed engineers with six or more years experience. Training to familiarize the employee with departments and their functions was desired by 100 percent of the Electrical Engineers.

TABLE XXI

RESPONSES TO "FAMILIARIZATION WITH ALL INDUSTRIAL PRODUCT LINES SOLD BY THE COMPANY" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	21	95.5	0	0	1	4.5
Electrical Engineering	8	88.9	1	11.1	0	0
Mechanical Engineering	26	96.3	1	3.7	0	0
Non-Engineering Degree	10	83.3	1	8.3	1	8.3
No Degree	10	71.4	3	21.4	1	7.1
Years of Experience With Engineering Degree						
Less than 6	20	95.2	0	0	1	4.8
6 - 10	17	94.4	1	5.6	0	0
11 - 15	9	90.0	1	10.0	0	0
Over 15	9	100.0	0	0	0	0
Years of Experience - No Engineering Degree						
Less than 6	10	90.9	0	0	1	9.1
6 - 10	5	83.3	1	16.7	0	0
11 - 15	2	40.0	3	60.0	0	0
Over 15	3	75.0	0	0	1	25.0

TABLE XXII

RESPONSES TO "FAMILIARIZATION WITH DEPARTMENTS AND THEIR FUNCTIONS" BY ACADEMIC PREPARATION AND YEARS OF EXPERIENCE

	Want More Information		Satisfied		N/A	
	N	%	N	%	N	%
Academic Preparation By Discipline						
Chemical Engineering	15	68.2	6	27.3	1	4.5
Electrical Engineering	9	100.0	0	0	0	0
Mechanical Engineering	22	81.5	4	14.8	1	3.7
Non-Engineering Degree	10	83.3	1	8.3	1	8.3
No Degree	10	71.4	3	21.4	1	7.1
Years of Experience With Engineering Degree						
Less than 6	17	80.9	3	14.3	1	4.8
6 - 10	16	88.9	1	5.6	1	5.6
11 - 15	6	60.0	4	40.0	0	0
Over 15	7	77.8	2	22.2	0	0
Years of Experience - No Engineering Degree						
Less than 6	8	72.7	2	18.2	1	9.1
6 - 10	5	83.3	1	16.7	0	0
11 - 15	4	80.0	1	20.0	0	0
Over 15	3	75.0	0	0	1	25.0

This was also an area in which employees in engineering positions who did not have engineering degrees showed a strong desire for training. All of the non-degreed engineers with six to ten years experience desired training in the start-up of equipment. Engineers with over fifteen years experience who did not have engineering degrees showed the strongest desire for training in determining manufacturing requirements and applicable materials, familiarization with departments and their functions, and familiarization with all industrial product lines sold by the Company. None of the non-degree engineers who had over fifteen years experience wanted training in the start-up of equipment, coordination of production with appropriate departments, developing job schedules, preparing shop orders and specification sheets, or interpreting customer specifications. Also, non-degreed engineers with eleven to fifteen years experience did not express an interest in training in the preparation of flow, wiring, and logic diagrams, specification sheets, or cost estimates for control systems.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes and discusses the results of the study. Summary of the findings presented in Chapter IV is presented first, followed by conclusions based on these findings. The final part of this chapter presents recommendations for practice and further studies.

Summary

The specific problem with which this study dealt was the identification of engineering employees' training needs. The purpose of the study was to determine what skills areas engineers in a specific company needed to develop in order to perform their jobs efficiently.

The total workforce of employees performing in engineering positions completed questionnaires regarding 22 subject areas. The results of their responses indicated that in specific areas, such as, familiarization with all industrial product lines, and departments and their function, a majority of the engineers surveyed wanted training regardless of their academic preparation or years of experience. In response to the other subject areas, interest in training varied depending on its applicability to the engineer's specific job and his current knowledge in the area.

Conclusions

The conclusions drawn from this study were as follows:

1. Most engineers in this study perceived the need for continued training in specific areas that affected their performance on their current job.
2. Academic preparation affected the engineer's need for training in specific areas as was illustrated in the variance of responses to certain subjects by the different disciplines.
3. Increased years of experience did not negate the need for training in specific areas.

Recommendations for Practice

It is recommended that training programs be developed for employees based on the engineers' identification of need. Those subjects in which the engineers expressed the greatest desire for training should receive priority in implementation, since employees feel they need more training in those areas in order to perform their jobs more efficiently.

Since this survey represented employees' perceived needs at one point in time, it is recommended that the survey be conducted, periodically to determine if the training needs change. If training programs are developed, changes in responses to the need for training in those areas could represent the effectiveness of the programs in meeting the specific training needs of the employees.

Recommendations for Research

Further studies are recommended to determine other subject areas relative to engineering jobs. To accomplish this, individual engineers could be asked to identify the areas in which they feel they need more training. Also, a study could be made to determine if there are certain training areas common to all industries in which engineers are employed. Another area for further study would be to determine whether specific training needs could be identified according to the type of engineering job performed.

Although this study was undertaken to determine the training needs of engineers in one specific company, the results indicate the continuing need for training of engineers as was also supported by related literature. Therefore, other companies that have not identified the training needs of engineering employees could probably benefit through conducting a survey on subject areas specifically related to their jobs.

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APPENDIX

Training Needs Analysis

This is an opportunity for you to express your individual training needs or wants. As you are not asked to sign the form, your particular responses will remain anonymous. The responses of all the participants will be compiled to identify those areas where there is a strong interest in training.

Check at least one of the following. If you have a degree in more than one major, check each one you obtained.

Electrical Engineering _____

Mechanical Engineering _____

Chemical Engineering _____

Other (please specify) ____

Do not have a degree _____

Check one of the following. How many years have you worked in an engineering position?

Less than 6 years _____

6 to 10 years _____

11 to 15 years _____

Over 15 years _____

Definition of column headings:

N/A - The job function is not applicable to your current position.

More Information - You would like to have the opportunity for additional training in this particular function to help you in your current position.

Satisfied with Current Knowledge - You feel totally knowledgeable in this particular job function and do not desire any additional training.

Check one column for each of the following job functions.

	N/A	More Information	Satisfied With Current Knowledge
1. Interpreting customer specifications.			
2. Performing energy and materials balance calculations.			
3. Specifying appropriate equipment, size and type, for the customer's needs.			
4. Determining optimum configuration of equipment.			
5. Determining manufacturing requirements for customer specifications.			
6. Selecting valves and instruments for control systems.			
7. Specification of appropriate parts.			
8. Preparation of flow, wiring and logic diagrams.			
9. Preparation of specification sheets.			
10. Preparation of cost estimates for control systems.			
11. Determining profit margin on bid proposals.			
12. Certifying customer and shop drawings.			
13. Preparing shop orders.			
14. Developing job schedules.			
15. Coordinating production with appropriate departments.			
16. Determining applicable materials.			
17. Handling customer problems by telephone and written correspondence.			
18. Functional checkout of control panels.			
19. Start-up of equipment.			
20. Troubleshooting equipment problems in the field.			
21. Familiarization with all industrial product lines sold by the company.			
22. Familiarization with departments and their functions.			

VITA

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