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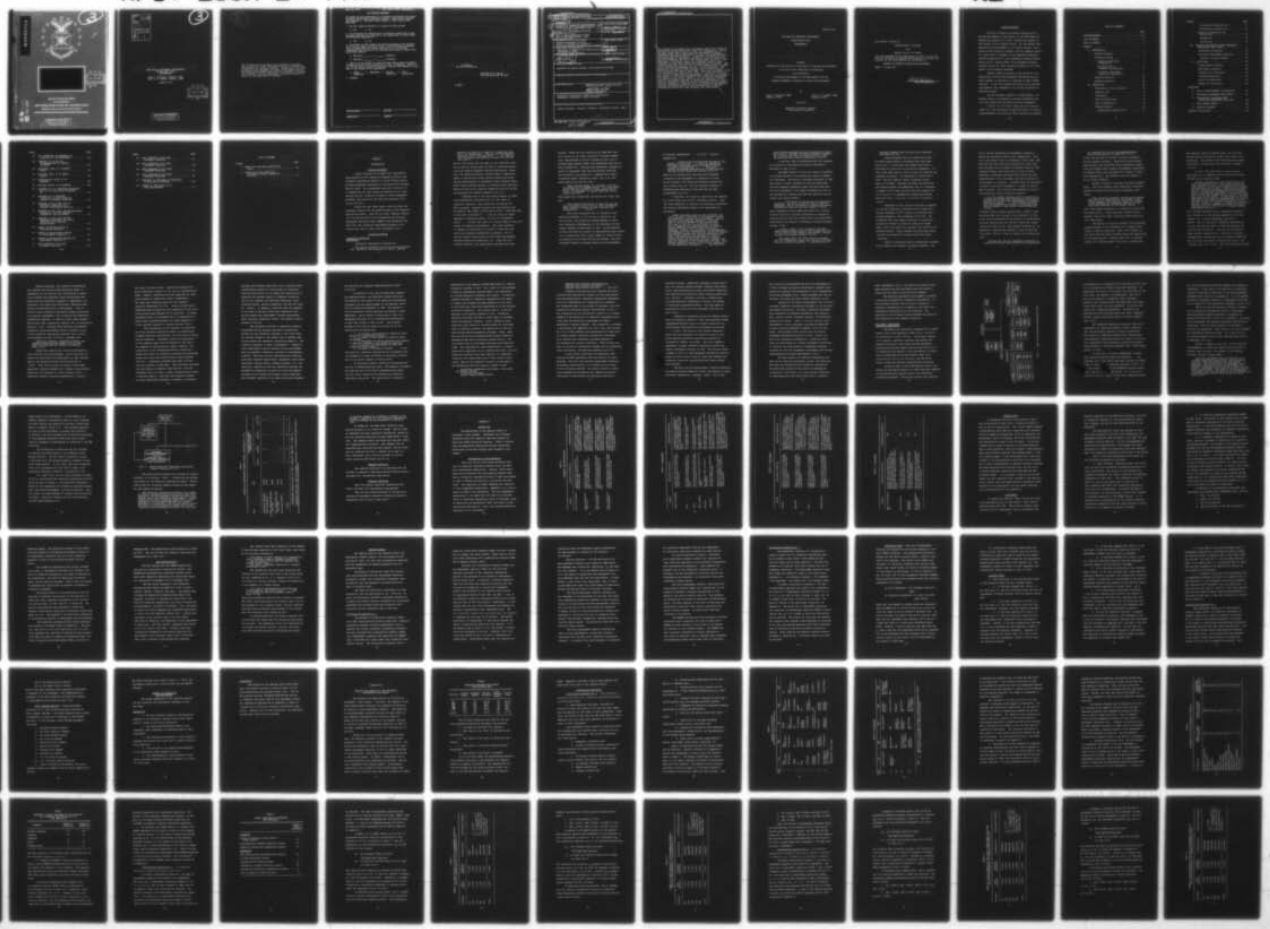

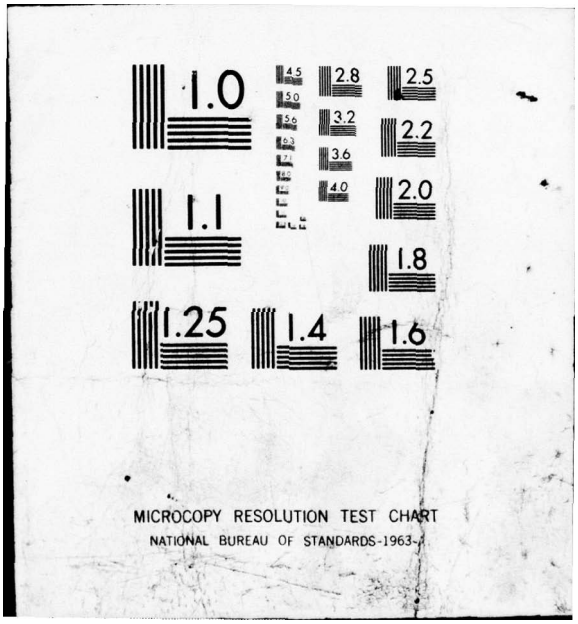
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THE ROLE OF INDUSTRIAL ENGINEERING WITHIN BASE CIVIL ENGINEERING

Mark J. Farineau, Captain, USAF
Alan E. M. Tucker, Captain, USAF

LSSR 20-77A

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The purpose of the thesis was to determine what role industrial engineering should play within Base Civil Engineering. During the past three years, there has been considerable concern expressed about the effectiveness of Base Civil Engineering's Industrial Engineering Branch. A detailed literature review of the development of industrial engineering from the Industrial Revolution through the 1970's was accomplished initially. The remainder of the thesis report was developed around a questionnaire entitled the Industrial Engineering Role Survey. The questionnaire was mailed to all Air Force bases having an industrial engineering department of four or more personnel. The population surveyed included officers and civilians holding the following positions at each base: Base Civil Engineer, Chief of Engineering and Construction, Chief of Industrial Engineering, Chief of Operations and Maintenance, and Chief of Programs. The results of the survey revealed that industrial engineering is needed at base level; however, its role should be changed. Some of the changes required in industrial engineering's role include: deletion of quality control responsibilities; emphasis upon the management consultant role and industrial engineering studies, and the acquiring of more professional industrial engineering staffs with less reliance upon technicians.

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THE ROLE OF INDUSTRIAL ENGINEERING WITHIN BASE CIVIL ENGINEERING

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Facilities Management

By

Mark J. Farineau, BSME
Captain, USAF

Alan E. M. Tucker, BSIE
Captain, USAF

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This thesis, written by

Captain Mark J. Farineau

and

Captain Alan E. M. Tucker

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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Ronald E. Kingston
COMMITTEE CHAIRMAN

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CHAPTER I

INTRODUCTION

Problem Statement

A major function of all Base Civil Engineering organizations is the Industrial Engineering Branch. The Industrial Engineering Branch is a staff function which provides management assistance to the Base Civil Engineer and his staff. As a management consultant function, it is responsible for such things as evaluating civil engineering service, conducting studies on known management problems, and evaluating and improving resource utilization (27:9-10).

During the last three years, there has been considerable concern over the effectiveness of the Industrial Engineering Branch. Both the Air Force Inspector General (IG) and the Air Force Civil Engineering and Services Management Evaluation Team (CESMET) have documented the fact that "the Industrial Engineering program is not working very well at base level [28:Change 76-1]."

Literature Review

Origins of Industrial Engineering

Industrial engineering is defined as:

> The art and science of utilizing and coordinating men, equipment, and materials to attain a desired

> quantity and quality of output at a specified time and at an optimum cost. This may include gathering, analyzing, and acting upon facts . . . for controlling the quality and quantity of goods and services [18:1:116-7].

The art and science has its roots in the Industrial Revolution when man seized upon the idea of improving productivity by reducing manpower through technological innovation. Sir Richard Arkwright (1732-92) made a significant impact on the British cotton-textile industry by devising and administering "a successful code of factory discipline" and by getting workers "to renounce their desultory habits of work and to identify themselves with the unvarying regularity of complex automation [18:1:9]."

Although many of the early practitioners of industrial engineering techniques were not then known as industrial engineers, they understood and applied the basic concepts. Benjamin Franklin has been honored with the name of "The Father of Efficiency [8:56]." The sixth item in his list of virtues is ". . . lose not time; be always employed in something useful; cut off all unnecessary action . . . [8:56]." This idea is a central theme of the principles of industrial engineering. The actual practice of industrial engineering as we know it today was used during the Industrial Revolution in England. Two of the most famous practitioners of that time were Matthew Robinson Boulton and James Watt, Jr. These two individuals inherited the steam engine business from their

fathers. Faced with the expiration of James Watt Senior's patent on the steam engine and increased competition, they decided to build a foundry of their own to produce steam engines rather than subcontract the work as their fathers did. Although they inherited a substantial amount of knowledge, they used enlightened foresight and planning in the design of a "complete and closely integrated modern engineering plant, 100 if not 150 years before its time [18:1:10]."

> Their costing system, for instance, involved the keeping of 22 standard books: as in any modern plant, the main use made of these records was to assist the management to detect waste and inefficiency [18:1:10].

Many people have lauded Watt and Boulton for their work but,

> The greatest shortcoming of these men was the fact that they did not write up their accomplishments except in letters to their partners and acquaintances . . . [20:16].

The first recognized book on industrial engineering principles, *On the Economy of Machinery and Manufactures*, was written by Charles Babbage, a Lucasian Professor of Mathematics at the University of Cambridge, England and published in 1832. He was inspired to write the book as a result of experiments he was conducting in conjunction with a large number of visits he made to factores in both Great Britain and Europe. His book discussed "general principles bearing on the management

of business undertakings . . . [3:1:11]." Charles Babbage was:

> . . . aware of the possibilities and some of the dangers of time study . . . [and] he understood the value of printed standard information blanks *in making investigations*. . . . . [The book] quickly ran through three editions in Great Britain, and some 10,000 copies were printed [18:1:11].

There is no evidence that this book had widespread influence on the management of industries in Great Britain because "the tradition of business secrecy was still strong [18:1:11]" and the research necessary to determine what occurred in this area has not been accomplished (18:1:11).

In America, the Industrial Revolution was gearing-up in the latter half of the nineteenth century. With the rapid expansion of industry and increasing technology, the field of engineering began to be recognized as a profession.

> Before the middle years of the nineteenth century, the direct influence of contemporary science on engineering practice was quite uneven. Some of America's most prominent mechanical engineers, even in the last decades of that century were still men of little or no scientific training who had happened into apprenticeships at various engine works and evinced a knack for machine building. However, the scientific and mathematical achievements of such technologists as William Rankine and Rudolph Clausius soon gave the mechanical engineers with scientific and mathematical training such a decided advantage that they, in effect, blocked entry into the field for most engineers who were not graduates of the engineering colleges. This brought important changes in the social composition of the engineering fellowship. . . . The elevation

> which science provided and the new sources of recruitment which it demanded converted mechanical engineering from what had been considered a trade to what was now more often called a profession [12:8-9].

It was this idea of professionalism that prompted the formation of the American Society of Mechanical Engineers in 1881 (2:35).

The ASME devoted its first six years of existence to problems related to the traditional duties of mechanical engineers. The forum of discussion enlarged in 1886 when Henry R. Towne, President of Yale and Towne Manufacturing Company presented a paper entitled, "The Engineer as an Economist." This paper discussed the role of the engineer as a manager and that the engineer could no longer just concern himself

> . . . with things in the best way by engineering standards. He had to recognize other criteria of efficiency, and in particular of economic efficiency, expressed in terms of cost and revenue [2:35-36].

Towne suggested that the ASME would serve as a fitting clearing house for available information on managerial practice and for the next several years the organization concentrated its efforts on developing incentive payment schemes (2:36).

> In 1895, a small, thin, pernickety engineer named Fredrick Winslow Taylor read a paper entitled "A Piece Rate System, Being A Step Toward a Partial Solution of the Labor Problem" [12:1].
>
> This paper dealt with wage incentive systems and its "differential piece rate" was more stringent than cost incentive systems. It required that the

shortest possible time for each job be computed and fixed [12:1-2].

"Taylor proposed that an 'honest day's work' be fixed scientifically, by methods free from human bias [12:2]." It was from this concept that Taylor developed and practiced his scientific management. In 1910, after many years of work to prove his theories and establish principles for obtaining an "honest day's work" from the laborer, Taylor presented another paper to the ASME. Although the paper was shelved by the Society because "the membership was not interested in papers of this sort and that there was nothing new in it [12:18]," it subsequently became world-famous under the title, *Principles of Scientific Management* (12:18).

Published in 1911, Taylor's book grew in popularity and was eventually translated into at least nine foreign languages (12:18). Taylor's principles were a welcome blessing to the businesses of his day. The Protestant Ethic was deeply ingrained in the society causing the workers to press for higher and higher wages, while the owners and engineers were striving for improved profits. Taylor thought his principles would provide the mechanism to achieve both goals simultaneously.

Taylor's principles were not unanimously accepted as the panacea for business' economics problems. The

unions saw the principles as management's method of exploiting the worker without just compensation. Also, due to the worker's lack of knowledge of time study, they believed that the times being measured for their jobs were too short and to receive any benefit from the wage incentive system, they would have to work too hard. Therefore, resistance developed which placed the Time Study Engineer in the unenviable position of being the "Black Sheep" of industry. Although there was resistance to Taylor's Scientific Management, it began to attract many followers. Two followers who expanded on Taylor's principles were Frank and Lillian Gilbreth.

> In 1912 (Frank) Gilbreth left his construction industry and adopted the technique of taking motion-pictures to get more exact measurements of peoples motions and timing. . . . The increased precision also made possible his isolation of sixteen fundamental elements of hand motion, called Therbligs . . . [12:40].

Gilbreth's basic concept required that a worker's task be broken down into its basic "true elements" or Therbligs, and be evaluated for elimination of wasted motion and then restructured into the best method for accomplishing the task (12:40). This became "Gilbreth'(s) all-embracing, inexhaustible concept of 'The One Best Way To Do Work' [12:41]." Prior to leaving his construction firm,

> Gilbreth set down his management techniques in a series of manuals which pictured his organization

> as a machine built on the interchangeable-part plan and specializing in speed work [12:37],

so his "One Best Way To Do Work" fitted in perfectly with his general thinking. Frank and Lillian Gilbreth applied their time and motion study techniques successfully and became highly sought as management consultants. As Fredrick Taylor was considered the "Father of Industrial Engineering," the Gilbreths could be thought of as its "First Children."

Another of Taylor's followers was Henry Lawrence Gantt. Like the Gilbreths, Gantt developed a different approach to applying the Scientific Management principles.

> Most of Gantt's technical innovations in management, his cost system and his long series of production charts, arose from his search for a device to set standards for management analogous to the stop watch standards for the worker [12:44].

Gantt also became successful as a consultant during and after World War I. Gantt made many valuable contributions, such as the Gantt Production Charts which are still used today.

The arrival of the third decade of the twentieth century brought no new techniques for increasing efficiency in factory production. Most of the efforts of the Taylorites were being directed toward the application of his principles of a "defined task" with a "defined method" in a "defined time" (18:1:12-13), though some

were applying them in different ways. By the 1930s, another group of efficiency experts were coming into prominence. The methods study techniques were another ramification of both Taylor and Gilbreth's concepts (18:1:13).

In 1933, the term *methods engineering* was developed by H. B. Maynard and his associates and was defined in the following words:

> Methods engineering is the technique that subjects each operation of a given piece of work to close analysis in order to eliminate every unnecessary operation and in order to approach the quickest and best method of performing each necessary operation; it includes the standardization of equipment, methods, and working conditions; it trains the operator to follow the standard method; when all this has been done, and not before, it determines by accurate measurement the number of standard hours in which an operator working with standard performance can do the job; finally, it usually, although not necessarily, devises a plan for compensating labor which encourages the operator to attain or to surpass standard performance [18:1:13].

This expanded technique was an improvement because it was a beginning of the systems approach to view work methods, but further improvement was still needed. Most of the work of industrial engineers up to this time had been done in existing factories and existing work situations. The idea was conceived to apply methods engineering to a task prior to actual accomplishment through the use of Gilbreth's Therbligs and then train the worker to perform the task in the "one best way" (18:1:13-14). The first practical attempt

to establish such elementary time standards was made by A. B. Segur prior to 1930 (13:1:14). His work helped focus on the problem, and in 1940, H. B. Maynard conducted a study sponsored by the Westinghouse Electric Company that "finally developed into what is known as *methods-time measurement*, or MTM [18:1:14]." A book under this title describing the procedure was written by Maynard, Stegemerton, and Schwab and was published in 1948. The use of MTM spread rapidly and it's use continues today (18:1:4).

Thanks to the early geniuses like Taylor, Gilbreth, Gantt, Maynard and many others, the industrial sector of American society was provided with new techniques to improve its productivity. These "traditionalists" were concerned primarily with applying their expertise to manufacturing situations. The tasks of the traditional industrial engineer include:

1. Methods engineering: operational a alysis, motion study, materials handling . . .
2. Work measurement: time study . . .
3. Control determination: production control, inventory control, quality control . . .
4. Wage and job evaluations . . .
5. Plant facilities and design: Plant layout . . . [18:1:18].

Post World War II Industrial Engineering

Prior to World War II, industrial engineering was primarily manufacturing oriented. Hence, the term

"industrial" engineer seemed appropriate. Since that time, industrial engineering has expanded its frontiers to numerous new challenges in nonmanufacturing areas "such as health services, banking, public utilities, transportation, and retailing [3:42]." This transition to the nonmanufacturing industries has been more dramatic in the last ten years. According to the American Institute of Industrial Engineers' (AIIE) statistics, the shift in total employment of industrial engineers was evidenced by a drop from 82 percent in 1966 to 59 percent in 1971 in the manufacturing industries. There were subsequent increases in nonmanufacturing areas (14:23).

The reader should not construe this increased emphasis in nonmanufacturing areas as meaning that the industrial engineer's role has diminished in manufacturing areas. The Bureau of Census' *Occupation by Industry* shows that the number of employed industrial engineers increased from 40,140 in 1950 to 185,389 in 1970 (14:23). A greater percentage of industrial engineers have entered nonmanufacturing areas because of the new opportunities created by a universal recognition of improved productivity and effective problem solving through industrial engineering. Nevertheless, the industrial engineer will continue to play an important role in manufacturing industries. His manufacturing role remains even though his employment demand has stabilized (13:38).

Before discussing how industrial engineering has impacted the various nonmanufacturing areas, an examination of the factors--the introduction of operations research and computers--which precipitated the break from the traditional approach is appropriate. As mentioned, this break with traditional industrial engineering is a post-World War II development. Just as Taylor's early industrial engineering efforts were known as scientific management, this relatively new industrial engineering technique is known by other terms--management science (MS), operations research (OR), or qualitative analysis (15:87). Although there has been considerable discussion concerning whether MS/OR is actually a part of the industrial engineering spectrum, Roy L. Allen, past-president of AIIE, 1973-1974, stressed that:

> Operations research, management science, and systems engineering were added to the IE name [and] have been used by college and industry alike [3:41].

Operations research was initially developed to solve tactical military problems. One of the first successes was associated with development of radar systems used in the defense of Britain during World War II (15:90). This initial effort utilized "a mixed team approach to develop mathematical, instead of qualitative, models for the analysis of a total system [20:21]." Operations research remained predominantly a military

tool until the early 1950s. Operations research had early nonmilitary success in rail and air transportation areas. However, offsetting failures appeared for every great success in these early years; consequently, the 1950s were turbulent years for the "upstart" operation researchers (17:130). A basic problem which underlined many failures was the complexity of the calculations which were required for OR solutions. In those precomputer days, the problems had to be simplistic in nature which limited the efforts of those engaged in a "total systems" approach to problem solving (20:21).

The introduction of the computer is recognized as having the most significant impact on productivity, likewise industrial engineering, since the days of Taylor and the Gilbreths. Successful industrial application of the computer began with the UNIVACs of the 1950s. The computer's characteristics--speed, capacity, and reliability of its information-handling capability--opened new vistas for industrial engineers and permitted system activities and controls never before possible (20:21-2). Industrial engineers have been involved with the computer in many ways. They have been concerned with the design of computer installations, from the management point of view, to make information more useful in decision making. They have used computer systems to solve complicated problems in industry, to simulate

business and industry conditions, and to provide almost instantaneous answers for varying sets of conditions. They have been active in the design and installation of computers for process control in numerous situations such as for chemical and petroleum industries, manufacturing plants, service industries, and even for traffic control. In addition, they have used the computer to aid them in the more traditional industrial engineering areas--work measurement, methods engineering, plant location, production control, and quality control systems (17:41-20).

The successful marriage of operations research techniques and the computer resulted in significant strides for the industrial engineer in the 1970s which has carried forward to the recent rise of systems engineering within the industrial engineering spectrum. The industrial engineer of today is equipped with sophisticated techniques to solve a myriad of problems whether they are business, industrial, societal or governmental oriented. While the various techniques which comprise operations research--game theory, simulation, Monte Carlo techniques, queuing theory, systems analysis, etc.--are important, recognition that the industrial engineer has expanded his repertoire of skills to solve the complex problems of his current environment is more important. The successful application of these skills has broadened

his horizons into numerous nonmanufacturing fields (17:41-20).

In addition to the rise of operations research and computerization, one additional factor which has contributed to the growth of the industrial engineering profession was the establishment of the American Institute of Industrial Engineers in 1948. The growth of the IE profession closely parallels the growth in AIIE membership. From a group of twelve men in 1948, the membership has grown to an international organization of more than 20,000 in 1975 (25:20). The original purpose of the AIIE as stated in Article III of its Constitution and Bylaws was:

> 1. To maintain the practice of Industrial Engineering on a professional status.
> 2. To foster a high degree of integrity among the members . . . .
> 3. To encourage and assist education and research in areas of interest to the Industrial Engineer.
> 4. To promote the interchange of ideas and information among members . . . .
> 5. To serve in the public interest . . . [1:18].

The growth of industrial engineering as a profession and its acceptance in many new fields is partially attributable to the active support of AIIE (20:22).

As previously stated, industrial engineering has shifted to nonmanufacturing areas. The Hospital and Health Services was one of the first nonmanufacturing organizations which recognized the benefits of industrial engineering expertise. The application of industrial

engineering to the hospital system dates back to a Kellog Foundation workshop in 1952. As a result of this workshop, industrial engineering programs began to be implemented at various hospitals throughout the country. In addition, academic programs in industrial engineering which apply to health care systems developed momentum in the 1960s. In the early 60s, there were approximately 39 IEs directly involved in hospitals. This figure rose to 1,100 IEs employed in the health industry in 1973. Industrial engineers have been utilized in three types of programs within the hospital industry. First, industrial engineers have been used on an in-house basis for individual study of hospital problems. The second area of use has been through shared engineering programs. Today, there are over thirty state programs which provide industrial engineering services to hospitals across the U.S. The third major area of involvement has been with consulting firms. This approach has grown significantly in recent years and is applicable on an international basis (14:25-6). Industrial engineers have been credited with improving virtually every conceivable area of the hospital institution. Some of the successful projects accomplished in the Metropolitan New York hospital system include:

Automating, mechanizing and systems improvement of medical records
Blood bank functions
Central Supply reorganization

Computerized accounting implementation . . .
Delivery room forecast and control . . .
Hospital organization structure . . . [23:44-5].

Industrial engineering first impacted the transportation and distribution industry in 1941 when United Airlines established an industrial engineering department which was "responsible for investigating all methods and procedures used in the conduct of business, with the objective of promoting greater effectiveness [14:27]." The transportation and distribution industry is a classic example of the transition of industrial engineering practices from the traditional techniques to complex mathematical systems analyses. This transition is evident in practically all segments--air, rail, sea, and trucking. Not all of these segments have experienced the same level of success through industrial engineering involvement. Only recently have industrial engineers emerged within the shipping and trucking industries. Their success has been in the area of operational systems such as scheduling, fleet utilization, and materials handling (14:27-8).

A more recent application of industrial engineering has been associated with the solution of urban problems. New York City recently established industrial engineering organizations in an attempt to solve some of its intricate problems. An initial project to establish standards and procedures for inspecting sanitary conditions in food stores and restaurants has been a

qualified success. Additional successes include resolution of a garbage removal problem, improved park maintenance, improved efficiency within the welfare department, more effective and efficient street cleaning operations, etc. (16:32-3). Similarly, the City of Phoenix has utilized simulation techniques to improve its methods of collecting uncontained refuse. This new method is estimated as saving the city government $400,000 per year (20:23).

Industrial engineering within the federal government encountered a rebirth in 1948 "when President Truman commissioned Herbert Hoover to conduct studies of the effectiveness and efficiency of government activities . . . [13:24]." The result of the "Hoover Commission Study" was the issuance of an executive order in 1949 which required industrial engineering programs be initiated in federal activities. The first complete experiment to apply industrial engineering within the federal government occurred in 1952. This was the establishment of the U.S. Army Management Engineering Training Agency at Rock Island, Illinois, which was staffed with industrial engineers, statisticians and other related practitioners.

The Navy also has established a vigorous industrial engineering program especially within the Bureaus of Yards and Docks, Aeronautics, Ordnance, Ships. One of the

Navy's major IE achievements has been the development of a widely accepted engineering performance standard (EPS) program for planning and estimating of civil engineering/ facilities management work. These standards are used by the Navy, Air Force and other federal agencies (14:25)

Parallel to the Army's developments, the Air Force initiated industrial engineering programs in its aircraft maintenance activities. Air Force industrial engineers were concerned with methods engineering, work measurement, quality control, economic analysis, and production planning and control. Later in the 50s, the Air Force implemented a strong management program for establishing and validating manpower standards in all Air Commands. This program later evolved into the current Management Engineering Program (14:24-5). Within the Base Civil Engineering organization, industrial engineers are functioning as in-house management consultants to "monitor the effectiveness of management systems, identify the need for management improvements and develop recommendations for those improvements [4:16]."

The past history of industrial engineering has been one of recurring turbulence, growth, and stability. What does the future hold for industrial engineering? The task which confronts the industrial engineering profession in the future "is no more unique, difficult, or unsolvable than that which faced Taylor, Gilbreth,

Gantt, and Emerson [7:27]." The name of the game is the same--productivity and efficiency--only the player's skills and the scope of the field have changed.

The previous discussion was intended to provide a historical background of industrial engineering. In the following section, the Air Force's concept of industrial engineering as it applies to the Base Civil Engineering organization will be developed. The specifics of the following section provide the basis for the formulation of the research objective.

Air Force: Base Level Industrial Engineering

The Base Civil Engineering organization is established by Air Force Regulation (AFR) 85-10, *Operations and Maintenance of Real Property*. Its primary mission "is to acquire, construct, maintain and operate real property facilities, and provide related management engineering and other support work and services [27:1]." To accomplish this mission, Civil Engineering is organized as prescribed by Air Force Manual (AFM) 26-2, *Organizational Policy and Structure*, and AFR 85-10. Figure 1 shows the required organizational structure.

As can be seen in the organizational chart, the Industrial Engineering Branch is a staff function composed of two subfunctions--Quality Control and Industrial Engineering Analysis. The Quality Control (QC) function

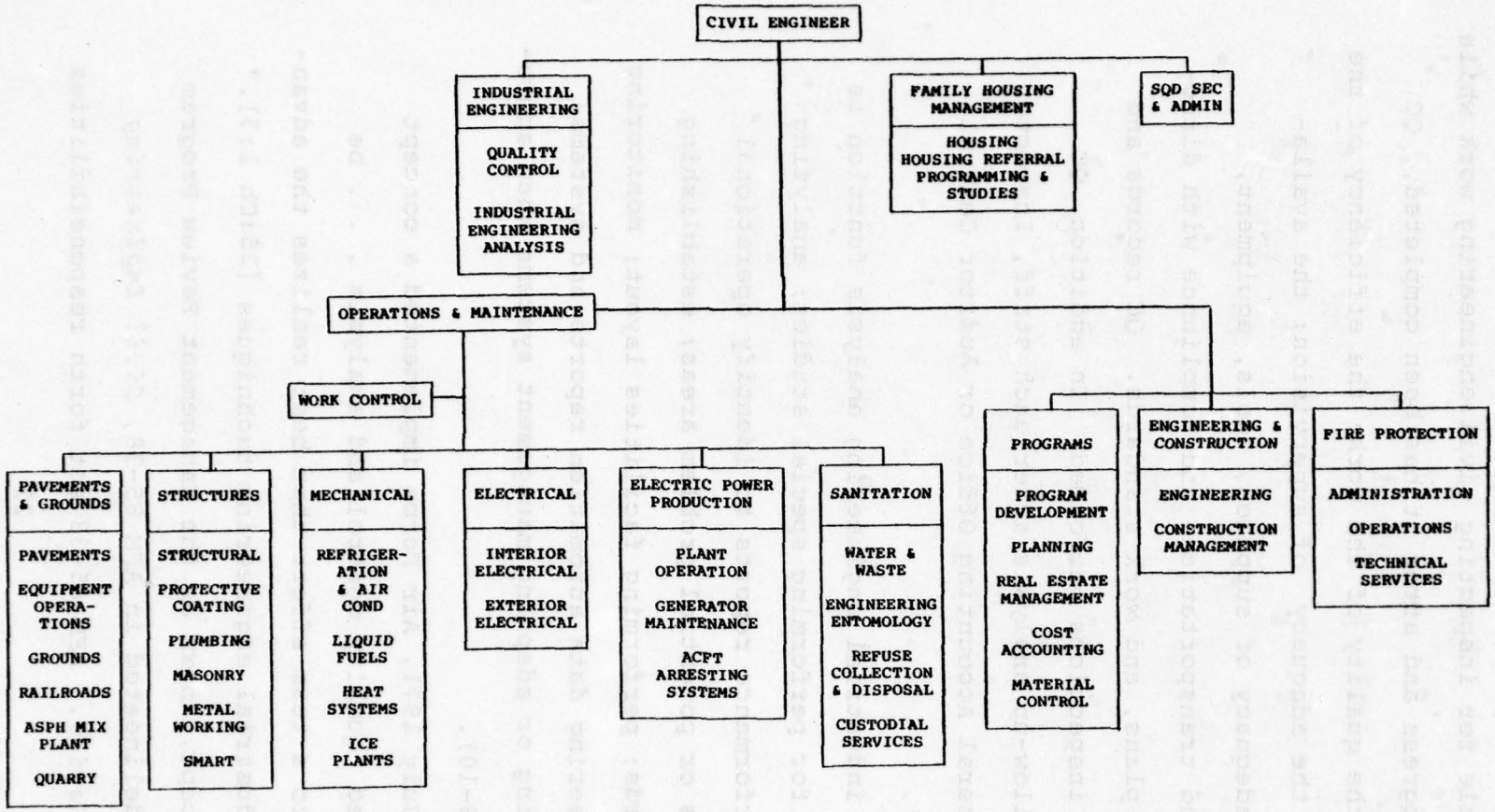

Fig. 1. Base Civil Engineer Organization Chart

is responsible for inspecting civil engineering work while it is in-progress and after it has been completed. QC determines the quality of the work; the efficiency of the work force; the adequacy of supervision; the availability and adequacy of supplies, tools, equipment, personnel and transportation; and compliance with directives, work plans, and work standards. QC records and reports all inspections performed. In addition, QC performs follow-up analysis after each staff, Inspector General, General Accounting Office or Auditor General visit (27:9).

The industrial engineering analysis function is responsible for performing special studies; analyzing cost and performance reports to identify operational deficiencies or potential problem areas; establishing time standards; performing facilities layout; monitoring civil engineering data automation reports and systems; and developing or adapting management systems when appropriate (27:9-10).

In July 1971, Air Force implemented a concept that required "quality control and analysis . . . be combined into a team effort that best realizes the advantages of industrial engineering techniques [25:Ch 1:3]." The new concept, known as the Management Review Program (MRP), was delineated in AFM 85-38, *Civil Engineering Management Review*. AFM 85-38 set forth responsibilities

for civil engineering functional managers and industrial engineering. A key facet of the MRP was to concentrate industrial engineering resources on the major management problems within base civil engineering. In this capacity, industrial engineering serves as a management consultant to all levels of civil engineering management (28:Ch 1:3-5).

AFM 85-38 provided detailed procedural guidance for the Industrial Engineering function. Many bases have encountered numerous problems in attempting to comply with AFM 85-38's "how to do" procedures. Initially, the IG documented the problems associated with AFM 85-38 compliance. Some of these problems are discussed in the next few paragraphs. More recently, Air Force CESMETs have documented similar problems. As a result of the continuing problems, the Air Staff rescinded AFM 85-38 on 24 September 1976 (26).

During 1 January-30 June 1974, the IG evaluated the management of industrial engineering activities at fourteen installations. The summary of the findings highlight the main problem areas:

> Personnel assignment practices deprived IE of a stable, experienced work force. Quality control policies varied significantly and were seldom enforced. Analysis sections and management review committees contributed little to the overall IE program. Management review studies failed to address major problem areas. And finally, the structuring of analysis functions was found to be counterproductive and hindering the overall effectiveness of the IE effort [29:1].

Further amplification of some of the identified problem areas is provided to establish the background of the research objectives. The first item of concern is the problem of a stable and experienced work force. Factors which contributed to this situation were:

1. IE manning was consistently below authorizations.

2. IE manning was adversely affected because of a multitude of additional duties and the common practice of loaning IE personnel to other BCE functions.

3. Less qualified personnel were being assigned to the IE function (29:4).

Since the IG report, the Air Staff has implemented its CESMET concept to evaluate the management of base support functions. CESMET performs as management consultants and not as headquarters inspectors (8:3). One of CESMET's concerns is that IE has sufficient manning to do its jobs and that it is not a convenient labor pool for other BCE functions (30:136).

A second major problem has been ineffective and inconsistent quality control of BCE operations. An underlying cause of this problem was the varying Major Command interpretations of the quality control procedures in the recently rescinded AFM 85-38. Air Force has not specified new quality control procedures except to state that the basic requirements of AFR 85-10 and the

standard Industrial Engineer position descriptions still apply (26). Also, CESMET emphasizes that industrial engineering must be involved in quality control "to keep the program 'honest' [30:135]."

A third major problem has been that Management Review Committees (MRC) have failed to support and direct industrial engineering efforts to improve civil engineering management. The Management Review Committee is a group comprised of the Base Civil Engineer and his functional staff whose basic responsibilities include the guiding of the Industrial Engineering Program (28:1-1). The IG found that at 80 percent of the bases inspected, the MRCs were not effectively guiding and directing the IE effort. MRC meetings, which were required quarterly, were "meeting infrequently, some as seldom as once a year [30:13]." A cause of this problem, as noted by the IG, was in AFM 85-38's failure to fully outline the responsibilities of the MRC. At that time, the Air Staff planned to expand on the responsibility of the MRC in a proposed revision to AFM 85-38 (29:17-18). Now that AFM 85-38 has been rescinded, no procedures exist for guiding the MRC. However, CESMET continues to emphasize that "the Industrial Engineer's study efforts should be guided by the Management Review Committee . . . [30:136]."

A fourth major problem has been that Management Review Studies (MRS) failed to address major problem

areas within civil engineering. An MRS refers to an indepth industrial engineering study of a major problem and whose results are expected to provide a significant amount of payback (28:Ch 2:11). This problem parallels the lack of MRC involvement in guiding the IE effort. In addition, the final problem--the artificial structuring of IE procedures required by AFM 85-38--was a direct cause of inadequate IE performance as reflected in the MRS (29:15-20).

The elimination of AFM 85-38 was not intended to diminish the significance of the industrial engineering function. The Air Staff is pursuing a policy of providing only the minimum essential guidance to base level organizations. In this case, they have eliminated "how to do" procedures and will rely on "what to do" procedures contained in AFR 85-10 and AFM 26-3 (26).

On 7 April 1977, the Air Staff announced the adoption of a restructured BCE industrial engineering function. As can be seen in Figure 2, the Industrial Engineering Branch is now responsible for Industrial Engineering Analysis, Real Estate Management, and Cost Accounting. Quality control has been removed as a formal section from the IE branch. Under this concept, QC will be provided by the O&M superintendents (21).

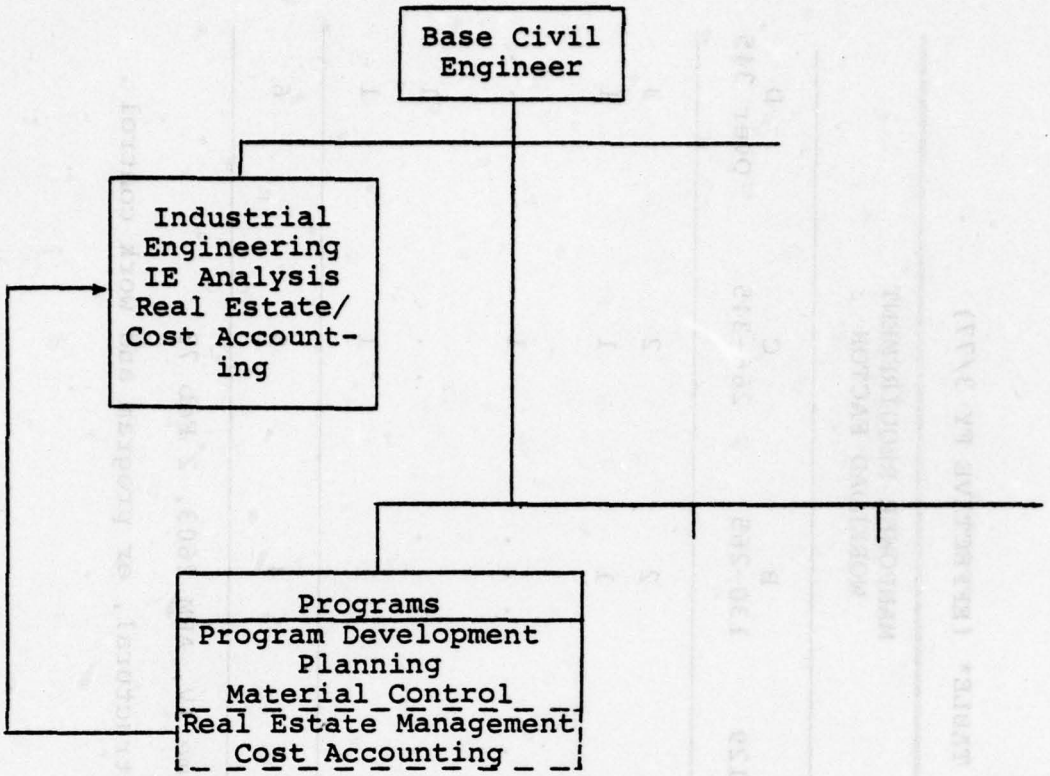

Fig. 2. Restructured BCE Industrial Engineering Branch (Effective FY 3/77)

The restructuring package also outlined an interim reduction in IE manning. Table 1 illustrates the new manning table for the Industrial Engineering Branch. The Air Staff noted the following comments concerning the reason for the reduced IE manning.

> The industrial engineering reduction is a result of control procedures which have recently been incorporated in the BCE management systems and which complement many of the inspection requirements. Further capability for work-in-progress inspections is also provided by the O&M superintendents and foremen. Therefore, as reflected in the interim manning guide, the quality control/inspection capability will be limited to one authorization for base. The reduction

TABLE 1

INDUSTRIAL ENGINEERING MANNING TABLE* (EFFECTIVE FY 3/77)

AFSC	AFSC	MANPOWER REQUIREMENT WORKLOAD FACTOR			
		A 70-129	B 130-265	C 266-345	D Over 345
Industrial Engineer	7725D	1	2	2	3
Admin Specialist	70250	1	1	1	1
Real Estate/Cost Mgt Anal Sup	55490	. . .	. . .	1	. . .
Real Estate/Cost Mgt Anal Tech	55470	. . .	. . .	. . .	1
Electrical Tech**	54270	1	1	1	1
Total		3	4	5	6

*Supersedes manning table, FC 4403, Vlume IV, AFM 2603, 2 Feb 73

**Another technician (heating systems, structural, or program and work control may be substituted to meet local requirements).

in analysis capability is based on a change in the concept of operation for the industrial engineering function presaged by the rescinding of AFM 85-38 [21].

To summarize, the base level industrial engineering function is in a state of change. The Air Staff is concerned with what industrial engineering should do and the following objective has been established in that view. The research effort was based upon the pre-7 April 1977 organizational structure. Even though a new IE organizational structure has been adopted, the Air Force has not finalized the role it expects IE to play (6). Thus, meaningful input could be provided to the Air Staff concerning the future role of IE.

Research Objective

The research objective is to determine how the concept of industrial engineering should function within the Base Civil Engineering organization.

Research Questions

What role should industrial engineering play within the Base Civil Engineering organization?

What are the current opinions of the key Civil Engineering management personnel concerning industrial engineering and its use at base level?

CHAPTER II

METHODOLOGY

The methodology of the research effort is explained in this chapter. Throughout the following discussion there are numerous terms and concepts of which the reader should be cognizant. Table 2 contains both the descriptive definitions and the operational definitions of the key concepts used throughout this chapter.

Description of the Population

There are 126 Air Force bases worldwide which have an Industrial Engineering Branch within the Base Civil Engineering Organization. However, twelve small bases were eliminated from consideration because they have an Industrial Engineering staff of three individuals or less or because the base has a contracted O&M work force. The remaining 114 bases comprised the locations of five independent populations. Appendix A is a list of bases included in the population. The five independent populations at the bases were the Base Civil Engineer, Chief of Industrial Engineering, Chief of Programs, Chief of Operations and Maintenance (O&M), and Chief of Engineering and Construction. Thus, each defined population consisted of 114 individuals.

TABLE 2

CONCEPTS AND DEFINITIONS

Concept	Descriptive Definition	Operational Definition
Base Civil Engineer	A person who fills the Base Civil Engineering (BCE) position at an Air Force Base (AFB).	A respondent who in a questionnaire survey is currently assigned as a Base Civil Engineer at one of the 119 AFBs identified in the population.
Chief of Industrial Engineering	A person who fills the Chief of Industrial Engineering position within the BCE organization at an AFB.	A respondent who in a questionnaire survey is currently assigned as a chief of an Industrial Engineering Branch at one of the 119 AFBs identified in the population.
Chief of Engineering and Construction	A person who fills the Chief of Engineering and Construction position within the BCE organization at an AFB.	A respondent who in a questionnaire survey is currently assigned as a Chief of an Engineering and Construction Branch at one of the 119 AFBs identified in the population.
Chief of Operations and Maintenance	A person who fills the Chief of Operations and Maintenance position within the BCE organization at an AFB.	A respondent who in a questionnaire survey is currently assigned as a Chief of an Operations and Maintenance Branch at one the 119 AFBs identified in the population.

TABLE 2--Continued

Concept	Descriptive Definition	Operational Definition
Chief of Programs	A person who fills the Chief of Programs position within the BCE organization at an AFB.	A respondent who in a questionnaire survey is currently assigned as a Chief of a Programs Branch at one of the 119 AFBs identified in the population.
Rank	The official assigned grade of an individual in the United States Air Force.	The military rank of the respondent in a questionnaire survey.
Grade	The official assigned civilian grade of an individual in the Civil Service.	The civilian grade of a respondent in a questionnaire survey.
Major Command	A specific designated major Air Force Command.	The major Air Force Command of a respondent in a questionnaire survey.
Education	The education level attained by individuals.	The highest education level of a respondent in a questionnaire survey.
Experience	The total amount of job experience attained by individuals.	The total amount of working experience gain in time at base level of a respondent in a questionnaire survey.
Strongly Disagree	Refers to an opinion of a respondent indicating the least favorable degree of response to a particular survey question.	The value of *1* associated to a response on a questionnaire survey indicating the least favorable degree of response. In the analysis, a value greater than *0* but less than *1.5* indicates the strongly disagree position.

TABLE 2--Continued

Concept	Descriptive Definition	Operational Definition
Disagree	Refers to an opinion of a respondent indicating the second least favorable degree of response to a particular survey question.	The value of *2* associated to a response on a questionnaire survey indicating the second least favorable degree of response. In the analysis, a value of *1.5* or greater but less than *2.5* indicates the disagree position.
Undecided	Refers to an opinion of a respondent indicating no degree of favorableness or unfavorableness to a particular survey question.	The value of *3* associated to a response on a questionnaire survey indicating no degree of favorableness or unfavorableness. In the analysis, a value of *2.5* or greater but less than *3.5* indicates an undecided position.
Agree	Refers to an opinion of a respondent indicating the second most favorable degree of response to a particular survey question.	The value of *4* associated to a response on a questionnaire survey indicating the second most favorable degree of response. In the analysis, a value of *3.5* or greater but less than *4.5* indicates the agree position.
Strongly Agree	Refers to an opinion of a respondent indicating the most favorable degree of response to a particular survey question.	The value of *5* associated to a response on a questionnaire survey indicating the most favorable degree of response. In the analysis, a value of *4.5* or greater indicates the strongly agree position.

TABLE 2--Continued

Concepts	Descriptive Definitions	Operational Definitions
Base Civil Engineering	The base level organization whose primary mission is to acquire, control, maintain and operate real property facilities and provide related management engineering and other support work and services (20:1).	N/A
Quality Control	The BCE section which is responsible for the quality, efficiency, and adequacy of civil engineering work (20:9).	N/A
Management Consultant	The role of the Industrial Engineer as an internal management consultant to assist all levels of BCE management.	N/A
Key Civil Engineering Management Personnel	The five identified Base Civil Engineering persons identified to be surveyed--BCE, Chief of IE, Chief of O&M, Chief of E&C, and Chief of Programs.	N/A

Sampling Plan

To determine the role of the Industrial Engineer as perceived at base level, a census was taken of each of the five populations. The invited sample entailed a questionnaire being mailed to each Base Civil Engineer, Chief of Industrial Engineering, Chief of Operations and Maintenance, Chief of Programs, and Chief of Engineering and Construction at each of the 114 bases. It was anticipated that at least 60 percent of the questionnaires sent to each population would be returned. Questionnaires which were returned comprised the accepted sample. From the accepted sample, it was anticipated that a small percentage of the questionnaires would have to be discarded due to their incompleteness or possibly improper responses. The questionnaires which remained after the culling of incomplete/improper questionnaires comprised the data producing sample. If 50 percent or more of the invited sample for each population were included in the data producing sample, then the sample would be considered representative of the population; and the results obtained could be generalized to the population.

Instruments

To answer the question, "What role should industrial engineering play at base level?," three similar questionnaires were used. There was one general questionnaire for all respondents, with an attachment with

specific questions for the Base Civil Engineer, the Chief of Industrial Engineering, and selected branch chiefs--O&M, Programs, and E&C--at each base identified in the population.

The questionnaire format was selected so that the current opinions of the key Civil Engineering (CE) Management personnel--BCE and Chiefs of IE, O&M, E&C, and Programs--could be obtained. The key CE management personnel were surveyed because it was assumed that their perception of industrial engineering would best describe what role industrial engineering should play in the future.

Each of the three questionnaires was based upon the following investigative questions:

1. What functions, responsibilities, and activities are base level industrial engineering branches currently performing? The purpose of this question was intended to establish the current functions of industrial engineering at base level. The turbulence created by AFM 85-38 and its rescission made it difficult to fully identify what base level industrial engineering functions were accomplishing. To provide validity to this question, the questionnaire's results were compared to findings identified in the CESMET reports. It is assumed that an understanding of the current industrial engineering responsibilities was required prior to determining if it is adequate or should be changed.

2. Is industrial engineering capability needed at base level? The purpose of this question was to determine if industrial engineering is of value to the BCE organization. It was quite possible that the key CE management personnel could perceive of industrial engineering as providing no benefit to the organization.

3. If industrial engineering is needed at base level, should it continue to function as is or should it be modified/changed? The purpose of this question was to determine how the key CE management personnel perceive the future of industrial engineering based upon their view that it is "of value." It is quite possible that industrial engineering could have been viewed as: (a) being strictly a quality control function; (b) being strictly an analysis and studies function; (c) being a mix of quality control and analysis as currently required by AFR 85-10; (d) expanding its scope of work outside the BCE organizations; (e) incorporating additional responsibilities such as Cost Accounting and Real Estate; or (f) a mix of the above and others not mentioned.

In addition to the measurement questions, the questionnaire collected basic demographic data, such as:

1. Rank, if military.
2. Grade, if civilian.
3. Job title/position.
4. Manning strength of the BCE organization.

5. Major Air Force Command.

6. Level of education.

7. Base level IE experience (DEI group only).

8. Level of IE degree (DEI group only).

9. IE authorization level (DEI group only).

10. IE assigned level (DEI group only).

A copy of the proposed questionnaire can be seen in Appendix B. The general questionnaire was used for every respondent. Attachment number one was used for the Base Civil Engineer. Attachment number two was used for the Chief of Industrial Engineering. Attachment number three was used for the identified branch chiefs.

Validity of the questionnaires was attained by conducting a small pilot study. The respondents in the pilot study included civil engineering instructors at the Air Force Institute of Technology's Civil Engineering School and Engineering and Services personnel assigned to the Air Force Logistics Headquarters (AFLC). The CE instructors surveyed were the experts associated with the functional areas included in the questionnaire--IE, O&M, E&C, and Programs. Likewise, AFLC personnel surveyed were the appropriate functional experts.

Data Collection Plan

The data necessary for this research effort were obtained from three primary sources; the literature research, compilation of existing data, and the Industrial

Engineering Role Survey. The literature research encompassed pertinent information to provide a background for the existing climate of base level industrial engineering and the many aspects of the industrial engineering field. The compilation of existing data and the Industrial Engineering Role Survey provided the basis for descriptive and analytical data.

The compilation of existing data consisted of the CESMET recorded observations for the bases visited by them during the period of approximately November 1975 to November 1976. Air Staff CESMET provided the portion of their reports which dealt with industrial engineering for use in this research effort. CESMET data provided information concerning the situation as it existed within base level industrial engineering.

The second method in which data were collected was through the Industrial Engineer Role Survey. The Industrial Engineering Role Survey contained questions to collect two types of data--quantitative and qualitative. The quantitative questions collected demographic data about the populations' qualities. The demographic data were used to construct treatments which were used to analyze and test the data gathered in the opinion section of the survey. In addition, the demographic data were used to develop descriptive statistics concerning the population--frequency diagrams,

means and ranges. The qualitative section of the survey contained questions to determine the personal opinion of the respondents concerning the role of the industrial engineer in terms of the existing situation and the future.

The Industrial Engineering Role Survey included five groups of respondents--the Base Civil Engineer, the Chief of Industrial Engineering, the Chief of Engineering and Construction, the Chief of Operations and Maintenance, and the Chief of Programs. Each of the five groups of responses were used either as separate treatments or collective treatments.

The second section of the questionnaire was constructed to ascertain the opinions of the population on "what base level industrial engineering is" at the survey time and what, in their opinion, it should be. The opinion type questions were designed to answer the research investigation questions as previously stated (see pages 34 & 35). See Appendix C for particular association of investigative question to measurement opinion questions.

The Industrial Engineering Role Survey questions were mailed to the bases listed in Appendix A. The position identifiers of the five populations were the Base Civil Engineer--DE, the Chief of Engineering and Construction--DEE, The Chief of Industrial Engineering--DEI, the Chief of Operations and Maintenance--DEM, and Chief of

Programs--DEP. The questionnaires were mailed on 8 February 1977. The cut off date for receipt of data from the respondents was 4 March 1977.

Data Classification

The data gained from the CESMET reports were analyzed and classified on descriptive content. The CESMET data described what conditions existed within base level Industrial Engineering Air Force-wide during the time period of November 1975 to November 1976.

The data being requested in the Industrial Engineering Role Survey included all levels of data--nominal, ordinal, interval, and ratio. The nominal data included the population categorizations--Base Civil Engineer, the Chief of Engineering Construction, the Chief of Industrial Engineering, the Chief of Operations and Maintenance, and Chief of Programs. Also, the specific major Air Force commands were considered descriptive in nature only and therefore nominal data. Ordinal data consisted of the military rank or civilian grade, the level of education, and experience of the respondents at base level. The rank ordered responses were considered to be ordinal level data. Interval level data included the responses to the opinion questions and were based on the five-point Likert Scale (9:248-250). Ratio data consisted of percentage-type responses.

The interval level data consisting of the answers to opinion-type questions on the Likert Scale, were based on the following assumptions:

> Each sample is drawn randomly and independently from a different class or treatment population.
> The variances of the class or treatment populations are all equal.
> The class or treatment population is normally distributed [5:458].

The assumptions that were made concerning the validity of the interval level data of the Likert Scale are well supported by Mr. P. L. Gardner in his *Review of Educational Research* article, "Scales and Statistics." In his summary, Mr. Gardner states:

> If a test is constructed by psychophysical scaling methods [the Likert Scale], . . . then, it is argued the measure possesses interval scale [11:46].

There were arguments concerning the validity of assuming the Likert Scale-type results are interval data; but for the purposes of this research effort, the data obtained from the opinion questions were assumed to be interval data and, therefore, were treated as such.

As stated previously, the results obtained from the raw data were based upon the assumptions made about the raw data. The assumptions allow the classification of the data as nominal, ordinal, interval, and ratio upon which various statistical techniques were based.

Research Design

The sampling plan of this research effort was considered a census; however, for the purpose of the statistical tests, the data were considered as complying with the assumptions of sampled parametric and non-parametric data.

The design of statistical tests and criteria tests was structured from the measurement questions developed to answer the investigative questions. Each statistical test was designed to provide definitive input to criteria tests.

The level of statistical significance for each statistical test was maintained at .05. Using the .05 level of significance provided a reasonable probability of making the correct decision concerning the statistical hypothesis and provided sufficient protection from rejecting the null hypothesis when it was true.

Investigative Question No. 1

The purpose of investigative question number one--"What functions/activities are base level industrial engineering branches currently performing?"--was to identify the current industrial engineering situation. The data collected from investigative question number one's measurement questions were used with the CESMET data to describe the current base level industrial engineering concept. The statistical procedures used in

answering investigative question number one were intended only to support the above purpose. There were no statistical tests associated with investigative question number one to support criteria tests.

Initially for investigative question number one, the measurement question--"What are the five most important functions of the Industrial Engineering Branch?"--was analyzed for two groups of respondents--BCE and Chief of IE. In addition, a similar question--"What are the three most important functions that the IE staff can accomplish to satisfy your management needs?"--was analyzed for the remaining three groups of respondents--Chiefs of DEE, DEP, and DEM. A list of the important industrial engineering functions was developed for each of the five groups of respondents. It was assumed that the five lists represented the backbone of industrial engineering's work responsibilities. The five individual ranked lists were based upon the frequency of response for each type of IE function. The Kendall coefficient of concordance, W, was used to measure the extent of associations among the five rankings. If W was greater than or equal to 0.70, the extent of association was considered to be high. Likewise, the W statistic was tested at the 0.05 level to determine its significance. Significance means that the rankings are

related and that the respondents applied essentially the same standard in ranking the IE functions (22:229-238).

The two rankings of the BCE and Chief of IE were analyzed to measure their degree of association. The Spearman rank correlation coefficient, r_s, was used for this analysis. If r_s was greater than or equal to 0.70, the extent of association was considered to be high dependent upon the test for significance. If when tested, r_s was found to be significant, then it could be concluded that there was a high degree of association between the BCE and Chief of IE groups' opinions.

The second measurement question analyzed was the "Estimate of the percentage of time that the Industrial Engineering Branch has expended in each category" listed in the previously discussed measurement question. The IE group was the only group asked this question. A summary listing of time percentages per category was developed to illustrate how much of industrial engineering time has been expended per category during the previous twelve months. No statistical tests were conducted on these results.

The third measurement question analyzed was "What are the weaknesses or limitations currently associated with the base level industrial engineering concept?" A frequency list was developed to illustrate

the individual weaknesses noted by the respondents. No statistical tests were conducted on these results.

The fourth measurement question, associated with investigative question number one, analyzed was "Rank order the importance of how industrial engineering work requirements are generated." This question was answered only by the industrial engineering group. A frequency list was developed to illustrate how IE work requirements are generated. No statistical tests were conducted on these results.

The final measurement question, associated with investigative question number one, analyzed was "Is the industrial engineer's greatest contribution to your branch in the area of quality control?" This question was analyzed for the Chief of Operations and Maintenance group. The mean response of the Chief of O&M group was determined to ascertain their opinion concerning the quality control program. No statistical tests were conducted on the results.

The CESMET provided data were analyzed to provide additional input concerning IE's role at base level. CESMET provided extracts of thirty-two of its reports for analysis in this research effort. The CESMET data were analyzed to determine an overall appraisal of base level IE functions, and to determine what strengths and weaknesses existed within base level IE functions.

Investigative Question No. 2

The measurement questions for investigative question number two--"Is industrial engineering capability needed at base level?"--were drawn entirely from the survey opinion-type questions. The data were assumed to be interval level data allowing the use of parametric statistics. The measurement question's data were coded with numerical values to the Likert Scale response of: *1* for Strongly Disagree, *2* for Disagree, *3* for Undecided, *4* for Agree, and *5* for Strongly Agree.

To answer investigative question 2, two sets of measurement questions were asked to all respondents. The first set of measurement questions--numbers 10, 11, 12, 18, 19, 20, and 21--were intended to imply that IE is needed at base level and should be retained. For specific wording of the measurement questions, see Appendix B. The second set of measurement questions only contained one measurement question--number 8--which implies that IE is not needed at base level and should not be retained. The purpose of using only one measurement question which implies unfavorableness to retaining IE was that the grouped questions which imply favorableness to retaining IE may have provided inconclusive results. Thus, from the one question implying unfavorableness to retaining IE , conclusive results can still be provided.

Statistical Test. Each set of measurement questions was analyzed by the one-way analysis of variance (ANOVA) technique. The computerized Statistical Package for the Social Sciences (SPSS), version 6, was used in the analyses. The results of the ANOVA runs provided: (1) individual treatment--BCE, Chief of E&C, Chief of IE, Chief of O&M, and Chief of Programs--means, (2) the overall or grand mean, (3) the F_s statistic at the .05 level, and (4) the homogeneous treatment subsets. The F_s statistic which was provided allowed the following hypothesis to be tested:

H_0 (Null hypothesis): The treatment means are equal.

H_1 (Alternate hypothesis): At least two treatments differ.

Based upon the degrees of freedom which was determined from the ANOVA run, a critical value of F_c at the .05 level was found in the F_c tables of reference five. If the F_s statistic was greater than the F_c critical value, then the null hypothesis was rejected, and it was concluded that there is a statistical difference among means. However, if the F_s statistic was less than the F_c value, then the null hypothesis could not be rejected, and it was concluded that the treatments had a statistically similar opinion which could be represented by the overall or grand mean.

If a statistical difference among means were found to exist, then the H. Scheffe test for critical differences of means was used to ascertain the Simple Pairwise Difference of Means--these are the homogeneous subsets which were provided in the computer run. The homogeneous subsets are those in which treatments have statistically similar opinions at the .05 level.

Criteria Tests.

1. The conclusions to the analyses were based on the following ranges for the treatment means:

A. If the mean response fell within 1.0 and less than 1.5, then the conclusion drawn was that the respondents "strongly disagree" with the question statement.

B. If the mean response fell within 1.5 and less than 2.5, then the conclusion drawn was that the respondents "disagree" with the question statement.

C. If the mean response fell within 2.5 and less than 3.5, then the conclusion drawn was that the respondents were "undecided" about the question statement. However, if the mean response was less than 2.75, it was concluded that the respondent "tended to disagree" with the question statement. Likewise, if the mean response was greater than 3.25, then it was concluded that the respondents "tended to agree" with the question statement.

D. If the mean response fell within 3.5 and less than 4.5 then the conclusion drawn was that the respondents "agreed" with the question statement.

E. If the mean response fell within 4.5 and 5.0, then the conclusion drawn was that the respondents "strongly agreed" with the question statement.

2. If no statistical difference of the treatment means existed, or only one treatment mean (other than the Industrial Engineer treatment) was statistically different, the overall or grand mean of the responses to the sets of measurement questions was accepted as the combined group's response pending completion of criteria tests 5 and 6.

3. If a statistically significant difference of two or more treatment means existed, the results of the H. Scheffé test provided which treatments were statistically different. In this case, the group mean was considered to be too indecisive and the homogeneous subsets were used to show the differences of opinion.

4. If only the Industrial Engineer's treatment mean was significantly different, then responses to the Industrial Engineer's measurement questions were eliminated from the averaging of responses and a new mean of the four remaining treatments was completed. The new mean was accepted as the overall group's response to the measurement questions of investigative question number two pending completion of Criteria Test number five.

5. If the means of the two dichotomous sets of measurement questions for investigative question number two were positioned on opposite ends of the Likert Scale, and one mean was less than *2.5* and the other mean was equal to or greater than *3.5*, the opinions were in agreement and were accepted as the population's opinion for this portion of the analysis.

6. If either of the means of the dichotomous sets of measurement questions was equal to or greater than *2.5* and less than *3.5*, the responses to the sets of measurement questions were considered to be too indecisive. If this was the case, then the results to the single measurement question number 8--which implied unfavorableness to *retaining IE*--was used to draw the conclusions to investigative question 2.

Investigative Question No. 3

The measurement questions for investigative question number three--"If industrial engineering is needed at base level, should it continue to function as is or should it be modified/changed?"--consisted of the answer to opinion-type multiple-choice questions, open-ended questions and rank order-type questions. The opinion-type multiple-choice questions were answered on the Likert Scale. The resulting data were assumed to be interval level which allowed for statistical testing with the use of parametric statistics. The

measurement question's data were coded with numerical values to the Likert Scale responses of: *1* for Strongly Disagree, *2* for Disagree, *3* for Undecided, *4* for Agree, and *5* for Strongly Agree.

To answer investigative question number three, two sets of measurement questions were asked all respondents. The first set of measurement questions--numbers 7 and 17--were intended to imply favorableness to changing the role of IE. The second set of measurement questions--13, 14, 16, and 20--were intended to imply unfavorableness to changing the role of IE.

Statistical Test. Each set of measurement questions was analyzed by the one-way ANOVA technique as explained for investigative question 2 on pages 48 and 49.

Criteria Tests. Each set of measurement questions utilized the same criteria tests--pages 49-51--as was used for investigative question 2. The only difference between the criteria tests for investigative questions 2 and 3 was criteria test number 6. Criteria test 6 for investigative question 3 was: *If either of the means of the dichotomous sets of measurement questions was equal to or greater than 2.5 and less than 3.5, the responses were considered to be too indecisive. If this was the case, then the results of measurement*

question 20 were used to draw conclusions to investigative question 3.

Individual Measurement Questions. An analysis was made of each individual measurement question. For measurement questions 7, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, and 21, the ANOVA technique, as discussed on pages 48-49, was utilized to determine the individual treatment means and the statistically similar opinions. Criteria tests 1, 2, and 3 were utilized to draw the conclusions of each analysis. Also, for the referenced measurement questions, histograms were plotted and have been included in Appendix D.

For the remaining measurement questions, frequency tables were developed. The frequency tables illustrate how the various respondents answered the particular measurement questions.

If the conclusion to investigative question 2 was that IE should be changed or modified, then the following questions were intended to identify how IE should be changed or modified:

#15 of the General Section

#25 of the BCE's Section

#26 of the BCE's Section

#31 of the IE's Section

#32 of the IE's Section

#25 of the Branch Chief's Section

#26 of the Branch Chief's Section

Each of the above questions were analyzed by developing a frequency of like responses. The summarization of responses to the above questions provided the changes or improvements which should be made to IE.

Major Command Analysis. Three measurement questions--8, 13, and 20--were analyzed according to Major Command (MAJCOM). The ANOVA technique was utilized to determine if there was a difference in the MAJCOM opinions. In the analyses, eleven MAJCOM treatments were used:

1. Aerospace Defense Command
2. Air Force Logistics Command
3. Air Force Systems Command
4. Air Training Command
5. Military Airlift Command
6. Pacific Air Forces
7. Strategic Air Command
8. Tactical Air Command
9. U.S. Air Force in Europe
10. U.S. Air Force Security Service
11. Other--includes Air University, Air Force Academy, Alaskan Air Command, and Air Force Communication Service.

The ANOVA technique and criteria tests 1, 2, and 3, as discussed on pages 49-51, were utilized for the MAJCOM analyses.

Summary of Assumptions and Limitations

The prime assumptions of the research question and the collection and statistical treatment of the data were:

Assumptions

1. The data producing sample of the population response to the Industrial Engineer Role Survey represented a census of the entire population.

2. The observations/responses made by each respondent were independent of responses made by other respondents.

3. The observations/responses to the Industrial Engineer Role Survey were drawn from a normally distributed population.

4. The variance of the observations/responses of the populations were assumed all equal.

5. The psycholphysical scaling method (Likert Scale) provides responses that were assumed to be interval level data.

Limitations

The results of the research effort were based upon the personal opinions of persons within the Air Force Engineering and Services career field. Ideally, data should have been collected from non-DOD service or nonprofit functions, such as city management staffs, for comparative purposes and to determine if there is a better way of utilizing industrial engineering capability. However, due to time constraints, the additional non-DOD data could not be collected.

CHAPTER III

ANALYSIS AND RESULTS OF THE INDUSTRIAL ENGINEERING ROLE SURVEY

The analysis and summarization of the data are presented in this chapter. Initially, the analysis of the three investigative questions are presented followed by an analysis of each measurement question. The numbering of the measurement questions follows the same format as the Industrial Engineering Role Survey as shown on pages 152-162. The final portion of the chapter includes an anlysis of selected measurement questions in terms of the major commands rather than the civil engineering job position.

Except for a brief analysis of CESMET-provided data, the analyses included in this chapter are based primarily on the Industrial Engineering Role Survey. The survey was forwarded to each of the five key civil engineering management personnel at the 114 bases identified in the population. There were 470 questionnaires mailed in the invited sample. As Table 3 illustrates, 490 of the questionnaires were completed and returned. The 490 total represents the accepted sample. Four-Hundred-sixty-nine or 82.3 percent of the invited sample were used to produce the data upon which the analyses are based.

TABLE 3

INDUSTRIAL ENGINEER ROLE SURVEY
PARTICIPATION RATE

Position	Invited Sample	Accepted Sample	Percent Returned	Data-Produced Sample	Percent Used
DE	114	96	84.2%	94	82.5%
DEE	114	101	88.6	94	82.5
DEI	114	102	89.5	97	85.1
DEM	114	96	84.2	92	80.7
DEP	114	95	83.3	92	80.7
Totals	570	490	86.0%	469	82.3%

The following convention was used for the key civil engineering positions throughout the analyses:

1. DE refers to the Base Civil Engineer
2. DEE refers to the Chief of Engineering and Construction.
3. DEI refers to the Chief of Industrial Engineering.
4. DEM refers to the Chief of Operations and Maintenance.
5. DEP refers to the Chief of Programs.

All of the data except the opened-ended questions were entered and stored in the Honeywell 635 Computer System via computer scan sheets. The computerized Statistical Package for the Social Sciences (SPSS), Version 6, was used extensively throughout the analysis

phase. Appendix E includes a copy of the computer programs which were used in the research effort.

Investigative Questions

Investigative Question No. 1. What functions/activities are base level industrial engineering branches currently performing?

1. Most important functions: The BCE and Chief of IE were both asked to list the five most important IE functions in the order of their importance. Likewise, the Chiefs of DEE, DEM, and DEP were asked a similar question--list the three most important IE functions in order of their importance.

The respondents noted numerous IE functions which were categorized into fourteen major functions for use in developing the rankings. The fourteen categories are listed below:

A. Management consultant work

B. QC which includes activity evaluations, work-in-progress and completed work evaluations, and self-inspections.

C. IE studies includes special studies, large or small studies, and Level II and III studies.

D. IE analysis includes trend analysis.

E. BEAMS oriented work

F. Manpower related work.

G. Follow-up work associated with IG, GAO, Auditor or MAJCOM visits.

H. Problem Solving--this category was not elaborated on. It was listed as problem solving or problem solving work.

I. Customer Relations Program--IE work associated directly with the Customer Relations Program.

J. Management by Objective--responses normally associated IE as being the MBO monitor.

K. Training and testing within BCE organization.

L. Traditional IE includes standards established, methods study, time study, etc.

M. Systems and Procedures--work associated with the development, documentation, and implementation of new systems and procedures

N. Other duties includes administrative duties, Prime BEEF, extra duties, briefings, etc.

Table 4 illustrates how the five groups ranked the IE functions. Tables 42 through 46 in Appendix D contain the development of each of the five rankings shown in Table 4. The Kendall Coefficient of Concordance, W, was used to measure the extent of association among the five rankings. The results of this analysis provided a value of W equal to 0.785 which implies a high degree of association among the five rankings. The

TABLE 4

RANKING OF IE FUNCTIONS
(Descending Order of Importance)

Rank	DE	DEE	DEI	DEM	DEP
1.	Mgt Consultant	Mgt Consultant	BEAMS	Mgt Consultant	QC
2.	IE Studies	IE Studies	Mgt Consultant*	IE Studies	Mgt Consultant
3.	BEAMS	QC	QC*	IE Analysis	IE Studies
4.	QC	Manpower	IE Studies	BEAMS	BEAMS
5.	MBO	beamsn	Problem Solving	QC	Problem Solving
6.	Manpower	Extra Duties	IE Analysis	Systems Procedures	Manpower
7.	Problem Solving	Problem	Follow-up to IG, Auditor, etc	MBO	Systems &
8.	IE Analysis	Systems & Procedures	Manpower	Problem Solving	IE Analysis
9.	Follow-up to IE, Auditor, etc., reports	IE Analysis	Customer Relations*	Customer Relatins	Entra Duties

*Represents tied ranks.

TABLE 4--Continued

Rank	DE	DEE	DEI	DEM	DEP
10.	Extra Duties*	Training & Testing	Extra Duties*	Training & Testing	Follow-up to IG, Auditor, etc., reports
11.	Training & Testing	Traditional IE	MBO	Extra Duties*	MBO
12.	. . . . .	MBO	Systems & Procedures	Manpower	. . . . .
13.	. . . . .	Follow-up to IG, Auditor etc., reports	Training & Testing	Traditional IE	. . . . .
14.	. . . . .	Customer Relations	Traditional IE	Follow-up to IG, Auditor, etc., reports	. . . . .

NOTE: 1. BEAMS refers to the Base Engineer Automated Management System.
2. MBO refers to Management by Objectives Program.

W statistic was tested at the .05 level and was found to be significant. The resulting conclusion is that the rankings are related and that the respondents applied essentially the same standard in ranking the IE functions. For the detailed analysis, the reader is referenced to page 180 in Appendix D.

The rankings of the BCE and Chief of IE were analyzed to determine their degree of association. The Spearman rank correlation coefficient, r_s, was used to measure the extent of association between the BCE and Chief of IE rankings. The results of this analysis provided a value of r_s equal to 0.8177 which implies a high degree association between the BCE and IE rankings. The r_s statistics was tested at the .05 level and was found to be significant. The resulting conclusion is that there is a high degree association between the BCE and IE rankings. For the detailed analysis, the reader is referenced to page 183 in Appendix D.

2. Percentage of IE time expended per category: To ascertain approximately how much time IE expends on various types of work, the Chief of IE was asked to estimate the amount of time he has expended during the last twelve months on those five categories which he listed as most important. To fully determine how much time IE

expends in various categories, the question should have been directed at all categories of work and not the five most important categories. Thus, the data collected does not reflect IE's total workload over the last twelve months. However, the data does reflect the amount of time being expended on those functions which IE's consider important.

The results revealed that 80 percent of the IE's who consider QC and BEAMS to be one of the five most important functions have expended 20 percent of their time in each of these activities. Also, 54 percent of the IEs have expended 20 percent of their time on management consultant work. Likewise, 44 percent of the IEs have expended 30 percent of their time on IE studies. Table 5 provides a complete breakout of the percentage of IE time expended per function. For the complete analysis which supports Table 5, see page 176 in Appendix D.

3. Weakness/limitations of IE: All five groups of respondents were asked to list the weaknesses or limitations of the current IE concept. The weaknesses refer to the IE concept prior to the recent (7 April 1977) organizational change. There were fifty-one different weaknesses/limitations identified by the respondents. Table 6 illustrates the weaknesses/limitations which were noted by at least five of the respondents. A listing of

TABLE 5

ESTIMATE OF IE TIME EXPENDED BY FUNCTION

IE Function	Number of Bases With Responses	Percent of Bases With Responses	Estimated Average Time Expended by IE
Management Consultant	50	54%	20%
Quality Control	74	80	20
IE Studies	41	44	30
IE Analysis	28	30	25
BEAMS	74	80	20
Manpower	16	17	15
Follow-Up Work	26	28	15
Problem Solving	25	27	25
Customer Relations	16	17	10
Management by Objectives	12	13	10
Traing & Testing	5	5	10
Traditional IE	3	3	10
Systems & Procedures	4	4	10
Extra Duties	15	16	15

TABLE 6

WEAKNESSES/LIMITATIONS OF IE

Weakness	DE	DEE	DEI	DEM	DEP	Total
Unqualified IE Staffs	24	42	37	29	22	154
Undermanned	13	6	17	18	14	68
Failure to Solve Problems	4	15	...	22	24	65
QC/Black Hat Image	6	11	11	18	11	57
Either Not Used or Improperly Used by the BCE & Staff	9	4	24	3	7	47
Too Many Additional Duties	1	6	14	5	3	29
Inadequate Training Available for IE Personnel	4	...	21	1	3	29
None	7	5	...	6	5	23
High Turnover of Personnel	7	2	5	4	2	20
Inexperience of IE Chief	13	4	...	...	2	19
Lack of Direction	5	...	8	...	...	13
Poor Interpersonal Writing or Speaking Skill	...	1	4	5	1	11
No Teeth in QC/IE Program	...	...	4	4	2	10
IE Staff Not Motivated	2	1	...	2	4	9
IE Grades are too low	3	...	3	3	...	9
Lack of Understanding of IE Role	...	...	8	...	...	8
BEAMS--Requires too much time/too few benefits	1	...	6	...	...	7
Not E&C Oriented	...	7	...	...	...	7
Not Flexible for BCE Requirements	5	...	...	...	...	5
Requires too much Paper Work	...	4	1	...	...	5
Customer Relations Program Requires too much Time	3	...	2	...	...	5
IE Lacks Credibility	2	...	...	...	3	5

the weaknesses/limitations which were noted by less than five respondents can be found on page 178 of Appendix D.

4. Source of IE Work Requirements: The Chief of IE group was asked to rank order the various sources of their work requirements. Based on the responses, the following list represents the rank ordering of IE's work requirements in decending order of importance:

Rank		Total Points
1	IE--Self Generated	539
2	BCE	504
3	Branch Chiefs	385
4	Command, IG, Auditor, etc. reports	354
5	Required by regulation (AFR 85-1, AFR 85-10, etc)	325
6	Management Review Committee	264
7	Other BCE Personnel	256

The reader is referenced to page 177 of Appendix D for development of the above ranking. The ranking reveals that the IE and BCE are considered the most important sources of IE requirements. The Branch Chiefs, reports, and regulations appear to fall into an equal grouping of IE work requirements generation. Likewise, the Management Review Committee and other BCE personnel groups appear to be equal and are the least important sources of IE work requirements.

5. Contribution of QC to O&M Branch: The Chief of O&M was asked if the IE's greatest contribution to his branch was in the area of quality control. The results of this question are illustrated in Table 7.

TABLE 7

FREQUENCY OF DEM'S RESPONSES TO THE QUESTION: IE'S GREATEST CONTRIBUTION IS IN THE AREA OF QC

Response	Number of Responses	Percent of Responses
Strongly Disagree	23	25%
Disagree	35	38
Undecided	6	7
Agree	26	28
Strongly Agree	2	2

The mean response to the question was 2.446 which falls in the "Disagree" range of 1.5 to 2.5.

6. Summary of CESMET's findings concerning IE: The Air Force CESMET provided extracts of thirty-two of its reports for analysis in this research. The extracts deal specifically with the IE branch, thereby providing additional input concerning the current IE role at base level.

It should be emphasized that CESMET is not an inspection activity which rates an organization in the manner that the IG does, i.e., excellent, satisfactory, marginal, etc. (7:3). However, in its final report CESMET does provide an overall appraisal of each activity assisted. For the purposes of the analysis, the appraisals of IE branches were divided into two categories--

favorable appraisals and unfavorable appraisals. The results of this analysis revealed that eighteen (56 percent) of the bases received favorable appraisals and fourteen (44 percent) received unfavorable appraisals.

In reviewing the CESMET reports, it appears that CESMET appraises the IE Branch in terms of five aspects: (1) manning posture, (2) the amount of additional duties assigned to IE, (3) the effectiveness of the Customer Relations Program, (4) the number of and impact of IE studies, and (5) the effectiveness of QC--activity inspections, work-in-progress inspections, etc. Table 8 illustrates the strengths and weaknesses which CESMET documented in the thirty-two reports analyzed. For the detailed documentation of the CESMET report analysis see page 86 in Appendix D.

Investigative Question No. 2. Is industrial engineering capability needed at base level?

To answer investigative question 2, two sets of measurement questions were asked to all respondents. The first set of measurement questions--numbers 10, 11, 12, 18, 19, 20, and 21--were intended to imply that IE is needed at base level and should be retained. For specific wording of the measurement questions see Appendix B. The second set of measurement questions only contained one measurement questions--number 8--which implies that IE is not needed at base level and should not

TABLE 8

CESMET IDENTIFIED IE STRENGTHS AND WEAKNESSES

	Number of Bases Recognized
Strengths	
Strong IE studies program aimed at "money makers"	10
Good/Excellent Customer Relations Program	11
Effective QC/Activity Inspections Program	12
Weaknesses	
Poor manning posture/insufficient manning	10
Too many additional duties	5
Ineffective IE studies program	11
Ineffective Customer Relations Program	18
Ineffective QC/Activity Inspections Program	12
Lack of Support by BCE and Staff	4

be retained. The sets of measurement questions were analyzed by the one-way analysis of variance (ANOVA) technique. The SPSS ANOVA subprogram was utilized for these analyses. A copy of the computer program utilized to activate the ANOVA subprogram can be found on page 205 of Appendix E.

A summary of the ANOVA results for the set of measurement questions implying favorableness to the retention of IE is illustrated in Table 9. The null hypothesis (H_0) and alternative hypothesis (H_1) of the analysis was as follows:

H_0: The treatment means are equal
($\mu_{DE}=\mu_{DEE}=\mu_{DCI}=\mu_{DEM}=\mu_{DEP}$)

H_1: At least two treatment means are not equal
(at least one $\neq$).

The resulting test statistic F_s equaled 20.640 and the critical value F_c at the .05 level for degrees of freedom of 4 and 448 equals 2.39 (5:850). Because F_s is greater than F_c, the null hypothesis is rejected and it is concluded that a significant difference in opinion exists among the treatments at the .05 level.

To determine which groups differ, the H. Scheffé test for critical differences of means was incorporated into the referenced computer program. Three homogenous

TABLE 9

SUMMARY OF ANOVA RESULTS TO THE SET OF MEASUREMENT QUESTIONS IMPLYING FAVORABLENESS TO THE RETENTION OF IE

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.8799	0.7288	Agree	
DEE	2.7742	1.0585	Undecided	$F_s = 20.640$
DEI	3.5331	0.9149	Agree	$F_c = F_{.05,4,448} = 2.39$
DEM	3.1441	0.8749	Undecided	$F_s > F_c$ Meaning there is a significant difference among the treatment means
DEP	3.1739	0.8463	Undecided	
Total	3.2974	0.9648	Undecided	

subsets--statistically similar opinions--were found to exist:

1. DE (3.8799) and DEI (3.5331)
2. DEI (3.5331), DEP (3.2974), and DEM (3.1739)
3. DEP (3.2974), DEM (3.1444), and DEI (2.7742)

A summary of the ANOVA results for the measurement question implying unfavorableness to the retention of IE is illustrated in Table 10. The null hypothesis (H_0) and alternative hypothesis (H_1) of the analysis was as follows:

H_0: The treatment means are equal
($\mu_{DE}=\mu_{DEE}=\mu_{DEI}=\mu_{DEM}=\mu_{DEP}$)

H_1: At least two treatment means are not equal
(at least one $\neq$).

The resulting test statistic F_s equaled 14.459 and the critical value F_c at the .05 level for degrees of freedom of 4 and 468 equals 2.39 (5:850). Because F_s is greater than F_c, the null hypothesis is rejected, and it is concluded that a significant difference in opinion exists among treatments at the .05 level.

To determine which groups differ, the H. Scheffé test for critical differences of means was conducted. Three homogeneous subsets--statistically similar opinions --were found to exist:

TABLE 10

SUMMARY OF ANOVA RESULTS TO THE MEASUREMENT QUESTION IMPLYING UNFAVORABLENESS TO THE RETENTION OF IE

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	1.6702	0.9086	Disagree	
DEE	2.9255	1.3136	Undecided	$F_s = 14.459$
DEI	2.0309	1.3575	Disagree	$F_c = F_{.05,4,464} = 2.39$
DEM	2.3370	1.1699	Disagree	$F_s > F_c$ Meaning there is a statistical difference among the treatment means
DEP	2.1304	1.0916	Disagree	
Total	2.2175	1.2471	Disagree	

1. DE (1.6702), DEI (2.0309), and DEP (2.1304)
2. DEI (2.0309), DEP (2.1304), and DEM (2.3370)
3. DEE (2.9255)

Thus, for the set of measurement questions implying favorableness to the retention of IE, only the DE and DEI groups "agreed"; whereas, the DEE, DEM and DEP groups were "undecided." However, for the single measurement question implying unfavorableness to the retention of IE, all groups except DEE "disagreed." The DEE group was again "undecided."

Investigative Question No. 3. If industrial engineering is needed at base level, should it continue to function as is or should it be modified or changed?

To answer investigative question 3, two sets of measurement questions were asked all respondents. The first set of measurement questions--number 7 and 17--were intended to imply favorableness to changing the role of IE. The second set of measurement questions--number 13, 14, 16, and 20--were intended to imply unfavorableness to changing the role of IE. The sets of measurement questions were analyzed through the use of the SPSS one-way ANOVA subprogram. A copy of the computer program utilized to activate the ANOVA subprogram can be found on page 205 of Appendix F.

A summary of the ANOVA results for the set of measurement questions implying favorableness to changing the role of IE was illustrated in Table 11. The null hypothesis (H_0) and alternative hypothesis (H_1) was as follows:

H_0: The treatment means are equal

($\mu_{DE}=\mu_{DEE}=\mu_{DEI}=\mu_{DEM}=\mu_{DEP}$)

H_1: At least two treatment means are not equal

(at least one $\neq$)

The resulting test statistics F_s equal 3.307 and the critical value F_c at the .05 level for degrees of freedom of 4 and 462 equals 2.39 (5:850). Because F_s is greater than F_c, the null hypothesis is rejected, and it is concluded that a significant difference in opinion exists among treatments at the .05 level.

To determine which groups differ, the H. Scheffé test for critical difference of means was conducted. Two homogenous subsets--statistically similar opinions--were found to exist:

1. DE (2.9840), DEE (3.0798), DEM (3.1703), and DEP (3.2637)

2. DEE (3.0798), DEM (3.1703), DEP (3.2637), and DEI (3.4485).

TABLE 11

SUMMARY OF ANOVA RESULTS TO THE SET OF MEASUREMENT QUESTIONS IMPLYING FAVORABLENESS TO CHANGING THE ROLE OF IE

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	2.9840	0.9545	Undecided	
DEE	3.0718	0.9108	Undecided	$F_s = 3.307$
DEI	3.4485	1.0039	Undecided	$F_c = F_{.05,4,462} = 2.39$
DEP	3.1703	0.9256	Undecided	$F_s > F_c$ Meaning there is a significant difference among the treatment means
DEM	3.2637	0.9898	Undecided	
Total	3.1906	0.9673	Undecided	

A summary of the ANOVA results for the set of measurement questions implying unfavorableness to changing the role of IE was illustrated in Table 12. The null hypothesis (H_0) and alternative hypothesis (H_1) was as follows:

H_0: The treatment means are equal

($\mu_{DE}=\mu_{DEE}=\mu_{DEI}=\mu_{DEM}=\mu_{DEP}$)

H_1: At least two treatment means are not equal

(at leat one $\neq$)

The resulting statistic F_s equaled 6.079 and the critical value F_c at the .05 level for degrees of freedom of 4 and 464 equals 2.39 (5:850). Because F_s is greater than F_c the null hypothesis is rejected, and it is concluded that a significant difference in opinion exists among the treatments at the .05 level.

To determine which groups differ, the H. Scheffé test for critical difference of means was conducted. Two homogenous subsets--statistically similar opinions--were found to exist:

1. DEI (2.7010), DEE (2.9122), DEM (2.9158), and DEP (3.000)

2. DEE (2.9122), DEM (2.9158), DEP (3.000) and (3.2021).

TABLE 12

SUMMARY OF ANOVA RESULTS TO THE SET OF MEASUREMENT QUESTIONS IMPLYING UNFAVORABLENESS TO CHANGING THE ROLE OF IE

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.2021	0.7534	Undecided	
DEE	2.9122	0.5942	Undecided	$F_s = 6.079$
DEI	2.7010	0.7968	Undecided	$F_c = F_{.05,4,464} = 2.39$
DEM	2.9158	0.6976	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	3.0000	0.7158	Undecided	
Total	2.9446	0.7308	Undecided	

AD-A045 214 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCHO--ETC F/G 15/5
THE ROLE OF INDUSTRIAL ENGINEERING WITHIN BASE CIVIL ENGINEERIN--ETC(U)
JUN 77 M J FARINEAU, A E TUCKER

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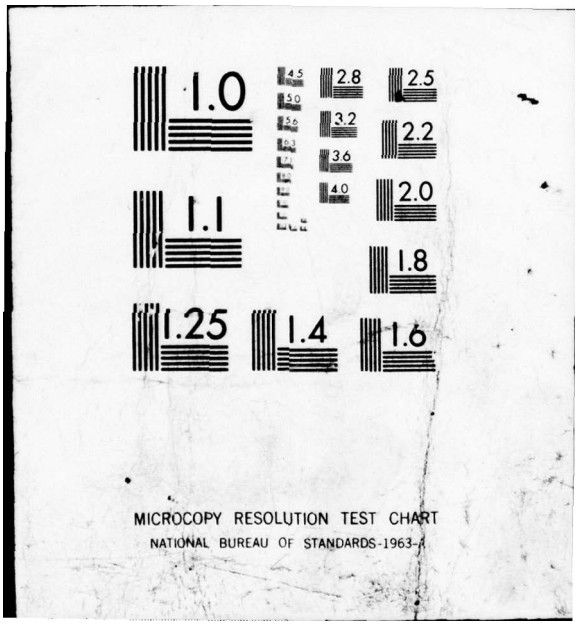
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Thus, to both sets of measurement questions concerning continuing IE as is or changing its role, the respondents were "undecided."

Individual Measurement Questions

In this section of the chapter, the analysis of each individual measurement question is provided. For each of the measurement questions asked on the general section of the questionnaire, a histogram has been plotted which illustrates how each group of respondents replied to the question. The histograms, which were plotted using the Honewell 365 computer's graph plotter, can be found in Appendix D beginning on page 191 The computer program used to plot the histograms can be found on page 210 of Appendix E. In addition to the histograms, each measurement question structured with the Likert Scale responses were analyzed through the use of the SPS one-way ANOVA subprogram. A copy of the computer program utilized to activate the ANOVA subprogram can be found on page 205 of Appendix E.

The format for the analysis of each measurement question incorporating the Likert scale responses will be the same. The null and alternative hypothesis of the one-way ANOVA will be:

H_0: The treatment means are equal

$(\mu_{DE}=\mu_{DEE}=\mu_{DEI}=\mu_{DEM}=\mu_{DEP})$

H_1: At least two treatments are not equal (at least one $\neq$)

If the resulting test statistic F_s is greater than the critical value F_c, the null hypothesis will be rejected, and it will be concluded that a significant difference in opinion existed. The H. Scheffé test for critical differences of means will be used to determine the homogeneous subsets--statistically similar opinions. If the resulting test statistic F_s is less than the critical value F_c, then the null hypothesis cannot be rejected, and it will be concluded that the treatments have statistically similar opinions.

Measurement Question No. 7. The Industrial Engineering Branch would be more effective if it concentrated on solving management problems rather than doing quality control work.

A summary of the ANOVA results for measurement question 7 is illustrated in Table 13. As can be seen, the five groups have a statistically similar opinion which is they were were "undecided" concerning measurement question 7.

Measurement Question No. 8. The Industrial Engineering Branch should be eliminated.

A summary of the ANOVA results for the measurement question 8 is illustrated in Table 10. As can be seen,

TABLE 13

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 7

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.2979	1.3266	Undecided	
DEE	3.3191	1.2200	Undecided	$F_s = 0.503$
DEI	3.4536	1.3465	Undecided	$F_c = F_{.05,4,462} = 2.39$
DEM	3.2747	1.3171	Undecided	$F_s < F_c$ Meaning that the treatments have statistically similar opinions
DEP	3.4835	1.2855	Undecided	
Total	3.3662	1.2975	Undecided	

except for the DEE group, the key CE personnel "disagreed" with the elimination of IE.

Measurement Question No. 9. Rather than having base level industrial engineering staffs, there should be industrial engineering team(s) to study common base-level problems. Where do you think that this industrial engineering capability should be located?

In response to this question, 286 respondents recommended that an IE staff be located at the AFIT Civil Engineering School, 112 respondents recommended that an IE staff be located at Major Command level, 2 respondents recommended that an IE staff be located at the Civil Engineering Center, 22 respondents recommended no change, and 47 respondents made no comment.

Measurement Question No. 10. As a manager, you seek the assistance of the industrial engineer and his staff for purposes of problem solving.

A summary of the ANOVA results for measurement question 10 is illustrated in Table 14. As can be seen, except for the DEE group, the key DE personnel "agreed" that the IE is sought for purposes of problem solving.

Measurement Question No. 11. The industrial engineer's recommendations are given serious consideration and implemented a majority of the time.

A summary of the ANOVA results for measurement question 11 is illustrated in Table 15. As can be seen,

TABLE 14

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 10

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	4.3191	0.7650	Agree	
DEE	2.9677	1.3867	Undecided	$F_s = 18.065$
DEI	3.9268	1.1416	Agree	$F_c = F_{.05,4,448} = 2.39$
DEM	3.6304	1.1263	Agree	$F_s > F_c$ Meaning there is a significant difference among the treatment means
DEP	3.7065	1.0948	Agree	
Total	3.7064	1.2010	Agree	

NOTE: H. Scheffé test revealed three homogenous subsets:

1. DEE (2.9677)
2. DEM (3.6304), DEP (3.7065), and DEI (3.9268)
3. DEI (3.9268) and DE (4.3191)

TABLE 15

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 11

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	4.0851	0.7282	Agree	
DEE	2.9681	1.1864	Undecided	$F_s = 14.341$
DEI	3.2396	1.2957	Undecided	$F_c = F_{.05,4,463} = 2.39$
DEM	3.3804	0.9816	Undecided	$F_s > F_c$ Meaning there is a significant difference among the treatment means
DEP	3.2717	1.0598	Undecided	
Total	3.3889	1.1290	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets:

1. DEE (2.9631), DEI (3.2396), DEP (3.2717), and DEM (3.3804
2. DE (4.0851)

only the BCE "agreed" the IE's recommendations are given serious consideration and implemented a majority of the time. The remaining key CE personnel were "undecided" concerning measurement question 11.

Measurement Question No. 12. The Base Civil Engineering Organization would be adversely affected if the Industrial Engineering Branch were dissolved.

A summary of the ANOVA results for measurement question 12 is illustrated in Table 16. As can be seen, only the BCE "agreed" that the elimination of IE would adversely affect the BCE organization. The remaining key CE personnel were "undecided" concerning measurement question 11. However, the opinion of DEI group almost fell within the "agree" range of greater than 3.5 but less the 4.5. Interestingly, the opinion of the DEE group tended to the "disagree" range of greater than 1.5 but less than 2.5.

Measurement Question No. 13. The Industrial Engineering Branch should continue to do quality control inspections of the Operations and Maintenance Shops' work.

A summary of the ANOVA results for measurement question number 12 is illustrated in Table 17. As can be seen, all five groups have a statistically similar opinion which is "undecided." However, the DE and DEP group's opinion tended toward the "disagree" range while

TABLE 16

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 12

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.8191	1.0571	Agree	$F_s = 9.659$
DEE	2.7128	1.3490	Undecided	$F_c = F_{.05,4,464} = 2.39$
DEI	3.4021	1.3743	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEM	3.1957	1.2600	Undecided	
DEP	3.1957	1.1696	Undecided	
Total	3.2665	1.2940	Undecided	

NOTE: H. Scheffé test revealed three honogenous subsets:

1. DEE (2.7128), DEM (3.1957), and DEP (3.1957)
2. DEM (3.1957), DEP (3.1957), and DEI (3.4021)
3. DEI (3.4021), and DE (3.8191)

TABLE 17

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 13

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	2.7660	1.2219	Undecided	
DEE	3.1383	1.2409	Undecided	$F_s = 1.837$
DEI	2.9485	1.4816	Undecided	$F_c = F_{.05,4,464} = 2.89$
DEM	2.9130	1.3148	Undecided	$F_s < F_c$ Meaning that the treatments have
DEP	2.6522	1.3213	Undecided	statistically similar opinions
Total	2.8849	1.3251	Undecided	

the opinions of the DEE, DEI, and DEM groups remained close to the median (3.0) of the "undecided" range.

Measurement Question No. 14. Present staffing of the Industrial Engineering Branch is adequate to perform their work.

A summary of the ANOVA results for measurement question number 14 is illustrated in Table 18. As can be seen, the DE and DEE groups "agreed" that the IE staff is adequate. Although the opinions of the DEI, DEM, and DEP groups fell within the "undecided" category, the opinions of the DEM and DEP tended toward the "agree" range and the DEI groups opinion tended toward the "disagree" range.

Measurement Question No. 15. If the Industrial Engineering Branch were to be reorganized, which section should be included in the reorganizaed branch?

Table 19 illustrates the frequency of responses per possible IE section.

Measurement Question No. 16. The role of the industrial engineer as a quality control inspector has no bearing on his acceptance as a management consultant.

A summary of the ANOVA results for measurement question 16 is illustrated in Table 20. As can be seen the DEI group "disagreed" with measurement question 16; whereas the remaining four groups were "undecided."

TABLE 18

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 14

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.5000	1.1047	Agree	
DEE	3.5426	1.1039	Agree	$F_s = 4.763$
DEI	2.8736	1.3327	Undecided	$F_c = F_{.05,4,464} = 2.39$
DEM	3.3152	1.1572	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	3.3261	1.2054	Undecided	
Total	3.3092	1.2038	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets:

1. DEI (2.8763), DEM (3.3152), and DEP (3.3261)
2. DEM (3.3152), DEP (3.3261), DE (3.5000) and DEE (3.5426)

TABLE 19

FREQUENCY OF RESPONSES TO MEASUREMENT QUESTION 15

Section	Number Responses Favorable	Percent of Favorable Responses
Financial Management	293	62.5%
IE Analysis	424	90.4
Cost Accounting	310	66.1
Real Estate	195	41.6
Financial Management	214	45.6

Measurement Question No. 17. The scope of industrial engineering work should be expanded outside the Base Civil Engineering organization to areas such as; supply, transportation, budget, etc.

A summary of the ANOVA results for measurement question 17 is illustrated in Table 21. As can be seen, all groups fell in the "undecided" range. However, the DEI group's opinion tended toward the "agree" range, and the DE and DEE group's opinion tended toward the "disagree" range.

Measurement Question No. 18. The studies performed by the Industrial Engineering Branch play a significant role in improving the Base Civil Engineering organization.

TABLE 20

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 16

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	2.9574	1.1815	Undecided	
DEE	2.8936	1.2907	Undecided	$F_s = 3.077$
DEI	2.4021	1.2555	Disagree	$F_c = F_{.05,4,464} = 2.39$
DEM	2.9022	1.3429	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	2.7935	1.2002	Undecided	
Total	2.7868	1.2665	Undecided	

NOTE: H. Scheffé test revealed that all five groups make a homogenous subset.

TABLE 21

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 17

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	2.6702	1.2390	Undecided	
DEE	2.8404	1.3385	Undecided	$F_s = 4.467$
DEI	3.4433	1.3614	Undecided	$F_c = 2.39$
DEM	3.0543	1.3697	Undecided	$F_s > F_s$ Meaning there is a statistical difference among treatment means
DEP	3.0217	1.3746	Undecided	
Total	3.0085	1.3571	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets:

1. DE (2.6702), DEE (2.8404), DEP (3.0217), and DEM (3.0543)
2. DEP (3.0217), DEM (3.0543), and DEI (3.4433)

A summary of the ANOVA results to measurement question 18 is illlustrated in Table 22. As can be seen, only the DE and DEI groups felt that IE studies improved the Base Civil Engineering Organization; whereas, the DEE, DEM and DEP groups were "undecided."

Measurement Question No. 19. The Industrial Engineering Branch is responsive to the problem solving needs of management.

A summary of the ANOVA results to measurement question 19 is illustrated in Table 23. As can be seen, only the DE and DEI groups "agreed" that the IE is responsive to the needs of management; whereas, the DEE, DEM and DEP groups were "undecided."

Measurement Question No. 20. The role of industrial engineering should remain as it is.

A summary of the ANOVA results to measurement question 20 is illustrated in Table 24. As can be seen, only the BCE was "undecided" concerning IE's role remaining as is; whereas, the remaining four groups either "disagreed" or tended to the "disagree" range.

Measurement Question No. 21. The Industrial Engineering Branch can be relied upon to provide objective and effective solutions to management problems.

A summary of the ANOVA results to measurement question 21 is illustrated in Table 25. As can be seen, only the DE and DEI groups "agreed" that IE provides

TABLE 22

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 18

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.9362	1.0453	Agree	
DEE	2.7553	1.2242	Undecided	$F_s = 13.767$
DEI	3.5464	1.2418	Agree	$F_c = F_{.05,4,464} = 2.39$
DEM	3.1413	1.1914	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	3.2500	1.0755	Undecided	
Total	3.3284	1.2208	Undediced	

NOTE: H. Scheffé test revealed three honogenous subsets.

1. DEE (2.7553), DEM (3.1413), and DEP (3.2500)
2. DEM (3.1413), DEP (3.2500), and DEI (3.5464)
3. DEI (3.5464) and DE (3.9362)

TABLE 23

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 19

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	4.0000	0.8920	Agree	
DEE	2.9149	1.2151	Undecided	$F_s = 18.378$
DEI	3.9072	1.0905	Agree	$F_c = F_{.05,4,464} = 2.39$
DEM	3.1957	1.1601	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	3.1630	1.1220	Undecided	
Total	3.4414	1.1800	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets.

1. DEE (2.9149), DEP (3.1630), and DEM (3.1957)
2. DEI (3.9072) and DEE (4.000)

TABLE 24

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 20

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.1170	1.1810	Undecided	
DEE	2.3511	1.1332	Disagree	$F_s = 7.381$
DEI	2.4742	1.2340	Disagree	$F_c = F_{.05,4,464} = 2.39$
DEM	2.3587	0.9787	Disagree	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	2.5326	1.1039	Undecided	
Total	2.5672	1.1613	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets.

1. DEE (2.3511), DEM (2.3587), DEI (2.4742), and (2.5326)
2. DE (3.1170)

TABLE 25

SUMMARY OF ANOVA RESULTS TO MEASUREMENT QUESTION 21

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
DE	3.8830	0.8781	Agree	
DEE	2.7660	1.2820	Undecided	$F_s = 24.379$
DEI	4.0719	1.0686	Agree	$F_c = F_{.05,4,464} = 2.39$
DEM	3.1087	1.3350	Undecided	$F_s > F_c$ Meaning there is a significant difference among treatment means
DEP	3.0978	1.1100	Undecided	
Total	3.3902	1.2068	Undecided	

NOTE: H. Scheffé test revealed two homogenous subsets.

1. DEE (2.7660), DEP (3.0978), and DEM (3.1087)
2. DE (3.8830) and DEI (4.0619)

objective and effective solutions to management problems; whereas, the DEE, DEM, and DEP groups were "undecided."

Measurement Question No. 22 (BCE Attachment). The *The rescission of AFM 85-38 has improved industrial engineering's responsiveness to your management needs.*

Approximately 63 percent of the BCEs felt that the rescission of AFM 85-38 had improved IE's responsiveness. Table 26 illustrates how the BCEs responded to their measurement question 22.

TABLE 26

FREQUENCY OF BCE RESPONSES CONCERNING AFM 85-38 RESCISSION IMPROVING IE

Response	Frequency	Percent of Response
Strongly Disagree	1	1%
Disagree	13	14
Undecided	21	22
Agree	43	46
Strongly Agree	16	17

Measurement Question No. 23 (BCE Attachment).

The Industrial Engineering Branch can be effective without a governing directive.

Approximately 62 percent of the BCEs felt that the IE Branch can be effective without a governing directive. Table 27 illustrates how the BCEs responded to their measurement question 23.

TABLE 27

FREQUENCY OF BCE RESPONSES CONCERNING IE BEING EFFECTIVE WITHOUT A GOVERNING DIRECTIVE

Response	Frequency	Percent of Response
Strongly Disagree	2	2%
Disagree	26	28
Undecided	7	8
Agree	47	51
Strongly Agree	11	12

Measurement Question No. 24 (BCE Attachment). *What do you consider the five most important functions of your IE Branch to be?*

The BCEs responses to this question were discussed on pages 59-63. The ranking of the BCE's responses concerning IEs most important functions can be found in column one of Table 4.

Measurement Question No. 25 (BCE Attachment). *What are the weaknesses or limitations currently associated with the base level industrial engineering concept?*

The BCE's responses to this question were discussed on page 64. A listing of the IE's weaknesses as perceived by the BCEs can be found in column one of Table 6.

Measurement Question 26 (BCE Attachment). Describe briefly the single achievement of the Industrial Engineering staff which has impressed you most favorably.

The BCEs identified fifteen categories of IE achievements. Table 28 illustrates a listing of IE achievements and the frequency per category. The BCE responses are in column one (DE). The BCEs most frequently identified IE achievement dealt with quality, indepth IE studies. Some of the titles of the IE studies, which were noted by the BCEs were:

1. Controller Concept Study
2. Recurring Maintenance Program Study
3. SMART Study
4. COCESS Study
5. Housing Management Study
6. IWP Compliance Study
7. Central Heating Plants Study
8. Vehicle Use Study
9. Materials Requirement List Study
10. MFH Appliance Study

Measurement Question No. 27 (BCE Attachment). To better serve the needs of you and your staff, what changes or improvements in the industrial engineering concept do you recommend?

Table 29 illustrates a listing of the BCE's and IE's recommendations to improve the IE Branch. Out of the eighteen different BCE recommendations, only four were noted by at least ten of the BCEs: (1) keep future IE directives general in nature and which allows for

TABLE 28

IE'S NOTEWORTHY ACHIEVEMENTS AS PERCEIVED BY THE RESPONDENTS

		DE	DEE	DEI	DEM	DEP
1.	Quality IE Studies with Realistic Solutions	22	14	23	19	18
2.	IE Analysis Capability/Accomplishments	9	3	4	10	4
3.	Management Consultant Capability	6	3	7	7	9
4.	QC/Activity Evaluation Type Work	8	3	2	7	4
5.	MBO Monitor/Motivator	5	5	3	3	5
6.	BEAMS/BLIS/Computer Expertise	7	1	9	6	17
7.	Manpower Expertise/Accomplishments	6	6	6	5	2
8.	Customer Relations Program Monitor/Motivator	2	2	...	...	1
9	Outstanding IG/CESMET Ratings	1	...	5	...	...
10.	Implementing Squadron Safety Program	1	...	...	...	...
11.	RECON Monitor/Motivator	1	...	1	...	...
12.	Development of Visible Mgt Information System	1	...	1	...	...
13.	Excellent Work on Additional Duties	1	...	...	...	...
14.	COCESS Implementation Assistance	1	...	...	...	...
15.	"Nothing Noteworthy"/"Not Important"	2	32	3	14	11
16.	Establishing a BCE Customer Service Center	...	...	1	...	...
17.	Improved rapport with other branches, willingness to help	...	2	11	3	2

TABLE 28--Continued

		DE	DEE	DEI	DEM	DEP
18.	Development of an Automated DEE Design Schedule	...	4	1	...	...
19.	Training Activity (Associated with new Procedures)	...	1	2	...	2
20.	Implementing Word Processing Center	...	...	2	...	...
21.	Implementation of Test Reorganization	...	...	1	...	...
22.	Energy Conservation Program Accomplishments	...	2	...	2	...
23.	Troubleshooting Problem Areas	...	1	...	1	...
24.	Effective Writing & Speaking Ability	...	1	...	1	...
25.	Thorough Knowledge of BCE Organization and Procedures	...	...	...	1	...
26.	Development of AICUZ	...	...	...	1	...
27.	Negative Achievement--"Black Hat Image"	...	...	...	2	...
28.	Development of Squadron Operating Instruction	...	...	...	...	1
29.	Upgrade of "Unsatisfactory" IE Staff to "Satisfactory"	...	...	2	...	...
30.	Administrative Assistance	...	1	...	...	...
31.	Monitor MRC Meetings & Weekly Stand-Up Briefings	...	1	...	...	...

TABLE 29

FREQUENCY OF DE AND DEI RECOMMENDATIONS
TO IMPROVE IE BRANCH

		DE	DEI	Total
1.	Keep future IE directions general in nature and which allows for flexibility for IE use.	19	8	27
2.	Delete QC & IG Type work from IE's responsibility.	14	17	31
3.	Emphasize IE's management consultant role.	6	15	21
4.	Upgrade the quality of IE staffs by acquiring more professional IEs.	16	14	30
5.	Incorporate Real Property, Cost Accounting and/or Financial Management within IE	11	11	22
6.	Provide greater training opportunities for IE Staff, include behavioral aspects, oral & written communication as well as IE techniques.	3	13	16
7.	Reduce number of additional duties assigned to IE	0	10	10
8.	Publish a directive outlining IE's role	2	12	14
9.	Teach BCEs and his staff in how to use IE effectively--possibly at AFIT's CE School	2	17	19
10.	Establish an AFSC for IE technicians	0	8	8
11.	Establish an IE Staff at MAJCOM level	1	5	6
12.	Emphasize QC	5	1	6

TABLE 29--Continued

		DE	DEI	Total
13.	Expand the scope of IE work to other base organizations	5	2	7
14.	Assign greater enforcement powers concerning the implementation of approved recommendations	0	5	5
15.	Increase the rank/grade of IE chief	0	4	4
16.	Increase manning of IE Branches	1	3	4
17.	Delete requirements to monitor Customer Relations Program	0	3	3
18.	Conduct Air Force or MAJCOM IE seminars	0	3	3
19.	Clearly delineate IE's BEAMS responsibility	3	3	6
20.	Emphasize indepth IE studies	3	0	3
21.	Delete IE at base level	2	2	4
22.	Do not man with NOCs below the E-6 level	0	2	2
23.	Eliminate the need for formal documentation of IE work	0	1	1
24.	Provide IE a vehicle for transportation	0	1	1
25.	Eliminate IE's conflicting role of QC and Mgt Consultant	0	1	1
26.	Do not utilize the IE as the MBO monitor	0	1	1
27.	Develop an IE technique handbook for base leve use	0	1	1

TABLE 29--Continued

	DE	DEI	Total
28. Develop a customer survey form which branch chiefs can use to request IE help	0	1	1
29. Hire more civilian IEs	0	1	1
30. Increase the length of base level assignments	0	1	1
31. Do not use IE as a manpower pool	0	1	1
32. Introduce statistical analysis for base level IE use	0	1	1
33. Establish O&M or Program Experience as prerequisite for IE Chief	1	0	1
34. Assign at least one qualified IE per base	1	0	1
35. Give IE a waiver from IG inspections	1	0	1

flexibility of IE use, (2) upgrade the quality of IE staffs, (3) delete QC/IG type work from IE's responsibility, and (4) incorporate Real Property, Cost Accounting, and/or Financial Management within IE.

Measurement Question No. 22 (CEI Attachment). How much base level industrial engineering experience do you have?

Table 30 illustrates the overall experience level of the IE Branch Chiefs.

TABLE 30

EXPERIENCE LEVEL OF IE BRANCH CHIEFS

Experience Level	Number of IE Chiefs	Percent of Total
Less than 1 year	25	26%
Greater than 1, but less than 2 years	15	16
Greater than 2, but less than 3 years	11	11
Greater than 3, but less than 4 years	18	19
Greater than 4 years	27	28

Measurement Question No. 23 (DEI Attachment). What level of an industrial engineering degree do you hold?

Table 31 illustrates the overall educationl level of the IE Branch Chiefs.

TABLE 31

EDUCATION LEVEL OF IE BRANCH CHIEFS

Education Level	Number of IE Chiefs	Percent of Total
Bachelor of Science	46	48%
Master's Degree	16	17
Doctorate	1	1
Have a degree but not an IE degree	23	24
Do not have a degree	10	10

Measurement Question No. 24 (DEI Attachment). How many people are authorized for your branch?

Table 32 illustrates the authorization levels of IE Branches.

TABLE 32

AUTHORIZATION LEVELS OF IE BRANCHES

Authorization Level	Frequency of Response	Percent of Response
1 to 3	0	0%
4 to 6	32	33
7 to 9	42	44
10 to 12	14	15
Greater than 12	8	8

Measurement Question No. 25 (DEI Attachment). How many people are currently assigned to your branch?

Table 33 illustrates the assigned levels of IE Branches.

TABLE 33

ASSIGNED LEVELS OF IE BRANCHES

Assigned Level	Frequency of Response	Percent of Response
1 to 3	6	6%
4 to 6	47	49
7 to 9	34	35
10 to 12	6	6
Greater than 12	3	5

Measurement Question No. 26 (DEI Attachment). The rescission of the AFM 85-38 has improved your branch responsiveness to the management needs of the Base Civil Engineer and his staff.

Approximately 65 percent of the Chiefs of IE felt that the rescission of AFM 85-38 had improved their branches' responsiveness to management's needs. Table 34 illustrates how the IE Chiefs responded to their measurement question 26.

TABLE 34

FREQUENCY OF IE'S RESPONSES CONCERNING AFM 85-38's RESCISSION IMPROVING IE

Response	Frequency	Percent of Response
Strongly Disagree	7	7%
Disagree	10	11
Undecided	16	17
Agree	36	38
Disagree	26	27

Measurement Question No. 27 (DEI Attachment). The Industrial Engineering Branch can be effective without a governing directive.

Approximately 68 percent of the IE Chiefs felt that the IE Branch can be effective without a governing directive. Table 35 illustrates how the IE Chiefs responded to their measurement question 27.

Measurement Question No. 28 (DEI Attachment). Rank order the sources of IE requirements.

The IE's responses to this questions were discussed on page 67.

Measurement Question No. 29 (DEI Attachment). What do you consider the five most important functions of the IE Branch to be?

TABLE 35

FREQUENCY OF IE RESPONSES CONCERNING IE BEING EFFECTIVE WITHOUT A GOVERNING DIRECTIVE

Response	Frequency	Percent of Responses
Strongly Disagree	13	14%
Disagree	13	14
Undecided	4	4
Agree	45	47
Strongly Agree	20	21

The IE's responses to this question were discussed on pages 59-63. The ranking of IE's responses concerning IE's most important functions can be found in column three of Table 4.

Measurement Question No. 30 (DEI Attachment). Estimate the amount of time the IE Branch has expended on their most important functions during the past twelve months.

The IE's responses to this question were discussed on pages 63-64. Table 5 illustrates the amount of IE time expended per function.

Measurement Question No. 31. To make the industrial engineering staff more responsive to the needs of management, what changes or improvements do you recommend?

Table 29 illustrated a listing of the BCE and IE's recommendations to improve the IE Branch. The IEs identified thirty-one different recommendations to improve the IE Branch. Eight of the thirty-one recommendations were noted by ten or more IEs: (1) delete QC/IG type work from IE's responsibility, (2) teach BCEs and his branch chiefs in how to use IE effectively, (3) emphasize the management consultant role, (4) upgrade the quality of IE staffs, (3) provide greater training opportunities for IEs, (6) publish a directive outlining IE's responsibility, (7) incorporate Real Property, Cost Accounting, and/or Financial Management within IE, and (8) reduce the number of additional duties assigned to IE.

Measurement Question No. 32 (DEI Attachment). *What weaknesses or limitations of your IE Branch have kept you from serving the BCE and his staff effectively?*

The IE's responses to this question were discussed on pages 64-67. A listing of IE's weaknesses as perceived by the IE Chiefs can be found in column three of Table 6.

Measurement Question No. 33 (DEI Attachment). *Describe briefly the single achievement or accomplishment by your branch of which you are proudest.*

The IE Branch Chiefs identified eighteen categories of noteworthy achievements. Table 28 illustrated the listing of IE achievement and the frequency per

category. The IE identified achievements and frequencies are in column three (DEI). The IE Branch Chiefs noted that IE studies provided them most of their achievements. The titles of the studies paralled those identified by the BCE on page 101.

Measurement Question No. 22 (Branch Chief's Attachment). The industrial engineer's greatest contribution to your branch is the area of quality control.

Table 36 illustrates how the DEE, DEM, and DEP Branch Chiefs responded to this question. As can be seen, a majority (greater than 50 percent) of each group felt that IE's greatest contribution is not in the area of QC.

Measurement Question No. 23 (Branch Chief's Attachment). The industrial engineering branch should be primarily oriented to the efficiency of the Operations and Maintenance Branch.

Table 37 illustrates how the DEE, DEM, and DEP Branch Chiefs responded to this question. As can be seen, a majority (greater than 50 percent) of each group felt that IE should not be primarily oriented to the O&M Branch.

Measurement Question No. 24 (Branch Chief's Attachment. Industrial Engineering studies conducted in your branch have measurably improved effectiveness of your branch.

TABLE 36

FREQUENCY OF DEE, DEM, AND DEP RESPONSES CONCERNING IE'S GREATEST CONTRIBUTION BEING QC

Response	DEE Frequency	DEE % of Response	DEM Frequency	DEM % of Response	DEP Frequency	DEP % of Response
Strongly Disagree	47	50%	23	25%	27	30%
Disagree	36	38	35	38	46	51
Undecided	4	4	6	7	6	7
Agree	4	4	26	28	10	11
Strongly Agree	3	3	2	2	2	2

TABLE 37

FREQUENCY OF DEE, DEM, AND DEP RESPONSES CONCERNING IE BEING PRIMARILY ORIENTED TO THE O&M BRANCH

Response	DEE Frequency	DEE % of Response	DEM Frequency	DEM % of Response	DEP Frequency	DEP % of Response
Strongly Disagree	17	18%	14	15%	12	13%
Disagree	37	39	49	58	50	55
Undecided	4	4	2	2	4	4
Agree	27	28	27	29	18	20
Strongly Agree	10	11	0	0	7	8

Table 38 illustrates how the DEE, DEM, and DEP Branch Chiefs responded to this question. As can be seen, 38 percent of the DEM group, 34 percent of the DEP group, and 20 percent of the DEE group felt that IE studies improved their branches effectiveness.

Measurement Question No. 25 (Branch Chief's Attachement). What do you consider the three most important functions of the IE Branch to be?

The DEE, DEM, and DEP Branch Chief's responses to this question are discussed on pages 59-63. The ranking of the DEE, DEM, and DEP Branch Chief's responses concerning IE's most important functions can be found in columns two, four and five respectively in Table 4.

Measurement Question No. 26 (Branch Chief's Attachment). What weaknesses or limitations of the IE Branch have you noticed which has kept them from assisting you effectively?

The DEE, DEM, and DEP Branch Chief's responses to this question were discussed on page 64. A listing of the IE weaknesses as perceived by the DEE, DEM, and DEP Branch Chiefs can be found in columns two, four, and five respectively of Table 6.

Measurement Question No. 27 (Branch Chief's Attachment. Describe briefly the single achievement of the IE Staff which has impressed you the most.

TABLE 38

FREQUENCY OF DEE, DEM, AND DEP RESPONSES CONCERNING IE STUDIES IMPROVING THEIR BRANCHES EFFECTIVESS

Response	DEE Frequency	DEE % of Response	DEM Frequency	DEM % of Response	DEP Frequency	DEP % of Response
Strongly Disagree	31	33%	8	9%	7	8%
Disagree	34	36	30	33	35	38
Undecided	11	12	19	21	18	20
Agree	17	18	33	36	29	32
Strongly Agree	2	2	2	2	2	2

The DEE, DEM, and DEP Branch Chiefs identified sixteen, fifteen, and twelve categories of noteworthy IE achievements respectively.

Table 28 illustrated the listing and frequency of IE achievements and the frequency per category. DEE, DEM, and DEP's responses are in columns two, four, and five respectively. Numerous Branch Chiefs--32 DEEs, 14 DEMs, and 11 DEPs--noted that they could not identify any achievements of IE which impressed them. IE studies was the single category which the Branch Chiefs were most impressed as 14 DEEs, 19 DEMs, and 18 DEPs noted.

Analysis by Major Commands

The remainder of this chapter includes an analysis of measurement questions 8, 13, and 20 by Major Command. The one-way ANOVA technique was utilized on each of the identified measurement questions to determine if there was a significant difference in opinion among Major Commands.

Measurement Question No. 8. The Industrial Engineering Branch should be eliminated.

Table 39 illustrates the summary of ANOVA results by Major Command for measurement question 8. Of the eleven identified MAJCOM treatments, all but two "disagreed" that IE should be eliminated. The other two

TABLE 39

SUMMARY OF MAJCOM ANOVA RESULTS TO MEASUREMENT QUESTION 8

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
ADC	2.5263	1.4670	Undecided	
AFLC	2.3448	1.2034	Disagree	
AFSC	2.6667	1.4259	Undecided	$F_s = 0.594$
ATC	2.1091	1.0831	Disagree	$F_c = F_{.05,10,460} = 2.37$
MAC	2.1167	1.1061	Disagree	$F_s < F_c$ Meaning the
PACAF	2.1250	1.1539	Disagree	treatments have a
SAC	2.1983	1.2595	Disagree	statistically simi-
TAC	2.1923	1.2899	Disagree	lar opinions
USAFE	2.1429	1.3535	Disagree	
USAFSS	2.2727	1.0090	Disagree	
Other	2.4348	1.5905	Disagree	
Total	2.2251	1.2498	Disagree	

NOTE: Other includes Air University, Alaskan Air Command, Communications Service and the Air Force Academy.

MAJCOM treatments--Air Defense Command and Air Force Systems Command--fell in the "undecided" range.

Measurement Question No. 13. The Industrial Engineering Branch should continue to do quality control inspections of the operations and Maintenance Shops' work.

Table 40 illustrates the summary of ANOVA results by Major Command for measurement question 13. Only one of the eleven MAJCOM treatments--Tactical Air Command--"Agreed" that IE should continue QC inspections of O&M shops. The remaining ten MAJCOM treatments fell within the "undecided" range. However, three MAJCOM treatments--Air Force Systems Command (3.2857), Air Training Command (3.3818), and Other (3.3913) tended toward the "Agree" range; while two MAJCOM treatments--Military Airlift Command (2.7667) and Strategic Air Command (2.7672) tended toward the "disagree" range.

Measurement Question No. 20. The role of industrial engineering should remain as it is.

Table 41 illustrates the summary of ANOVA results by Major Command for measurement questions 20. As can be seen, five of the eleven MAJCOM treatments--Air Defense Command, Air Force Systems Command, Air Force Logistics Command, Security Service, and Military Airlift Command--"disagreed" that IE's role should remain the same. Even the six MAJCOM treatments which fell within the "undecided" range tended to the "disagree" range.

TABLE 40

SUMMARY OF MAJCOM ANOVA RESULTS TO MEASUREMENT QUESTION 13

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
ADC	3.1579	1.5005	Undecided	
AFLC	3.1379	1.2457	Undecided	
AFSC	3.2857	1.5538	Undecided	$F_s = 3.161$
ATC	3.3818	1.1137	Undecided	$F_c = F_{.05,10,460} = 2.37$
MAC	2.7667	1.2936	Undecided	$F_s > F_c$ Meaning there
PACAF	3.0417	1.4590	Undecided	is a significant dif-
SAC	2.7672	1.2878	Undecided	ference among treat-
TAC	3.6667	1.2656	Agree	ments.
USAFE	2.9143	1.3144	Undecided	
USAFSS	3.0909	1.3003	Undecided	
OTHER	3.3913	1.2336	Undecided	
Total	3.1125	1.3233	Undecided	

NOTE: H. Scheffé test indicated that all treatments fell within a single homogenous subset.

TABLE 41

SUMMARY OF MAJCOM ANOVA RESULTS TO MEASUREMENT QUESTION 20

Treatment	Mean Response	Standard Deviation	Interpretation	Statistical Analysis
ADC	2.1579	1.1187	Disagree	
AFLC	2.4138	1.1807	Disagree	
AFSC	2.2381	0.8891	Disagree	$F_s = 0.665$
ATC	2.6727	1.2180	Undecided	$F_c = F_{.05,10,460} = 2.35$
MAC	2.4667	1.1118	Disagree	$F_s < F_c$ Meaning the
PACAF	2.6667	1.2740	Undecideed	treatments have a
SAC	2.6207	1.1471	Undecided	statistically simi-
TAC	2.6026	1.1435	Undecided	lar opinion
USAFE	2.6857	1.1825	Undecided	
USAFSS	2.4545	1.2136	Disagree	
OTHER	2.6957	1.3959	Undecided	
Total	2.5626	1.1613	Undecided	

CHAPTER IV

CONCLUSIONS

The conclusions of investigative questions two and three are presented initially. There were no conclusions drawn from investigative question one as explained in the methodology. Following the investigative questions are the conclusions to the individual measurement questions. A discussion of the conclusions is presented after the measurement questions. The discussion of the conclusions is written in terms of the research question--"What role should the industrial engineering function play within Base Civil Engineering?" The final discussion deals with the problems which were encountered in the research effort. The Chapter closes with a summary listing of conclusions to the research effort. All conclusions are based upon the analysis of the Industrial Engineering Role Survey and the CESMET findings as explained in Chapter III.

Investigative Questions

Investigative Question No. 2. Is industrial engineering capability needed at base level?

The results of the Industrial Engineering Role Survey revealed that the key civil engineering management personnel believed that industrial engineering capability

is needed at base level. All of the respondents except the Chief of Engineering and Construction group firmly believed that the Industrial Engineering Branch should not be eliminated. The Chief of Engineering and Construction group was "undecided."

The respondents favorableness to the retention of IE implies that IE has been of value to Base Civil Engineering. Except for the Chief of Engineering and Construction group, the respondents must feel that IE can continue to provide a service which is beneficial to the civil engineering mission.

Investigative Question No. 3. If industrial engineering is needed at base level, should it continue to function as is or should it be modified or changed?

The results of the Industrial Engineering Role Survey revealed that the key civil engineering management personnel believed that the role of industrial engineering should be changed. All of the respondents except the BCE group believed that "the role of IE should (not) remain as it is." The BCE group was "undecided."

It appears the respondents feel that IE could be more effective if it's role were changed. Obviously from investigative question two, IE has been of value to the key civil engineering management personnel.

From investigative question three, the key civil engineering management personnel appear to be saying that IE can provide a more beneficial service if it's role were changed.

Considering the fact that IE has been constantly criticized over the past few years by the IG, it appears logical that the respondents would forsee a need to change IE's role. The constant problems, which have been associated with IE, have kept IE from maximizing it's service to the BCE and his staff. Thus, to improve it's service IE's role must be revised to meet the needs of the BCE and his staff.

Measurement Questions

Measurement Question No. 7. The Industrial Engineering Branch would be more effective if it concentrated on solving management problems rather than doing quality control work.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that industrial engineering should concentrate on the management consultant role and be relieved of all quality control responsibilities. This conclusion was further supported by the results of the open-ended questions dealing with IE weaknesses. IE's negative or "black hat" QC image

was rated as one of the five major IE weaknesses or limitations.

Measurement Question No. 8. The Industrial Engineering Branch should be eliminated.

The conclusions to this question are the same as for investigative question 2.

Measurement Question No. 9. Rather than having base level industrial engineering staffs, there should be industrial engineering team(s) to study common base-level problems. Where do you think that this industrial engineering capability should be located?

It was concluded that an industrial engineering capability to study common base-level civil engineering management problems be established above the base level. From the results of the survey, it was difficult to conclude where such an IE capability should be located. Sixty percent of the respondents recommended the AFIT Civil Engineering School for the location of an Air Force IE staff; whereas, 24 percent recommended that IE staffs be established at the MAJCOM level.

Measurement Question No. 10. As a manager, you seek the assistance of the industrial engineer and his staff for purposes of problem solving.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that civil

engineering managers seek the IE for assistance in solving management problems.

Measurement Question No. 11. The industrial engineer's recommendations are given serious consideration and are implemented a majority of the time.

Based upon the results of the Industrial Engineering Role Survey and the CESMET findings, it was concluded that IE's recommendations are not always given serious consideration nor are they implemented a majority of the time. In reflection, it was concluded that this question was ambiguous or confusing in that it asked two questions--IE's recommendations are given serious consideration and IE's recommendations are implemented a majority of the time. However, as the CESMET findings indicated and as the responses to the open-ended questions concerning IE's weaknesses and limitations indicated, IE recommendations are not always seriously considered nor are they always implemented once approved.

Measurement Question No. 12. The Base Civil Engineering Organization would be adversely affected if the Industrial Engineering Branch were dissolved.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that the BCE organization would be adversely affected if the IE Branch were dissolved.

Measurement Question No. 13. The Industrial Engineering Branch should continue to do quality control inspections of the Operations and Maintenance Shop's work.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that IE should be relieved of all quality control responsibilities. This conclusion was further supported by the results to measurement question 7 and the open-ended questions dealing with IE weaknesses.

Measurement Question No. 14. Present staffing of the Industrial Engineering Branch is adequate to perform their work.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that this question was incorrectly stated. Although in response to this particular question, the respondents "agreed" that IE was adequately staffed. However, in response to the open-ended questions dealing with IE weaknesses, the single largest category identified was "inadequate and unqualified IE staffs." All groups of respondents emphasized that IE staffs are too often staffed with inexperienced and unqualified personnel.

It was presumed that the respondents were thinking in terms of numbers of people rather than quality when they responded to measurement question 14. The

significant point which was revealed in the open-ended question responses was that IE staffs were not considered to be adequate in terms of professonalism and experience to perform their mission.

Measurement Question No. 15. If the IE Branch were to be reorganized, which sections should be included in the reorganized branch?

Based upon the results of the Industrial Engineering Role Survey, it was concluded that IE should be reorganized to include an IE analysis section, Cost Accounting, Real Estate Management, and Financial Management. This conclusion was further supported by the responses to the open-ended questions concerning possible improvements to IE.

Measurement Question No. 16. The role of the industrial engineer as a quality control inspector has no bearing on his acceptance as a management consultant.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that the IE's role of the quality control inspector conflicted with his management consultant's role. This conclusion was further supported by the responses to the open-ended questions concerning IE weaknesses and limitations.

Measurement Question No. 17. The scope of industrial engineering work should be expanded outside the

Base Civil Engineering organization to areas such as; Supply, Transportation, Budget, etc.

In reflection, it was concluded that this question was stated incorrectly. It was intended to ask that if a BCE management oriented problem was in part caused by an outside agency, then IE should have the authority to expand its analysis to the suspect areas to fully study the problem at hand. Feedback showed that many respondents felt that this question asked that IE should be available to solve other organizational--Supply, Transportation, etc., problems. Thus, no conclusion was drawn from the results of measurement question 17.

Measurement Question No. 18. The studies performed by the Industrial Engineering Branch play a significant role in improving the Base Civil Engineering organization.

Based upon the results of the Industrial Engineering Role Survey and the CESMET findings, it was concluded that IE studies can and have, in some cases, played a significant role in improving BCE organizations. It was also concluded that IE studies have not been successful within numerous BCE organizations. The Chiefs of DEE, DEM, and DEP were "undecided" concerning the impact of IE studies. This was further supported by the open-ended questions concerning IE weaknesses. The third largest category of IE weaknesses as identified by the Branch Chiefs involved IE studies which failed to resolve

problems. Another weakness, which was further stressed by CESMET, was that, oftentimes, IE studies were not supported by the BCE and his staff. Thus, it was concluded that IE studies have not made a significant impact on BCE organizations Air Force wide.

Measurement Question No. 19. The Industrial Engineering Branch is responsive to the problem solving needs of management.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that IE Air Force wide has not been responsive to the problem solving needs of civil engineering managers--Chiefs of DEE, DEM, and DEP. Whereas, the BCE believes his IE is responsive, the Branch Chiefs were "undecided." The Branch Chiefs' undecidedness was assumed to be important in that it questions just how responsive IE has been. This was further substantiated by the responses to the open-ended questions concerning IE weaknesses. Again, the third largest category of weaknesses was that IE failed to solve problems.

Measurement Question No. 20. The role of industrial engineering should remain as it is.

The conclusion to this question are the same as for investigative question 3.

Measurement Question No. 21. The Industrial Engineering Branch can be relied upon to provide objective and effective solutions to management problems.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that a difference in opinion exists concerning the reliance upon IE to provide objective and effective solutions to management problems. Whereas, the DE and DEI groups believe IE could be relied upon, the DEE, DEM, and DEP groups were totally "undecided." The DEE, DEM, and DEP groups further emphasized in their responses to the open-ended questions that IE did not really solve problems, and that too often the IE solutions were too shallow in depth to effectively solve the management problems. Thus, it was concluded that IE could not always be relied upon to provide objective and effective solutions to management problems.

Measurement Question No. 22 (BCE Attachment) and No. 26 (DEI Attachment). The rescission of AFM 85-38 has improved industrial engineering's responsiveness to management's needs.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that IE's responsiveness to management's needs has been improved since the rescission of AFM 85-38.

Measurement Question No. 23 (BCE Attachment) and No. 27 (DEI Attachment). The Industrial Engineering Branch can be effective without a governing directive.

Based upon the results of the Industrial Engineering Role Survey, it was concluded that IE could be effective without a detailed governing directive. However, in response to the open-ended questions concerning improvements to IE, the respondents identified as their third most important recommendation that IE should have a directive of some sort. The respondents noted that the directive should be general in nature, should allow flexibility in the use of the IE staff, and should provide the IE with general guidelines as to the functions he sould be accomplishing.

Measurement Question No. 24 (BCE), No. 29 (DEI) and No. 25 (Branch Chiefs). What are the most important functions of the IE Branch?

Based upon the results of the Industrial Engineering Role Survey and the CESMET reports, it was concluded that the most important IE functions at the time of the survey were: Management consulting, IE studies, BEAMS, QC, IE Analysis, Manpower duties, and the Customer Relatives Program. The order of importance varied among respondents.

Measurement Question No. 25 (BCE), No. 32 (DEI), and No. 26 (Branch Chiefs). What are the weaknesses or limitations currently associated with the base level industrial engineering concept?

Based upon the results of the Industrial Engineering Role Survey and the CESMET findings, it was concluded the major weaknesses or limitations of IE at the time of the survey were: (1) unqualified, inadequate, or inexperienced IE staffs, (2) undermanned IE staffs, (3) the failure of too many IE staffs to solve problems, (4) a negative IE image caused by the QC program, (5) BCEs not using his IE staff properly or not supporting his IE staff, (6) too many additional duties assigned to the IE Branch, and (7) inadequate training available for IE personnel.

Measurement Question No. 27 (BCE) and No. 31 (DEI). To better serve the needs of the BCE and his staff what changes or improvements in the industrial engineering concept do you recommend?

Based upon the results of the Industrial Engineering Role Survey, it was concluded that the following changes be made in the industrial engineering concept: (1) delete QC and any sort of IG follow-up work from IE's responsibility, (2) upgrade the quality of IE staffs by acquiring more degreed IE personnel and reduce the number of technicians, (3) incorporate Real Property, Cost Accounting and Financial Management within the IE Branch, (4) publish a directive or brochure which outlines IE responsibilities and which explains the various IE techniques which can be used to accomplish his responsibilities, (5) emphasize IE's management

consultant role, (6) provide the BCE and his staff with appropriate training as to how the IE can be effectively used, (7) provide greater training opportunities for the IE staff--the training should include behavioral management techniques and effective writing and speaking fundamentals as well as proven base level IE techniques, (8) keep the number of additional duties assigned to IE on a par with other branches--do not overload the IE with additional duties, and (9) establish an IE team capability above the base level to study and resolve common Base Civil Engineering management problems.

Discussion of Conclusions

It was interesting to note that the Base Civil Engineer and the Chiefs of *E&C, O&M, and Programs ranked* Management consulting and IE studies as being two of the most important IE functions. Then when asked the following questions only the BCE believed that IE actually accomplished the intent of the questions:

No. 18--The studies performed by the Industrial Engineering Branch play a significant role in improving the Base Civil Engineering organization.

No. 19--The Industrial Engineering Branch is responsive to the problem solving needs of management.

No. 21--The Industrial Engineering Branch can be relied upon to provide objective and effective solutions to management problems.

The referenced Branch Chiefs were undecided about how well IE accomplishes the intent of the questions. Their undecidedness was further elaborated in response to the open-ended question concerning IE weaknesses. The Branch Chiefs were very concerned that all too often IE failed to solve the problems at hand and in many cases IE's were reworking the same problems over and over.

The results of the survey did, however, reveal that approximately twenty out of the one hundred and fourteen bases had IE staffs which were accomplishing quality IE studies which actually provided realistic and effective solutions to problems.

When reviewing the results there appeared to be certain detrimental factors which have kept IE from being successful Air Force wide. The factor which seemed to have been the biggest detriment to IE was unqualified IE staffs. This fact was stressed by all five groups of respondents. By inadequate IE staffs, the respondents noted that there was too much reliance upon technicians and there were not enough degreed IE personnel authorized for the branch. In addition to the reliance upon technicians, the Base Civil Engineers were very concerned about the number of inexperienced, young military officers being assigned as the Chief of the IE Branch.

The first major change required for the IE branch appears to be the establishment of a more professional--more degreed IEs--IE function. The literature review revealed that IEs are more in demand today than ever before. The reason for this demand has been the proven performance of professional IEs in all facets of civilian industry. Professionally staffed IE branches most likely could be equally successful in the Base Civil Engineering environment. It appears that the Air Staff has recognized the need for more degreed IEs and fewer technicians. As mentioned in Chapter I, the Air Staff recently--7 April 1977--adopted a restructured IE branch which included the reduction of technicians and emphasis upon professional IEs.

The failure of IEs to solve problems was a second major detrimental IE factor. The basic reasons that were given concerning why IEs fail to solve problems included (1) IEs are too compliance oriented, (2) IEs fail to adequately analyze problems sufficiently, (3) IEs fail to assist in implementing solutions, (4) IEs fail to follow up to ensure the corrective action was adequate, and (5) there is a lack of teamwork between IE and other branches because of IEs QC image. Although the research effort was not aimed at the cause of IE ineffectiveness, it is conjectured that many of the above reasons can be attributed to (1) the lack of trained IEs, (2) friction

between IE and the other branches because of IEs conflicting role as a management consultant and QC inspector, and (3) the constraining factors which were associated with the recently rescinded AFM 85-38.

The third major detrimental factor associated with IE was a negative image which appears to be caused by previously required QC responsibilities. Although there were a few (5) BCEs which felt that QC should be emphasized, it appeared that all groups of respondents fovored that QC be de-emphasized. Thus, it was concluded that QC be eliminated as an Industrial Engineering responsibility. QC has been a valuable tool in maintaining high standards of workmanship in many industries as well as in the military environment. However, the literature review revealed that IEs only concern with QC is to develop and evaluate quality control plans for the production functions or a separate QC function.

The elimination of QC from the IE function should allow IE to emphasize the management consultant role and IE studies of known problem areas. The elimination of QC should allow IE to develop credibility with other BCE functions. With a professional IE staff, IE should be able to become a valuable member of the BCE team. The Air Staff has also recognized the need to de-emphasize IE's QC role. In the 7 April 1977 restructured IE function, QC was formally deleted as an IE section. However,

one technician slot has been retained for QC oriented work. In regards to the results of the research effort, the retention of a QC inspector within IE could continue to be detrimental to IE's role as a management consultant.

Another major change which appears to be required as seen in the results of the survey is the incorporation of Cost Accounting, Real Property, and Financial Management within IE. The respondents noted that IE could do a better job of analyzing trends if the referenced functions were within IE. The Air Force recently--7 April 1977--restructured IE to include Cost Accounting and Real Property. It is difficult to determine the objectivity of the respondents replies concerning this change. The Air Staff is currently evaluating two test Base Civil Engineering reorganization structures at eight different bases--four bases are testing one BCE organizational structure and a separate four bases are testing a second BCE organizational structure. Each of the test concepts involve the incorporation of the referenced sections within IE. It is quite possible that some of the respondents were biased in their response to a new IE organizational concept. However, no respondents noted that IE should not incorporate the Cost Accounting and Real Property functions. It is interesting to note that the literature

review revealed no IE functions which incorporated functions like Cost Accounting and Real Property Management. However, the base level IE function did at one time--during the 1960s--incorporate the referenced functions (6).

Finally, the least major detrimental factor associated with IE dealt with the lack of use or improper use of the IE staff. This factor was noted mostly by the IE chiefs; however, there were BCEs and Branch Chiefs who were also concerned about the improper use of the IE capability. CESMET also noted that IE staffs were improperly used and quite often were not supported. The BCE and IE groups recommended that training be provided to the BCE and his staff on how to use the IE effectively. Also, recommended was the need to provide IEs with appropriate training so they can become effective problem solvers.

Problems Encountered

The research effort was not without problems and setbacks. The most notable problem involved the analysis of investigative questions two and three. Both investigative questions were based upon a dichotomous set of measurement questions. One set of measurement questions was intended to imply favorableness to the question at hand; while the second set of measurement

questions was intended to imply unfavorableness to the question at-hand.

It was hoped that the results of the two sets of measurement questions would have led to the same conclusion to the appropriate investigative question. However, the results of the set of measurement questions to both investigative question two and three were inconclusive. To answer the investigative questions, criteria six, which was based upon a single measurement question, had to be invoked.

In reviewing the measurement questions which were used to make up the two dichotomous sets, it was determined that faulty logic was used in developing the sets of measurement questions. The faulty logic primarily involved including measurement questions in a particular set to which they did not belong. The impact of this action, in addition to the averaging of measurement questions over all groups of respondents, created the inconclusive results. This problem could have been foreseen if time had been available to conduct a small pilot survey. However, the questionnaire was developed in such a manner that valid conclusions could be drawn just in case the sets of measurement questions were inconclusive. Criteria six for each investigative question had been established to overcome any inconclusiveness in the sets of measurement questions.

There were some minor problems associated with three of the measurement questions--9, 14, and 17. These problems were presented in the appropriate conclusion discussion. No other significant obstacles were encountered.

Future Considerations

The research effort concentrated upon the base level civil engineering environment. It was built around the opinions of the key civil engineering management personnel. The research would have been more complete if a survey of civilian IE staffs could have been accomplished. Therefore, it may be worthwhile for future researchers to explore how civilian IE staffs differ from military IE staffs. It is quite possible that the military could benefit from IE's successes in the civilian environment. The literature review revealed a greater reliance upon IEs in most aspects of civilian life. Surely, if IEs can be successful in the civilian environment, they can also be successful in a military environment such as within Base Civil Engineering.

Finally, it may be worthwhile that two years from now follow-up research be conducted to determine if the Base Civil Engineering industrial engineering concept

has been changed, and to determine if it is successful and meeting the management needs of the Base Civil Engineer and his staff.

Summary of Conclusions

A summary of the conclusions of the research effort follows:

1. Industrial engineering capability is needed within the Base Civil Engineering organizations.

2. The role of industrial engineering should be changed. The following should be incorporated into a revised BCE industrial engineering role/concept:

a. The IE staff should be built around a nucleus of degreed IE personnel at least two of which should be civilians for continuity. The number of IEs per base will depend upon the size of the Base Civil Engineering organization and should be determined by a Management Engineering Team. The reliance upon technicians to conduct industrial engineering activities should be reduced.

b. Quality control-type activities should be eliminated from the IE function.

c. Real Property, Cost Accounting, and Financial Management, should be incorporated with the IE analysis section to form a new IE branch. IE analysis is the only true IE function; therefore, it may be necessary to rename the branch.

d. The IE staff should concentrate its activities on solving management problems; therefore, the management consultant role and the IE studies should be emphasized in IE's new role.

e. A directive should be published which outlines IE responsibilities. The directive should provide for flexibility to IE use and not constrain the IE function as the AFM 85-38 publication did.

f. An industrial engineering handbook should be developed and published which outlines how IEs can be effective problem solvers. The handbook should include the IE techniques which have been successfully used at base level.

g. The Base Civil Engineer and the various branch chiefs should be provided training in how to use the IE effectively. Likewise, IEs should be provided greater training opportunities which includes proven base level IE techniques, behavioral management techniques, and effective writing and speaking fundamentals.

h. The Chief IE position should be a qualified IE who has at least two years of BCE experience.

i. The restructured IE branch should not be encumbered with an overload of additional duties.

j. Provide the restructured IE branch with the authority to expand its analysis to other base

organizations when required to solve civil engineering problems.

3. An Industrial Engineering team capability should be established above the base level to study and resolve common Base Civil Engineering management problems.

4. Although IE has been considered to be unsuccessful Air Force-wide, there are several outstanding industrial engineering staffs in the Air Force. This fact was confirmed by CESMET, and several Base Civil Engineers and several Branch Chiefs. Many of the strengths of the existing, outstanding IE staffs were incorporated into the recommended IE role.

5. The key base civil engineering personnel which were surveyed in the research effort must have been quite concerned about the IE function. Their response was excellent which provided a clear message concerning "what role IE should play within Base Civil Engineering."

APPENDIXES

APPENDIX A

LIST OF BASES/COMMAND IN POPULATION

Command	Base
Air Defense Command	Air Force Academy Duluth International Apt. Hancock Field Peterson Field Tyndall AFB
Air Force Communication Service	Richards-Gebaur AFB
Air Force Logistics Command	Hill AFB Kelly AFB McClellan AFB Newark AFB Robins AFB Tinker AFB Wright-Patterson AFB
Air Force Security Service	Goodfellow AFB Misawa AB San Vito AB
Air Force Systems Command	Brooks AFB Edwards AFB Eglin AFB Kirtland AFB L. G. Hanscom AFB Los Angeles AFB Patrick AFB
Air Training Command	Chanute AFB Columbus AFB Craig AFB Keesler AFB Lackland AFB Laughlin AFB Lowry AFB Mather AFB Randolph AFB Reese AFB Sheppard AFB Webb AFB Williams AFB
Air University	Maxwell AFB

Command	Base
Military Air Command	Altus AFB
	Andrews AFB
	Bolling AFB
	Charleston AFB
	Dover AFB
	Little Rock AFB
	McChord AFB
	McGuire AFB
	Norton AFB
	Pope AFB
	Scott AFB
	Travis AFB
	Lajes AFB
Tactical Air Command	Bergstrom AFB
	Cannon AFB
	England AFB
	George AFB
	Howard AFB
	Holloman AFB
	Homestead AFB
	Hurlburt AFB
	Langley AFB
	Luke AFB
	MacDill AFB
	Moody AFB
	Mt. Home AFB
	Myrtle Beach AFB
	Nellis AFB
	Seymour Johnson AFB
	Shaw AFB
Strategic Air Command	Barksdale AFB
	Beale AFB
	Blytheville AFB
	Carswell AFB
	Castle AFB
	Davis Monthan AFB
	Dyess AFB
	Ellsworth AFB
	F. E. Warren AFB
	Fairchild AFB
	Grand Forks AFB
	Griffiss AFB
	K. I. Sawyer AFB
	Kincheloe AFB
	Loring AFB
	Malmstrom AFB
	March AFB
	McConnell AFB

Command	Base
Strategic Air Command --Continued	Minot AFB
	Offutt AFB
	Pease AFB
	Plattsburgh AFB
	Rickenbacher AFB
	Vandenberg AFB
	Whiteman AFB
	Wurtsmith AFB
	Anderson AFB
Alaskan Air Command	Eielson AFB
	Elmendorf AFB
Pacific Air Force	Clark AB
	Hickam AFB
	Kadena AB
	Korat AB
	Kunsan AB
	Osan AB
	Yokota AB
United States Air Force Europe	Aviano AB
	Bitberg AB
	Hahn AB
	Lindsey AB
	Ramstein AB
	Sembach AB
	Spangdahlem AB
	Templehof AB
	Terrejon AB
	Zaragoza AB
	Zweibrucken AB

APPENDIX B

INDUSTRIAL ENGINEERING ROLE SURVEY

General Section

Please record your responses for the general section (questions 1 through 21) on the computer scan sheet.

1. What is your grade (Military only)?

_____ (a) Colonel
_____ (b) Lt. Colonel
_____ (c) Major
_____ (d) Captain
_____ (e) First Lieutenant
_____ (f) Second Lieutenant

2. What is your grade (Civilian only)?

_____ (a) GS-15
_____ (b) GS-13 or 14
_____ (c) GS-12
_____ (d) GS-11
_____ (e) GS-9
_____ (f) other

3. What position do you hold within base Civil Engineering?

_____ (a) Base Civil Engineer
_____ (b) Chief of Engineering and Construction
_____ (c) Chief of Industrial Engineering
_____ (d) Chief of Operations and Maintenance
_____ (e) Chief of Programs

4. What is the total manning strength of your civil engineering organization (Military & Civilian)?

_____ (a) 800 or more
_____ (b) Less than 800 but more than 400
_____ (c) 400 or less

5. What major Air Force command do you belong to?

_____ (a) ADC
_____ (b) AFLC
_____ (c) AFSC
_____ (d) ATC
_____ (e) MAC
_____ (f) PACAF
_____ (g) SAC
_____ (h) TAC
_____ (i) USAFE
_____ (j) USAFSS
_____ (k) other

6. What level of education have you achieved? (Indicate highest level obtained)

_____ (a) Bachelor of Science or Bachelor of Arts
_____ (b) Masters
_____ (c) Doctorate
_____ (d) High school plus college credits
_____ (e) High school and no college

Please answer the following questions based on your personal opinion and record your response on the computer scan sheet.

7. The Industrial Engineering Branch would be more effective if it concentrated on solving management problems rather than doing quality control work.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

8. The Industrial Engineering Branch should be eliminated.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

9. Rather than having base level industrial engineering staffs, there should be industrial engineering team(s) to study common base-level problems. Where do you think that this industrial engineering capability should be located? (Select one)

_____ (a) Civil Engineering Center
_____ (b) AFIT Civil Engineering School
_____ (c) Major Commands (Each command to have an IE staff)
_____ (d) Recommend no change.

10. As a manager, you seek the assistance of the industrial engineer and his staff for purposes of problem solving.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

11. The industrial engineer's recommendations are given serious consideration and are implemented a majority of the time.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

12. The Base Civil Engineering Organization would be adversely affected if the Industrial Engineering Branch were dissolved.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

13. The Industrial Engineering Branch should continue to do quality control inspections of the Operations and Maintenance Shops' work.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

14. Present staffing of the Industrial Engineering Branch is adequate to perform their work.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

15. If the Industrial Engineering Branch were to be reorganized, which of the following sections should be included in the reorganized branch? Select as many of the following as you desire.

_____ (a) Quality Control Section
_____ (b) Industrial Engineering Analysis
_____ (c) Cost Accounting
_____ (d) Real Estate
_____ (e) Financial Management

16. The role of the industrial engineer as a quality control inspector has no bearing on his acceptance as a management consultant.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

17. The scope of industrial engineering work should be expanded outside the Base Civil Engineering organization to areas such as; supply, transportation, budget, etc.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

18. The studies performed by the Industrial Engineering Branch play a significant role in improving the Base Civil Engineering organization.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

19. The Industrial Engineering Branch is responsive to the problem solving needs of management.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

20. The role of industrial engineering should remain as it is.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

21. **The industrial engineering branch can be relied upon to provide objective and effective resolutions to management problems.**

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (3) Strongly Agree

Base Civil Engineer's Attachment

In this section of the questionnaire, please record your responses on the questionnaire itself and not on the computer scan sheet.

22. The recissionof AFM 85-38, Civil Engineering Management Review, has improved industrial engineering's responsiveness to your management needs.

____ (a) Strongly Disagree
____ (b) Disagree
____ (c) Undecided
____ (d) Agree
____ (3) Strongly Agree

23. The Industrial Engineering Branch can be effective without a governing directive.

____ (a) Strongly Disagree
____ (b) Disagree
____ (c) Undecided
____ (d) Agree
____ (3) Strongly Agree

24. What do you consider the five most important functions of your industrial engineering branch to be? (Examples: Quality Control, IE Studies, MBO, BEAMS Monitor, Manpower Expert, Mgt. Consultants, etc.)

1. First Most Important: _____

2. Second Most Important: _____

3. Third Most Important: _____

4. Fourth Most Important: _____

5. Fifth Most Important: _____

25. What are the weaknesses or limitations currently associated with the base level industrial engineering concept?

26. Describe briefly the single achievement of the Industrial Engineering staff which has impressed you most favorably.

27. To better serve the needs of you and your staff what changes or improvements in the industrial engineering concept do you recommend?

Chief of Industrial Engineering's Attachment

In this section of the questionnaire, please record your response on the questionnaire itself and not on the computer scan sheet.

22. How much base level industrial engineering experience do you have?

_____ (a) Less than 1 year
_____ (b) Greater than 1 but less than 2 years
_____ (c) Greater than 2 but less than 3 years
_____ (d) Greater than 3 but less than 4 years
_____ (e) Greater than 4 years

23. What level of an industrial engineering degree do you hold?

_____ (a) Bachelor of Science
_____ (b) Master's Degree
_____ (c) Doctorate
_____ (d) Have a degree but not an IE degree
_____ (e) Do not have a degree

24. How many people are authorized for your branch?

_____ (a) 1 to 3
_____ (b) 4 to 6
_____ (c) 7 to 9
_____ (d) 10 to 12
_____ (e) Greater than 12

25. How many people are currently assigned to your branch?

_____ (a) 1 to 3
_____ (b) 4 to 6
_____ (c) 7 to 9
_____ (d) 10 to 12
_____ (e) Greater than 12

26. The recission of AFM 85-38, Civil Engineering Management Review, has improved your branch responsiveness to the management needs of the Base Civil Engineer and his staff.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

27. The Industrial Engineering Branch can be effective without a governing directive.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

28. The following list represents the sources of IE work requirements. Rank order the list to show how IE work requirements are generated: Rank #1 is the source which generates the most work for IE, rank #2 generates the second most work for IE, and so on.

_____ (a) Base Civil Engineer
_____ (b) Branch Chiefs
_____ (c) IE-Self Generated
_____ (d) Management Review Committee
_____ (e) Other BCE Personnel
_____ (f) Reports from Command, IG, Auditor, etc.
_____ (g) Required by Manuals; Regulations (AFR 85-1, AFR 85-10, etc.)

29. The Industrial Engineering Branch performs numerous functions. Of the many it does perform what do you consider to be the 5 most important (ranked in the order of importance)? *Short answers please.*

1. First Most Important: _____

2. Second Most Important: _____

3. Third Most Important: _____

4. Fourth Most Important: _____

5. Fifth Most Important: _____

30. For your response to question 29, estimate the amount of time your IE staff has expended on each listed function during the past twelve months. Your estimate should be rounded to the nearest 5% and the total percent does not have to sum to 100%.

31. To make the industrial engineering staff more responsive to the needs of management, what changes or improvements do you recommend?

32. What weaknesses or limitations of your IE Branch have kept you from serving the BCE and his staff effectively?

33. Describe briefly the single achievement or accomplishment by your branch of which you are proudest.

Branch Chief's Attachment

In this section of the questionnaire, please record your response on the questionnaire itself and not on the computer scan sheet.

22. The industrial engineer's greatest contribution to your branch is in the area of quality control.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

23. The industrial engineering branch should be primarily oriented to the efficiency of the Operations and Maintenance Branch.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

24. Industrial Engineering studies conducted in your branch have measurably improved effectiveness of your branch.

_____ (a) Strongly Disagree
_____ (b) Disagree
_____ (c) Undecided
_____ (d) Agree
_____ (e) Strongly Agree

25. What are the three most important functions that the IE staff can accomplish to satisfy your management needs? (Examples: Quality Control, Activity Evaluations, Mgt. Consultant, IE studies, etc.)

1. First Most Important: _____

2. Second Most Important: _____

3. Third Most Important: _____

26. What weaknesses or limitations of the IE branch have you noticed which has kept them from assisting you effectively?

27. Describe briefly the single achievement of the IE staff which has impressed you the most.

APPENDIX C

INVESTIGATIVE QUESTIONS WITH SUPPORTING MEASUREMENT QUESTIONS

Investigative Question No. 1

What functions/activities are base level industrial engineering branches currently performing?

Measurement Question No.

22 of Branch Chief Section. The industrial engineer's greatest contribution to your branch is in the area of quality control.

24 of BCE Section and 29 of IE Section. The Industrial Engineering Branch performs numerous functions. Of the many it does perform, what do you consider to be the 5 most important (ranked in the order of importance)? Note: This question also supports Investigative Question No. 3.

25 of BCE Section and 26 of Branch Chief Section. What are the weaknesses or limitations currently associated with the basel level industrial engineering concept?

28 of IE Section. Rank the order of importance of how industrial engineering work requirements are generated.

30 of IE Section. For your response to question 29, estimate the amount of time your IE staff has expended in each category during the past twelve months.

Investigative Question No. 2

Is industrial engineering capability needed at base level?

Measurement Question No.

8. The Industrial Engineering Branch is a "frill" that can be eliminated.

9. Rather than having base level industrial engineering staffs, there should be industrial engineering team(s) to study common base level problems.

10. As a manager, you seek the assistance of the industrial engineer and his staff for the purposes of problem solving.

11. The industrial engineer's recommendations are given serious consideration and are implemented a majority of the time.

12. The Base Civil Engineering Organization would be adversely affected if the Industrial Engineering Branch were dissolved.

18. The studies performed by the Industrial Engineering Branch play a significant role in improving the Base Civil Engineering organization.

19. The Industrial Engineering Branch is responsive to the problem solving needs of management.

20. The role of industrial engineering should remain as it is.

21. The Industrial Engineering Branch can be relied upon to provide objective and satisfactory solutions to management problems.

24 of Branch Chief Section. Industrial engineering studies conducted in your branch have measurably improved effectiveness of your branch.

Investigative Question No. 3

If industrial engineering is needed at base level, should it continue to function as is or should it be modified/changed?

Measurement Question No.

7. The Industrial Engineering Branch would be more effective if it concentrated on solving management problems rather than doing quality control work.

13. The Industrial Branch should continue to do quality control inspections of the Operations and Maintenance Shops' work.

14. Present staffing of the Industrial Engineering Branch is adequate to perform their work.

15. If the Industrial Engineering Branch were to be reorganized, which of the following sections should be included in the reorganized branch?

16. The role of the industrial engineer as a quality control inspector has no bearing on his acceptance as a management consultant.

17. The scope of industrial engineering work should be expanded outside the Base Civil Engineering organization to areas such as--supply, transportation, budget, etc.

20. The role of industrial engineering should remain as is.

22 of BCE Section and 26 of IE Section. The recission of AFM 85-38 has improved industrial engineering's responsiveness to your management needs. (AFM 85-38, *Civil Engineering Management Review.*)

23 of BCE Section and 27 of IE Section. The Industrial Engineering Branch can be effective without a governing directive.

27 of BCE Section 31 of IE Section. To better serve the needs of you and your staff, what changes or improvements in the industrial engineering concept do you recommend?

23 of Branch Chief Section. The Industrial Engineering Branch should be primarily oriented to the efficiency of the Operations and Maintenance Branch.

25 of Branch Chief Section. What are the three most important functions that the IE Staff can accomplish to satisfy your management needs?

APPENDIX D

DATA SUMMARY TABLES

TABLE 42

BCE'S RANKING OF IE'S MOST IMPORTANT FUNCTIONS

Function	1st Most Important		2nd Most Important		3rd Most Important		4th Most Important		5th Most Important		Total	Rank
Mgt Cons	(38)	380	(19)	152	(10)	60	(14)	56	(5)	10	658	1
QC	(12)	120	(8)	64	(21)	126	(12)	48	(13)	26	384	4
IE Studies	(24)	240	(25)	200	(16)	96	(9)	36	(10)	20	592	2
IE Anal	(2)	20	(2)	16	(3)	18	(1)	4	...	...	58	8
BEAMS	(8)	80	(21)	168	(15)	90	(14)	56	(17)	34	428	3
Manpower	(3)	30	(5)	40	(14)	84	(15)	60	(10)	20	234	6
Follow-Up Work	...	...	(2)	16	(2)	12	(1)	4	(1)	2	34	9.5*
Problem Solving	(2)	20	...	...	(2)	12	...	...	(1)	2	68	7
Cust Rel	...	...	...	...	...	...	...	...	...	...	...	...
MBO	(3)	30	(11)	88	(6)	36	(19)	76	(23)	46	276	5
Training	(1)	10	...	...	...	...			(1)	2	12	11

*Tied ranks were averaged, i.e., 9+10÷2=9.5

TABLE 42--Continued

Function	1st Most Important		2nd Most Important		3rd Most Important		4th Most Important		5th Most Important		Total	Rank
TRAD IE	...	...	...	...	...	...	...	...	...	...	...	...
Sys & Proc	...	...	...	...	...	...	...	...	...	...	...	...
Extra Duties	...	...	...	...	(3)	12	(3)	12	(2)	4	34	9.5*

NOTE: 1. The above frequency data were extracted from the BCE responses to question 24 of the Base Civil Engineer's attachment.

2. The figures in parentheses represent the frequencies per function. The frequecy for the 1st, 2nd, 3rd, rth and 5th most important function are multiplied by 10, 8, 6, 4 and 2 respectively for each function. The product of the five multiplications per function were summed and the total figure was used to develop the resulting ranks.

TABLE 43

DEE'S RANKING OF IE'S MOST IMPORTANT FUNCTIONS

Function	1st Most Important		2nd Most Important		3rd Most Important		Total	Rank
Mgt Cons	(41)	410	(19)	152	(8)	48	610	1
QC	(14)	140	(21)	168	(30)	180	488	3
IE Studies	(27)	270	(26)	208	(12)	72	490	2
IE Anal	(1)	10	(2)	16	(1)	6	32	9
BEAMS	(1)	10	(2)	16	(4)	24	60	5
Manpower	(3)	30	(3)	24	(2)	12	66	4
Follow-Up Work	...	...	...	...	(1)	6	6	13.5*
Problem Solving	(3)	30	(1)	8	...	...	38	7
Cust Rel	...	...	...	...	(1)	6	6	13.5*
MBO	...	...	(1)	8	(1)	6	14	12
Training	(1)	10	(1)	8	...	...	18	10
Trad IE	(1)	10	...	...	(1)	6	16	11
Sys & Proc	...	...	(1)	8	(3)	18	36	8
Extra Duties	...	...	(4)	32	(2)	12	44	6

*Represents tied rankings.

NOTE: 1. The above frequency data were extracted from the DEE responses to question 25 of the Branch Chief's attachment.

2. See Note 2 on page 170. The same format was utilized in developing the above except that this involved only three listed most important functions; whereas, the referenced note involved five most important functions

TABLE 44

DEI'S RANKING OF IE'S MOST IMPORTANT FUNCTIONS

Function	1st Most Important		2nd Most Important		3rd Most Important		4th Most Important		5th Most Important		Total	Rank
Mgt Consul	(20)	200	(12)	96	(14)	84	(3)	12	(1)	2	394	2.5*
QC	(12)	120	(13)	104	(14)	84	(14)	56	(15)	30	394	2.5*
IE Studies	(15)	150	(12)	96	(9)	54	(3)	12	(3)	6	318	4
IE Anal	(8)	80	(6)	48	(7)	42	(5)	20	(3)	6	196	6
BEAMS	(12)	120	(21)	168	(18)	108	(10)	40	(9)	18	454	1
Manpower	...	...	(4)	32	(7)	42	(5)	20	(1)	2	96	8
Follow-Up Work	(1)	10	(6)	48	(4)	24	(8)	32	(9)	18	132	7
Problem Solving	(18)	180	(7)	56	(3)	18	(7)	28	...	...	282	5
Cust Rel	(1)	10	(1)	8	(2)	12	(8)	32	(5)	10	72	9.5**
MBO	(1)	10	(1)	8	(4)	24	(3)	12	(3)	6	60	11

*Represents tied rankings

**Represents tied rankings

TABLE 44--Continued

Function	1st Most Important		2nd Most Important		3rd Most Important		4th Most Important		5th Most Important		Total	Rank
Training	(1)	10	(1)	8	(1)	6	(1)	4	(3)	6	34	13
Trad IE	...	...	...	...	...	...	(3)	12	(2)	4	16	14
Sys & Proc	...	...	(3)	24	(1)	6	(1)	4	(1)	2	36	12
Extra Duties	...	...	(1)	8	(4)	24	(7)	28	(6)	12	72	9.5**

NOTE: 1. The above frequencies data were extracted from the DEI responses to question 29 of the Chief of IE's attachment.

2. See Note 2 on page 170.

TABLE 45

DEM'S RANKING OF IE's MOST IMPORTANT FUNCTIONS

Function	1st Most Important		2nd Most Important		3rd Most Important		Total	Rank
Mgt Cons	(21)	210	(19)	152	(18)	108	470	1
QC	(3)	30	(5)	40	(9)	54	124	5
IE Studies	(17)	170	(18)	144	(16)	96	410	2
IE Anal	(24)	240	(15)	120	(8)	48	408	3
BEAMS	(14)	140	(18)	144	(11)	66	350	4
Manpower	(1)	10	(1)	8	...	...	18	12
Follow-Up Work	(1)	10	...	...	...	...	10	14
Problem Solving	(1)	10	(2)	16	(2)	12	38	8
Cust Rel	(1)	10	(1)	8	(2)	12	30	9
MBO	(2)	20	(1)	8	(2)	12	40	7
Training	...	...	(1)	8	(2)	12	20	10.5*
Trad IE	...	...	(2)	16	...	...	16	13
Sys & Proc	(3)	30	(1)	8	(2)	12	50	6
Extra Duties	(2)	20	...	...	...	...	20	10.5*

*Represents tied rankings.

NOTE: 1. The above frequency data were extracted from the DEM responses to question 25 of the Branch Cheif's attachment.

2. See note 2 on page 171.

TABLE 46

DEP'S RANKINGS OF IE'S MOST IMPORTANT FUNCTIONS

Function	1st Most Important		2nd Most Important		3rd Most Important		Total	Rank
Mgt Cons	(37)	370	(29)	232	(5)	30	632	2
QC	(24)	240	(21)	168	(39)	234	642	1
IE Studies	(20)	200	(24)	192	(18)	90	482	3
IE Anal	(1)	10	(1)	8	...	...	18	8
BEAMS	(3)	30	(6)	48	(6)	36	114	4
Manpower	(2)	20	...	...	(2)	12	32	6
Follow-Up Work	...	...	(1)	8	...	...	8	10
Problem Solving	...	...	(2)	16	(5)	30	46	5
Cust Rel	...	...	...	...	...	...	...	13*
MBO	...	...	...	...	(1)	6	6	11
Training	...	...	...	...	...	...	...	13*
Trad IE	...	...	...	...	...	...	...	13*
Sys & Proc	...	...	(2)	16	(1)	6	22	7
Extra Duties	(1)	10	...	...	(1)	6	16	9

*Represents tied rankings.

NOTE: 1. The above requency data were extracted from the DEP responses to question 25 of the Branch Chief's attachment.

2. See note 2 on page 171.

AD-A045 214 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCHO--ETC F/G 15/5
THE ROLE OF INDUSTRIAL ENGINEERING WITHIN BASE CIVIL ENGINEERIN--ETC(U)
JUN 77 M J FARINEAU, A E TUCKER

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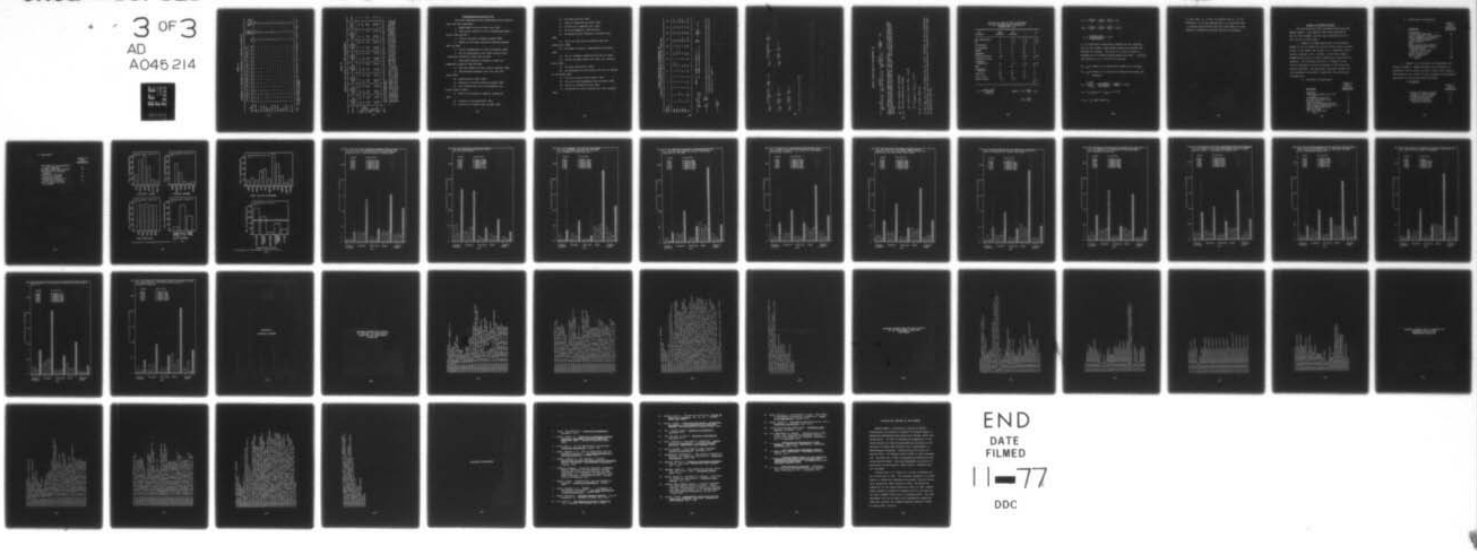

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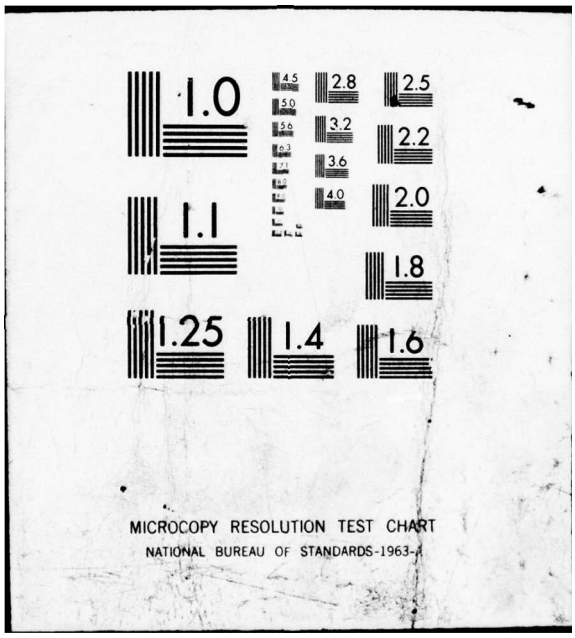
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6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE 47

FREQUENCY OF RESPONSES BY PERCENTAGE OF TIME PER IE FUNCTION

IE Function	Percentage of Time Expended During January 1976-January 1977																CESP	% of Bases with Resp.	Avg % of Time Exp By IE
	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%			
Mgt Cons	6	11	8	10	5	3	1	3	...	1	...	...	1	...	1	...	50	54%	20%
QC	8	18	10	9	3	15	3	1	4	2	...	...	...	...	...	1	74	80	20
IE Stds	1	2	4	10	5	...	3	6	2	5	3	...	...	...	...	...	41	44	30
IE Anal	1	7	2	6	2	4	1	4	...	1	...	...	...	...	...	...	28	30	25
BEAMS	5	17	16	13	7	7	2	5	...	1	...	1	...	...	...	...	74	80	20
Mnpr	6	4	3	1	...	...	1	1	...	...	...	...	...	...	...	...	16	17	15
F-Up Wk	7	7	9	1	1	...	...	1	...	...	...	...	...	...	...	...	26	28	15
Pb Solv	2	2	3	5	5	2	3	...	...	...	2	1	...	...	...	...	25	27	25
Cus Rel	6	5	4	1	...	...	...	...	...	...	...	...	...	...	...	...	16	17	10
MBO	5	4	2	1	...	...	...	...	...	...	...	...	...	...	...	...	12	13	10
Trng	2	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	5	5	10
Trad IE	2	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	3	3	10
S & P	2	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	4	4	10
Ex. Du.	4	3	6	5	...	...	...	...	...	...	...	...	...	...	...	...	15	16	15

NOTE: The above data were extracted from ninety-three cases of IE responses for question number 30 of the Chief of IE's attchment.

TABLE 48

RANKING OF THE SOURCE OF IE WORK REQUIREMENTS

Source	1st Important Source		2nd Important Source		3rd Important Source		4th Important Source		5th Important Source		6th Important Source		7th Important Source		Total Points	Rank
BCE	(29)	203	(22)	132	(19)	95	(10)	40	(5)	15	(9)	18	(1)	1	504	2
Branch Chiefs	(7)	49	(14)	84	(16)	80	(18)	72	(28)	84	(7)	14	(2)	2	385	3
IE Self-Gen	(37)	259	(20)	120	(22)	110	(7)	28	(5)	15	(3)	6	(1)	1	539	1
MRC	(7)	49	(7)	42	(4)	20	(17)	68	(10)	30	(12)	24	(31)	31	264	6
Other BCE Per	(2)	14	(6)	36	(10)	50	(9)	36	(11)	33	(32)	64	(23)	23	256	7
Reports	(4)	28	(16)	96	(15)	65	(19)	76	(18)	54	(13)	26	(9)	9	354	4
Regs	(9)	63	(11)	66	(8)	40	(14)	56	(16)	48	(17)	34	(18)	18	325	5

NOTE: 1. The above frequency data were extracted from the DEI responses to question number 28 of the Chief of IE's attachment.

2. The figures in parentheses represent the frequencies for each source by the importance of that source. The frequency of the 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th important sources was multiplied by 7, 6, 5, 4, 3, 2, and 1 respectively for each of the identified sources. The product of the seven multiplications per source (line) were summed and the total figure was used to develop the resulting ranks.

Weaknesses/Limitations of IE

This list represents those weaknesses which received less than five responses:

1. Requirement for an IE Work Plan (BCE)
2. IE's scope limited to Civil Engineering Organization (BCE and DEI)
3. IE not involved in budget process (BCE)
4. There are too many centrally directed studies (BCE and DEP)
5. IE not responsible for Cost Accounting (DEE)
6. IE is constrained to Air Force policy which constrains innovation (DEE, DEM and DEP)
7. IE biases results of studies to meet the commander's desires (DEE and DEM)
8. Too many formal written reports required (DEI)
9. IE's unstable/changing role over last few years (DEI)
10. Limitations of BLIS (DEI)
11. Failure to utilize previous studies (DEI)
12. IE's conflicting role of Management Consultant and QC (DEI)
13. Lack of time-sharing computer capability (DEI)
14. IE work is not meaningful (DEI)
15. Inability to effect real savings (DEI)

16. Too much politics (DEI)

17. Lack of organizatinal goals (DEI)

18. IE used as a manpower pool (DEI)

19. IE is unresponsive (DEM and DEI)

20. IE expects other branches to collect data (DEM)

21. IE is not real-world oriented--they are unrealistic (DEM)

22. IE doesn't assist in implementing solutions (DEM)

23. IE is a problem respository for the IG (DEM)

24. IE has too many people for their job requirements (DEM)

25. IE lacks objectivity (DEP)

26. QC personnel are O&M workers who are not wanted in the shops (DEP)

27. IE's QC role has been reduced (DEP)

28. IE is not BCE management-team oriented (DEP)

29. Lack of a defined IE role (DEP)

30. IE should be staff oriented not line oriented (DEP)

KENDALL COEFFICIENT OF CONCORDANCE (W)
(A Measure of Association Among IE Functions' Rankings)

Categories	1	2	3	4	5	6	7	8	9	10	11	12	13	14
BCE	1	4	2	8	3	6	9.5	7	13	5	11	13	13	9.5
DEE	1	3	2	9	5	4	13.5	7	13.5	12	10	11	8	6
DEI	2.5	2.5	4	6	1	8	7	5	9.5	11	13	14	12	9.5
DEM	1	5	2	3	4	12	14	8	9	7	10.5	13	6	10.5
DEP	2	1	3	8	4	6	10	5	13	11	13	13	7	9
R_j	7.5	15.5	13	34	17	36	54	32	58	46	57.5	64	46	44.5

$$W = \frac{S}{\frac{1}{12}k^2(N^3-N)-k\Sigma T}$$

where k = Number of rankers = 5

N = number of categories = 14

$$\frac{\Sigma R_j}{N} = \frac{525.4}{14} = 37.5$$

$$S = \sum\left(R_j - \frac{\Sigma R_j}{N}\right)^2 = (7.5-37.5)^2+(15.5-37.5)^2+(13-37.5)^2+(34-37.5)^2+(17-37.5)^2+(36-37.5)^2$$
$$+(32-37.5)^2+(58-37.5)^2+(46-37.5)^2+(57.5-37.5)^2+(64-37.5)^2+(46-37.5)^2$$
$$+(44.5-37.5)^2 = 4,437.5$$

$$T = \frac{\Sigma(t^3-t)}{12}$$

$$T_{BCE} = \frac{(2^3-2)+(3^3-3)}{13} = \frac{6+24}{12} = 2.5$$

$$T_{DEI} = \frac{(2^3-2)+(2^3-2)}{12} = \frac{6+6}{12} = 1$$

$$T_{DEE} = \frac{2^3-2}{12} = \frac{6}{12} = .5$$

$$T_{DEM} = \frac{2^3-2}{12} = \frac{6}{12} = .5$$

$$T_{DEP} = \frac{(3^3-3)}{12} = \frac{24}{12} = 2$$

$$\Sigma T = 2.5 + .5 + 1 + .5 + 2 = 6.5$$

KENDALL COEFFICIENT OF CONCORDANCE (W)

$$W = \frac{S}{\frac{1}{12}k^2(N^3-N)-k\Sigma T} = \frac{4,437.5}{\frac{1}{12}5^2(14^3-14)-5(6.5)} = \frac{4,437.5}{\frac{25}{12}(2,730)-32.5} = \frac{4,437.5}{5,655} = .785$$

W is a measure of the association among the five rankings. A W of 0.785 shows a high degree of association among the rankings. The value of W can be tested to determine if it differs significantly from zero (22:229-238). The testing of W=0.785 is as follows:

H_0: The five rankings are unrelated

H_1: The five rankings are related

$$\chi_s^2 = k(N-1)W = 5(14-1)(.785) = 51.025$$

$$\chi_c^2 = \chi_{\alpha,df=N-1}^2 = \chi_{.05,13}^2 = 22.36$$

If $\chi_s^2 > \chi_c^2$ then reject H_0.

In this case, $\chi_s^2 = 51.025$ is greater than $\chi_c^2 = 22.36$. Therefore, H_0 can be rejected and it is concluded that the five rankings are related which is evidenced by the high degree of association (W=0.795).

ANALYSIS OF THE BCE AND IE RANKINGS BY THE SPEARMAN RANK CORRELATION COEFFICIENT (r_s)

IE Function	BCE Ranking	IE Ranking	d	d^2
Mgt Consultant	1	2.5	-1.5	2.25
QC	4	2.5	+1.5	2.25
IE Studies	2	4	-2	4
IE Analysis	8	6	+2	4
BEAMS	3	1	+2	4
Manpower	6	8	-2	4
Follow-Up Work	9.5	7	+2.5	6.25
Problem Solving	7	5	+2	4
Customer Relations	13	9.5	+3.5	12.25
MBO	5	11	-6	36
Training & Testing	11	13	-2	4
Trad IE	13	14	-1	1
Sys & Proc	13	12	+1	1
Extra Duties	9.5	9.5	0	0
				85

$$r_s = \frac{\Sigma x^2 + \Sigma y^2 - \Sigma d^2}{2\sqrt{\Sigma_x{}^2 \Sigma_y{}^2}}$$

Where: $\Sigma x^2 = \frac{N^3 - N}{12} - \Sigma T_x$

$$\Sigma T_x = \frac{t^3 - t}{12}$$

$$\therefore \Sigma x^2 = \frac{14^3-14}{12} - \left(\frac{2^3-2}{12} + \frac{3^3-3}{12}\right) = 225$$

$$\&\Sigma y^2 = \frac{14^3-14}{12} - \left(\frac{2^3-2}{12} + \frac{2^3-2}{12}\right) = 226.5$$

$$r_s = \frac{225+226.5-85}{2\sqrt{(225)(226.5)}} = .8117$$

r_s is a measure of association between the two rankings. An r_s=0.8117 shows a high degree association between the BCE and IE rankings. The value of r_s can be tested to determine if it differs significantly from zero (:202-213). The testing of r_s = 0.8177 is as follows:

H_0: $\rho_{xy}=0$ (There is no association between the rankings)

H_1: $\rho_{xy}\neq 0$ (There is a significant association between the rankings)

$$t_s = \frac{r_s\sqrt{n-2}}{\sqrt{1-r_s^2}} = \frac{.8117\sqrt{14-2}}{\sqrt{1-(.8117)^2}} = \frac{2.8118}{.5841} = 4.8141$$

$$t_c = t_{\alpha/2,df=n-2} = t_{.025,12} = 2.179$$

If $t_s > t_0$ then reject H_0.

In this case, $t_s = 4.8141$ is greater than $t_c = 2.179$. Therefore, H_0 can be rejected and it is concluded that r_s differs significantly from zero and there is a high degree of association between BCE and IE rankings.

Summary of CESMET Findings

The following data were extracted from thirty-two CESMET reports. The reports, which were provided by the Air Force CESMET, provide input concerning the current IE role at base level.

1. Summary of CESMET Appraisals of IE Branches: CESMET is not an inspection activity which rates an organization in the manner the IG does, i.e., excellent, satisfactory, marginal, etc. However, in its final report, CESMET does provide an overall appraisal of each activity assisted. The following listing is a summary of the overall appraisals of the IE branches in the thirty-two reports analyzed. The appraisals have been divided into two categories--favorable IE appraisals and unfavorable IE appraisals.

A. Favorable IE Appraisals:

Appraisal	Number of Bases Receiving Appraisals
Excellent	1
Excellent program as far as it goes	1
Outstanding Operation	1
As good as we have seen	1
Strong program	1
Very good program/operation	3
Pretty good program/operation	3
Good program/operation	5
About Average	1
Fair but improving	1
Total	18

B. Unfavorable IE Appraisals

Appraisal	Number of Bases Receiving Appraisals
Ineffective	2
A very weak operation	2
Lack of support is the problem	1
Needs emphasis and support from top management	1
Needs support	1
Poor	1
Poor manning hurts effort	1
Additional duties hurting effectiveness	1
Primarily a QC effort	1
A lot of work to do	1
Needs improvement	1
Fair at best	1
Total	14

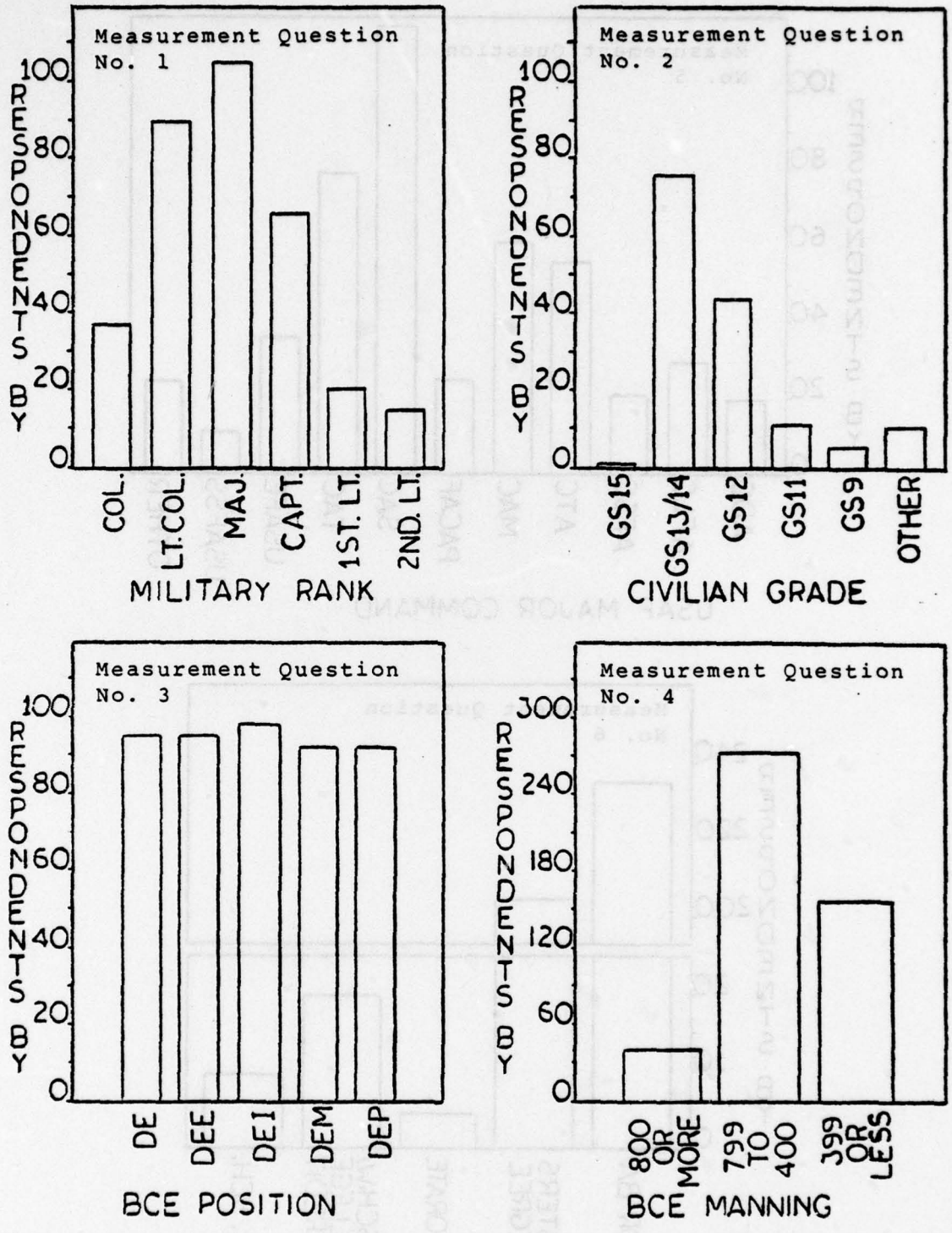
2. Summary of IE Strengths and Weaknesses documented by CESMET: CESMET documents the strengths and problems of the IE branch in each of their final reports. The following is a listing of the strengths and weaknesses identified in thirty-two reports analyzed:

A. Strengths

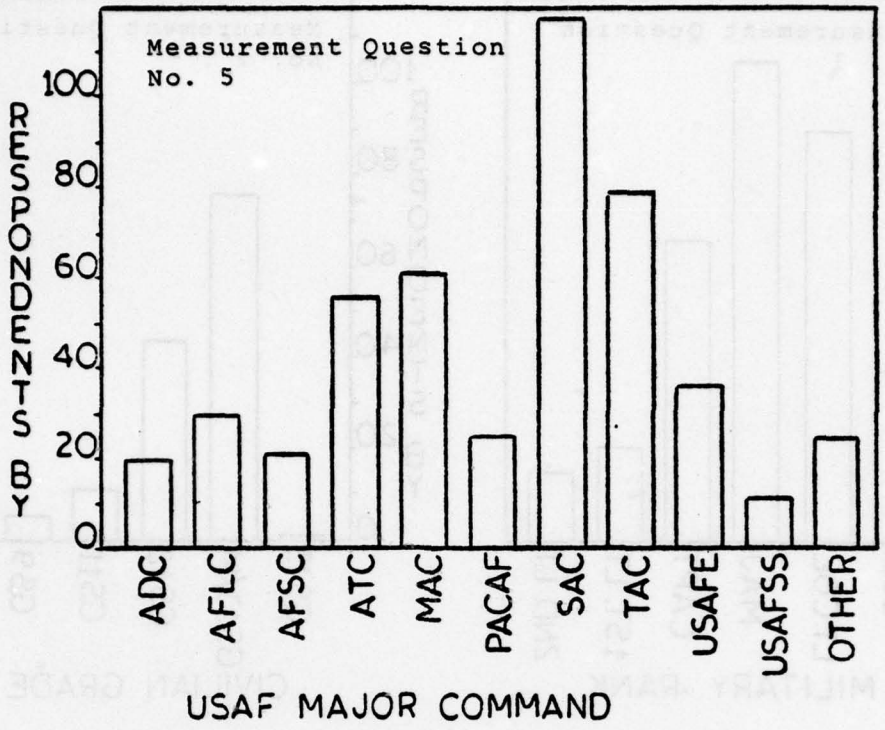
	Number of Bases Recognized
Strong IE studies program aimed at "money makers"	10
Good/Excellent Customer Relations Program	11
Effective QC/Activity Inspection Program	12

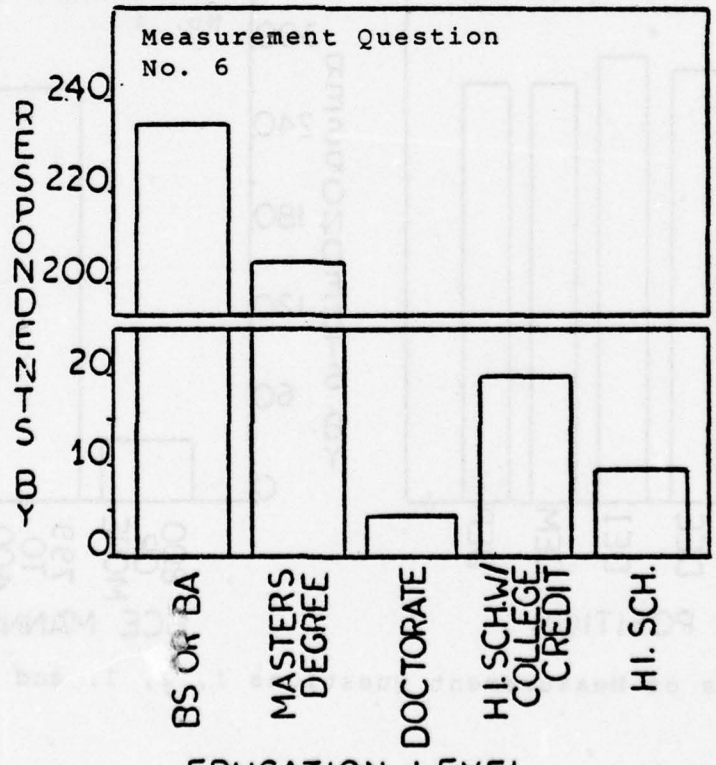
B. Weaknesses

	Number of Bases Recognized
Poor Manning Posture/Insufficient Manning	10
Too Many Additional Duties	5
Ineffective IE Studies Program	11
Ineffective Customer Relations Program	18
Ineffective QC/Activity Inspection Program	12
Lack of Support by BCE and Staff	4

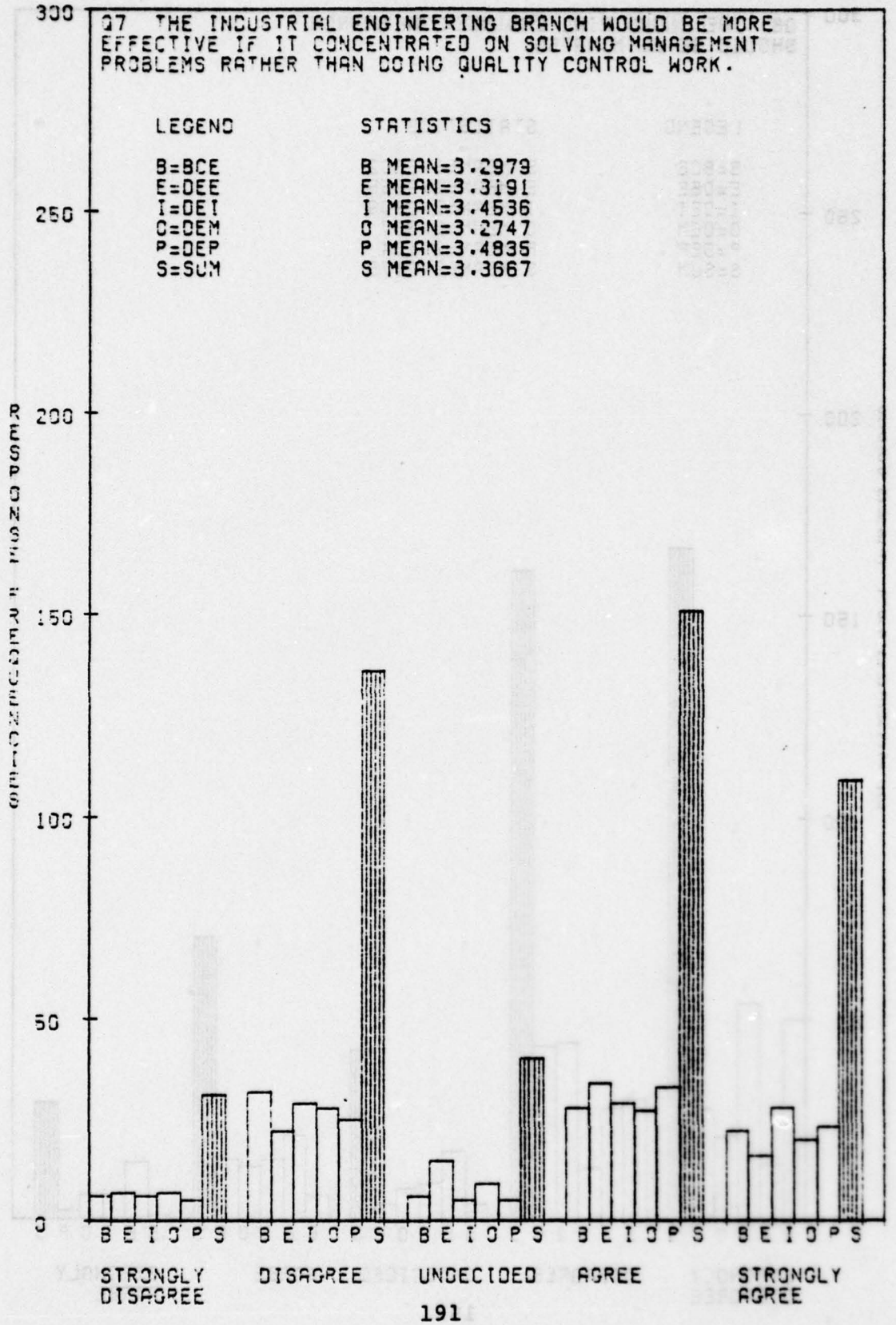


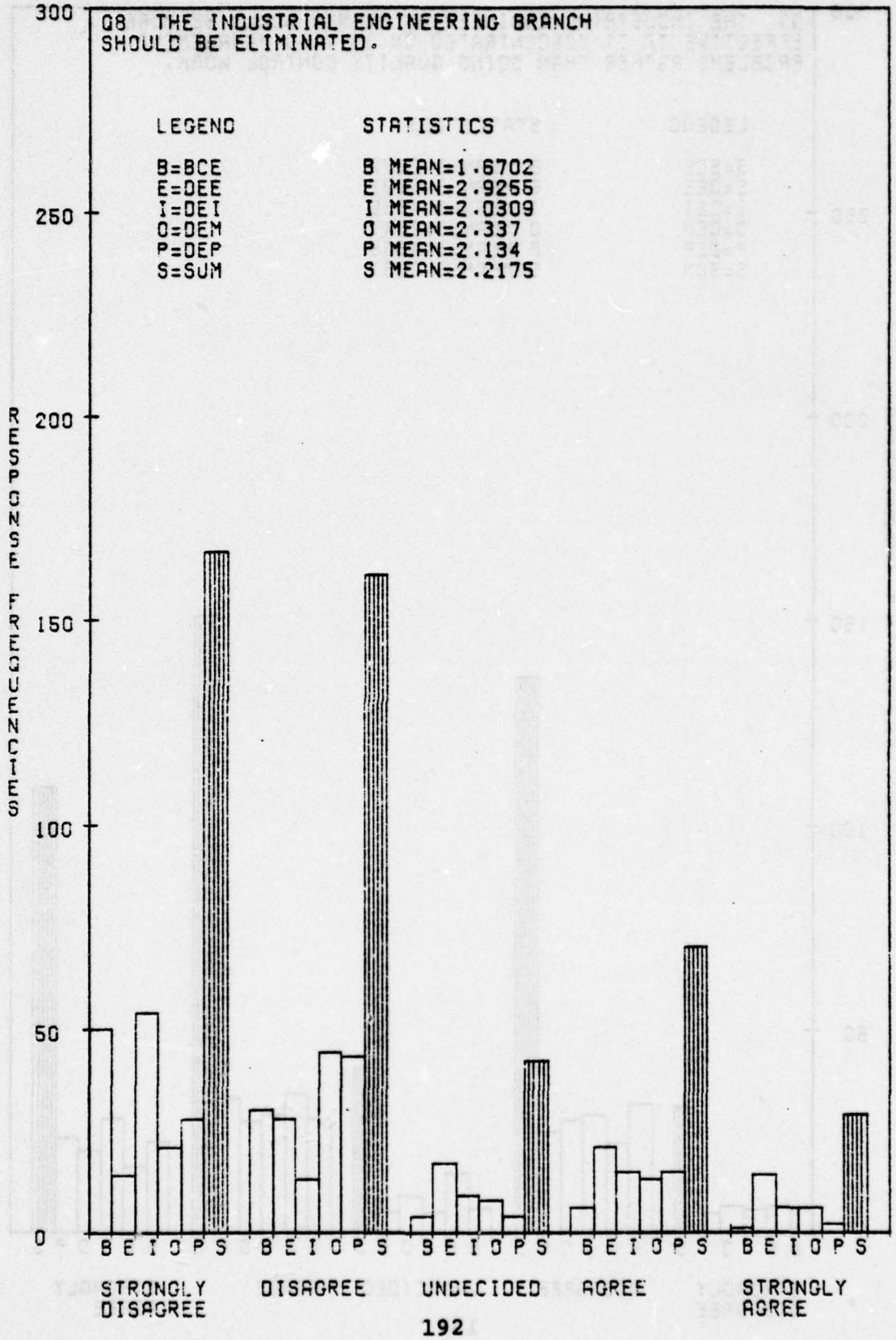
Histograms of Measurement Questions 1, 2, 3, and 4.

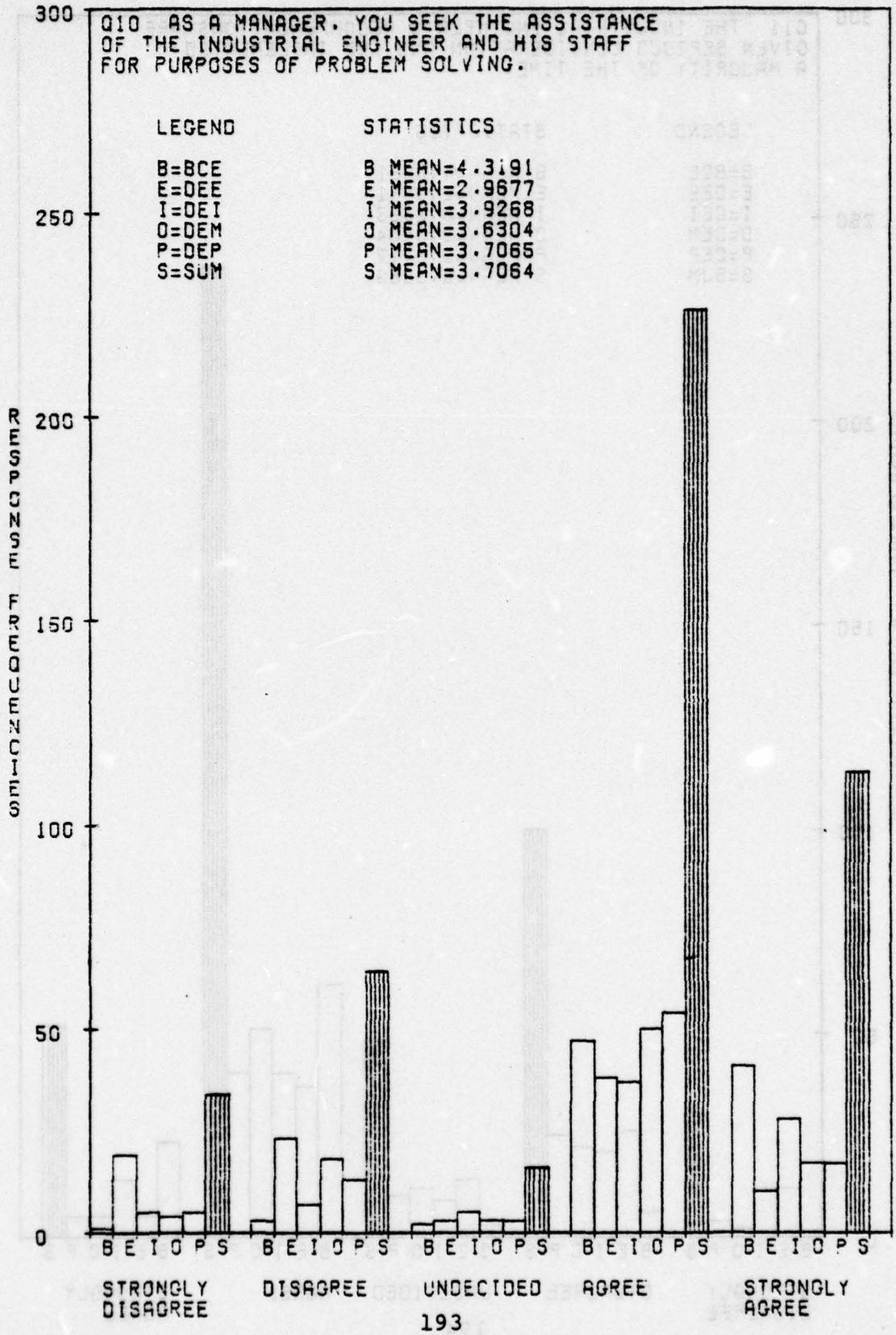


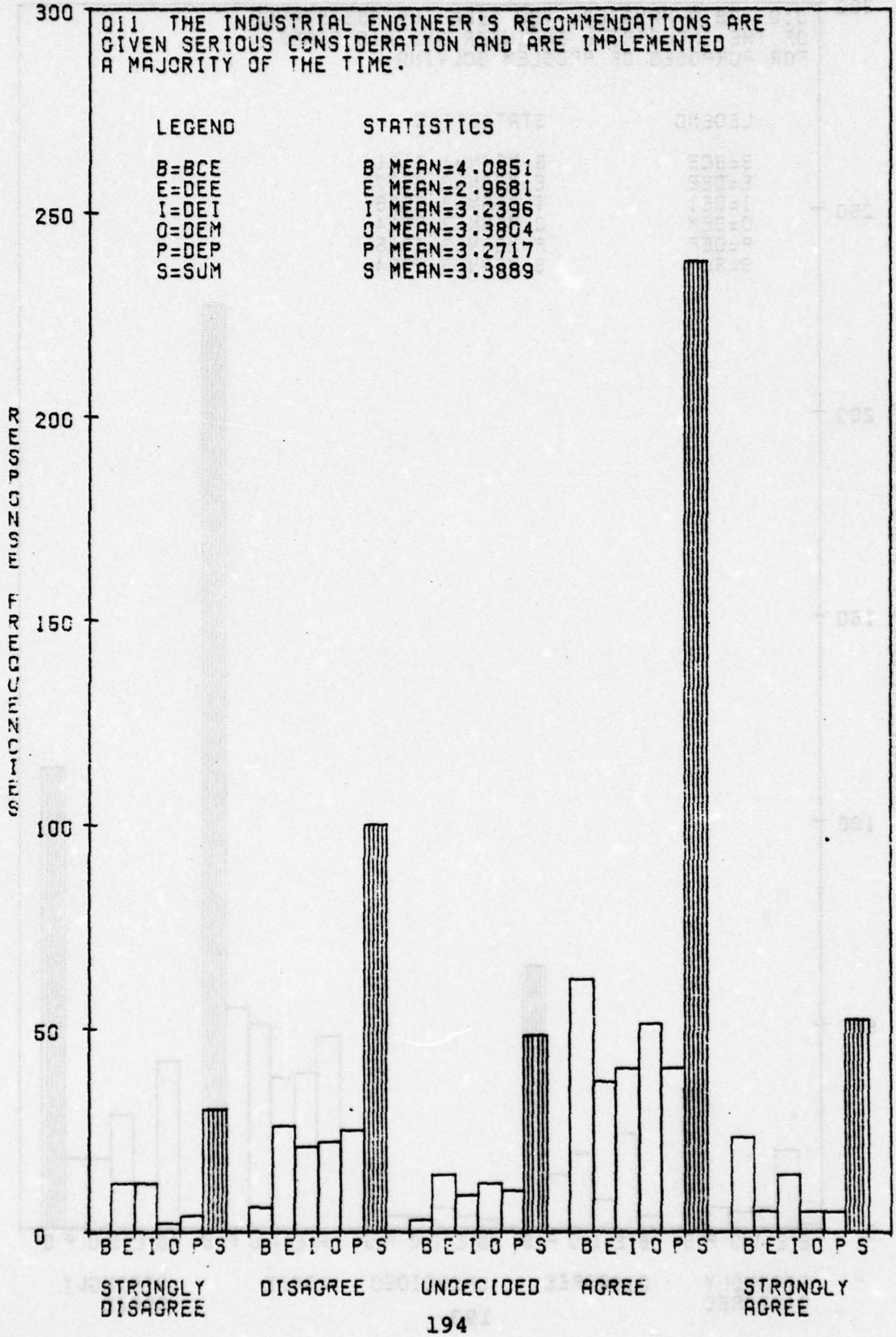


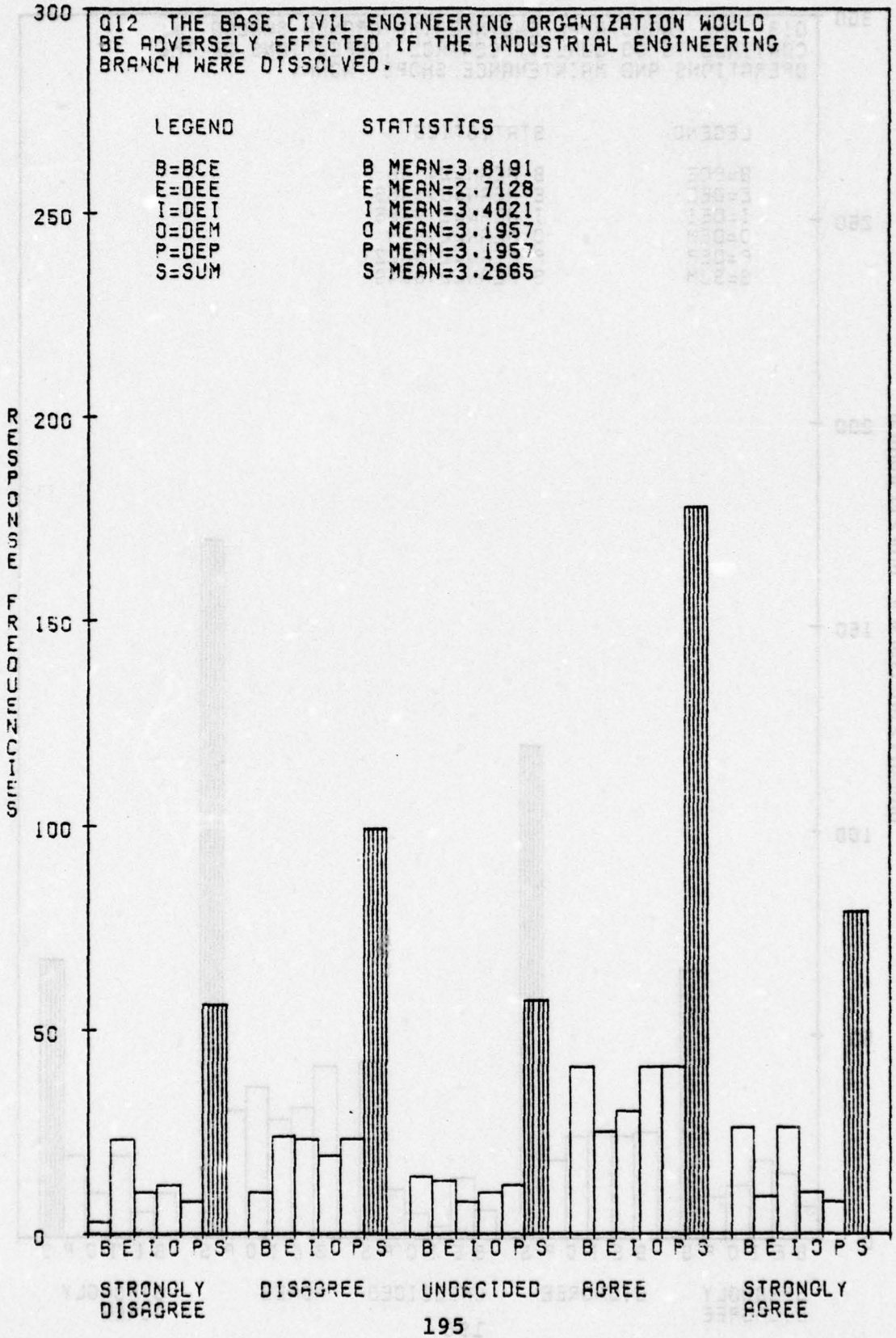
Histograms of Measurement Questions 5 and 6.

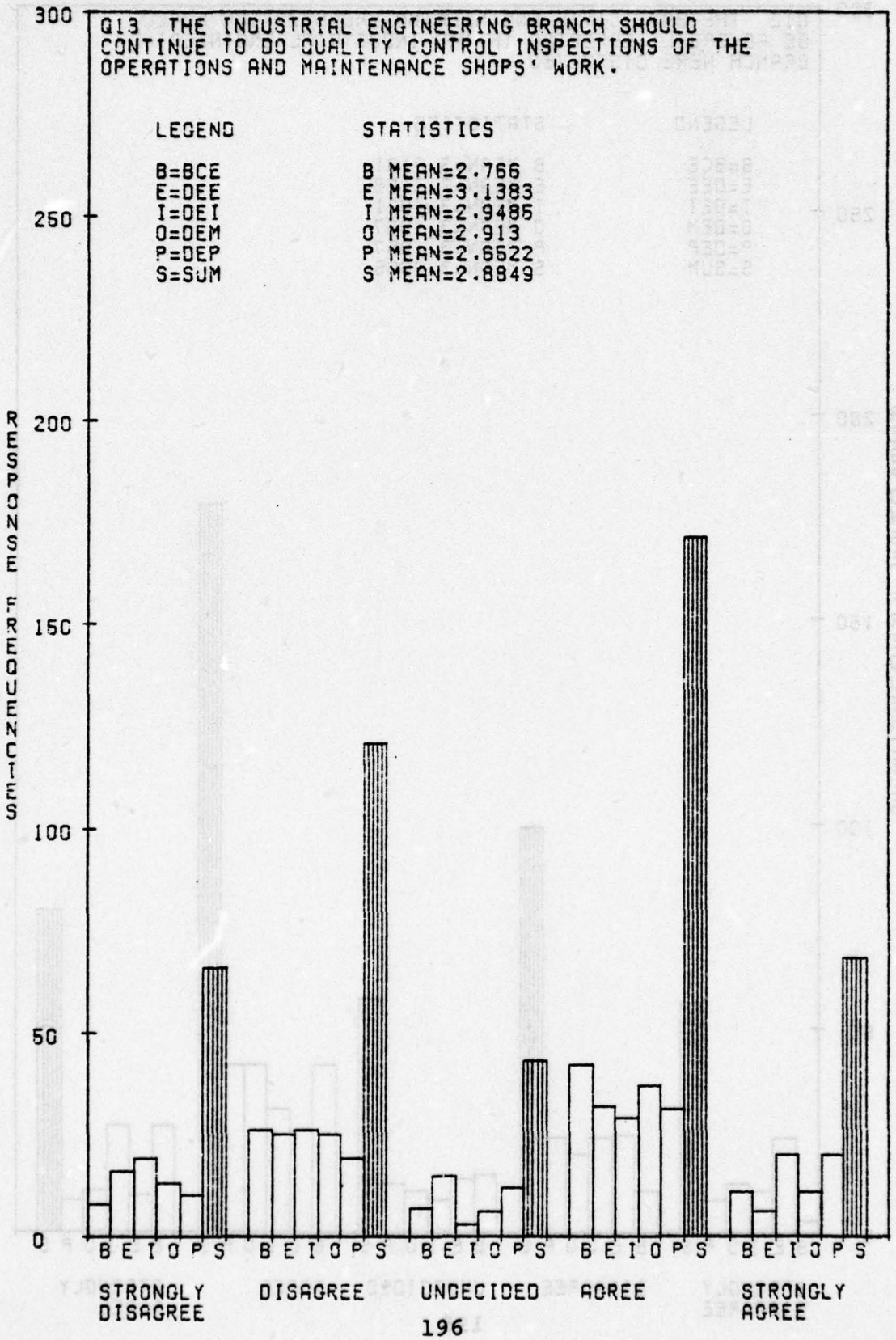

Q7 THE INDUSTRIAL ENGINEERING BRANCH WOULD BE MORE EFFECTIVE IF IT CONCENTRATED ON SOLVING MANAGEMENT PROBLEMS RATHER THAN DOING QUALITY CONTROL WORK.
LEGEND
B=BCE
E=DEE
I=DEI
C=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.2979
E MEAN=3.3191
I MEAN=3.4536
C MEAN=3.2747
P MEAN=3.4835
S MEAN=3.3667
300
250
200
150
100
50
0
B E I C P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

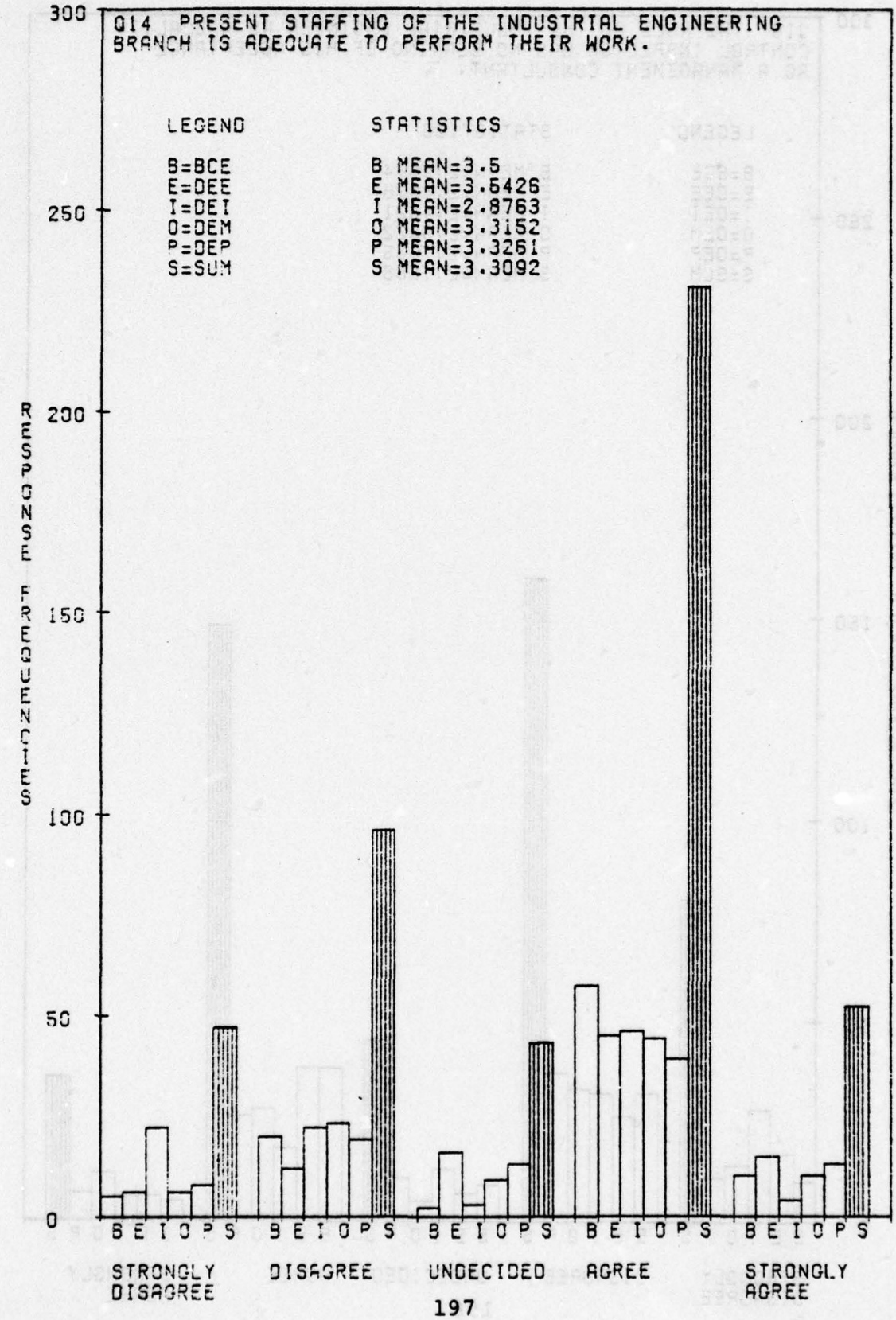

Q8 THE INDUSTRIAL ENGINEERING BRANCH SHOULD BE ELIMINATED.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=1.6702
E MEAN=2.9255
I MEAN=2.0309
O MEAN=2.337
P MEAN=2.134
S MEAN=2.2175
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

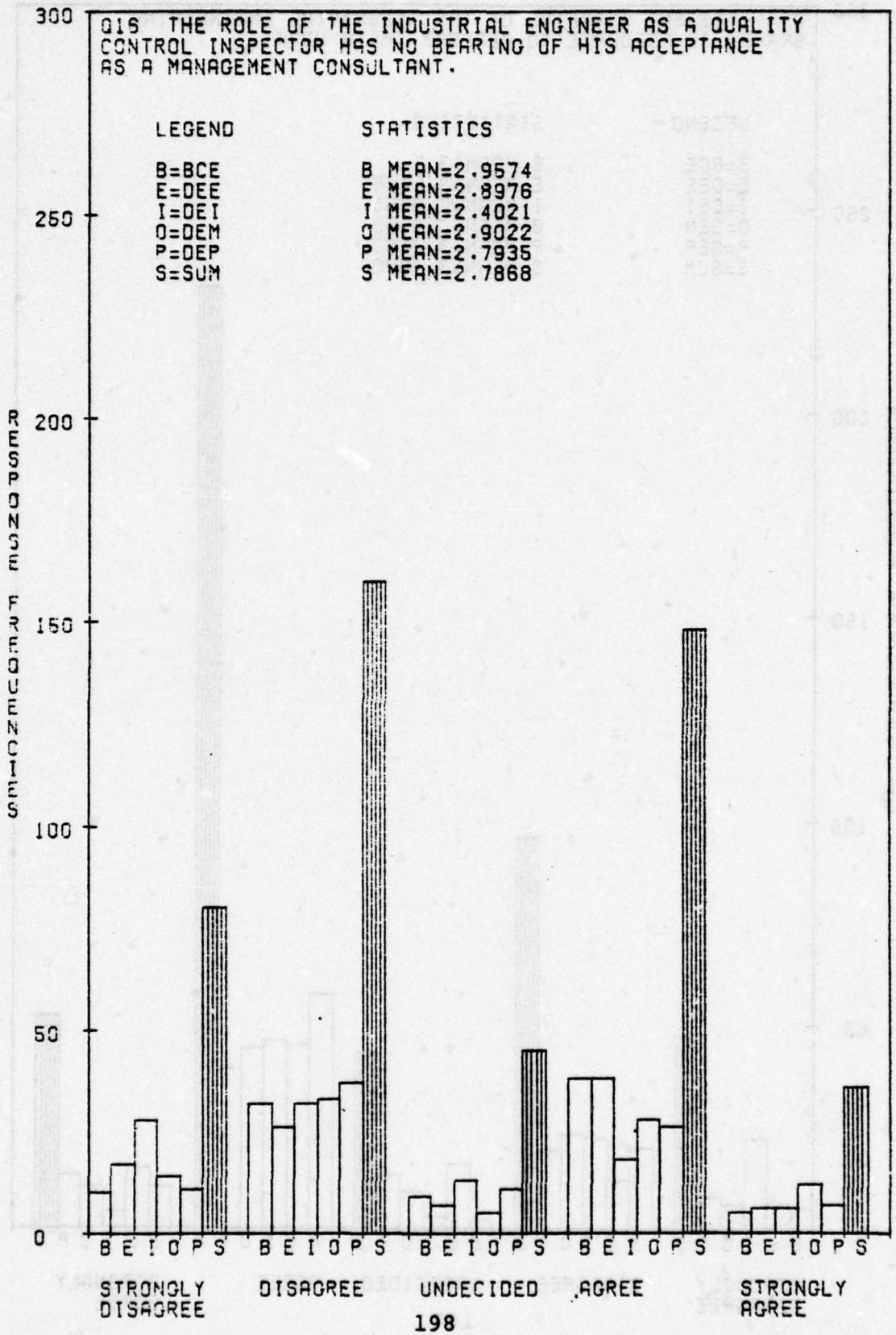

Q10 AS A MANAGER. YOU SEEK THE ASSISTANCE OF THE INDUSTRIAL ENGINEER AND HIS STAFF FOR PURPOSES OF PROBLEM SOLVING.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=4.3191
E MEAN=2.9677
I MEAN=3.9268
O MEAN=3.6304
P MEAN=3.7065
S MEAN=3.7064
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

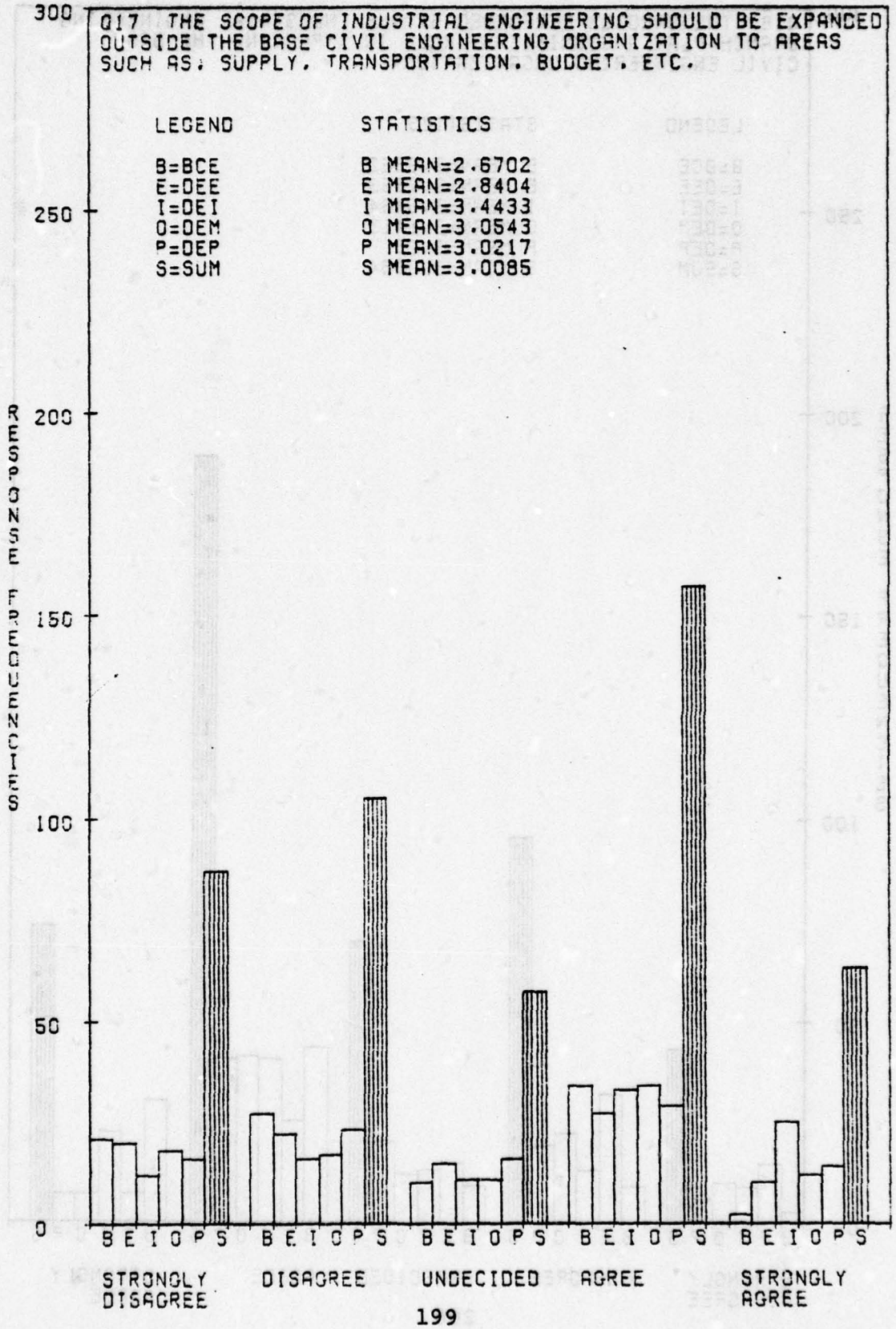

Q11 THE INDUSTRIAL ENGINEER'S RECOMMENDATIONS ARE GIVEN SERIOUS CONSIDERATION AND ARE IMPLEMENTED A MAJORITY OF THE TIME.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=4.0851
E MEAN=2.9681
I MEAN=3.2396
O MEAN=3.3804
P MEAN=3.2717
S MEAN=3.3889
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

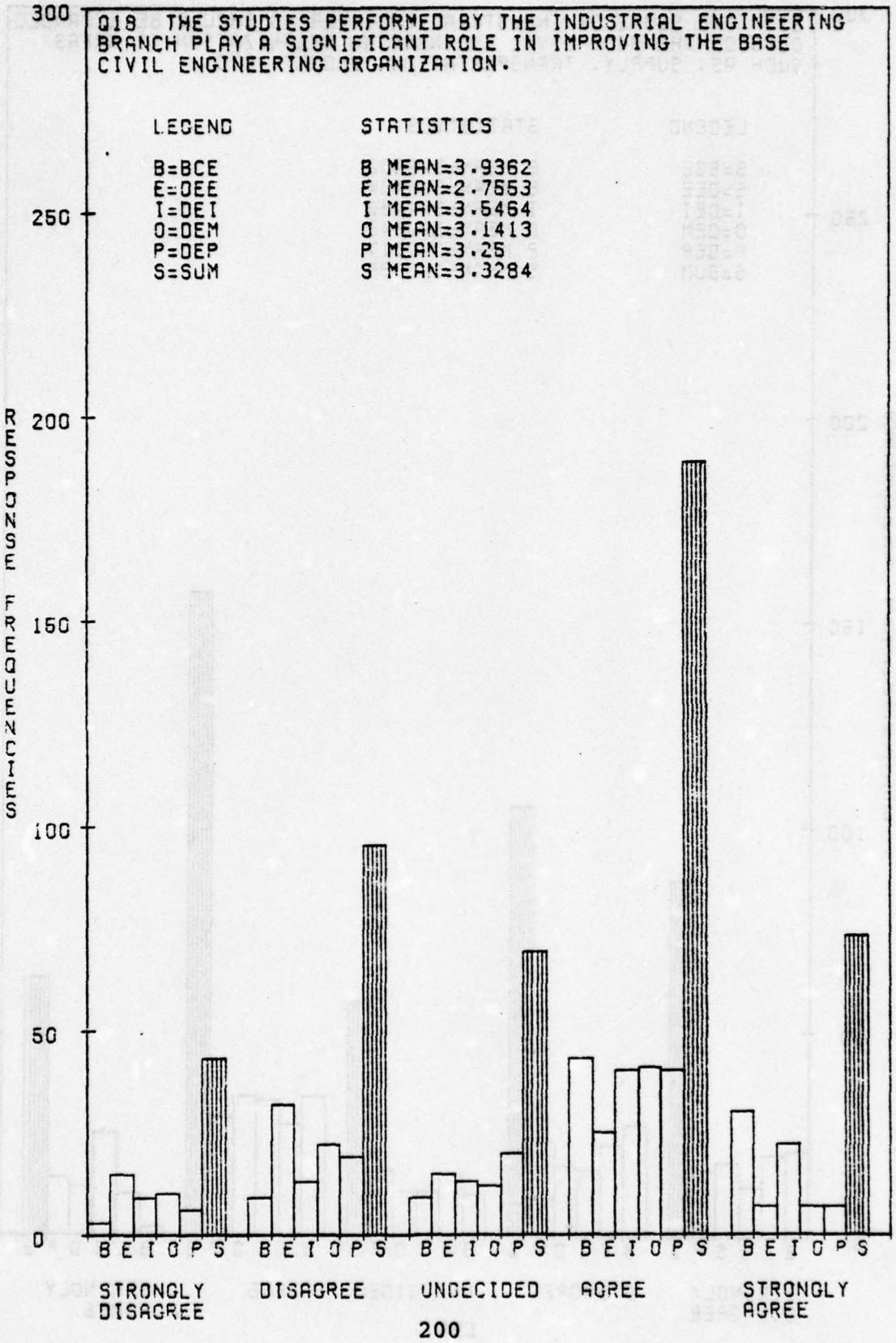

Q12 THE BASE CIVIL ENGINEERING ORGANIZATION WOULD BE ADVERSELY EFFECTED IF THE INDUSTRIAL ENGINEERING BRANCH WERE DISSOLVED.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.8191
E MEAN=2.7128
I MEAN=3.4021
O MEAN=3.1957
P MEAN=3.1957
S MEAN=3.2665
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S B E I O P S B E I O P S B E I O P S B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

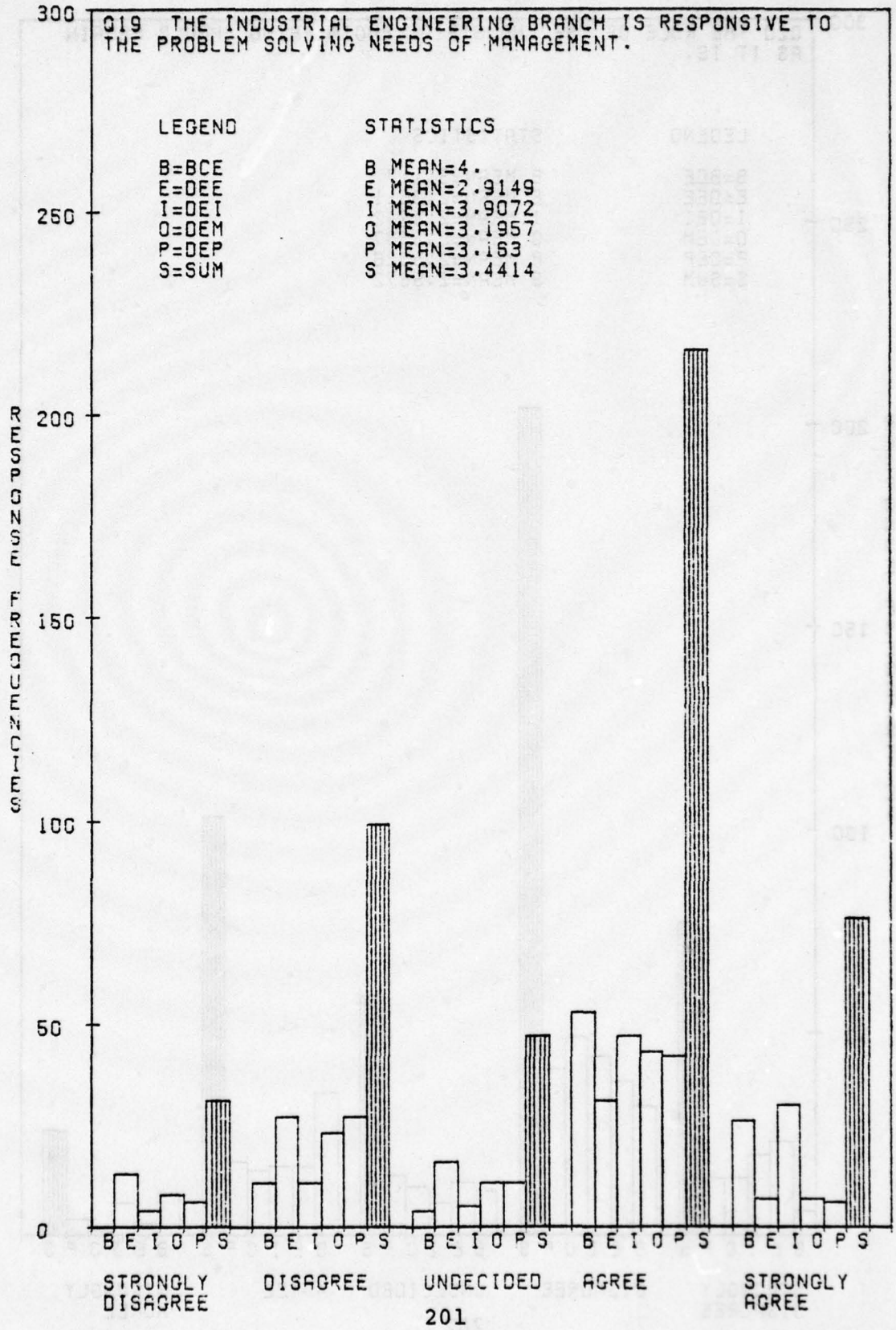

Q13 THE INDUSTRIAL ENGINEERING BRANCH SHOULD CONTINUE TO DO QUALITY CONTROL INSPECTIONS OF THE OPERATIONS AND MAINTENANCE SHOPS' WORK.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=2.766
E MEAN=3.1383
I MEAN=2.9485
O MEAN=2.913
P MEAN=2.6522
S MEAN=2.8849
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

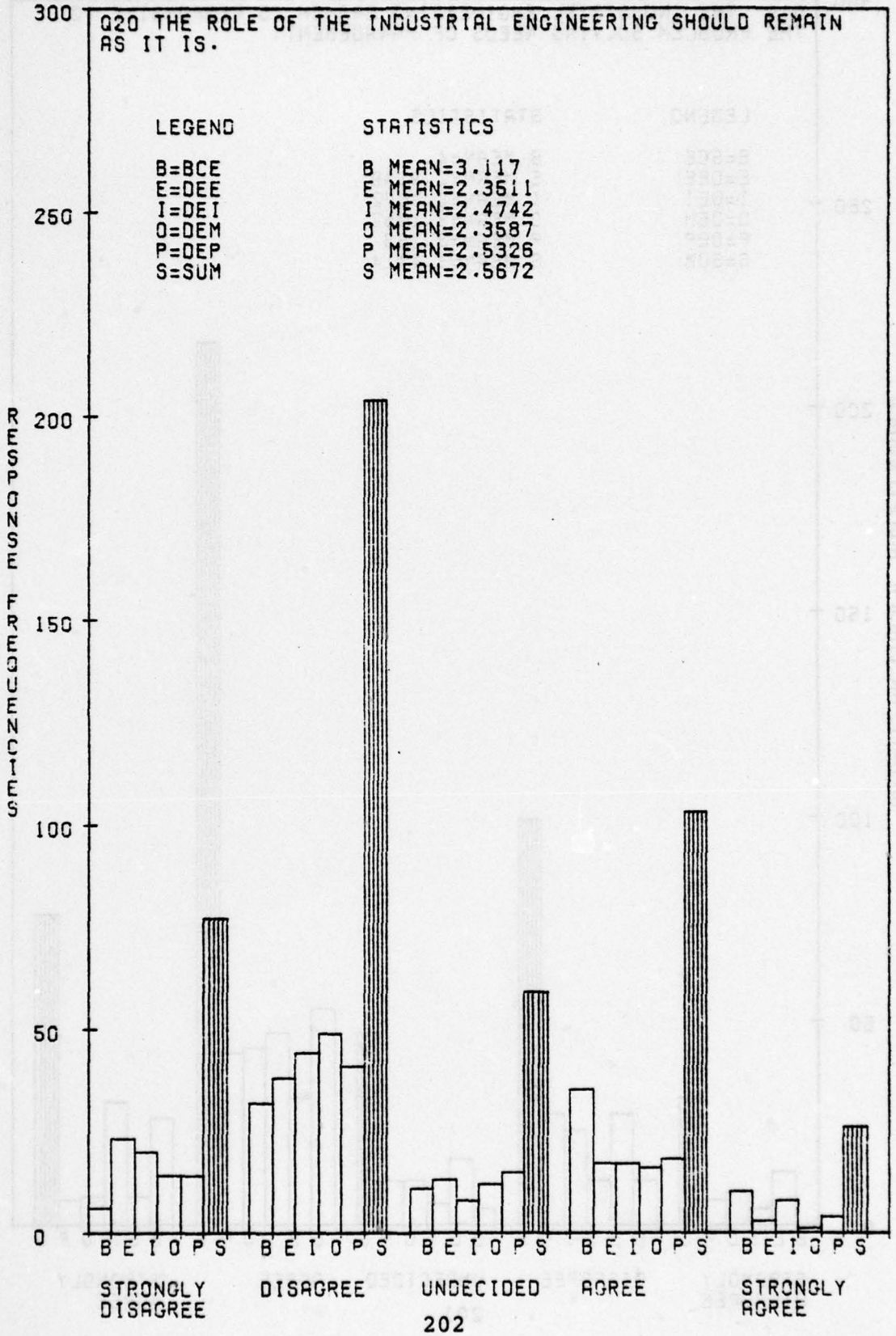

Q14 PRESENT STAFFING OF THE INDUSTRIAL ENGINEERING BRANCH IS ADEQUATE TO PERFORM THEIR WORK.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.5
E MEAN=3.6426
I MEAN=2.8763
O MEAN=3.3152
P MEAN=3.3261
S MEAN=3.3092
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

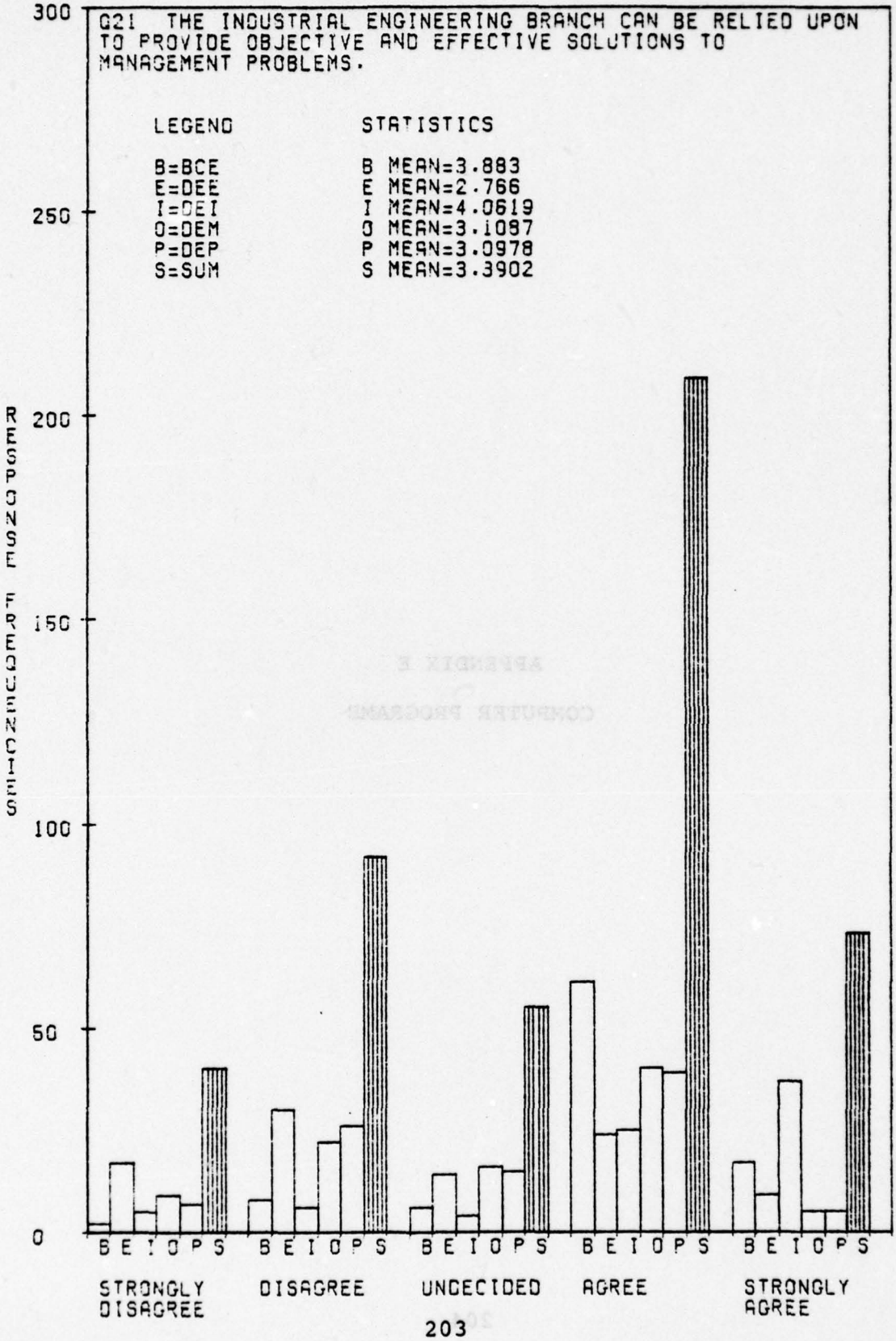

Q15 THE ROLE OF THE INDUSTRIAL ENGINEER AS A QUALITY CONTROL INSPECTOR HAS NO BEARING OF HIS ACCEPTANCE AS A MANAGEMENT CONSULTANT.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=2.9574
E MEAN=2.8976
I MEAN=2.4021
O MEAN=2.9022
P MEAN=2.7935
S MEAN=2.7868
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE


Q17 THE SCOPE OF INDUSTRIAL ENGINEERING SHOULD BE EXPANDED OUTSIDE THE BASE CIVIL ENGINEERING ORGANIZATION TO AREAS SUCH AS: SUPPLY, TRANSPORTATION, BUDGET, ETC.
LEGEND
B=BCE
E=OEE
I=OEI
O=OEM
P=OEP
S=SUM
STATISTICS
B MEAN=2.6702
E MEAN=2.8404
I MEAN=3.4433
O MEAN=3.0543
P MEAN=3.0217
S MEAN=3.0085
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE


Q18 THE STUDIES PERFORMED BY THE INDUSTRIAL ENGINEERING BRANCH PLAY A SIGNIFICANT ROLE IN IMPROVING THE BASE CIVIL ENGINEERING ORGANIZATION.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.9362
E MEAN=2.7653
I MEAN=3.5464
O MEAN=3.1413
P MEAN=3.25
S MEAN=3.3284
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE
200


Q19 THE INDUSTRIAL ENGINEERING BRANCH IS RESPONSIVE TO THE PROBLEM SOLVING NEEDS OF MANAGEMENT.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=4.
E MEAN=2.9149
I MEAN=3.9072
O MEAN=3.1957
P MEAN=3.163
S MEAN=3.4414
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE


Q20 THE ROLE OF THE INDUSTRIAL ENGINEERING SHOULD REMAIN AS IT IS.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.117
E MEAN=2.3611
I MEAN=2.4742
O MEAN=2.3587
P MEAN=2.5326
S MEAN=2.5672
RESPONSE FREQUENCIES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE


Q21 THE INDUSTRIAL ENGINEERING BRANCH CAN BE RELIED UPON TO PROVIDE OBJECTIVE AND EFFECTIVE SOLUTIONS TO MANAGEMENT PROBLEMS.
LEGEND
B=BCE
E=DEE
I=DEI
O=DEM
P=DEP
S=SUM
STATISTICS
B MEAN=3.883
E MEAN=2.766
I MEAN=4.0619
O MEAN=3.1087
P MEAN=3.0978
S MEAN=3.3902
NUMBER OF RESPONSES
300
250
200
150
100
50
0
B E I O P S
STRONGLY DISAGREE
DISAGREE
UNDECIDED
AGREE
STRONGLY AGREE

APPENDIX E

COMPUTER PROGRAMS

COMPUTER PROGRAM FOR ANALYSIS OF VARIANCE OF INVESTIGATIVE QUESTIONS AND MEASUREMENT QUESTIONS

```
0010##S,R(SL) :,8,16::,16
0020$:IDENT:WP1191,AFIT/SLG M J FARINEAU 77A
0030$:SELECT:SPSS/SPSS
0040RUN NAME: CROSSTABS!
0050VARIABLE LIST: Q1 TO Q62
0100VAR LABELS:Q1, MILITARY GRADE/
0110:Q2, CIVILIAN GRADE/
0120:Q3, CE POSITION/
0130:Q4, MILITARY STRENGTH/
0140:Q5, MAJCOM/
0150:Q6, EDUCATION LEVEL/
0160:Q7, SOLV MGMT PROB W QC/
0170:Q8, SHOULD IE B ELIMINATED/
0180:Q9, WHERE SHLD IE B LOCATED/
0190:Q10, YOU SEEK THE IE FOR PROB SOLVING/
0200:Q11, IE RECOMMENDATIONS ARE GVN CONSIDERATION & IMPLEMTD/
0210:Q12, CE WOULD BE ADVERSELY AFFECTED IF IE ELIMINTED/
0220:Q13, CONTINUE QC FOR THE O&M BRANCH/
0230:Q14, THE IE STAFF IS ADEQUATE FOR WORK REQ/
0240:Q15, ADD WHICH NEW SECTIONS TO IE/
0250:Q16, ROLE QC HAS TO BEARG ON IE AS MGMT CONS/
0260:Q17, ROL OF IE SHLD BE EXPNDED OUTSIDE CE/
0270:Q18, IE STUDIES IMPROVE BCE ORG/
0280:Q19, IE IS RESPONSIVE TO PROB SLVG NEEDS/
0290:Q20, IE ROLE SHLD REMAIN STHE SAME/
0300:Q21, IE PROVIDE OBJ EFF SOLUTIONS TO MGMTS PROBLEMS/
0310:Q22, IES GREATEST CONTRIBUTION IS IN QC/
0320:Q23, IE SHD BE ORIENTED TO EFF OF O&M/
0330:Q24, BCE FIRST MOST INPT IE FUNCTION/
0340:Q25, BCE SECOND MOST IMPT IE FUNCTIION/
0350:Q26, BCE THIRD MOST IMPT IE FUNCTION/
0360:Q27, BCE FORTH MOST IMPT IE FUNCTION/
0370:Q28, BCE FIFTH MOST IMPT IE FUNCTION/
```

```
0380;Q29, DEE-IES GREATEST COMTRIBUTION IN QC/
0390;Q30, DEE-IE SHD BE ORINETED TO EFF OFF O&M/
0400;Q31, IE STDS IN DEE HAVE IMPRVED EFF/
0410;Q32, DEE FIRST MOST IMPT IE FUNCTION/
0420;Q33, DEE SECOND MOST IMPT IE FUNCDTION/
0430;Q34, DEE THIRD MOST IMPT IE FUNCTION/
0440;Q35, BASE LEVEL IE EXPERIENCE/
0450;Q36, IE DEGREE LEVEL/
0460;Q37, NO. OF PEOPLE AUTHORIZED TO IE BRANCH/
0470;Q38, NO. OF PEOPLE ASSIGNED TO IE BRANCH/
0480;Q39, RECIND OF AFM 85-38 IMPROVED THE RESPONSE OF IE/
0490;Q40, IE CAN BE EFFECTIVE WITHOUT A GOV DIRECT
0500;Q41, BCE, WORK GENERATED BY/
0510;Q42, BRANCH CHIEFS, WORK GENERATED BY/
0520;Q43, IE-WORK SELF-GENERATED/
0530;Q44, MANAGEMENT REVIEW COMMITTEE, WORK GENERATED BY/
0540;Q45, OTHER BCE PERSONNEL, WORK GENERATED BY/
0550;Q46, REPORTS FROM CMD, AUDITOR,IG, ETC-WORK GEND BY/
0560;Q47, REQUIRED BY REGS AND MANUALS, WORK GEND BY/
0570;Q48, IE FIRST MOST IMP IE FU CTION/
0580;Q49, IE-SECOND MOST IMP IE FUNCTION/
0590;Q50, IE-THIRD MOST IMPT IE FUNCTION/
0600;Q51, IE-FORTH MOST IMPT IE FUNSTION/
0610;Q52, IE-FIFTH MOST IMPT IE FUNCTION/
0620;Q53, DEM-IES GREATEST COMTRIBUTION IS IN QC/
0630;Q54, DEM-IE SHD BE ORIENTED TO EFF OD O&M/
0640;Q55, IE STUDIES IN DEM HAVE IMPROVED EFF/
0650;Q56, DEM-FIRST MOST IMPT IE FUNCTION/
0660;Q57, DEM-SECOMD MOST IMPT IE FUNCTION/
0670;Q58, DEM-THIRD MOST IMPT IE FUNCTION/
0680;Q59, DEP-IES GREATEST CONTRIBUTION IS IN QC/
0690;Q60, DEP-IE SHD BE ORIENTED TO EFF OF O&M/
0700;Q61, IE STUDIES IN DEP HAVE IMPROVED EFF/
```

```
0710;Q62, DEP-FIRST MOST IMPT IE FUNCTION/
0790INPUT FORMAT;FIXED(62A1)
0800INPUT MEDIUM;CARD
0810N OF CASES;472
0890RECODE;Q1 TO Q62(' '=0)
0900RECODE; Q1 TO Q14, Q16 TO Q62('A'=1)('B'=2)('C'=3)
0905;('D'=4)('E'=5)('F'=6)('G'=7)('H'=8)('I'=9)('J'=10)('K'=11)
0910;('L'=12)('M'=13)('N'=14)('O'=15)
0930VALUE LABELS;Q7,Q8,Q10 TO Q14,Q16 TO Q23,Q29,Q30,Q31,Q39,Q40,
0940;Q53 TO Q55,Q59 TO Q61 (1)STRONGLY DISAGRE (2)DISAGRE (3)UNDEC
0950;(4)AGREE (5)STRONGLY AGREE/ Q24 TO Q28, Q32 TO Q34,
0960;Q48 TO Q52,Q56 TO Q58,Q62 (1)MANAGEMENT CONSULTANT
0970;(2)QC AND ACTIVITY EVALUATIONS (3)IE STUDIES (4)IE ANALYSIS
0980;(5)BEAMS MONITOR (6)MANPOWER STUDIES (7)IG FOLLOWUP,CESMET,ETC
0990;(8)PROBLEM SOLVING (9)CUSTOMER RELATIONS-1255'S (10)MBO
1000;(11)TRAINING AND TESTING (12)TRADITIONAL IE WORK
1010;(13)SYSTEMS AND PROCEDURES IMPLEMENTATION (14)EXTRA DUTIES/
1020;Q1 (1)COLONEL (2)LT COLONEL (3)MAJOR (4)CAPTAIN (5)1ST LIEUTENANT
1030;(6)2ND LIEUTENANT/ Q2 (1)GS15 (2)GS13 OR 14 (3)GS12 (4)GS11
1040;(5)GS9) (6)OTHER/ Q3 (1)BASE CIVIL ENGINEER (2)DEE (3)DEI
1050;(4)DEM (5)DEP/Q4 (1)8000R MORE (2)<800 BUT >400 (3)400 OR LESS/
1060;Q5 (1)ADC (2)AFLC (3)AFSC (4)ATC (5)MAC (6)PACAF (7)SAC (8)TAC
1070;(9)USAFE (10)USAFSS (11)OTHER/ Q6 (1)BS OR BA (2)MASTERS DEGREE
1080;(3)DOCTORATE (4)HIGH SCHOOL PLUS COLLEGE CREDIT (5)JUST HIGH
1090;SCHOOL/ Q35 (1)LESS THAN ONE YEAR (2)GTR THN 1 LESS THN 2
1100;(3)GTR THN 2 LESS THN 3 (4)GTR THN 3 LESS THN 4 (5)GTR THN 4/
1110;Q36 (1)BS (2)MASTERS DEGREE (3)DOCTORATE (4)HAVE A
1120;DEGREE BUT NOT AN IE DEGREE (5)NO DEGREE/Q37 (1)1 TO 3 ASSINED
1130;(2)4 TO 6 ASSIGNED (3)7 TO 9 ASSIGNED (4)10 TO 12 ASSIGNED
1140;(5)GTR THN 12 ASSIGNED/Q38 (1)1 TO 3 AUTH (2)4 TO 6 AUTH
1150;(3)7 TO 9 AUTH (4)10 TO 12 AUTH (5)GTR THN 12 AUTH/
1155;Q41 TO Q47 (1)BASE
1160;CIVIL ENGINEER (2)BRANCH CHIEFS (3)IE SELF GENERATED (4)MGMT
```

```
1170;REVIRW COMMITTEE (5)OTHER BCE PERSONNEL (6)REPORTS FROMCMD, IG
1180;AUDITOR (7)REQUIRED BY REGS. MANUALS, ETC/
1200;Q9 (1)NO COMMENT (2)RECOMMEND NO CHANGE (3)MAJCOM
1210;(4)AFIT CIVIL ENGINEERING SCHOOL (5)CIVIL ENGINEERING CENTER/
1212MISSING VALUES;ALL(Ø)
1214COMPUTE;IQU4=(Q13+Q14+Q16+Q20)/4
1216ASSIGN MISSING;IQU4(Ø)
1220ONEWAY;IQU4 BY Q3(1,5)/
1225;RANGES = SCHEFFE(.Ø5)/
1240STATISTICS;ALL
1250READ INPUT DATA
1260$;SELECTA;77A63/THESIS1
1270FINISH
1280$;ENDJOB
```

COMPUTER PROGRAM USED FOR THE PLOTTING
OF THE MEASUREMENT QUESTION'S
HISTOGRAMS

```
10##NORM,R(SL)
20$:IDENT:WP1191,GRAPHICS FARINEAU GCS 3.0 PLOT
30$:MSG2:1,SEND PLOT TAPE TO PLOTTER   (G012B,WP1191)
35$:MSG2:1,PLEASE USE BLACK INK
40$:OPTION:FORTRAN
50$:FORTY:NFORM,NLNO
60 REAL Y(35),STATS(6)
70 CHARACTER LAB1*/2,LAB2*72,LAB3*72,LAB*3(35)
80 DATA LAB/" B\"," E\"," I\"," O\"," P\"," S\","  \"," B\"," E\",
90&" I\"," O\"," P\"," S\","  \"," B\"," E\"," I\"," O\"," P\"," S\","  \"
100&," B\"," E\"," I\"," O\"," P\"," S\","  \"," B\"," E\"," I\"," O\",
110&" P\"," S\","  \"/
120 YMAX=300
130 CALL USTART
140 CALL USET("SMALL")
150 10 READ(10,900,END=999)LAB1,LAB2,LAB3
160 900 FORMAT(A72,/,A72,/,A72)
170 DO 100 J=1,29,7
190 READ(10,901)(Y(K), K=J,J+6)
200 901 FORMAT(V)
220 100 CONTINUE
221 READ(10,901)STATS
230 CALL UDAREA(0.,8.5,0.,11.)
240 CALL UOUTLN
250 CALL UDAREA(1.25,7.25,1.5,10.)
260 CALL USET("NOXLABELS")
270 CALL USET("YBOTH")
280 CALL UPSET("YLAB","RESPONSE FREQUENCIES\")
290 CALL UWINDO(0.,35.,0.,YMAX)
300 CALL USET("OWNSCALE")
310 CALL UPSET("TICX",1.)
320 CALL UAXIS(0.,35.,0.,YMAX)
330 DO 200 J=1,35
```

```
340 X=J-1
350 CALL UMOVE(X,0.)
360 CALL URECT(X+1.,Y(J))
370 CALL USET("DEVICE")
380 CALL UDOIT("LF01")
390 CALL UPRNT1(LAB(J),"TEXT")
400 CALL USET("VIRT")
410 200 CONTINUE
420 DO 600 J=5,37,7
430 X=J
440 DO 601 K=1,4
450 X=X+.2
460 CALL UMOVE(X,0.)
470 CALL UPEN(X,Y(J+1))
480 601 CONTINUE
490 600 CONTINUE
500 CALL UMOVE(0.,YMAX)
510 CALL USET("DEVICE")
520 CALL UDOIT("LF01")
530 CALL UWRIT1(LAB1,"TEXT")
540 CALL UDOIT("LF01")
550 CALL UWRIT1(LAB2,"TEXT")
560 CALL UDOIT("LF01")
570 CALL UWRIT1(LAB3,"TEXT")
580 CHARACTER TXT*10(10)/"STRONGLY\","DISAGREE\","DISAGREE\",
590&" \","UNDECIDED\"," \","AGREE\"," \","STRONGLY\","AGREE\"/
600 M=1
601 CALL USET('VIRTUAL')
610 DO 700 J=1,34,7
620 X=J-1
630 CALL UMOVE(X,0.)
640 CALL USET("DEVICE")
645 CALL UDOIT("LF03")
```

```
646 CALL UDOIT('SP01')
650 CALL UWRITI(TXT(M),"TEXT")
660 CALL UDOIT("LF01")
670 CALL UWRITI(TXT(M+1),"TEXT")
680 CALL USET("VIRTUAL")
690 M=M+2
700 700 CONTINUE
710 CALL UMOVE(3.,300.)
720 CALL UDOIT("LF06")
730 CALL UWRITI("LEGEND\","TEXT")
740 CALL UDOIT("LF02")
750 CALL UWRITI("B=BCE\","TEXT")
760 CALL UDOIT("LF01")
770 CALL UWRITI("E=DEE\","TEXT")
780 CALL UDOIT("LF01")
790 CALL UWRITI("I=DEI\","TEXT")
800 CALL UDOIT("LF01")
810 CALL UWRITI("0=DEM\","TEXT")
820 CALL UDOIT("LF01")
830 CALL UWRITI("P=DEP\","TEXT")
840 CALL UDOIT("LF01")
850 CALL UWRITI("S=SUM\","TEXT")
860 CALL UMOVE(12.,300.)
865 CALL UDOIT("LF06")
870 CALL UWRITI("STATISTICS\","TEXT")
880 CALL UDOIT("LF02")
890 CALL UWRITI("B MEAN=\","TEXT")
900 CALL UDOIT("LF01")
910 CALL UWRITI("E MEAN=\","TEXT")
920 CALL UDOIT("LF01")
930 CALL UWRITI("I MEAN=\","TEXT")
940 CALL UDOIT("LF01")
950 CALL UWRITI("0 MEAN=\","TEXT")
```

```
960 CALL UDOIT("LF01")
970 CALL UWRITI("P MEAN=\","TEXT")
980 CALL UDOIT("LF01")
990 CALL UWRITI("S MEAN=\","TEXT")
1000 CALL UDOIT("UP05")
1010 CALL UDOIT("SP07")
1020 CALL UPSET("PRECISION",5.)
1030 DO 701 J=1,6
1040 CALL UWRITI(STATS(J),"REAL")
1050 CALL UDOIT("LF01")
1060 701 CONTINUE
1070 CALL USET("VIRTUAL")
1075 CALL UOUTLN
1080 CALL UPAUSE
1081 CALL UERASE
1090 GO TO 10
1100 999 CALL UEND
1110 STOP
1120 END
1130$:LIBRARY:A1,A2,A3
1140$:EXECUTE
1150$:LIMITS:,30K
1160$:PRMFL:A1,R,R,GRAPHICS.LIB/GCS/GCS3.0
1170$:PRMFL:A2,R,R,GRAPHICS.LIB/GCS/CALC3.0
1180$:PRMFL:A3,R,R,AF.LIB/CALLIB
1190$:FFILE:27,FIXLNG/80,BUFSIZ/81
1200$:TAPE:27,XID,,,,PLOT-TAPE/WR
1210$:DATA:10
1220$:SELECTA:77A63/INFOR1
1230$:ENDJOB
```

COMPUTER PROGRAM USED TO GENERATE THE
FREQUENCY DATA FOR THE
MEASUREMENT QUESTIONS

```
0010##S,R(SL) :,8,16:;,16
0020$:IDENT:WP1191,AFIT/SLG M J FARINEAU 77A
0030$:SELECT:SPSS/SPSS
0040RUN NAME: FREQUENCY DATA AND HISTOGRAMS
0050VARIABLE LIST: Q1 TO Q62
0100VAR LABELS:Q1, MILITARY GRADE/
0110:Q2, CIVILIAN GRADE/
0120:Q3, CE POSITION/
0130:Q4, MILITARY STRENGTH/
0140:Q5, MAJCOM/
0150:Q6, EDUCATION LEVEL/
0160:Q7, SOLV MGMT PROG VS QC/
0170:Q8, SHOULD IE B ELIMINATED/
0180:Q9, WHERE SHLD IE B LOCATED/
0190:Q10, YOU SEEK THE IE FOR PROB SOLVING/
0200:Q11, IE RECOMMENDATIONS ARE GVN CONSIDERATION & IMPLEMTD/
0210:Q12, CE WOULD BE ADVERSELY AFFECTED IF IE ELIMINTED/
0220:Q13, CONTINUE QC FOR THE O&M BRANCH/
0230:Q14, THE IE STAFF IS ADEQUATE FOR WORK REQ/
0240:Q15, ADD WHICH NEW SECTIONS TO IE/
0250:Q16, ROLE QC HAS NO BEARG ON IE AS MGMT CONS/
0260:Q17, ROL OF IE SHLD BE EXPNDED OUTSIDE CE/
0270:Q18, IE STUDIES IMPROVE BCE ORG/
0280:Q19, IE IS RESPONSIVE TO PROB SLVG NEEDS/
0290:Q20, IE ROLE SHLD REMAIN STHE SAME/
0300:Q21, IE PROVIDE OBJ-EFF SOLUTIONS TO MGMTS PROBLEMS/
0310:Q22, IES GREATEST CONTRIBUTION IS IN QC/
0320:Q23, IE SHD BE ORIENTED TO EFF OF O&M/
0330:Q24, BCE FIRST MOST INPT IE FUNCTION/
0340:Q25, BCE SECOND MOST IMPT IE FUNCTION/
0350:Q26, BCE THIRD MOST IMPT IE FUNCTION/
0360:Q27, BCE FORTH MOST IMPT IE FUNCTION/
0370:Q28, BCE FIFTH MOST IMPT IE FUNCTION/
```

```
0380:Q29, DEE-IES GREATEST COMTRIBUTION IN QC/
0390:Q30, DEE-IE SHD BE ORINETED TO EFF OFF O&M/
0400:Q31, IE STDS IN DEE HAVE IMPRVED EFF/
0410:Q32, DEE FIRST MOST IMPT IE FUNCTION/
0420:Q33, DEE SECOND MOST IMPT IE FUNCDTION/
0430:Q34, DEE THIRD MOST IMPT IE FUNCTION/
0440:Q35, BASE LEVEL IE EXPERIENCE/
0450:Q36, IE DEGREE LEVEL/
0460:Q37, NO. OF PEOPLE AUTHORIZED TO IE BRANCH/
0470:Q38, NO. OF PEOPLE ASSIGNED TO IE BRANCH/
0480:Q39, RECIND OF AFM 85-38 IMPROVED THE RESPONSE OF IE/
0490:Q40, IE CAN BE EFFECTIVE WITHOUT A GOV DIRECT
0500:Q41, BCE, WORK GENERATED BY/
0510:Q42, BRANCH CHIEFS, WORK GENERATED BY/
0520:Q43, IE-WORK SELF-GENERATED/
0530:Q44, MANAGEMENT REVIEW COMMITTEE, WORK GENERATED BY/
0540:Q45, OTHER BCE PERSONNEL, WORK GENERATED BY/
0550:Q46, REPORTS FROM CMD, AUDITOR,IG, ETC-WORK GEND BY/
0560:Q47, REQUIRED BY REGS AND MANUALS, WORK GEND BY/
0570:Q48, IE FIRST MOST IMP IE FU CTION/
0580:Q49, IE-SECOND MOST IMP IE FUNCTION/
0590:Q50, IE-THIRD MOST IMPT IE FUNCTION/
0600:Q51, IE-FORTH MOST IMPT IE FUNSTION/
0610:Q52, IE-FIFTH MOST IMPT IE FUNCTION/
0620:Q53, DEM-IES GREATEST COMTRIBUTION IS IN QC/
0630:Q54, DEM-IE SHD BE ORIENTED TO EFF OD O&M/
0640:Q55, IE STUDIES IN DEM HAVE IMPROVED EFF/
0650:Q56, DEM-FIRST MOST IMPT IE FUNCTION/
0660:Q57, DEM-SECOMD MOST IMPT IE FUNCTION/
0670:Q58, DEM-THIRD MOST IMPT IE FUNCTION/
0680:Q59, DEP-IES GREATEST CONTRIBUTION IS IN QC/
0690:Q60, DEP-IE SHD BE ORIENTED TO EFF OF O&M/
0700:Q61, IE STUDIES IN DEP HAVE IMPROVED EFF/
```

```
0710;Q62, DEP-FIRST MOST IMPT IE FUNCTION/
0790INPUT FORMAT;FIXED(62A1)
0800INPUT MEDIUM;CARD
0810N OF CASES;472
0890MISSING VALUES; ALL(' ')
0900RECODE; Q1 TO Q14, Q16 TO Q62('A'=1)('B'=2)('C'=3)
0905;('D'=4)('E'=5)('F'=6)('G'=7)('H'=8)('I'=9)('J'=10)('K'=11)
0910;('L'=12)('M'=13)('N'=14)('O'=15)
0915;('B'=4)('C'=3)('D'=2)('E'=1)
0930VALUE LABELS;Q7,Q10 TO Q12,Q17 TO Q23,Q29 TO Q31,Q39,Q40,
0940;Q53 TO Q55,Q59 TO Q61 (1)STRONGLY DISAGRE (2)DISAGRE (3)UNDEC
0950;(4)AGREE (5)STRONGLY AGREE/ Q24 TO Q28, Q32 TO Q34,
0960;Q48 TO Q52,Q56 TO Q58,Q62 (1)MANAGEMENT CONSULTANT
0970;(2)QC AND ACTIVITY EVALUATIONS (3)IE STUDIES (4)IE ANALYSIS
0980;(5)BEAMS MONITOR (6)MANPOWER STUDIES (7)IG FOLLOWUP,CESMET,ETC
0990;(8)PROBLEM SOLVING (9)CUSTOMER RELATIONS-1255'S (10)MBO
1000;(11)TRAINING AND TESTING (12)TRADITIONAL IE WORK
1010;(13)SYSTEMS AND PROCEDURES IMPLEMENTATION (14)EXTRA DUTIES/
1020;Q1 (1)COLONEL (2)LT COLONEL (3)MAJOR (4)CAPTAIN (5)1ST LIEUTENANT
1030;(6)2ND LIEUTENANT/ Q2 (1)GS15 (2)GS13 OR 14 (3)GS12 (4)GS11
1040;(5)GS9) (6)OTHER/ Q3 (1)BASE CIVIL ENGINEER (2)DEE (3)DEI
1050;(4)DEM (5)DEP/Q4 (1)800OR MORE (2)<800 BUT >400 (3)400 OR LESS/
1060;Q5 (1)ADC (2)AFLC (3)AFSC (4)ATC (5)MAC (6)PACAF (7)SAC (8)TAC
1070;(9)USAFE (10)USAFSS (11)OTHER/ Q6 (1)BS OR BA (2)MASTERS DEGREE
1080;(3)DOCTORATE (4)HIGH SCHOOL PLUS COLLEGE CREDIT (5)JUST HIGH
1090;SCHOOL/ Q35 (1)LESS THAN ONE YEAR (2)GTR THN 1 LESS THN 2
1100;(3)GTR THN 2 LESS THN 3 (4)GTR THN 3 LESS THN 4 (5)GTR THN 4/
1110;Q36 (1)BS (2)MASTERS DEGREE (3)DOCTORATE (4)HAVE A
1120;DEGREE BUT NOT AN IE DEGREE (5)NO DEGREE/Q37 (1)1 TO 3 ASSINED
1130;(2)4 TO 6 ASSIGNED (3)7 TO 9 ASSIGNED (4)10 TO 12 ASSIGNED
1140;(5)GTR THN 12 ASSIGNED/Q38 (1)1 TO 3 AUTH (2)4 TO 6 AUTH
1150;(3)7 TO 9 AUTH (4)10 TO 12 AUTH (5)GTR THN 12 AUTH/
1155;Q41 TO Q47 (1)BASE
```

```
1160$:CIVIL ENGINEER (2)BRANCH CHIEFS (3)IE SELF GENERATED (4)MGMT
1170$:REVIRW COMMITTEE (5)OTHER BCE PERSONNEL (6)REPORTS FROMCMD, IG
1180$:,AUDITOR (7)REQIRED BY REGS. MANUALS, ETC/
1200$:Q9 (1)NO COMMEENT (2)RECOMMEND NO CHANGE (3)MAJCOM
1210$:(4)AFIT CIVIL ENGINEERING SCHOOL (5)CIVIL ENGINEERING CENTER/
1220FREQUENCIES$:GENERAL=Q7,Q8,Q13,Q14,Q16,Q54
1230STATISTICS$:1,2,5,6,7,8
1240OPTIONS$:3,5,8,9
1250READ INPUT DATA
1260$$:SELECTA$:77A63/THESIS!
1270FINISH
1280$$:ENDJOB
```

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BIOGRAPHICAL SKETCHES OF THE AUTHORS

Captain Mark J. Farineau is a native of Apollo, Pennsylvania and recieved a Bachelor of Science degree in Mechanical Engineering from Grove City College, Grove City, Pennsylvania. In 1966 he recieved his commission in the United States Air Force through ROTC and continued in his education at Texas A&M University for a Certificate in Meteorological Sciences. After serving five years as a meteorologist, he changed career fields to Civil Engineering. He served as a Chief of Programs and Mechanical Engeering Section Chief. His next assignment is as Chief of Operations and Maintenance, NORAD Control, Cheyenne Moutain, Colorado.

Captain Alan E. M. Tucker is a native of England and was naturalized in 1963. He recieved a Bachelor of Science degree in Industrial Engineering from West Virginia University, Morgantown, West Virginia in 1968. He earned his commission in the United States Air Force in 1968. Captain Tucker worked as industrial engineer both at the base and the major command level prior to attending AFIT. His next assignment will be as Chief Civil Engineering Inspection Team with Tactical Air Command Inspector General's Staff at Langley AFB, Virginia.