AN EVALUATION OF THE SUITABILITY OF THE COURSE COMMUNICATION SKILLS I FOR ENGINEERING STUDENTS AT TECHNIKONS IN NATAL

by

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Date of Submission: *January 1997*

I declare that the dissertation represents my own work, both in conception and execution.

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Reference declaration in respect of a Master's Dissertation.

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ABSTRACT

The title of this research dissertation includes the appellation "Natal". Since the work began in 1989, the name of that province has officially become "KwaZulu-Natal". However, the previous designation has largely been used interchangeably with the present one, mainly because the course evaluated was and has been identified with Natal.

This research was inspired by the assumption that the Communication Skills I course presently being offered to engineering students at technikons in South Africa did not appear to satisfy the workplace needs (in terms of content and time) of the engineering industry. This assumption arose out of a pilot study undertaken by the writer in 1989. In this pilot study, engineering companies were visited, and interviews were held with managers/directors/training managers, to ascertain the communication skills requirements of engineering technicians in the workplace. Many criticisms were made regarding the communication competency of engineering technicians in the workplace.

According to the findings of the pilot study, engineering practitioners hold the view that the literacy skill demands of jobs are increasing while the basic skills of the available workforce, eg. reading, writing and speaking are decreasing. Employers expressed concern with the large numbers of workers who lack such skills in listening, speaking, reading, writing and thinking, and believe that this limits their chances of upward mobility in the workplace as well as their ability to adapt to workplace changes. All these factors, according to employers, have a negative impact on productivity levels.

It was, as a result of the pilot study, suggested that engineering curricula, specifically the Communication Skills I course, should be fully evaluated to see to what extent they meet the workplace requirements of industry. What seems important is that the engineering technician should practise what has been learned and for the lecturer/instructor to bring practitioners and the workplace experiences into the classroom.

The extremely rapid rate of change in engineering technology and practice makes it more necessary for academics at tertiary level constantly to evaluate their programmes and ascertain whether they satisfy the demands of an ever-changing engineering industry.

This study proposed to investigate the cognitive and workplace requirements of engineering technicians with regard to communication skills. The study was limited to broad areas of communication competencies that could perhaps form part of a revised Communication Skills 1 course for engineering students at technikons in KwaZulu-Natal. This study was informed by the statement that :

> "*We must go outside our classrooms, testing our conceptions of what engineers actually do, and refine the theoretical assumptions upon which our discipline is built*" (Casari and Povlacs 1988 : 145).

The specific methods that were used in this research are as follows:-

1. Questionnaires were administered to 400 engineering companies in and around KwaZulu-Natal to ascertain the communication skills requirements of engineering technicians in the workplace and to rate the importance of the skills for optimum job proficiency in the engineering workplace.

2. Similar questionnaires were administered to academic staff in the Faculties of Science and Engineering at three technikons in KwaZulu-Natal - M L Sultan Technikon, Technikon Natal and Mangosuthu Technikon.

3. Semi-structured interviews were held with training managers/training coordinators/managing directors of thirteen engineering companies in Natal to ascertain the communication skills necessary amongst their workers and the importance of these skills to their specific industry.

4. Both qualitative and quantitative analysis techniques were used in the analysis of the data collected from the questionnaires and interviews.

5. A literature study of related research in workplace communication, with particular reference to the engineering industry, formed the basis for the writer's approach.

The questionnaire and interview findings revealed the great importance of a variety of communication skills to an engineering technician in industry. A one-semester course in communication skills within the engineering programme does not appear to satisfy the workplace and cognitive needs of industry. This study clearly revealed that today's engineering technicians should be more than merely good writers and speakers. They must be good listeners and they must be able to interact interpersonally with others and they must possess good organisational skills. They have to be able to do whatever research is necessary to solve problems or respond to opportunities and challenges. In addition, they are very likely to have to represent their companies and deal with people of other cultures.

In summary, an engineering technician today should be versatile and competent in a variety of communication skills. In conclusion, the words of Bachman (1988 : 138), should be noted:

> "*Realistically preparing students for their communication roles in business could conceivably take a multitude of course offerings*".

It is hoped that the conclusions and recommendations arising from this study will assist in improving the quality of the communications skills course for Science and Engineering students following the relevant qualifications, thus providing industry with efficient and well-trained engineering technicians.

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CHAPTER ONE

THE AIM AND PURPOSE OF THIS STUDY

1.1 Introduction

One description of vocational training and education has been that it

> "... *provides all citizens, considering unique individual interests, needs and abilities, with an equal opportunity to acquire marketable job skills, occupational knowledge, and positive attitudes for entering and continuing in satisfying the productive work of their choice; ... vocational education is vital to society and essential to the economy in a free enterprise system because it develops in the individual a belief in the dignity of work, pride in accomplishment, and a desire to learn; ... vocational education is a major component of the total education process with programs of instruction which are logical and relevant to actual and anticipated employment opportunities*" (An Abridged Version of the Indiana State Plan for Vocational and Technical Education, 1988 : 3).

One of the principles of vocational education is the shared responsibility of the local community, the state and the academic institution as a whole. According to the Indianapolis plan, vocational training education should be developed, conducted and evaluated in consultation with appropriate community involvement including business, industry, labour and representations of special populations that are being served. Vocational education is also based upon a systematic assessment of social, economic and employment needs and it must ensure necessary linkages and articulation between education and training and the workplace.

In planning a vocational education programme it is clearly necessary to assess the capacity of the vocational/technical programmes and services in terms of how they meet the following:

* current and projected occupational needs
* current and projected demands
* needs of students for improved skill levels
* needs of special populations, each in terms of meeting labour market needs.

1.2 Some Goals of Undergraduate Engineering Education

One of the goals of undergraduate education in Engineering is to provide a base for lifelong learning and professional development in support of evolving career objectives, which include students becoming informed, effective and responsible participants within the engineering profession and in society. While a particular undergraduate engineering curriculum cannot lay the foundation for all the areas that an engineer will need to master in a professional lifetime, it should provide a basis for lifelong learning.

According to Michel (1991), one specific objective of undergraduate engineering education which is relevant to this study is to provide the student with the ability to organise and express ideas logically and persuasively in both written and oral communication. It seems reasonable to state that faculties that do not keep abreast of advances in industrial practice and workplace basics will fail in their responsibility for tailoring the curriculum to meet the needs of industry - which will be to the disadvantage of their students. In order to preserve current relevance and advancement, it is essential that engineering academic staff participate continuously in professional development. The broad goals of undergraduate engineering education which are to prepare students for practice, graduate study and lifelong learning are the underlying reasons for evaluating engineering courses. As professional engineering practice changes, the educational base must change.

A second goal which is to prepare students for graduate study, is not always compatible with preparation for professional practice. The conflict appears not only in the approach and content of particular courses, but also in the time devoted to what appears to be an ever broadening range of subjects. A third goal which is providing a base for lifelong learning, in support of evolving career objectives, has a subtle and open-ended purpose.

It attempts to address the fact that during the active career life of an engineer, he or she might assume an increasing supervisory responsibility, which often leads to important management positions having a strong economic component. Thus, the 3-dimensional nature of the goals: practice, graduate study and lifelong learning, together with the dynamic interaction among them shapes the undergraduate engineering curriculum.

The author believes that in order to improve the quality of engineering education, vital links must be created between industry and academia. According to Michel (1991) engineering education must take into account this new age and integrate approaches which place more emphasis on new concepts, such as intercultural communication, information processing and retrieval, quality control and management. In addition to the traditional courses devoted to the learning of the basic engineering disciplines, technical and vocational training institutions abroad now propose new curricula which reflect such a modern philosophy of industrial and economic life.

Engineering education appears to be narrow such that graduates are severely limited in their ability to move about in the business world, and in addition they are unable to advance professionally owing to this narrow education base. Graduates lack the ability to read and write at the level required for upward mobility. The Canadian Engineering Accreditation Board (CEAB) expects engineering graduates to be competent in engineering as well as to have an understanding of the effect of engineering on society.

The CEAB ensures that engineering programmes not only develop technical competence, but also communications skills and an understanding of the environmental, economic, social and cultural impacts of engineering on society.

Research by Panckhurst (1986) revealed that some in-service training students had problems establishing meaningful links between study and the work-place. Some in-service training students considered their studies to be of limited use in illuminating their jobs. It was also found that subject matter was too unrelated to real work problems. Students found that specialised engineering subjects were not in keeping with current technology.

One question often asked by lecturers/instructors and personnel from industry pertains to the perceptions students have of the workplace and whether those perceptions influence an individual's commitment to engineering. The present author has concluded that engineers must not only possess the required technical skills but must also concern themselves with professional development, establishing a position of trust in respect of relating technical skills to the needs of the profession and to society at large. Engineers need more opportunities to attend professional meetings and seminars. For engineers to take full advantage of these support mechanisms, governmental organisations should allocate the necessary time and reimburse those attending activities related to professional development.

According to a report by the National Academy of Science National Research Council on Engineering Undergraduate Education in the United States (1986), the benefit of cooperative education is learning on-the-job skills. Cooperative education nurtures personal characteristics or affective skills that come mainly from experiencing positive attitudes, interests, values and motives. Technikons in South Africa are committed to a partnership role with commerce and industry in the provision of career education, offering in-service training that alternates with periods of technikon instruction. In this regard the words of Frey and Finan (1991 : 466) must be noted:

"The purpose of a university is to develop a rounded personality while providing the student with a general academic background. It is not their responsibility but rather that of the employer to offer graduates specialised professional training".

Most United States companies find that their graduates lack the ability to step into a job and become immediately productive. Perhaps the major difference in the education of Japanese and American engineers is in on-the-job training. In the United States training is brief and usually pursued on an ad hoc basis or through cooperative study. In Japan on-the-job training is perceived as an essential part of an engineer's career and an essential component of a long-term relationship is established between the company and its professionals. In South Africa education at a technikon (according to the M L Sultan Technikon Prospectus, 1996) aims to nurture the students' intelligence and broaden their outlook on life while at the same time preparing them for occupations.

1.3 Communication and Literacy in Engineering

Despite its apparently comprehensive content, the Communications Skills I course for engineering students offered presently at technikons in Natal does not appear to satisfy the cognitive and workplace needs of industry. The following is an outline of the current Communication Skills I syllabus for students pursuing engineering qualifications at technikons in Natal:

COMMUNICATIONS SKILLS I

Syllabus

1. COMMUNICATION THEORY

1.1 A model of the communication process

1.2 Barriers to communication such as ego-defences; territoriality and prejudice.

1.3 Non-verbal communication.

2. ORAL PRESENTATION

2.1 A videotaped oral presentation using OHP (verbal interpretation and exposition of graphic material); self-assessed on playback.

2.2 Interview skills, videotaped simulated job-selection interview; the interview as a structured means of soliciting information.

3. TECHNICAL WRITING

3.1 Conventions of technical writing (paragraph numbering, citation of written and graphic sources, integration of graphic and written material).

3.2 Report writing: summary and full technical reports, motivation and progress reports.

3.3 Correspondence: formal letter, letter of application, covering letter.

4. GROUP COMMUNICATION SKILLS

4.1 Small group dynamics.

4.2 Meeting leadership and participation skills; minutes and agendas of meeting.

4.3 Listening skills.

The Communication Skills I course is a semester programme that students take in their first year of study. Thereafter no communication courses are taken throughout their engineering programme.

All courses in Engineering up to Higher National Diploma have a mandatory component of in-service/experiential training. Recently introduced degree (Bachelor of Technology) qualifications require a minimum of one year of experiential training and three years of full-time studies at the technikon. To qualify for the National Diploma award, a candidate must be enrolled at the technikon for at least twenty-four months (four semesters) and pass all the prescribed S1, S2, S3 and S4 subjects and must in addition complete a period of twelve months' appropriate in-service/ experiential training. In all cases where in-service training is compulsory, it is the responsibility of the student concerned to obtain suitable employment in an organisation which will be able to provide this training. While the technikon will assist a student, where possible, in obtaining suitable in-service training, it cannot accept responsibility for such placement in industry.

Within one week of commencement of in-service training, the student must register with the technikon as a "Technician in Training" and pay the required registration fee. This procedure ensures that monitoring by technikon staff will be undertaken at the in-service training establishment. All students are provided with log-books which must be used during the in-service training periods. Training completed without the use of log-books or without monitoring by the technikon, is not recognised (summarised from M L Sultan Technikon, Prospectus, 1996).

It must be noted, however, that presently there is no requirement for communication skills to be monitored during the students' in-service training. This has a serious impact on engineering course evaluation as any form of evaluation of communication skills that does take place is of an informal nature. It must also be borne in mind that the technikons in Natal are now autonomous as far as interpretation of the syllabus for engineers is concerned. This means that technikons can tailor the syllabus to suit the needs of the students, the community and the industry being serviced.

The words of Dr J A Drennan, a practitioner engineer and Director of an engineering consulting firm in Natal appear to have summarised the problem very appropriately. He believes

> "*effective communication to be a vital aspect of engineering and in fact, regards the risks associated with defective communication to be as great as those associated with technical incompetence in the practice of engineering*" (Narsee, Pilot Study, 1989).

It seems reasonable to state that today's workforce needs high levels of literacy skills. Workplace literacy can be operationally defined as using literacy and related cognitive skills to perform job-related tasks. The performance of these tasks usually involves the integration of reading, writing, speaking and computing. Only through course evaluation that should be undertaken by academic staff, can engineering education progress and keep pace with the changing needs of commerce and industry. Employers express concern about the large numbers of engineering technicians who lack basic skills in listening, speaking, reading, writing and thinking, and this possibly limits their chances of upward mobility as well as their ability to adapt to workplace changes. Engineering curricula must be evaluated in terms of requirements of industry. What is important is for the engineering technician to practise what has been learned and for the lecturer/instructor to bring practitioners and the workplace experiences into the classroom. The extremely rapid rate of change in engineering technology and practice makes it increasingly necessary for academics constantly to evaluate their programmes to satisfy the needs of an everchanging industry.

For the purposes of this study, the following terms need to be defined: "*Communication Skill*" and "*Engineering Technician*".

Dimbleby and Burton (1989 : 58), as cited by Dickson et al, define communication skill as " ... *an ability to use means of communication effectively, with regard to the needs of those involved*".

The extent to which the desired outcomes of communications are accomplished is also an important attribute of '*skill*'.

An '*engineering technician*' may be defined as

> "*one who, in support of engineers or scientists, can carry out in a responsible manner either proven techniques known to those who are technically expert in a particular technology or those techniques especially prescribed by engineers*" (Report: Panel on Technology Education, 1985 : 21).

The education of an engineering technician places great emphasis on applied skills and practical knowledge. The definition of '*engineering technician*' provided in the work of Hayton (1986), must also be noted. Hayton found that engineering technicians may work in office-related or in trade-related workforce situations.

According to Hayton,

> "*An engineering technician in an engineering office engages upon work that is essentially mental and may be accompanied by manual skills in drafting, applied to the performance of less complex technical functions according to established practices*" and "*An engineering technician in a trade-related occupation essentially is engaged upon highly skilled manual work and exercises associated with mental skills in the operation and manipulation of complex machines or processes.*"
> (Hayton, 1986: 18)

Many well educated and technically skilled people at all career levels fail to obtain suitable employment and promotion because they lack training in basic workplace skills. To obtain the better jobs in their chosen fields, today's graduating technical students need more than a sound technical background and a few hours devoted to job search. Developing the skills to compete successfully in today's job market has unfortunately become a subordinate objective in many technical programmes of study.

Students entering the job market today must be prepared to adapt to the stresses of an unpredictable career (Troutt et al, 1988). Interestingly, Troutt found in a 1986 survey of representatives of private business and industry in Colorado Springs, that an estimated 85% of all people fired had experienced this not as a result of a lack in technical knowledge but because they lacked human relation skills. Furthermore, the best positions were often obtained by the most skilful job seekers, not necessarily the best technically qualified applicants.

The view is widely held in the United States as well as in South Africa that the literacy skill demands of jobs are increasing while the basic skills of the available workforce are decreasing. In March 1988, the United States Department of Labour issued a request for proposals in which it stated that many engineering technicians lack the basic skills to read, write and compute, and it was proposed that problem areas be identified in order to improve engineering training programmes (Grover et al, 1990). In the study by Grover et al, it is stressed that research in workplace literacy should also note the discrepancy between employers' perceptions of the requirements of entry-level jobs and the actual skills required to perform those jobs. Mikulecky's workplace literacy studies of 1983 and 1986 as referred to by Grover et al, have shown that the interactions between task and literacy materials are critical to effective job performance, and that the nature of the task determines the way in which materials will be used.

Hamilton (1982), referred to by Rose and Lewis (1989), asserts that vocational students need to focus on the acquisition of general knowledge and skills and not view their occupational study as a substitute for academic achievement.

Brown (1989 : 4) states:

> "*We need a vocational education system which delivers the new basic skills industry needs, but in an applied technological setting. We should graduate workers who can adapt to technologies as they change around them.*"

Brown refers to this applied level of literacy as functional literacy. Functional literacy, according to him, includes the basic academic skills as well as knowledge in the areas of personal and interpersonal skills, communication, comprehension, quantification, critical thinking and technology literacy skills. In addition, one must be able to apply those strategies that permit individuals to adapt information and skills for use in unfamiliar as well as familiar situations and contexts. The implication is that our concept of training must also move beyond that of training workers in single, static skills to one of preparing workers to function in complex, ever-changing environments.

According to a report by the Association of American Colleges on Integrity in the College Curriculum: A Report to the Academic Community (1985), apart from being technically competent, it is better that engineers be able to ask important questions that affect their survival in society, than to learn one more higher order differential equation. Communication is a major ingredient in building all human relationships. Ineffective communication affects work production adversely and the foundation on which a business is run becomes insecure. The more that is known about competencies needed in science and engineering courses and the more they are taken into account in curriculum development, the more competitive engineering graduates can be (Wheelock and Zekeri, 1988).

It seems that South African technikons should strive towards striking a balance between the demands of a specific occupation or employer and the demands of general technological or vocational moulding.

According to Howe and Warren (1988), curricula for science and engineering majors are continually being modified by education, science and engineering practitioners jointly. Modifications to the curriculum include (in summary) the following:

* selection of new content and elimination of old
* reorganisation of content
* increased emphasis on integration of content and interdisciplinary approaches

* increased emphasis on social science and humanities content for science and engineering qualifications
* increased emphasis on communication skills
* inclusion of more content and experiences related to application.

For any academic programme to be appropriate and successful it is essential that there be regular evaluation both of the initial course proposals and their day to day implementation; particularly for Engineering, "*where the rate of change of requirements technological, sociological and educational must be greater than in any other discipline*" (Dubbey, 1992: 3).

It is essential for syllabus designers and materials writers to appreciate the importance of sociopolitical factors in course design. These factors include the changing demographics of the student population entering tertiary institutions in South Africa. Markee (1986) believes that syllabus designers must ensure the '*survivability*' of their courses, ensuring that course materials will not become obsolete when required changes are implemented (3). These changes are dictated by the changing student population.

1.4 Importance of Communication Skills

Boileau (1989 : 88) cites the work of Mathes wherein it is argued that "*communication may be the engineer's primary social responsibility*". According to Mathes, the responsibility to communicate effectively is determined by two sources: the organisation for which the engineer is problem-solving and the society that must adapt to engineering changes. Since the engineer belongs to a profession whose objective is to improve the conditions of human life by changing the physical environment and the systems of human life, the engineer has a great responsibility to society. In order to discharge that responsibility, effective communication skills must be developed. Mathes also maintains that in order to be an effective communicator an engineer must develop good listening and conflict management skills.
Communication skills needed in the business world are as varied as the tasks assigned to employees.

A worker in a business environment is constantly being asked to think, plan, communicate in writing or verbally and take responsibility for accompanying tasks. Bennet and Olney (1988), in a study involving respondents from industry noted that communication skills had an overwhelming impact on career advancement. Donald (1991 : 190) summarises what experts consider engineering expertise to be:

> "*Engineers have to solve problems which are open ended. They have to work with other disciplines including management and trade people and they have to have a broader perspective. Engineers need to be able to verbalise and to be able to convince others ... even though others do not understand the technical language. They must be able to express it in accurate layman's language*".

Jennings (1988) stated that workers in industry lack the basic communication and computational skills required to meet the challenge of a highly competitive labour market. He further stated that skills most needed at present are: adaptability, communication skills, problem-solving skills and learn-how-to-learn skills. Languages were introduced into engineering courses in Australia because of their intrinsic benefits to the individual and the profession. Apart from this it seemed obvious that industry would increasingly need engineers with a wide variety of communication skills such as organisational and leadership skills.

It is logical to assume that governments of countries world wide are keen to increase exports and develop a more outward-looking mentality in industry. Recent studies of the relationship between linguistic competence and export performance and of language education at tertiary level in Australia emphasise the importance of a systematic linkage at tertiary level between language education and professionally-orientated programmes. It is believed that this linkage will help the Australian business community become more outward-looking and better prepared to operate in an international environment (Holgate, 1992).

An interesting conclusion from Holgate's study was that a knowledge of the general culture of other countries and the manner in which this affects business methods and interaction in the working environment is as important as language skills.

Brown (1989 : 303) made reference to the study of Langerno and Modlin (1986), who concluded that the most significant skill demanded by businesses everywhere is the ability to communicate. Brown refers to a survey of over 2 000 businesses where "*the ability to communicate was chosen above ambition, drive, education, experience, self-confidence and good appearance*".

In the Laser-Optics Curriculum at the Texas State Technical Institute, all returned task inventories done for curriculum evaluation emphasised the importance of communication skills and human relations (Reid, 1988). Students take courses in communication skills throughout the engineering programme. In their last term before graduation, students take two courses which demand communication skills. They engage in project work which includes oral presentations and written reports. Educators from industry and institutions believe that the need for communication skills should be emphasised always by all academic staff not only the communication lecturers. The academic staff stated that they were yet to attend an advisory committee meeting where the need for communication skills was not emphasised. The Colorado School of Mines conducted a survey to determine the progress of their graduates in industry. The findings revealed that too often their former students, though they had started in excellent entry-level positions, remained on a plateau, rarely learning how to improve themselves within the company. These were the students who did not have the benefit of communication skills course/s in their engineering curriculum. This study prompted the School of Mines to institute a curriculum much like that of Texas State Technical Institute, stressing the need for communication skills. It is very clear that on-going written and oral communication assignments in the classroom such as those that appear in the Communication Skills I syllabus on page six of this study, can provide technical students with an indication of the kinds of skills they need to succeed, and prepare them mentally for their careers (Reid, 1988: 15).

More than twenty years' experience as a public school administrator led Clough (1987) to the conclusion that effective communication skills can be the best and most useful tool one possesses in dealing with organisational and personal conflict.

Clough believes that nothing says more about a person's potential for leadership than his/her ability to communicate and to resolve conflicts effectively.

Pollman (1987) in his experiences and research interfacing with industry found that communication skills are among the attributes most sought after by prospective employers.

Hadgraft (1992) outlines four key attributes of engineering graduates for the future. They are, in order of importance:

* technical competence
* communication skills
* leadership skills
* innovation and initiative

This was strongly supported by Dr D Beaumont and Dr D Drennan, two engineering practitioners and Directors of highly respected consulting engineering firms in South Africa (Narsee, Pilot Study: 1989).

Today's workplace demands not only proficiency in reading, writing and speaking, but also other varied skills such as problem-solving, listening and learning skills. Teamwork, leadership skills and creative thinking are also viewed as essential. Deficiencies in these basic workplace skills are often barriers to engineering technicians in that the chances of promotion are decreased without them. Many employers are trying to improve the basic communication skills of engineering technicians by offering them training courses.

Employees themselves are recognising the need for this training as they are being challenged as never before. For those that are already employed, deficiencies in basic workplace skills affect career growth negatively.

Carnevale (1990) believes that the range of skills needed by engineers to participate successfully in today's economy has expanded.

Engineers are less supervised but more frequently called upon to identify problems and make crucial decisions. Changes in engineering technology also result in changes in basic skill requirements. The expanding range of tasks and responsibilities in the technician's job demands higher basic levels of reading, writing and computation. A workforce with sound basic communication skills will strengthen its employer's ability to compete. For the individual worker, such skills are also the key to greater opportunity and a better quality of life. According to Carnevale (1990), workers with good basic skills find it easier to acquire better jobs and higher pay. On the other hand poor basic communication skills limit the individual's choices and his/her potential for earning.

Studies by Bishop, referred to by Carnevale (1990), revealed that employees with strong basic skills such as speaking, writing and listening are more productive than those with limited skills in these areas of communication. Carnevale also cites the work of Mundale (1985), who concluded that communication skills are central to the smooth operation of a competitive venture. Communication skills are at the "*heart of getting and keeping customers*" (Carnevale, 1990: 45). Innovation, initiative, resolving conflict and providing meaningful feedback all hinge on effective communication skills. If an organisation's workers cannot communicate, little real progress can be made towards achieving strategic objectives. Communication training helps organisations achieve the goal of having articulate workers who are motivated and equipped to serve customers and to participate fully in organisational life. Landis as cited by Carnevale (1987) states that personal qualifications, not grades, were the primary factor in evaluating candidates for employment in industry. He goes on to state that he believes the most important factor related to personal qualifications is the ability to work and communicate effectively with people.

Troutt and Isberner (1988) cite the works of Murphy and Jenks (1983), in which forty-eight randomly selected San Francisco Bay area employers were interviewed to

identify qualities of the successful entry-level professional applicant. Employers were asked to state the required skills for successful job performance, which Murphy and Jenks then categorised as adaptive, functional and technical. Adaptive skills referred to personality, attitude and motivation, presentation of self and tactfulness.

Functional skills referred to oral and written communication and organisational problem-solving and research skills. Technical skills were given little importance, and most employers reported that the determining factors in appointing were adaptive and functional skills. Furthermore, it was concluded that the best positions are often obtained by the most skilful job seekers, not necessarily the best technically qualified applicants.

In general, college engineering curricula in the United States require that students take a number of courses involving written and oral communication. At technikons in KwaZulu-Natal, the situation is somewhat different. Students are required to take only one course in Communications Skills over one semester. Sometimes engineering students react with apprehension when faced with any type of communication other than technical.

Engineers today are working in a very competitive world: they must be able to "sell" their projects to top management. A host of engineers in industry and engineering institutions in countries around the world have highlighted the importance of both oral and written communication skills (Yin, 1988). They have lamented the lack of such skills in engineers and the limitations of training in this area. Yin believes that the acquisition of linguistic competence is not optional, but critical in order to get a job, to perform the tasks and to advance up the corporate ladder.

While the ability to communicate orally and in writing is recognised as essential for all engineers, it is particularly critical to those who must work with private and public owners, the public in general, architects, contractors and financial institutions.

Engineers are expected to organise and present their thoughts logically and effectively, whether in written memoranda to superiors or by means of oral presentations to concerned citizens at a public hearing. According to Pakos (1986), engineering associations and employers rate proficiency in communication among the most valuable asset of any engineering graduate.

Frey and Finan (1991) believe that today's graduate lacks the ability to step into a job and become immediately productive. Key shortcomings are in communication skills, teamwork and management skills. According to Bennet and Olney (1986), over 84% of business people stated that communication skills had affected advancement in the work situation. Being able to communicate in any form also provides the students (soon to be employed) with the confidence to assume tasks and see their tasks through to completion. Students should know what industry expects of them. Possessing communication skills and transferring them to business applications benefits both employees and employers. Flad (1988 : 63) believes that "*communication skills and resulting job performance are truly the keys to success in the business world*".

According to Rybczyk (1987), communication is the key to effective management for persons in a supervisory capacity. Kleiner and Peterson (1983), as cited by Rybcyzk concluded in their studies, that effective communication skills are important and necessary to accomplish tasks and to develop positive and productive work relationships. Rybczyk believes effective communication skills to be the key element in improving productivity and attaining job satisfaction.

The Australian Institute of Management believes that productivity in a firm could be increased by 50% if the focus of engineering education training was on communication skills. Overall, there appears to be a general consensus in the studies conducted abroad that communication skills rank high in the list of skills that are sought by employers in industry because the findings revealed that to achieve high productivity and goals in industry, effective communication skills are necessary (Rybcyzk, 1987).

Reference must also be made to Rybczyk's own studies (1987) wherein it was concluded that effective verbal and non-verbal communication on the part of management staff impacted greatly on the success rate of the business. Rybczyk maintains that communication is a skill and as such should not be treated as strictly a knowledge issue. It is the practice of communication skills which results in the desired results. In other words "*practice is an essential key element to skill acquisition*" (Rybczyk, 1987 : 11).

In Reid (1988), one of the conclusions reached was that a significant problem in industry today is the inability to communicate effectively. Many of the respondents stated that they experienced great difficulty in understanding the writing of engineering technicians. Problems ranged from mis-spellings to incorrect grammar and verbose writing styles. Interestingly, it must be noted that at almost every Academic-Industry Consultative meeting, the need for a variety of communication skills was emphasised. A manpower study conducted in the United States found employers generally satisfied with the technical knowledge preparation of entry-level engineers. However, industry personnel expressed concern about the writing and presentation skills of entry-level technicians. This appears to be a problem in South Africa as well. The present study also revealed a lack of training and skill in communication on the part of engineering technicians. Particular mention was made of poor quality technical reports, inability to present ideas or concepts orally and difficulty communicating with peers at work (Reid, 1988). The findings of the questionnaires and interviews in the present study revealed similar problems. Meyer (1989) emphasises the importance of effective communication skills for engineers, with special emphasis placed on writing skills, especially technical report writing, writing of proposals and technical periodicals.

One local engineering practitioner and Director of a Consulting Engineering firm, in an address to students studying Science and Engineering, had this to say:

> "... *my qualification for being here is the fact that I have to deal daily with the problem of communication in engineering,*

the consequences of poor communication and the pleasure of effective communication"
(Address to engineering students at M L Sultan Technikon, 1990)

In a paper presented at a conference on Technical Communication (1983), Retief concluded that the main cause of conflict amongst workers at all levels of the organisational hierarchy appears not to be an adjustment to new technological skills but a lack of proper communication, a problem that has relevance in South Africa. Other studies, as cited by Retief, revealed that one of the causes of dissatisfaction amongst workers could be attributed to poor interpersonal relations and basic communication skills. It was also found that poor communication was one of a number of factors that influenced productivity and labour turnover.

Literature studies in communication skills abound with further examples of the necessity to communicate effectively in training; and in a multi-cultural environment such as in South Africa, communication skills play an even more important role since the lecturer/instructor must be sensitive and knowledgeable in the traditions and culture of his/her trainee staff, as well as being aware of the subtleties of language and expression in order to communicate effectively.

1.5 Methods of Research

1.5.1 Questionnaires

A total of 400 structured questionnaires, together with self-addressed envelopes were administered to the following target groups:

* Science and Engineering companies that recruit technikon students for in-service training.
* Engineering companies that conduct job interviews at M L Sultan Technikon.
* A random selection of engineering companies that fall within the categories presently forming the Science and Engineering faculties at M L Sultan Technikon.

1.5.2 Questionnaires were also administered to all academic staff in the Faculties of Science and Engineering at three technikons in KwaZulu-Natal:-
M L Sultan Technikon, Technikon Natal and Mangosuthu Technikon.

1.5.3 **Semi-Structured Interviews**

Although ten interviews were the required number for this study, the author managed to conduct interviews with personnel from thirteen engineering companies. The author selected thirteen well-established diverse, well represented (in terms of the broad spectrum of the engineering field) corporate companies. Interviews were conducted with either the Training Manager, Training Coordinator, Training Officer, Employee Developmental Specialist or Managing Director, whichever individual was involved in the training of engineering technicians.

The following companies participated in the interview process:

* SIEMENS
* TRANSTEL
* NCP
* TOYOTA MANUFACTURING S.A.
* CONLOG
* GRINAKER
* ENGEN
* DURBAN ELECTRICITY
* BOSCH INSTRUMENTATION AND CONTROL
* BKS
* ERSKINE CONSULTING ENGINEERS
* SILTEK DISTRIBUTION DYNAMICS
* SMITH'S MANUFACTURING

1.6 Description of the Instrument

The instrument was divided into two sections: Section A posed general questions about the industry or in the case of academic staff, the department the respondent

represented, including the type of industry, the job title of the respondent, the current number of employees/academic staff. Section A also included five basic communication skills and respondents were expected to rate their importance to the engineering technician. Respondents could state reasons for their choices in response to an open-ended set of questions.

Section B comprised a checklist of forty-five communication skills which respondents rated in one of three ways: skills could be rated necessary, desirable or optional. The checklist was developed and based on the author's pilot study (1989), a survey of related literature and correspondence from industry. The preliminary/pilot questionnaire was rated by engineering and communication faculty members. The questionnaire was then revised, restructured and finalised accordingly. Both quantitative and qualitative analysis techniques were used in the analysis of the data collected from questionnaires and interviews.

1.7 Statistical Analysis

The Pearson chi-square statistic was used to test the strengths of associations between Y and X1 to X53. The Pearson chi-square statistic is used to test a null hypothesis that states that there is no significant association or interdependence between factors A and B. At the $\alpha = 0,05$ level of significance, the null hypothesis is rejected if the calculated Pearson chi-square value exceeds the tabulated chi-square value.

The Pearson calculated chi-square value is given by the following equation:

$$X^2_{cal} = \frac{\Sigma^r_{i=1} \Sigma^c_{j=1} (O_{ij} - E_{ij})^2}{E^{ij}}$$

where i = 1, ..., r = number of rows

j = 1, ..., c = number of columns

O_{ij} = the observed cell frequency in cell i,j

E_{ij} = the expected cell frequency in cell i,j

where E_{ij} =

$$\frac{n_{i} . n_{.j}}{n}$$

n = 101 = the sample size of the study.

The degrees of freedom of the tabulated chi-square value are equal to (r - 1) (c - 1) where r and c are the number of rows and the number of columns respectively. The level of significance of each test is fixed at the $\alpha = 0.05$ level.

The null hypothesis being tested is accepted if the calculated value of the Pearson chi-square is less than the tabulated chi-square value. Otherwise it is rejected.

All distributed assumptions that are required for the validity of the chi-square test are satisfied.

1.8 Literature Study

* A literature study of related, significant and influential research was completed. The available literature has been used to extract facts and figures for the purpose of making comparisons and to substantiate or exemplify the information obtained in the course of the study.

* Aspects of specific workplace communication skills were identified and discussed.

CHAPTER TWO

A REVIEW OF LITERATURE RELEVANT TO THIS STUDY

Literature on communication skills relevant to engineering can in terms of focus be very general, very specific, or somewhere in between. In this chapter, the writer sets out to review a range of such literature. For convenience, the review is sub-divided according to particular areas of skill, viz., writing, technical writing, reading, information retrieval and research, speech, listening, organisational ability, cognitive skills and interculturalism. The chapter concludes with other brief sub-sections on matters generally relevant to communication amongst engineers. Any survey of literature can obviously never be totally complete. The sources that the present author has drawn on in this chapter relate to specific job-related communication.

2.1 Writing Skills

Research on writing in the workplace has progressed rapidly. According to Davis and Stohrer (1989), there appear to be two distinct types of inquiry that have evolved. The first involves an assessment of the amount of writing done in the workplace, which analyses who writes what to whom, when and why. The other source of research is more quantitative or experiential, where the amount of time spent on writing, the composing process, and the needed writing skills is documented from self-reports, observations and interviews.

In the study conducted by Davies and Stohrer (1989) involving on-the-job writing, the following conclusions were reached:

* On-the-job writing is a major activity. 25 - 40% of a typical work day is spent in writing activities.
* College writing courses played a significant role in on-the-job writing preparation.

* 56% of respondents listed technical writing courses as the best element of their educational background in preparing them for current on-the-job writing.
* There appeared to be a gap between the writing training required for the work situation and the writing course actually practised in the programme.
* Purpose of message, audience analysis, organising for writing, grammar, syntax and mechanics were identified as the most important writing skills for these respondents. The respondents perceived errors in grammar, mechanics in writing and language use as some problem areas.

Writing skills today are important in almost every occupational field. Employers first judge a would-be employee's writing ability by the quality of an application, cover letter, or résumé. According to Carnevale, (1990 : 46)

> "*The quality of letters, memoranda, progress reports, work orders, requisitions, recommendations and instructions is regarded as an indicator of the overall quality of an employee's work.*"

The higher an employee's professional goals, the better the writing skills he or she will need.

The writer, in her pilot study (1989) received the following comments from employers:

> "*Certainly it is not necessary that every one we hire be a finished ..... writer, but it is necessary that he or she be able to communicate ...*"
>
> and
>
> "*Some of the reports that I have had occasion to read over the years would curl your hair - many of them can charitably be called atrocious*"
>
> *and*

"An applicant or employee who lacks writing skills is a lost cause."

Carnevale points out in his study (op.cit., 1990) that the costs businesses incur because of inadequate employee writing skills have a negative effect on productivity and product quality. Apart from that, responding businesses expressed concern about the impact such skill deficiencies have on employee retention and promotability, which has a direct impact on turnover costs.

If the purpose of providing employees with basic skills in writing courses is to improve performance on job writing tasks, instruction should presumably focus on objectives that most nearly match job processes and activities as they are performed by a highly competent worker. This requires that classroom instruction centre on writing tasks and materials actually used on the job.

To meet employers' needs, job writing tasks selected for instruction should be those found in entry-level positions or in middle-level positions to which entry-level workers may be promoted and should concentrate on tasks workers report having difficulty with or simply want to do better in. Drew and Mikulecky (1988) cited by Grover et al (1990) believe that in order to meet employers' needs, job writing tasks selected for instruction should include those for which performance results are critical to safety, upgrading or production and those in which employees frequently make mistakes. Another report by Rush Moe and Storlie (1986) as cited by Carnevale indicates that clarity is the chief requirement of on-the-job writing.

According to the studies of Carnevale (1990), companies commonly identify grammar as an area in writing in which they want their employees to receive instruction. By grammar they usually mean correct writing that is clear and readable. Organisations frequently classify employee-produced writing as having bad grammar when it shows the symptoms of vague diction, faulty punctuation, lack of clarity, lack of focus, wordiness or lack of purpose.

To be effective,

> "*instruction in workplace writing should not centre on grammatical exercises that treat these inaccurately labelled symptoms but should address the symptoms caused by making explicit the mental processes one needs to perform writing tasks*" (Carnevale, 1990 : 127).

In many parts of the world students at higher educational levels continue to prepare for careers in business occupations/industry by enrolling in several additional writing-related courses, including at least one that focuses on business writing.

Scott (1988) believes that while developing writing skills business educators should include such areas as a review of basic writing, mechanics of language, how to organise, edit and format different types of business letters, business reports and other forms of employment communications relevant in industry.

Scott (1988) believes that since writing is a complete task all business educators, not just business communication teachers, should work cooperatively to strengthen the business writing skills of students. Ording (1988 : 21) states clearly that:

> "*a sound framework for textual coherence should account for three aspects of workplace writings: interrelations, real-world referents, and global structure. ... we may be short-changing our students if we do not provide them with the rhetorical tools they will need to coherently build on the situations arising in the businesses and professions.*"

Gerson (1988 : 352) in his studies concluded that

> "*companies hire their employees for their human intellectual ability to review data, synthesize content and apply its worth.*"

Gerson (1988 : 352 - 353) goes on to state that an employee's value to a company lies in his/her ability to internalise his/her writing because doing so allows the individual

to convey his/her attitudes, and that is what makes him/her a valuable employee. He believes that

> "*by infusing humanism into our technical communiqués, we invite the reader into our writing, opening the door to dialogue rather than presenting impenetrable technical dogma.*"

This view is further supported by Moxley (1988 : 107) in his studies of technical writing wherein he states that the audience must be given more consideration when a writer writes in industry. He goes on to state that students need to be informed that "*the writing process is a thinking process ... it must encourage dialogue.*"

Employers believe that good writing skills are critical to career advancement. Without such skills advancement opportunities are limited. Treadwell (1989) in his studies found that although the hiring process of an employee favours technical skills and abilities, an individual with good writing skills, once hired, would probably be promoted faster because of his ability to communicate these ideas.

According to Stanley (1990), ABET postponed full accreditation of an Electrical and Computer Engineering Technology (ECET) programme until more writing was included in the academic programme of engineering students. Interestingly, the influence of an accrediting association also encouraged other departments to assign a great deal of importance to communication skills. It seems reasonable to conclude that writing skills play an important role in the engineering field. Spear and McGrath, as cited by Stanley (1990), suggest that the engineering student must be taught discipline-centred writing if he/she is to succeed in the professional workplace.

According to Scott (1988) business and industry have highlighted the need for the following communication skills: general skills including basic skills and audience analysis, written skills including organisation, style, and project development, verbal skills, including listening and oral presentations and interpersonal skills. Scott believes that there are three very important communication skills associated with writing in industry/business: organisation, style and project development.

Fielden, as cited by Scott (1988) suggests that style should embrace choice of words, sentences and paragraph format which should be appropriate to the situation and to the power positions of both writer and reader to produce the desired reaction and result. Project development in writing tasks is a necessity in the business world. In almost every business project, more than one piece of writing is required, for example report writing may continue for months with initial reports, progress reports, verbal reviews, suggestions, new research information and then an updated final report. It seems reasonable to conclude that thinking, researching and analysing all contribute to the first and final draft of a written project.

To increase the writing proficiency of the engineering student, the use of student journals is recommended by Scott (1988). These could be in the form of notebooks set aside for daily written responses of a relatively informal nature. These journals are used by students to record details about their course of study, lectures, projects, assignments, their responses to work assignments and so on. The lecturer/instructor reviews these journals from time to time and make comments and even grades them. These journals force students to engage in writing, a skill which is so necessary in industry. Excellent journal entries are circulated amongst students in class.

It has been concluded in the research by Grover et al (1990) that journal-typewriting tasks are beneficial. The class journals provide an insight into the course rarely experienced by the lecturer/instructor. Research has shown that most students seem to find the journal an effective learning tool. The journal assignment had the additional benefit of students reviewing each week's material and using their own way/words to explain concepts in order to understand them better. Apart from journals, short writing assignments should be given to students throughout the curriculum. It seems reasonable to suggest that the engineering staff should impress upon students that incompetence in written communication is deemed reason enough to lower a student's grade in projects. Scott (1988) believes that any engineering professional qualified to teach at a tertiary level should be able to critique the communication skills of an undergraduate student, especially with respect to the content, organisation, logic and persuasiveness of a document.

All available empirical, theoretical and pedagogical information points to the need to integrate language skills for effective language teaching (Kumaravadivelu, 1994).

Probably the most glaring immediate problem currently facing educators is the poor grammar usage that prevails in the educational environment. Study after study reveals that business practitioners in general have problems with writing skills. Whether students write from prior knowledge, do research or do some combination of the two, knowledge of subject matter is necessary for effective skill building (Pearce, 1988).

An integrated approach to teaching business writing appears to be an effective way to teach writing skills.

Gordon (1988 : 27) notes that

> "*integrated instruction places writing in a more realistic setting, thereby generating more interest in improvement*".

He further states that course instructors/lecturers in subjects other than communication should place sufficient emphasis on writing skills.

Realism is so important to the experience of learning to write well that any textbook-based instruction will be greatly improved when supplemented with some type of instruction from the world of work. Apart from this, inviting engineering practitioners from industry as guest speakers to address students and staff can be a very useful exercise in teaching writing skills. The practitioner, a person who writes daily as a part of his/her job, can share the work experience with students to give them ideas about what students can expect in the workplace. Practitioners can shed more light on the difference between classroom instruction and workplace practices. Classroom instructors need to devote their energies to improving the quality of instruction in especially writing skills.

A study by Braine (1989 : 3) investigated the types of writing assignments commonly found in undergraduate natural sciences and engineering courses.

Braine states that

> " ... *each discipline is a separate discourse community, with its own norms, conventions and rhetorical strategies.*"

This makes the challenge of business communication lecturers/instructors even greater; calling for a great deal of flexibility and adaptability in servicing engineering departments. In Braine's work, the findings showed that in the case of science, summary and paraphrase appear to be the dominant skills needed in the writing of laboratory reports.

In a Report entitled "Related Skills in the Marketplace" (1989) produced by Calhoun Community College, observations concerning job-related writing revealed that clarity was of primary concern for on-the-job writing, where emphasis is on conciseness rather than grammatical competence. A survey by Anderson (1988) as cited in this report, identified the following basic skills essential for employees in industry : critical thinking, problem-solving, and basic writing and reading skills. Business workplace needs for entry-level workers, according to the Report, included flexibility, ability to solve problems, ability to work independently and cooperatively and the ability to communicate in a multicultural and multilingual environment.

The Employability Skills Task Force (1988 : 58) identified the following skills required of Michigan workers in the future : academic skills, personal management skills and teamwork skills. Teamwork skills present new challenges for employees particularly in South Africa where more multicultural and multilingual working environments are prevalent.

Mikulecky as cited in the Report entitled "Related Skills in the Marketplace" (1989) mentioned above, stressed the importance of bringing real-world experiences into the classroom to increase the transfer level of knowledge from the academic environment to the workplace. On the other hand Fueyo (1988), also cited in this report, argued for an approach that focused on teaching the individual who could find the tasks meaningful rather than on teaching meaning to the student through the teaching of specific skills.

It is the view of Donald (1991) that writing is a crucial skill to develop in engineering students. Students of engineering must be able to describe, select information, organise, draw inferences, synthesise and verify. He states quite emphatically that

> "*In the professional life of the engineer, the manner in which oral and written communications are presented is considered to be extremely important; an engineering student is expected to develop these skills as an integral part of the undergraduate program*" (Donald, 1991 : 189).

Employers want productive employees who learn quickly, are articulate and are able to deal with clients.

In Barton and Barton (1989 : 2) the words of Felker must be noted : "*The organisation and format of a document may be just as important as its language.*" There is a growing appreciation that writing has a "*physical and spatial presence as well as abstract meaning*" (ibid).

The study of Baudin (1984) as referred to by Barton and Barton concluded that any piece of writing has an overall image, creates an impression and has a message; and that writers should be aware of the form and the content of written text. Baudin advocates that skills in visual editing should be developed as part of any communication skills course for engineering students.

Many technical writing textbooks emphasise the importance of integrating the text with appropriate graphics. According to Craig and Steinfatt in Barton and Barton (1989), the skilled communicator must know how to outline, draft and perfect each message so that it fits the purpose and suits the medium if he/she wishes to ensure personal success as well as the success of the company in which he/she is employed. Craig and Steinfatt believe that workers who strive to acquire language proficiency and who incorporate the art of human relations into their writing will attain the level of skill required by industry, and will gain the confidence necessary for successful business writing. It seems reasonable to conclude that no matter how complex or

extensive a communication system may be, effective communication still depends on each individual who functions within the organisation.

Learning to write about science and technology involves not only becoming acquainted with appropriate guidelines on style, but also becoming aware of what content to include. It is the view of Gastel in Barton and Barton (1986) that employees in the field of science and technology are obliged to write simply, concisely and intelligibly, especially when presenting information that health professionals and the public may need to make decisions on.

Spadora (1980), as cited by Barton and Barton (1989) in his survey of readability levels of brochures and pamphlets for patients concluded that such publications often are written at levels that are too advanced.

In Barton and Barton reference is made to the work of Grunder (1980), who made a striking finding in his survey which assessed readability levels of consent forms that patients must sign before surgery. His findings showed that these forms were written at, or nearly at, postgraduate reading levels. Writings in science and technology should not only be easily readable but should also include the basics of good writing style. Gearing the message to the receiver is central to good effective communication.

Students coming to higher education generally experience problems in writing, particularly the kind of writing that requires them to think and to express concepts that they are learning. They have no experience in manipulating language as a part of learning. Robinson (1988) in her research has shown that unless students use the writing skills they have developed at first year tertiary level on a regular basis in other classes, their writing skills are unlikely to improve.

Robinson concluded that when students understood the concepts that they were writing about they wrote clearly and concisely. When they did not understand them, their writing was not only confused and unclear, it was full of the kinds of grammatical errors that they did not normally make.

From Robinson's research, it can be concluded that poor writing skills and poor thinking and study skills are interrelated. The solution seems to be to integrate writing with learning in all the engineering students' courses. Students need to be given an opportunity to write about the concepts they are learning while they are learning them. Writing-as-learning is most effective when it is done with the emphasis on learning, not on 'correct' writing. For the purposes of writing-to-learn Robinson maintains that it is not necessary to give detailed explanations of grammatical errors; nor should such writings be graded; it should be looked upon as preparation for the kind of writing that will be graded.

Good writing is the result of writing in stages. Using writing-as-learning assignments can give students a powerful tool for learning and thinking.

It can also give students an educational experience of individualised instruction. Students writing about what they are doing and thinking can provide instructors with a means of establishing an instructor relationship. According to Robinson students learn to trust that the instructor will use what they write as a means of communication to help them to conceptualise and perfect what they are studying. This kind of writing turns passive students into active students. They assume responsibility for their own learning. It enhances their self-image and self-esteem and the result is an increase in self-confidence and a willingness to take risks in learning, and to engage in creative critical thinking.

Pollman (1987) in his experiences and research interfacing with industry, found that communication skills are among the attributes most sought after by prospective employees. As an instructor he found that writing was one of the most effective means of aiding the student to develop the logical, sequential thought processes required in the science and engineering fields. The writing done by technicians in high technology fields varies greatly with the type of industry and the stage of that industry's development. Today many technicians work in research and development laboratories. Much of their writing tasks involve the documentation of test results, often to accurate specifications.

Even the more established industries must continually write and update operation and service manuals, due to the rapid advancement made in high technology.

Many technicians advance into management positions and are required to write comprehensive reports and proposals. Industry has a need for technicians with both refined communication skills and logical thought processes which are developed through writing across the curriculum.

The project of Hirsch (1988) rests on the assumption that language may be used for different purposes and that one of these purposes is learning. Her tutorial model is rooted in the present-day writing-across-the-curriculum movement which recognises that writing is a means of learning subject matter.

Yet much of the research also emphasises the interaction between talk and writing and its significance for learning. Because expressive language is a powerful learning tool that externalises our first stages in solving a problem, it is the means by which project participants in Hirsch's study manipulated and learned the subject matter of their content area discipline. "Expressive" language, defined by Britton (1975), a noted British educator and theorist, is cited by Hirsch (1988) as language closest to natural speech. Roebuck, referred to by Hirsch, makes reference to research conducted by many language specialists who found that most on-the-job writing is collaborative from start to finish.

In addition these researchers discovered that co-authorship is especially common in professional and technical occupations. It places a different set of demands on a writer than does single authorship. Writers need to blend their styles with the styles of others so that the final document has a single, unified voice. Therefore, it seems that if students are to be prepared when they are in their first job, they must learn how to write with others and make joint decisions. Collaborative writing is a way to meet this need.

Covington et al (1984) believes that writing is important for successful engineering performance in order to help students gain the communication skills they require as professional engineers. Rumpf et al (1988) also emphasises the importance of written communication skills for engineers while noting the need for improved teaching in this area.

ABET requires evidence of written and oral communication skills and deans and engineering staff of colleges/universities have rated these skills as very important. In Rumpf et al (1988), the authors maintain that the problem many students have with writing, is the lack of practice, and since written communication skills improve writing skills, the integration of writing skills into other engineering courses should be encouraged.

In Covington et al (1984) it was concluded that writing skill is encouraged at all levels of the engineering curriculum if the engineering and communication/language staff work in consultation with one another. The emphasis engineering faculty members give to writing skills helps students understand the importance of writing in their professional lives. It seems reasonable to assume that the students will adopt a more positive attitude towards writing as they receive intensive practice in their own specific field. Every professional and vocational field has its own discourse community, meaning its own ways of communicating and its own forms of writing. Covington believes that writing in the classroom should be done in such a way that it forms links outside the classroom by encouraging the students to engage in the kinds of writing actually done on the job and addressed to the kinds of people the student will be working for and working with.

Kennedy (1988) believes that teachers/lecturers in vocational training institutions should prepare students to work in professions in which technical knowledge is increasing at an alarmingly fast rate and written and oral skills are as important as technical skills. According to experts in the field of writing across the curriculum, "*an individual's language is crucial in discovering, creating and formulating ideas as well as in communicating their substance to others*" (119).

An ability to write effectively not only enhances the individual's performance level but also provides a number of important by-products including:

* increased self-confidence
* increased ability to share ideas
* stimulation of creative thinking processes
* application of logical and sequential examination of options while solving problems
* practical focus on language and its usage
* increased awareness of the need for clear, concise communication, both written and oral (Robinson, 1988).

Berthelson cited by Killingsworth et al (1988 : 120), believes that

> "... *the requirements for general literacy and communication skills are becoming more stringent as employers deal daily with semi-literate employees who cannot work effectively in our information-based economy.*"

Reid (1988) found that engineering students, though they had started in excellent entry-level positions, remained on a plateau, rarely learning how to improve themselves within the company. From this it seems reasonable to conclude that habitual written and oral communication assignments in the classroom can provide technical students with the kinds of skills they need to succeed and prepare them mentally for their careers. Intensive writing courses are very important because they demand that the students work at a higher cognitive level and therefore retain and understand more of what they have learned. Engineering technicians should realise that although their hand skills (manual skills) will get them a job, being unable to effectively write, speak, read and listen will handicap them, limit their chances of promotion and leave them on the bottom rung of the career ladder.

Martin (1988 : 3) found in her studies on bridging language, that employers in industry might acquire the field-specific vocabulary of their respective professions, but they often lack the "bridging elements" of English which are used across disciplines and which link concepts together. Examples of these are: 'generally speaking', 'to emphasise', and 'however'.

It appears that the professionals in industry are often unable effectively to communicate technical ideas, solve problems or to interact with others. As professionals and many vocational educators understand, the needs of industry go far beyond just discipline - specific reading. Martin (1988) believes that engineering technicians need to be able to communicate effectively about issues in their field, to be able to write in a manner that is understood by both the non-technical and technical individual, and they need to be able to present their expertise orally. Martin also makes reference to "*bridging language*" which she maintains, falls between the professional/technical and general/non technical vocabulary.

Martin states that whilst bridging vocabulary is academic in nature, its use goes beyond the academic environment into the workplace. Martin concludes that bridging vocabulary performs a variety of functions for example, to clarify, to develop, to introduce, support ideas, summarise, to show relationships and so on. She believes that without this skill of using effective bridging vocabulary, a professional is not fully proficient and may not be able to communicate ideas as effectively. The present author is of the opinion that this bridging vocabulary appears to be the missing link in the instruction given to the engineering students at technikon level in South Africa.

2.2 Technical Writing

According to Kortner (1988), technical writing is an increasingly important type of corporate communication and one in which corporate culture intersects with the classroom. Each organisation speaks its own language and exhibits a unique personality. Pinelli et al (1991) found that engineers devote more time, on the average, to the communication of technical information than to any other specific or technical activity.

It is reasonable to suggest therefore, that steps should be taken not only to develop and maintain the technical competency of engineering technicians but also to enhance their technical skills.

Rapidly changing patterns of international cooperation and collaboration and revolutionary technological and managerial changes are combining to influence and transform the communication of technical information in the workplace. Consequently if academic programmes are to prepare engineers to communicate effectively, these programmes should reflect "*workplace culture, organisation and communications at the national and international levels*" (Pinelli, et al 1991 : 337). Pinelli reports the findings of a research project to determine the communication needs of the engineering field. Only two that apply to the present study are mentioned:

* Over 90% of the respondents indicated that the ability to communicate technical information effectively is very important.
* The ability to communicate technical information effectively is important to workplace performance and professional advancement.

From this it can be concluded that engineering curricula must acknowledge the need for effective communication skills to facilitate the technological innovation process. Knowing how and when to use information, rather than in simply having it is certainly of paramount importance in the workplace.

It is this '*how*' that should form an important part of the engineering curriculum to develop and maximise the competence of engineers. Another conclusion drawn from Pinelli's study is that clarity, brevity and logical order were essential elements of technical communication. In particular Pinelli found that

> "*the communication of technical information is critical to the success of technological innovation. Also the transfer of information is an inseparable part of the research and development process*" (idem : 338).

According to the study of Pinelli, strong relationships exist between the communication of technical information and technical performance at both the individual and group levels.

Treadwell (1989:264) found that "*communication content is determined ultimately by organisational policy rather than the end user*". Treadwell believes that communication specialists may have a major responsibility for adapting technical material to audience needs, but content is controlled ultimately by organisational policy and enforced where necessary by organisational procedure. The rising levels of education, increasing availability of information retrieval systems and other factors set the scene for a new technical communication role in which adaptation of technical information to specific audiences may become less significant than facilitating the ability of receivers to obtain technical information for themselves. Donald (1991) believes that the development of effective technical writing skills in engineering students significantly affects their potential for success in industry. In the study by Pond (1990), it was found that quality technical reporting was one of the most important factors in upward mobility for technicians. Pond also maintains that there is a need for improved articulation on the part of the engineering technician.

According to Masse and Ben (1989) professionals in business and technology should know how to do more than merely use language correctly; they must learn to use it effectively.

Correspondence, proposals and reports should be more than error-free forms of self-expression and each must be designed for a specific purpose and audience. Masse and Ben also put forward the view that to use language effectively for specific purposes and audiences, students require specific training to enable them to handle diverse situations. Fialkowski (1986), as cited by Masse and Ben, believes that instruction in technical writing results in strong communication skills.

This is further supported by Emerson (1980), as referred to by Masse and Ben who concluded that classroom instruction on how to use words effectively promotes

good analytical skills and therefore make students better functional writers. It can be summarised from the studies of Emerson and Fialkowski that a good grounding in the art of using words so as to persuade or influence provides a basis for writing clearly and logically, handling diverse writing situations, developing analytical skills and critical approaches, examining audiences and identifying structural relationships; in other words the art of rhetoric. Ziv and Lynch (1989) feel strongly that technical writing teachers should provide instruction in summarising techniques, paraphrasing and the different ways of documenting sources.

In a study conducted by Holgate (1992) in which academics, translators and engineering practitioners were consulted about communication skills requirements for entry-level engineering technicians; respondents answered a resounding "*yes*" to the question: "*Is there a need for engineers to have a technical vocabulary?*". Significantly, the majority of the respondents stated that technical vocabulary need not be taught because it was easily acquired as and when necessary. If technical vocabulary is taught, it would be difficult, according to Holgate (1992) to imagine a predetermined syllabus which would provide students with word lists and reading exercises in all the specified areas. The present author feels doubtful whether undergraduates acquire a sufficiently comprehensive vocabulary in their own language, to assimilate a general vocabulary in another.

Some engineering practitioners argue (according to the pilot study by the present author), that the main requirement is for a good basic knowledge of the language and that technical vocabulary can be acquired quickly on the job, as and if necessary.

2.3 Reading Skills

Selzer cited by Ziv and Lynch (1989 : 118) defines readability as follows:

> "*Readability is simply the efficiency with which a text can be comprehended by a reader, as measured by reading time, amount recalled, questions answered, or some other quantifiable measure of a reader's ability to process a text.*"

Ziv and Lynch (1989) also cited the work of Davis (1975) who in his study of comprehension of technical information indicated that

> "*comprehension was higher when drawings were present than when they were absent. When drawings were present, the presence or absence of the verbal description of the machine and its parts made no difference in comprehension*" (120).

According to Anderson (1988), communication is a cooperative activity among readers, writers and texts. That is to say, communication does not so much transmit meaning as it allows an interaction between readers and writers to take place. Anderson builds on the concept of discourse amenities; that the reading expectations of different communities, rather than universal rules or norms shape the conventions a writer may use to interact effectively with readers. Anderson focuses on individual readers and the dynamic relationships between reading and writing. He maintains that writers who understand how individual readers create meaning can learn to write effectively for them. The present author suggests that the primary goal of a workplace reading programme should be to increase workers' ability to perform job-reading tasks, thereby improving their job performance and enhancing their employment qualification skills, potential for retention and promotion and self-esteem.

Anderson suggests that teaching job-specific reading competencies with actual job-reading materials helps workers see that the purpose of instruction is their achievement of job proficiency. According to Grover et al (1990), job entry standards for business and industry set by employers do not always relate directly to the skills required to perform the tasks for which employees are hired. The context of workplace reading includes the demands of the job tasks, the perceived purpose of using the material and the availability of information from other sources like co-workers, supervisors and trainers. Rose and Lewis (1980) believe that academic reading as distinct from workplace reading, usually involves application of the reader's general knowledge and reading ability. Such reading is usually done in isolation.

On-the-job reading requires workers to decipher explanatory writing that is not clear, to discriminate between important and trivial messages, to respond rapidly to messages and to learn and develop specialised vocabulary. "*Time is money*" is a fact of life in industry. Thus, in proportion to the message that must be conveyed "*conciseness is valued almost as much as clarity*" (Grover et al, 1990 : 91). Technicians need job-occupational literacy; meaning the ability to perform job-related reading and writing tasks demanded in the workplace. According to Grover et al, on the job workers spend an average of 1½ - 2 hours per work day reading forms, graphs, charts, schematics, manuals and computer terminals.

The most critical success factor for training in workplace basic skills is the achievement of a precise match between job-specific tasks and traditional educational instruction. Consequently, a specialised area of training expertise that combines workplace knowledge and classroom instruction has recently evolved. Experts from those fields develop and implement effective curricula that use workplace knowledge to teach employees how to learn while simultaneously improving their ability to perform current job-reading tasks.

According to the research conducted by Taffy (1988), integrating across text structures is quite difficult for students. Spivey (1984) as cited by Taffy, examined university students who were involved in reading more than one text and wrote summaries that required integrating information across texts. Students had difficulty in selecting important information and integrating it. One reason according to Spivey (1988 : 4 - 5) that readers have difficulty in synthesising or integrating information from expository texts may be that "*they lack awareness about the differences among text structures*". If they lack this knowledge they may be unsuccessful in searching and locating important information. Briggaman and Sliva (1988) have recognised the increased productivity when employees are able to read rapidly; therefore many have included speed reading training in staff development seminars. It is the view of Briggaman and Sliva that "*reading is not an isolated skill; it is a process*" (36).

In order to read effectively, a person must be able to interact with print, to understand the author's meaning and purpose and to apply what has been read. Briggaman and Sliva believe that before reading can be meaningful, students must have the ability to manipulate language through speaking and listening.

The ability to proofread is important for both educators and the business community. According to Briggaman and Sliva the reading skills that underlie the ability to proofread include diction, word recognition skills, spelling skills, mastery of vocabulary and reading and comprehension. Students pursuing business and technical careers should be able to read at an appropriate technical level to survive the highly technological marketplace.

Research by Mikulecky and Winchester (1983), as cited by Rose and Lewis (1989) revealed that the ability to read and apply information obtained from complex textual and graphic materials is a major factor in determining success in the workplace. Rose and Lewis also refer to Thornton (1980), who asserts that reading needs to be addressed as a vocational skill and that reading instruction is appropriate in the engineering curriculum. Thornton found in his research that generally, the reading deficiencies of vocational training students are considered as academic drawbacks and should receive some form of additional tutoring/bridging.

According to Briggaman and Sliva (1988), a United States Department of Labour's Study reported that Motorola, Inc., spent 60% of its employee training budget on remedial mathematics and reading skills. This makes a strong case for a substantial inclusion of time to be allocated to reading skills in the engineering curriculum at technikons in South Africa. Research in workplace literacy by Mikulecky and Diehl (1980) as cited by Rose and Lewis (1980) has indicated that 99% of workers in both high and low level occupations spend an average of two hours a day reading job-related materials.

It seems reasonable to conclude that as people move from entry-level positions within business organisations, they spend more time reading both internally and externally

generated business communications and need increasingly sophisticated reading skills.

Educators according to the study by Rose and Lewis (1980) have found that they can improve student performance in business classes by infusing reading skill instruction with business content.

Spretnak (1987) found that on the average, engineers spend 25% of their job-related time writing, 23% reading technical and business material, 11% supervising the writing of others, and 7% giving oral presentations. More than 50% of an engineer's work is comprised of communication tasks. Once an engineer progresses beyond entry level, he or she spends a good deal of time reading technical material, analysing it, and responding to it. According to a Berkeley Alumni survey, as cited by Spretnak (1987), supervisors spend an average of 10% of their time critiquing the writing of others, but this amount nearly doubles when engineers move into positions of Project Head, Departmental Head or Division Director. Critical reading skills may be seen as a requisite for such advancement. Engineers at all levels must be able to assimilate written, technical information efficiently. One respondent in Spretnak's survey made a comment that too many engineers read for details and miss the overall view. Critical reading skills seem essential for advancement in an engineering career. The majority of the respondents to the Berkeley Alumni survey shared the opinion that if one does not read, one may find it difficult to write well. The survey also showed a positive correlation between writing skills and the amount of time engineers have for leisure.

It is the view of the present author that whilst the core of a technical writing course may be a number of writing assignments, many of them can be designed to incorporate the reading of technical literature, such as the well edited articles in journals published by several of the professional engineering societies. Spretnak (1987) maintains that to ensure that students learn to read closely, not merely scan, the lecturer/instructor can require them to analyse critically an article, essay or brief report in an area of engineering.

It is suggested that students of a well-structured technical writing course could soon develop an awareness of the distinguishing features of good or bad writing.

Analytical reading surely helps to prepare engineering students for supervisory tasks, which involve critiquing. Spretnak is of the opinion that reading also helps engineers learn to write. From this it seems reasonable to conclude that incorporating reading exercises into a communication skills course for engineers is very important.

While most students learn to read, many have difficulty in transferring these skills to the content materials they are expected to use. The present author believes that it is important to know how to instruct students so that they are best able to study and learn from the information presented in the printed materials they use each day.

An important goal of vocational education is to prepare individuals for work, and students enter technikon education programmes expecting instruction in skills that will prepare them for work. In order to satisfy these goals, according to Briggaman and Sliva (1988), instructors/lecturers should know how much reading is necessary, what kinds of literature must be read, and what skills are required to attain, maintain and achieve upward mobility in employment or lateral transferability across employment clusters. This means that a high priority for reading in a communication course for engineers must be the development of the ability to read for occupational competency. If the goal or outcome of the engineering education programme is to ensure that students enrolled in the programme can read the literature required to enter and survive in an engineering-related occupation, then establishing the reading levels of those materials and of the students entering the programme, and then considering those levels during classroom instruction is one means of ensuring student success in the programme and in the workplace.

2.4 Information Retrieval and Research Skills

Michel (1991 : 297) states:

> " ... *engineers need to be aware of the important role of information and communication in their day-to-day lives.*

They also need to understand and master what happens in their environment, what users of technical devices or products want and how the worldwide economical and industrial exchanges influence their own work".

Herein lies the importance of information retrieval for engineers. An engineer must be prepared to keep abreast with knowledge in his/her field throughout his/her professional life. Engineering technicians today need surely to be competent at screening and evaluation of appropriate information in their field of work.
Lossouarn (1991 : 213) states that

"*They must possess the method of detecting or spotting this and must manifest the aptitude to evaluate it, and if necessary integrate it into their field of knowledge and/or professional practice.*"

Lossouarn also states that "*creating the reflex of going to look for pertinent information is today a major objective in the training of engineers*" (215). He arrived at the following conclusions which are (in summary) as follows:

* Engineering education is incomplete without the skills of knowledge acquisition, information retrieval and documentation techniques.
* Engineering technicians must possess the ability to detect and process specialised information.
* The transmission of information must have its rightful place in the training process.
* Engineering technicians must be able to engage in interpersonal communication effectively with diverse specialists; to communicate concisely and precisely to multicultural and diverse people.

Erdmann (1987) believes that the engineering profession should encourage and promote information-gathering skills because students will need to know how to find information on current technological developments throughout their career.

It is important to determine what sources are most commonly used and appropriate in the engineering student's respective profession.

The words of Lossouarn (1991 : 220) very aptly summarise the importance of information gathering skills for engineering technicians:

> "... *the ability to find and process specialised information is today indispensable. ... for engineers are more and more men and women of communication.*"

2.5 Oral/Spoken Skills

Research according to Bellamy (1988), identified oral communication as a major factor in the communication process. According to several well-known research studies, the words spoken in face-to-face interactions account for 35% of the total meaning produced during the communication process. Many elements that affect oral communication are culturally bound. In other words, the message is determined by the culture and interpreted in the context of subtle situational cues.

In Wheelock and Zekeri (1988) respondents rated oral communication skills as most needed in industry. High ratings were given to written and spoken communication skills. According to Grover et al (1990 : 49) reading and writing are essential tools in industry, but "*it is through listening and speaking that employees interact most frequently*". Among the skills most basic to individual and organisational success, the skills of communicating orally and listening intelligently stand out.

Grover at al (1990) believe that people who lack proficiency in the skills of oral communication are handicapped not only in communicating with others, but also in learning for personal and professional development. Workers who can express their ideas orally and who understand verbal instructions make fewer mistakes, adjust more easily to change, and more readily absorb new ideas than those who cannot. Thus career development is enhanced by training in oral communication and listening, because these skills contribute to an employee's success in areas like interviewing, making presentations at or conducting meetings, negotiating and resolving conflict,

selling, leading, assertiveness, teaching or coaching others, working in a team, retraining and giving supervisors feedback about conversations with customers.

The strategic importance of oral communication skills in today's workplace has been amply documented and cannot be overstressed. To provide good service, employees must be trained in more than the technical aspects of their jobs, they must learn how to talk to customers , listen to them, handle their complaints courteously, deal with them even if they are difficult or unclear in their demands. Oral and listening communication skills are crucial to the smooth operation of a competitive venture. So is the resolution of conflicts, and providing meaningful feedback : which all hinge on the capacity to speak and listen well.

Workers spend most of their day in some form of communication. They communicate with each other about procedures and problems, and they relay information to and receive it from customers. Grover et al (1990 : 149) believe that

> "*employees who lack proficiency in oral communication and listening are handicapped in enhancing their personal and professional development.*"

Moreover, business leaders estimate that deficiencies in these skills cost employers millions of rands each year in lost productivity through errors. Carl Jung, as cited by Grover at al (op. cit.: 150) defines oral communication as the "*sharing of meaning*". Oral communication is a dynamic process, an ongoing interaction of elements that change as they interact.

It would appear from the literature that to be effective communicators, people must understand their own basic communication style, understand and value different styles, and adjust their own style to suit the style of others. For example, from an employer's perspective, an employee's competency in or mastery of oral communication skills may be demonstrated by the ability to handle complaints satisfactorily. Corder (1990) believes that speaking positively can promote better communication socially and in the workplace.

Combining the proper attitude with the right words will help a person succeed in getting the message intended across to his/her audience.

Haynes (1987 : 1), states that basic communication classes, particularly for engineers and scientists, should primarily address the restoration of an oral experience of the shared and sounded word. The high technology demanded by industry places such heavy demands on technical curricula that there is limited time allocated to the social skills. Haynes says quite appropriately that

> "*perhaps the greatest evidence that can be offered to stress the virtue of orality is that the computer only works well in consort with its human belief system*" (Haynes, 1987 : 20).

In other words the speaker must believe in what he/she says. Haynes also states that the speaker has to draw from his/her mental computer the following data:

* thorough knowledge of the subject
* audience awareness
* the speaker's own oral style
* an understanding of the theory behind the communication process.

Heugh and Tschirgi (1974), as cited by Parkinson et al (1988) noted that oral communication in the form of small-group or interpersonal meetings was common at entry-level positions. The respondents to their survey stated that personal and informal speaking situations at that level were frequent. Listening skills rated the third most frequently used skill, while the fourth was persuasive speech skills in selling ideas to colleagues. Formal oral presentations ranked fourth among oral forms of communication.

In Parkinson and Broderick (1988 : 202 - 203), findings revealed that

> "... *in business and technical professions, oral presentations form one part of an entire field of communication activities required for optimum job performance*".

Oral presentations can obviously be highly influential as these presentations support an opinion with a combination of personal presence.

It seems that lecturers/instructors should provide students with opportunities to present information orally. The more practice students receive, the easier the transition will be to business situations. Presentation skills in business rely on two aspects, content and process. Content is defined as being the explicit information being transmitted and process as being how a message is sent, that is, tone of voice, body language and the hidden or implicit messages that may be present (Gordon, 1988). According to Gordon, "*mastery of subject is a most important asset but speakers still need to be good presenters*" (20). Gordon believes that it is important to learn the language of the listeners; every profession has its own set of distinctive terms and expressions. According to Turner, as cited by Gordon "*body language conveys 40% of your communication message*" (Gordon op. cit.: 25).

Role-playing, case problems, and one-on-one or small group exercises can demonstrate to students the power of personal communication skills in satisfying customers' needs. As with writing skills, the responsibility for developing effective speaking skills according to Gordon should lie not only with the communication lecturer/instructor but with all instructors/lecturers in engineering courses, because it takes repeated practice to become proficient in a language.

According to Kahler, (1993 : 48), if our students are to become effective communicators in the target language, lecturers/instructors should provide ample opportunities to develop in the classroom "*the type of interactive skills that most closely approximate communication in the real world*". Both writing and speaking have entered a new era, one in which students need special skills to use the technology effectively for communication in the workplace. Lundgren (1988 : 69) believes that "*business communication has become to a large extent electronic communication*". Examples would involve the use of e-mail, world-wide internet and websites.

According to Bellamy (1988), current research has identified body language as a major factor in defining the communication process. Although body language is sometimes an unconscious activity, the message(s) conveyed can be controlled somewhat during the process of communicating. To have a clear understanding of the interrelation between verbal and nonverbal communication is of prime importance in today's world because people exchange a great deal of meaning nonverbally. As an employee advances in industry, his/her ability to speak convincingly, as well as his/her writing skill becomes increasingly important. At meetings an individual may be called on to explain the results of investigations, propose solutions to problems, report on the progress of projects and justify his/her department's requests for more employees and equipment. Every kind of formal written report supplements a written one and often an oral presentation takes the place of a written report.

In terms of the amount of time that people devote to various types of communication skills, speaking skills rank slightly behind listening skills (Gordon, 1988). According to Gordon, lecturers/instructors should include the following in their instruction: basic principles and techniques of speaking, forms of support for ideas, organisation of ideas, effects of language on ideas and listeners, use of speech to inform and to persuade, communicating with groups and interviewing skills. Interestingly, in a study done by Biersteker (1986) it was found that the interview is a powerful indicator of functional communication skills and its reliability has been tested and validated. Herein lies the power of the spoken word. In a survey conducted by Yin (1986), it was found that estimates of the time spent in an oral communication of one kind or another, on-the-job ranged from 70% to 85%. Significantly, none of the employees had received any formal training in oral communication. The present author believes that an oral skills course/module is particularly important because this aspect of communication is either neglected or given too little time in an engineering student's professional training.

It is further the view of the present author that classroom activity should be as authentic as possible, giving students roles they can recognise or identify with and roles that involve their engineering knowledge.

It seems reasonable to conclude that there is no substitute for actual use of language in a realistic interaction. In such situations the students are utilising the particular procedure, thought processes and problem-solving strategies typical of their discipline, while at the same time learning how to participate in discussions in appropriate ways.

When every lecturer/instructor shares in the responsibility for developing the listening, speaking, reading and writing skills of students, then engineering programmes at tertiary level can truly be credited for providing lifelong skills.

2.6 Listening Skills

The need for and importance of effective listening is given much emphasis by Rose and Lewis (1989). They note that although listening is the most frequently used communication skill, it receives little instruction time. Workers spend about 60% of their work-day listening. On an average, only 8% of instruction in communication skills is directed towards listening. Recognising that poor listening skills are costly, business and industry have often instituted listening training programmes. According to Carnevale (1990) the need for listening instruction was recognised by a Committee of the Association for Business Communication. In a survey done of business executives, it was concluded that listening instruction should be increased. Moreover, in a survey by a professional organisation of educators who teach business communication, the educators agreed that listening is a critical skill and should be taught (Carnevale, 1990).

The present author learned during her pilot study that because most engineering technicians have had no training in the critical skill of listening firms, suffered financially through misunderstandings and errors caused by poor listening habits.

Apart from this, much physical and emotional stress results from countless breakdowns in communication caused by poor listening habits.

While listening skills are widely recognised as important for both personal and professional development, most employees receive little or no formal instruction in listening. As a result both students and employees tend to be ineffective listeners who typically function at about 25% efficiency, according to researchers. Lecturers/instructors in subjects other than communication should also teach and positively reinforce throughout the curriculum, the use of specific techniques that increase listening proficiency (Summarised from Carnevale, 1990).

Listening skills in business and industry as in personal life allow insight into meanings and messages. In Bennet and Olney's (1988) study, listening was one of the top five skills listed as a common problem by respondents. An active listener uses acquired skills that focus on what is expected. According to the source, these skills are:

* asking appropriate questions
* jotting associated thoughts alongside notes so that appropriate questions can be asked
* paraphrasing what is heard
* restating if any misunderstanding occurs
* summarising the instructions.

The image of an active listener is that of a person who is interested, content orientated, concerned about the outcome and eager to explore options. According to Costner (1988 : 12),

> "*Approximately one third of a person's waking hours are spent listening either in school, in social interactions, at home, or on the job. Listening is well over half of any communication process*".

It is generally felt, according to Costner, that what one says is important, not necessarily what one hears. This is confirmed by the amount of time educators spend developing reading, writing and speaking skills compared to the small amount of time spent highlighting listening skills.

Active listening calls for concentration, absorption and registering mentally as many of the details as possible. It requires active participation and thinking. It seems reasonable to conclude that active listening is required by industry for optimum job performance and by the classroom lecturer/instructor for optimum learning in the classroom. Costner believes that cognitive listening is concerned with evaluating the information, not the speaker. Cognitive listening also involves the perception of nonverbal cues which influence communication as much as the spoken word.

However, a significant part of the message is derived from nonverbal cues such as posture, tone of voice, appearance, facial expression, eye contact, mannerism and rapport with speaker (Costner, op. cit.).

The development of a successful employee is dependent upon listening and following through on the assigned projects/tasks. Many corporations have added listening training to their in-house training programmes for engineers. The rationale for this emphasis is based on the belief that listening is in fact a communication skill and that efficient listening is just as important in improving communication between employees as any other skill (Brostrom, 1988). In the United States, major corporations such as General Motors, General Electric, Xerox and others, offer listening in-service programme training to their personnel at all levels of the organisational hierarchy. These companies believe that employees must be effective listeners if they are to be effective in their workplace. Listening is frequently identified as the skill most needed to increase profits or productivity. Instructors have the obligation to make their engineering students conscious of the need for effective listening skills and to provide instruction and practice to develop this. Employers are concerned that as larger numbers of people are employed in information-related jobs, fewer new graduates can follow simple directions, listen and respond to oral and written inquiries, or edit and make corrections to simple business documents. While these skills are priority concerns, business people now stress the critical need for employees who can actively listen, understand and follow directions. Employees need these basic communication skills in order for their companies to compete in today's high-tech society, especially since they use communication skills approximately 70% of

their working day. Although communication methods are changing with advances in electronic media, good communication skills are still needed to create those messages.

2.7 Organisational Skills

Organisational culture has been defined by Kortner (1988) as a system of shared values (what is important) and beliefs (how things work) that interact with a company's people organisational structures and control systems to produce behavioural norms (the way things are done around here). Central to organisational communication is the idea that people in organisations have positional roles that control how they communicate with others. In other words, employees become the kinds of communicators that their organisation expects them to be. The study of organisational communication involves the complex relationships between people and the organisation. Flad (1988) believes that in order to enhance one's knowledge of organisational communication, a study of the following should be made: information flows, managerial and leadership styles, motivation, communication styles, group communication, communication systems and their influence on messages and communication policies. Such diverse subject matter allows the lecturer/instructor an opportunity for developing a solid foundation of organisational communication theory.

According to Frey and Finan (1991), a successful engineer needs skills in group interaction and management. Most companies, they believe, find that today's graduate lacks the ability to step into a job and become immediately productive. Key shortcomings are skills in communication including teamwork and project management skills. Effective organisational communication is costly, according to Peeples and Morse (1988), both in human terms and in monetary terms. Ineffective organisational communication is very costly.

It seems that the time and effort spent to develop and nurture an effective system of organisational communication is well worth it in both human and corporate terms.

Ensuring that all employees in organisations from the chief executive officer downward possess effective communication skills is no longer driven by humanistic considerations alone.

> "*The abilities to work with managers, peers and subordinates to obtain critical information to develop collaborating relationships and to function as effective team players are often the determinants of career success. Without these skills, people offer little of value to an organisation regardless of their technical or functional abilities*" (Flad, 1988 : 63).

The development and application of organisational communication skills results in a concerned and committed workforce that is successful and profitable in a highly competitive environment. Communication requirements will vary in organisations depending on goals and nature of business. However, there is a certain aspect of communication, according to Karathanos and Pettypool (1992), which is crucial to creating a favourable working climate in all organisations. Rogers and Kincaid, as cited by Karathanos and Pettypool, note that the most basic principle of human communication is that the two way process of communication most often occurs between people who have similar characteristics, common meanings and similar value systems. Employees who are not part of the organisation's communication network

> "... *perceive communication to be closed to them, they are relatively disgruntled with the organisation and they often keep information to themselves*"
> (Karathanos and Pettypool , 1992 : 100).

McLaughlin and Cheatham, also cited by Karathanos and Pettypool in support of this, found in their research that

> "... *despite equal pay and promotion policies, employees left out of the communication network were enjoying less job satisfaction than their more fortunate colleagues who knew exactly where they fitted in on the organisational organogram*"
> (ibid., 100).

They concluded that employees isolated from others may suffer low morale. It must be pointed out however, that sometimes an employee may choose to isolate himself/herself from others. This is another problem that must be addressed by management, because it was found in the investigation by Roberts and Reilly, as cited by Karathanos and Pettypool, that participation in communication networks was positively correlated with high performance rate.

The importance of effective communication is generally recognised among employees in organisations. Communications network analyses can be used to understand who communicates to whom in an organisation, how often, and what it might mean. Flad (1988 : 47) states that

> "*Emphasis in organisational training is placed on employee involvement in order to increase productivity and to accelerate performance in order to compete within the business environment*".

Communication within organisations represents one of the primary forces that optimise the contributions of individual workers. This is accomplished by developing team-working skills and interpersonal skills. Flad also states that "*training and development within the human resource framework is seen as a tool for driving business strategies by recruiting, selecting and developing people*" (idem.). Attention must be given to training as a means to carry out individual development leading to improved performance on the job.

Flad points out that several communication activities can be identified within an organisational environment: understanding perceptual differences among people, managing conflict, managing individual communication, managing communications on different organisational levels, improving communication within a group, developing networks among people within the organisation, communicating personal ideas, long-sighted goals/objectives, oral presentations, meeting procedure and providing feedback.

He believes that :

> "... *by recognising various communication styles, recognising how people react to tension and developing communication strategies based on the needs of others, people will be better able to obtain and share critical information*" (Flad, 1988 : 51).

Basic training in organisational effectiveness is geared towards providing the engineering student with an understanding of what organisations are, why they exist and how one can "*navigate the complex social matters of varying types of organisations*" (Carnevale, 1990 : 59). Once armed with this basic framework, the student is exposed to the organisational culture and traditional modes of operation. Finally, training in skills that make the employee a fully functioning member of the organisation include interpersonal and group dynamics.

According to Carnevale (1990) organisational effectiveness skills are the building blocks for leadership. Organisational effectiveness skills help employees learn how to behave in a given situation to measure up to an organisation's internal rules and regulations. Because the ways in which people communicate strongly influence a team's potential for success,

> "*Effective communication should be considered the foundations on which other teamwork skills such as leadership, problem-solving, conflict resolution, interpersonal relations and task orientated productivity skills are constructed*"
> (Carnevale, 1990 : 337).

The task force reported by Brown (1989) identified the following skills profile for teamwork skills. Employees wanted a person who could:

* identify with the goals, norms, values, customs and culture of the group
* communicate with all members of a group
* show sensitivity to the thoughts and opinions of others in a group

* use a team approach to identify problems and devise solutions to get a job done
* show sensitivity to the needs of women and ethnic and racial minorities
* be loyal to a group (Summarised from Brown, 1989).

According to the present author's pilot study (1989) most engineers are not adept at organising and managing a team or even participating as a team member. It was found that engineers in private practice who demonstrate exceptional technical skills usually advance into positions with management responsibilities. However the lack of management training makes it difficult for them to assume these responsibilities.

It seems reasonable to conclude that if engineering students are to function effectively in industry, it is essential that instruction in the principles of good management be made available to them.

At Queensborough Community College, Bayside, New York, critical analyses, problem-solving and teamwork are seen as occupational needs of every student so that the thinking and learning that writing encourages will be of as high an order as possible (Stanley, 1990). Teamwork skills increase commitment, improve decision-making and encourage innovation. In an engineering world leadership involves communication and interaction.

Groupwork fosters a sense of community, prevents isolation and improves communication (Gardner, 1991). Engineering technicians will share their day with others who have different perceptions, assumptions and goals. Employers want people who are teamworkers yet capable of assuming individualised tasks and other responsibilities. Being a team worker means striving to achieve department goals. Teamwork involves a great amount of sharing information, forming strategy to complete tasks and analysing end results of a project. In the past two decades, there has been a tremendous increase in the use of teams in the workplace.

"*The team approach has been linked conclusively to higher productivity and product quality, as well as to increased quality of work life*" (Carnevale, 1990 : 57).

Employees today clearly need significantly higher basic skills. The new autonomous worker should have personal management skills to maintain self-esteem, set goals, and be motivated. As full members of an autonomous working team, these employees need higher levels of interpersonal, teamwork, negotiation and organisational skills and skills that enhance group effectiveness. At various points in the production or service process, each individual member of the working team should possess leadership skills. Carnevale (1990 : 36) believes that

> "*to be effective in their organisation, employees must understand how their own personal goals and objectives fit into the organisation's culture and strategic goals*".

With this understanding employees can influence the organisation to use and develop their skills in a mutually productive way. With competition being so strong in the market place for jobs, employees should be more responsible for their own career development and job security. It is probable that an examination and analysis of a company's overall communication network may provide some significant guidelines for increasing the organisation's communication effectiveness. Lecturers/instructors of organisational writing skills can help students by making them explicitly aware of a general need to adapt writing to the needs of the working environment.

The manner in which organisations and the people who work within them use language is directly related to the concept of organisational culture, since language is the prime element with which values are articulated. Kortner (1988) believes that students will always be in an organisational, bureaucratic world where organisational hierarchy is a fact of life. Treadwell (1989 : 264) states that *"communication content is determined ultimately by organisational policy rather than the end user"*. Treadwell believes that communication specialists may have a major responsibility for adapting technical material to audience needs, but content is controlled ultimately by organisational policy and enforced where necessary by organisational procedure.

Closely linked to organisational skills are management, interpersonal, teamwork, and problem-solving skills. Roberts (1988) maintains that it is impossible to be an effective manager without being an effective communicator. Because effective managers get things done through other people, delegating and communicating instructions accurately is very important. If instructions are not given in a way that promotes understanding and professionalism, the result may be that jobs may not get done correctly or they may not even get done at all. As a manager one will be speaking with people of various backgrounds, and one must be able to make them feel comfortable. The most basic and recurring consequence of poor communication according to Roberts, is that the receiver understands the message differently from the way it was intended. This can cause aggravation of a superior, defensive and hostile attitude and/or negative evaluations which could lead to a reprimand or dismissal. Roberts (op. cit.) reminds us that effective communication is much more than speaking and writing well. One must choose one's words carefully and know when to talk or when to remain silent. Communication is an activity which workers engage in most of the time and is going on in many different ways through a variety of verbal and nonverbal channels.

According to Beaufait (1991), students entering the engineering profession in the year 2000, will need management skills because they are likely to assume managerial positions earlier in their careers. The reason could be attributed to the fact that generally speaking graduates are much younger today, and they bring a great deal of innovation into the workplace. Beaufait goes on to state that *"creative thinking will also be essential for all engineers and of course effective communication skills will continue to be important if not critical"* (426). Apart from this Beaufait maintains that engineering students need a broad education in the humanities and social sciences.

Most projects require attention from engineers and technicians representing various disciplines, and herein lies the importance of teamwork. Engineers also need management skills because those who demonstrate exceptional technical skills usually advance into positions with management responsibilities.

If they are to function effectively, it is essential that instruction in the principles of good management be made available to these individuals.

Carnevale (1990 : 211) believes that "*Personal management skills are the building blocks for good morale, a focused work life, and even organisational productivity*".

The development of interpersonal skills in engineering students should be an integral component of any communication course. Craig and Steinfatt (1989 : 138) define interpersonal communication as "*the process of exchanging mutually understood symbols between two people*". It involves five sub-processes:

* the formation of meaning
* the phenomenological construction of a message
* the physical delivery of a message to another person
* the interactions between the two
* the internal reactions of the participants to what is taking place.

It is widely accepted according to Mainwaring and Markowski (1991) that interpersonal communication work styles and methods and work organisations are by no means universal. Interpersonal skills are considered unique since they are so dependent on the individual. Because they involve more personal contact with people, they are different to some degree from written or verbal skills. Yet they are crucial for workers in industry. According to Flad (1988), people are often retrenched, not because they lack specialised knowledge and skills, but because of not being able to interact effectively with co-workers and management staff.

According to Yin (1988), students experience problems with communication as an interactive process. This problem can be viewed as a confusion of form and function. Students have difficulty in matching their interaction with the social conditions prevailing on any particular occasion. It seems that inappropriateness of tone and language is a serious communication problem, as it is likely to affect interpersonal

relationships and create problems for the individuals involved and ultimately for the organisations they represent.

A similar problem is expressed by Pavelish et al (1984), who believe that graduates' shortcomings include poorly developed interpersonal and communication skills.

Smeltzer and Gebert as cited by Scott (1988) found in a survey of graduates from agriculture, business, engineering and physical sciences, that interpersonal communication received top priority among all four professions. Interestingly, the respondents spent approximately 14%, 6% and 39% of their time in informal group discussions, formal group meetings, and face-to-face communication respectively. The implications are that interpersonal functions are a very common occurrence in industry and an important basis for keeping a job. The uniqueness of interpersonal relationships is the individual. Not everyone works quite the same way or achieves goals in the same manner. With good interpersonal skills, workers in industry can learn how to work successfully with many groups of people and levels of supervisors.

Workers in industry will share their day with others who have different perceptions, assumptions and goals. Industry is inclined to employ people who are team workers, yet able to retain their individualism in the sense of assuming responsibility and completing tasks. It is important that entry-level technicians in industry understand how to perform work tasks and set goals compared with others, what frustrates them when working with others and what to expect when they conduct business with clients. Students must know what industry expects of them, and this should be the responsibility of all lecturers/instructors of engineering programmes. Possessing communication skills and transferring them to business practices benefits both employees and employers. Brostrom (1988 : 9-10) maintains that "*communication skills and job performance are keys to success in the business world*".

Flad (1988) believes that the ability to collaborate with others comes from possessing good interpersonal skills. Flad is of the opinion that within the business context, the ability to work across the organisational hierarchy is crucial for success in providing quality products within a specific time frame at a competitive cost.

Collaborative skills allow for all the sources of information that are necessary to develop a solution to be exploited, through sharing and team-work. Research supports the notion of "*optimal communication existing in a collaborating environment*" (Flad, 1988 : 54).

According to Pubis (1987), customer relations and interpersonal communication is a very high priority concern in technical field service occupations. Pubis also believes that communication skills, attitudes, values and personality are very often the key criteria in employee selection.

In a study conducted by Heugli and Harvey (1974), cited in Parkinson and Broderick (1988), it was found that most professionals need interpersonal communication skills far more than public-speaking skills. Motivating, delegating and listening skills should be stressed in a business communication course according to Hanna cited in Parkinson and Broderick (1988), who discovered that these were the most poorly performed communication activities in business.

According to Carnevale (1990 : 29) "*Competitive challenges are driving companies toward employing an array of strategies that require adaptive and innovative workers with strong interpersonal skills*". Business strategies such as collaboration, exemplary customer service and emphasis on quality demand teamwork, listening skills, the ability to set goals, creativity, problem-solving and decision-making skills. It is easy to see that a variety of skills must be applied if employees are to succeed in the market-place.

There is clearly a demand for employees who have a broad set of skills that were previously required only of supervisors and management staff. Organisations consist of individuals with differing opinions and operating styles. Whenever people work together, successful interaction depends upon effective interpersonal skills, focused negotiation, and a sense of group purpose.

Interpersonal skills training can help employees recognise and improve their ability to determine appropriate behaviour, cope with undesirable behaviour in others, absorb stress, deal with ambiguity, structure social interaction, share responsibility.

> "*Teamwork skills are critical for improving individual task accomplishment at work because practical innovations and solutions are reached sooner through cooperative behaviour*" (Carnevale, 1990 : 56).

In the past two decades there has been a tremendous increase in the use of teams in the engineering workplace. According to Carnevale "*the team approach has been linked conclusively to higher productivity and product quality, as well as to increased quality of work life*" (57). Individual employees also need the basic skills that allow them to interact effectively with other members of the working team. To do this, they must know how to listen and how to communicate their thoughts clearly. Effective interaction involves knowing how to influence others within the organisation. Employees must also be capable of recognising when, where, and how they should assume a leadership role.

Communication apprehension is a major area of interpersonal communication research that has considerable practical relevance to technical communication. Communication apprehension

> "*is the fear of communicating with another person. It refers to the fear and anxiety associated with interpersonal interactions and everyday human communication encounters*" (Craig and Steinfatt, 1989 : 153).

Lecturers/teachers at tertiary institutions need surely to address the problem of communication apprehension, defined as an anticipation or fear that creates anxiety when someone thinks about or is actually involved in a communication activity. If left unnoticed, it may lead to interference in the communication process.

According to Craig and Steinfatt (1989), data from national studies of communication apprehension indicate that approximately 1 out of every 5 adults is severely apprehensive concerning everyday interpersonal communication encounters.

Interestingly, a person may lack the social skills of interpersonal interaction yet experience no anxiety, according to Craig and Steinfatt. These writers point out that this works conversely too. Some highly communication apprehensive persons have learned to control their outward behaviours while invariably experiencing high levels of anxiety.

2.8 Problem-Solving and Cognitive Skills

It seems reasonable to assume that the ability to solve problems is important for an engineering technician. Success depends on the ability to produce workable solutions within given constraints, drawing upon scientific theories, mathematical procedures, logical thought and experiences. Skilled language is needed for problem-solving and for the presentation of solutions. Engineering technicians must be able to communicate their vision to their colleagues and to those who are going to be involved in implementing their plans and designs. At the same time they must be receptive to the ideas and concepts of others. Engineers do not only have to communicate orally; they must be able to produce written texts (reports, articles, correspondence) of a high standard and to use and interpret a wide variety of printed materials. According to the pilot study of the present author (1989), a highly skilled technician will not necessarily make a good engineer unless he/she has mastered the effective use of language.

An organisation's ability to achieve its strategic objectives often depends on how quickly it can effect problem-solving and creative thinking. Problem solving skills include the ability to recognise and define problems, invent and implement solutions, and analyse and evaluate results; skills that are frequently needed in engineering workplaces.

Carnevale (1990 : 53) believes that

> "*creative thinking not only requires the ability to understand problem-solving techniques, but also to transcend logical and sequential thinking and make the leap to innovation*".

According to studies done by Mikulecky et al (1987), as cited by Carnevale (1990), to communicate effectively whether it be filling in forms, writing memoranda or full length reports, employees should employ a problem-solving process. It seems reasonable to conclude that an engineering technician requires training in both problem-solving and creative thinking skills in order to perform at optimum level in the workplace.

Brown (1989 : 5) supports the views of Carnevale when he states the following: "*The ability to process information using abstract problem-solving skills is critical for workers in a high-tech workplace*". Brown concludes that

> "*concrete thinking patterns ..... can make a person unemployable and eventually unable to survive in a high-tech world that increasingly calls for abstract thinking skills*".

Banks and Railsback (1988) in their studies recommended that critical thinking be implemented to better understand and improve science and engineering education in colleges. Ziv and Lynch (1989 : 68) cites Garver who maintains that business communicators/instructors should teach

> "*prudent reasoning ... the ability required to take general values, desires and ideas and combine them with the facts and demands of some particular situation to arrive at a practical solution, a policy, an advocated action*".

Report writing, a specific area of technical writing is an important tool for the engineering student and is the final product of a long thinking process. This process involves conceptualising a given problem, analysing the findings, arriving at conclusions and thereby solutions and finally recommending action to be taken.

In order to work through the task of report writing, problem-solving skills are needed, together with the skill to research and retrieve information. All this requires the engineering student to think logically and creatively.

Briggaman and Sliva (1988) have criticised educators for not teaching the higher order skills such as decision-making, problem-solving and critical thinking. Developing critical thinking takes time and requires learners to integrate a variety of skills. These skills include understanding the problem or situation, thinking about or internalising the problem or situation, questioning, discussing, relating other relevant experiences, listing possible solutions and weighing pros and cons, selecting the best response, defending the selection and implementing the final choice.

In Donald (1991) findings revealed that "*problem-solving is the most prominent overall goal*" for engineering programmes (182). The instructors/lecturers expect their students to think logically, since the solution of any problem requires a series of logical steps. In three universities, Western Ontario, Cambridge and Stanford, problem-solving is a course on its own offered to students in the latter part of the engineering programme (Donald, 1991). Donald quotes the words of one engineering professor who said:

> "*In good engineering courses, the problems relate to the practice of engineering, so, in a sense the problems are more central to learning than the rules and concepts that are involved in them*" (191) .

It seems reasonable to conclude that course designers should take cognisance and be sensitive to the cognitive levels of their learners. According to Kotecha (1991), the most fundamental problem of second language learning is the imbalance between the learner's cognitive and conceptual abilities and the learner's linguistic level. Instructors/lecturers should find a workable method which enables both levels of the learners to be respected and appreciated. It is important to note that whilst the learner's linguistic competence might be low, knowledge of the specific subject discipline may be high.

According to the studies of Mikulecky and Drew (1988), as cited in "Related Skills in the Marketplace" Final Report (1989) higher levels of problem-solving and cognitive skills, not simply factual reading have a great bearing on overall job performance. Pond (1990) supports this view and believes that the skills of problem-solving, decision-making and learning-how-to-learn skills should be integrated throughout the engineering curriculum.

Mastenbrock (1983), as cited by Carnevale (1990) believes that negotiation skills are critical for the effective functioning of good teams as well as for individual acceptance in an organisation. Besides being important for building constructive relationships, skills in negotiating are basic and crucial to the problem-solving process at all levels of an organisation.

Clough (1987) concludes that effective communication skills can be the best and most useful tool one possesses in dealing with organisational and personal conflict. Conflict can damage an organisation by lowering staff morale and employee productivity. Clough believes that communicating with confidence, authority and power is not a skill that comes naturally to most of us. Yet, there are great personal and professional rewards for those who master this skill. Clough feels that nothing says more about one's potential for leadership than one's ability to communicate effectively and to mediate conflicts. In conclusion, he states that managing conflict requires above all else accomplished and effective communication skills.

Hadgraft (1992) concluded that the current tertiary engineering programmes are not designed to develop in students the critical, thinking and problem-solving skills needed by industry. It seems reasonable to conclude that problem-solving skills need to be developed throughout the student's engineering programme and through appropriate teaching style, examples collaborative learning in the classroom and participative teaching style.

Learning to learn is another important skill for engineering technicians, according to Donald (1991).

Engineers need to be able to verbalise and convince others that they do have for example, a decent design, even though others do not understand the technical language. They must be able to express it in accurate layman's language.

Engineering experts believe that engineers must learn how to make relationships, they should learn to solve problems on their own initiative. According to Fordyce and Robinson (1990), what is important in higher education is that individuals learn to learn from experience; they must develop their ability to handle specific situations. All students have different learning styles. Educators need to be aware of the fact that some students are aural learners and find lecture presentations very effective; other students are visual learners and find presentations with visual aids or independent reading assignments crucial to their academic success. There are other students who need to be active participants in a lesson to gain full meaning from the instructor/lecturer (Gomez, 1988).

As employees apply their learning skills, the employee's store of new knowledge is enriched. New knowledge eventually translates into efficient production, improvements in quality, and new applications for products or services. With good, solid workplace basics which include learning skills, the workforce can meet the challenge of change because "*employees continue to build on the knowledge and skills they need to adapt to innovations*" (Carnevale, 1990 : 33).

Other effects of technological change will increase basic skill requirements. Carnevale believes that technology is the means to product diversification. This creates a greater need for job-specific product knowledge and basic learning skills, strengths that help employees keep pace with development, design and production. To perform successfully in this situation, an employee must know how to learn.

Competitive pressures compel employees to shift workers between jobs and responsibilities, putting a premium on the ability to absorb and process new information quickly and effectively. In today's workplace, learning is an integral part of the engineer's life.

The skill of learning to learn is the key to acquiring new skills, and sharpening the ability to think through problems and to confront challenges in the workplace. Carnevale believes that "*knowing how to learn is the most basic of all skills because it is the key that unlocks future success*".

Each worker brings a different "*personal data base*" of experience and learning to the workplace (Carnevale, 1990 : 62). This base cannot remain static because human lives are a complex set of experiences responding to the need to adapt to changing circumstances.

In conclusion, the following statement must be noted: "*Learning how to learn is one of the most important attitudes for engineers and it is considered to be every bit as important as actual knowledge* ... " (Donald, 1991: 184).

2.9 Intercultural Communication

Communication literature abounds with examples of the necessity to communicate effectively in training and in a multicultural environment such as in South Africa. Communication skills play an even more important role in such contexts since

> "*the trainer must be conversant with and sensitive to the traditions and customs of his trainee population, as well as subtleties of language and expression in order to communicate effectively*" (Retief, 1983 : 1).

Language is an aspect of culture, and it is common to all cultures. Retief states that

> "*when an individual becomes a member of a linguistic community language plays an increasingly important role in his life because it is a symbolic system by means of which he understands and manipulates his physical environment*" (5).

It is therefore important that students are given instruction in the theoretical as well as the practical aspects of intercultural communication to prepare them for a diverse working environment.

An individual's first language has important effects in determining his styles of cognition, effective relationships and his internalisation of social structure.

Learning a second language and moving into its social context may result in tensions between the different intellectual and social relationships implied and emphasised by the two languages. The knowledge which both the communicator and the receiver have of the language is important and since there is a close relationship between language and culture, the cultural background of the receivers should be taken into account. Communication and culture are inseparably linked.

Retief cites the work of Cole and Scribner (1974), who state that problems of learning a language, perception, conceptualisation and problem-solving are all culturally relevant. It is largely because of value differences that the most intense aspects of culture clash. When one considers language, behavioural codes, moral norms, non-verbal patterns, perceptions, attitudes, thought processes and logic, it is the similarities and differences in each element that make intercultural and cross-cultural communication increasingly more complex. In African culture, it is considered disrespectful to look into the eyes of the person you are talking to. Not doing so is considered negatively in Western culture.

Retief (1983 : 5) states this about language:

> "*Language while being a product of culture, is simultaneously a screen for cognition and influences what the speaker perceives and the way in which he perceives it*".

One of the best ways to understand people is to gain knowledge of their culture. If culture is not taken into account, interference in communication can occur because a word is either strange or has different connotations for certain cultural groups so that ultimately the message is not reached as was intended.

Retief notes that aspirations have implications for communication and training in industry and employees' needs and values (which are components of aspirations) are as important as anybody else's in the company. Retief (1983 : 8) quotes the work of Kluckhohn and Strodtbeck's (1961) identification of four basic problems common to all human groups and cultures as important and interesting variables to consider in research on intercultural communication. These problems are human nature orientation, man-nature orientation, time orientation and space orientation. An understanding of such orientations and their variables is critical to those who expect to engage in intercultural communication. Although language is an aspect of culture it warrants separate consideration because of its importance as a medium of communication.

Verbal interaction can only really be successful if the communication is based on knowledge of the language and language usages of the receivers. Retief notes that in learning a second language/foreign language one does not necessarily learn to think in that language. Retief also notes that in technical education most second language students have great difficulties in following technical courses due to their inability to communicate in the language in which they are taught.

Retief (op. cit.) states that if management in industry are familiar with the cultural traditions of their second language employees, they can be spared many grievances. The second language worker is expected to assimilate overnight everything that is required by the employer, and he/she in turn finds that his/her own beliefs and traditions are not considered at all. The second language employee with little or no experience needs special orientation training in order to facilitate communication between worker and employer, and to facilitate his adaption to industry. It seems reasonable to conclude that in order to operate efficiently in a culturally diverse global business community, workers need to be skilled in intercultural communication. Employees should be able to understand the effects of cultural factors on values, beliefs, attitudes and perceptions of themselves and the communities they interact with. Communication courses at vocational institutions should focus on areas of verbal and nonverbal interaction across cultures, an

understanding of cultures that form part of the community they service and behaviours that prevent and promote effective communication.

The challenges facing instructors/lecturers of business communication obviously multiply as they interact with non-native speakers of English.

Although deficiencies in listening, speaking, reading and writing skills handicap many English first language speakers, the problems are compounded for non-native speakers of English. Educators of engineering students must acquire appropriate background knowledge like cultural and value differences, language barriers and nonverbal cues, before they can implement teaching activities that build the communication skills of non-native speakers of English. Instructors/lecturers who teach non-native speakers of English should cultivate and intensify those teaching-related traits that encourage and motivate non-native students to build their English language communication skills. Some of these traits could be open-mindedness, awareness and tolerance of other cultures and adaptability to other cultures (McCollough, 1988 : 80).

There is a definite need according to Gomez (1988 : 95) to develop a global viewpoint that would focus on, among other things, awareness of common goals and aspirations as well as respect for different value systems of other cultures. Intercultural communication education should focus on what happens to the message when the participants are from different backgrounds. Gomez believes that teachers of job-related communication can help improve cross-cultural understanding by being the change agents for developing awareness in their students about the need for and the usefulness of knowing about others whose beliefs, values and attitudes are different from their own. The end result could be a set of valuable skills that would assist them to be better informed and aware students, consumers or employees, as well as more sensitive and empathetic to cultural deficiencies.

The present writer suggests that when people develop a better understanding of intercultural differences, they begin to strengthen their communication skills. It has

become clear that there is very little that anyone does that is not influenced or affected by communication; yet it is often the area where the greatest difficulties are experienced. It is the responsibility of educators to expand the visions of their students by helping them develop the knowledge and skills that will make them more effective communicators in a culturally and linguistically diverse environment such as South Africa.

According to the research of Grandin (1988), the time has come for the humanist and the technologist to join forces and provide the next generation of students with the tools necessary for productive and rewarding careers in the global workplace. Many individuals in engineering faculties, in consultation with engineering practitioners in industry, surely believe that training should be provided to students in intercultural communication.

It is felt that engineers should be encouraged to study other languages and cultures. Grandin (1988 : 7) states,

> "*If we are to overcome our failure to compete successfully in the global marketplace, our professionals must be prepared to meet and deal effectively with counterparts from other cultures and with market conditions throughout the world*".

According to Grandin, "*engineers are not difficult to find and hire, but engineers with appropriate communication, social and intercultural skills are a rarity*".

In a survey conducted by Holgate (1992) there was overwhelming support amongst respondents for a thorough exposure to the language and culture of the target nation, at least in the sense of its business methods, conventions of negotiation, political sensitivities and general etiquette. A survey of industry in Holgate's study concluded that a lack of appreciation for customers can cause more problems than lack of knowledge of language. An ability to liaise with people is a must and an ability to speak their language is a bonus. According to Dickson (1982), the style of workers will vary depending on the skills they inherit from their communities that are directly related to their survival within the organisation.

Workers have different cultural experiences and consequently respond and react differently to situations at work. Mainwaring and Markowski (1991) believe that behind every activity, including the scientific and technical, is a human being whose motivation and behaviour is shaped by society, its political and economic structure, its cultural ethos and value system. Even those who rebel against it, do so in the context of this framework.

Martel (1993 : 25) states "*Diversity in learning, however, is not ethnic or domicile governed but individual*". He shows that research confirms that each individual performs significantly higher when learning in his or her own best way. According to Martel "*diversity must be understood as an asset, not as a deficit in need of remediation*" (26). Martel believes that instructors should capitalise on the strengths of diversity by evaluating, respecting and recognising differences that make a difference. This view is endorsed by academics such as Howard Gardner and David Perkins at Harvard; Robert Sternberg at Yale, and Ken and Rita Dunn at St Johns University. The importance of intercultural education should be recognised by South African educators in the tertiary sector, as the working environment is made up of linguistically and culturally diverse workers.

In conclusion, it seems important to note that leaders of institutions, corporations, colleges and technikons, increasingly speak about problems associated with increasingly diverse populations.

2.10 Humanities and Social Sciences in Engineering

Undergraduate engineering students and their advisors in many institutions in the United States are provided with a handbook to help improve the quality and coherence of the humanities and social science components of undergraduate engineering education. The handbook is the product of the Association of American Colleges. It has been prepared with the cooperation of the Accreditation Board for Engineering and Technology (ABET), the nationally recognised accrediting agency for engineering programmes. (Report: An Engineering Student's Guide to Humanities and Social Sciences, 1988).

Communication courses provide an excellent base for professional growth. The further engineers move in their careers, the more likely they are to need the skills and abilities associated with the humanities and the less likely they are to draw on specific technical skills. Technicians could become supervisors - a role in which they need to be able to synthesise, see things holistically and deal effectively with people. They are called upon more and more to communicate clearly and persuasively, in directing project teams or making presentations to clients. The broader their responsibilities, the more likely it is that they will need to explain their work to non-engineers in order simply to get the job done. And to do that they need not only to be able to speak and write effectively, but to understand non-engineering perspectives.

In this regard the following quotation seems significant:

> "... *there's no skill more valuable in business than an ability to work with people - to understand and respond to their needs and concerns and wants, and to communicate your ideas to them not only clearly but in a way that generates some interest and excitement*" (Report: An Engineering Student's Guide to the Humanities and Social Sciences, 1988:11).

The ability to lead a team, manage a project, exercise judgement are the kinds of things needed to move ahead in most fields. A broad course in communication can help lay a good foundation for these kinds of skills.

The words of Baum, as cited in the Report mentioned above must be noted:

> "*Today engineers must not only be technically proficient but also skilled in communication. They must grasp the complexity of social problems and the implications of their solutions. Therefore, it is imperative that future engineers be exposed to the social sciences and the humanities*" (13).

Courses in these subjects would surely expose students to ethical and social issues, train them to make sound decisions and most important, teach them to think critically and argue persuasively. By combining these skills with technological competence,

engineers would be able to play a leadership role in solving the profound problems facing our world.

Many engineers reach a point when they have to assume management roles only to find that they lack the skills - especially the 'people' and communication skills to be effective. This is unfortunate for them, since management often represents their only route for further advancement.

According to the Report: Engineering Technology Education (1985), engineers must not only possess the required technical skills but must also concern themselves with professional development, establishing a position of trust with respect to relating technical skills to the needs of the profession and to society at large.

Engineers frequently lack education in the basic concepts of the humanities, sociology, economics and politics, a deficiency that makes decision-making more difficult and which can result in decisions being made without considering all facets of an issue. If engineers are to serve the public, they must understand its nature in order to provide the best service. Furthermore, engineers should be encouraged and permitted to gain this added education and experience during their early or middle career stages. This ensures that the needed skills are not lacking when the stage of policy setting and programme making is reached. Making the possession of these skills a recognised requirement for promotion to certain positions would also ensure that employees acquire them. In Johnston et al (1988) a major project was implemented to improve the quality and coherence of the humanities and social sciences coursework of undergraduate engineering students.

In general, humanities and social science courses may be said to help equip students for citizenship, for family, in the transmission of culture, history and tradition. At the same time they can sharpen the student's critical thinking skills. They can also help develop learning and decision making skills needed for good engineering design. The humanities and social sciences are also widely valued as a way of developing skills of clear, persuasive communication. These skills are essential at a time when engineering is more a group enterprise and team effort than ever, and when engineers

must increasingly explain their work to non-engineers, consumers, environmentalists, legislators and members of the press in order to achieve their professional aims.

Many technical problems are also social problems and an ability to confront them is an increasingly necessary part of the professional training of engineers. Furthermore, courses in the humanities and social sciences can (it is suggested) help prepare engineers for careers in management, for public office and for other forms of leadership roles.

Samuel Florman, as cited by Johnston et al (1988) believes that engineers should be especially well equipped for public office and participation in society's highest councils, where they might not only help ensure informed public decision-making on technological issues but win increased public esteem and influence for their profession as well. In the 21st century, technology will give engineers a more central role in society. It seems reasonable to conclude that the humanities and social sciences should be an increasingly critical part of engineering education.

Worcester Polytechnic Institute recast its entire undergraduate programme in 1970, when increased emphasis was placed on the humanities and social science courses. Its management believes that the engineering student must learn the challenge of relating science or technology to social needs and social issues (Report: An Engineering Student's Guide to the Humanities and Social Sciences, 1988).

According to the Report: Engineering Undergraduate Education (1986:37-38), engineers should have some basic knowledge about the real world they will be operating in, such as industrial dynamics and the required communication skills,

> "*so that they can become more effective contributors to all aspects of industrial endeavours and ultimately become captains of industry in addition to being super technologists.*"

The report concluded that each course in the engineering curriculum needs to be re-examined for its contribution, and heavier doses of the arts and humanities added. When this is accomplished "*the sum should in fact be greater than the parts.*" One

interesting conclusion drawn in this Report maintains that a new system of engineering education will fall short of its desirable and necessary objectives unless it incorporates a list of features, one of which is that the engineering programme "*must broaden its base to include more communications and liberal arts, as a foundation for a professional career*" (39 - 40).

It seems reasonable to conclude that the humanities and social science components should form part of engineering programmes such that they reflect the aims and objectives of students in an institution. The rationale for including the humanities and social sciences in the undergraduate engineering programme is appropriately summarised by Johnston et al (1988), in that one is a human being first and an engineer second. Johnston believes that to be human is to encounter experiences which go beyond the realms of scientific and technological paradigms.

2.11 The Versatile Engineer

Today, industry requires engineers who can play different roles, who are flexible and versatile and able to adapt to changing situations. Shenk (1988 : 386) believes that since engineers

> "*wear many hats in their careers, indeed, even in one job a professional will be subordinate to some, superior to others, colleagues of yet a third group and will need to learn to take a somewhat different tone in each communication situation*".

In addition to basic communication skills, the skills required to work with a variety of disciplines, organisations and management levels will be required by today's engineering workforce. The new role, according to Treadwell (1989), implies a communicator who may be part manager, part public relations specialist, part entrepreneur. This view is supported by Yin (1988), who concluded in his study that today's engineers should be able to play a variety of roles in industry. The survey respondents in his survey communicated with a variety of people, contractors and manual workers with little formal education and knowledge of English, government officials, managers and financial controllers who were non-engineers, and other kinds

of engineers, for a variety of purposes. The suggested roles included: to inform, instruct, recruit and appraise.

Moreover, respondents played a variety of roles; even in one project, they could be in a client-project manager relationship in one situation, and in another they could play the opposite role. In Yin's survey employers agreed unanimously that the ability to get on with people and to motivate subordinates through good communication skills was an important criterion for promotion.

Basic workplace skills are of interest because rapid technological change, participative management, just-in-time production and other workplace innovations have created a demand for more flexibility, adaptability and a higher base level of skills from all workers, including those at the non-supervisory level. Carnevale (1990 : 10), believes that

> "*Although many workers have done well in the workplace despite skill deficiencies, it is increasingly apparent that such success in the future will be illusory for many workers if they continue to be ill-equipped in a broad spectrum of basic workplace skills.*"

Carnevale goes on to state that today's engineers must involve themselves in "*new technology, participative management, sophisticated statistical controls, customer service, just-in-time production*", if they wish to make progress in their profession (op. cit., 20). The workplace is changing and so are the skills that employees must have in order to keep pace with it.

Furthermore, to adapt quickly to new workplace demands, employees must know how to learn. They need problem-solving skills to overcome barriers that arise in new situations. They must be able to think creatively as they cope with new challenges. They need personal and career management skills, a strong realistic sense of self-worth and the ability to set and meet goals. Lossouarn (1991 : 20) supports this view that today's engineer must be versatile, when he states the following:

" ... for one must acquire the behaviours which allow one to formulate the questions, to dialogue effectively with diverse specialists and varied sources of information, to communicate with precision with a changing audience or interlocution."

The ability to tailor products and services requires the learning and problem-solving skills that make employees adaptable. Employees at the point of production and service delivery must know how to listen and to articulate their thoughts clearly to understand and be understood. In order to interact successfully with customers, and other co-workers in the company, employees need strong communication skills.

They also need interpersonal and negotiation skills to deal with customer grievances and complaints. Technical changes on the job tend to change basic skill requirements incrementally. The expanding range of job tasks and responsibilities in the engineering technician's job demands higher basic levels of reading, writing and computation. The technician must have higher-level personal management skills. He/she must have better computational skills and be able to read and comprehend technical manuals. These new tasks require the technician to adapt successfully to the job, learning to learn.

2.12 Ethics in Communication

Shaw (1988) sees the language of ethics and the language of communication as synonymous. He believes that if codes are important communication instruments, then unethical behaviour must be seen not only as a breach of moral order, but as an ineffective or unpersuasive communication of values, norms or injunctions. The failure of the codes according to Shaw can mean only one thing, the means of communication are not sufficient to the task. He stresses that in our eagerness to pin the blame on someone, thereby separating moral or ethical failures from failures in communication, we limit our view of communication in its organisational context to something only embodied in codes or their equivalent. The question of communication's real role in promulgating ethical consciousness and behaviour is the focus of Shaw's article. He believes that people are in the habit of excusing personal

behaviour by placing the blame on communication problems. How we understand these problems becomes a central question according to Shaw.

And we fail utterly in answering the question if we continue to see the practice of ethics and the job of communication as separate topics.

Ethical communication means understanding and developing the values of the community in which we live and work. Since ethical behaviour is not merely a matter of acting correctly and doing good deeds, the role of communication both outside and inside the organisation is not the medium for expressing a high moral tone, but the vehicle through which we come to share an understanding about issues which concern us.

Ziv and Lynch (1989) believe that a vocational communication course should develop each student's awareness of communication ethics and provide the student with an effective means to arrive at decisions which reflect high moral and ethical standards. Students must consider the role of ethics and the consequences of their actions. Class discussions should emphasise ethical practices when making decisions and reporting information. A business writing course may be unable to change a student's value system or ethics but it could influence the student's notion about the question of ethics in communication, and this could result in the student making more careful decisions and arriving at fair conclusions in the workplace. Instructors/lecturers should in terms of this viewpoint, increase an awareness in ethical practices in the workplace.

An excerpt from a paper presented by the Director of a Consulting Civil Engineering and Engineering Geologists Company to staff and students at a technikon in KwaZulu-Natal bears noting. In summary he suggests that, whereas the politician and advertiser will employ disinformation and emotive phrases to achieve their objective, the engineer is professionally bound to maintain total integrity in his communication. Herein lies his value to society for it often happens that, as one who possesses a specialised knowledge and preserves his integrity, he becomes the agent whereby disputes, superstitious fears and emotional situations are 'diffused'.

To do this, the engineer has to communicate convincingly, unambiguously, truthfully, and with 'sound' logic. (Internal seminar, proceedings unpublished, technikon in Natal, date not available).

Engineers must not only possess the required technical skills, but must also concern themselves with professional development and establishing a position of trust with respect to communicating their technical know-how to society (Report: Support Organisations for the Engineering Community, 1985).

In conclusion, the following quotation very aptly summarises the needs of engineering technicians in the 21st century:

> "*The newly graduated engineer's needs are: more liberal arts and humanities, some knowledge of a second language to better understand other cultures and to work with people internationally, and a better preparation for the legal, social, and ethical problems they will face in industry*" (Report: Engineering Undergraduate Education, 1986 : 59).

CHAPTER THREE

REVIEW OF FINDINGS

3.1 Responses to Questionnaires

The present research made significant use of questionnaires as instruments to establish views and attitudes amongst persons who have interests in the education of engineering technicians. Follow-up interviews with selected respondents allowed for further exploration of the responses.

A copy of the questionnaire sent to industry and to academic staff at the three technikons in KwaZulu-Natal: M L Sultan Technikon, Technikon Natal and Mangosuthu Technikon and a list of questions asked during interviews, appear as appendices to this work (Appendix A and Appendix B respectively).

After a general overview, the writer will proceed to a description of the main findings derived from the questionnaire responses. This will be followed by a report on the interviews. The writer records her appreciation for the cooperation, frankness and interest which marked her dealings with those who took part in her survey.

3.2 General Overview

Some broad conclusions deriving from the questionnaire responses now follow. A detailed statistical analysis of various types of communication skills as reflected in the questionnaire appear as Appendix E to this work.

3.2.1 Almost all respondents considered the following communication skills to be very important for an engineering technician:

* WRITING
* READING

* SPEAKING
* LISTENING
* ORGANISATIONAL
  (MANAGEMENT SKILLS, INTERPERSONAL SKILLS, TEAMWORK SKILLS)
* PUNCTUATION AND CAPITALISATION
* SPELLING
* CLARITY IN SENTENCE CONSTRUCTION
* WRITING AN ANALYSIS OF A PROBLEM
* WRITING SIMPLE PROPOSALS, REPORTS, MOTIVATIONS
* SUMMARISING
* SPEAKING ENGLISH CLEARLY
* EXPLAINING A PROCESS ORALLY
* APPLYING PROBLEM-SOLVING TECHNIQUES ORALLY
* DECISION-MAKING
* REQUESTING HELP
* READING AND INTERPRETING MANUALS/TEXT MANUALS
* COMPREHENDING VOCABULARY RELATED TO ENGINEERING
* READING AND INTERPRETING CHARTS, TABLES, GRAPHS
* READING AND INTERPRETING TECHNICAL REPORTS
* READING AND INTERPRETING PRODUCT INFORMATION
* CRITICAL THINKING
* TEAMWORK AND GROUP DISCUSSION
* AURAL COMPREHENSION
* FOLLOWING INSTRUCTIONS, DIRECTIONS
* NOTE-TAKING

3.2.2 Over 70% of all respondents considered the communication skills below to be very important for an engineering technician:

* NEGOTIATION
* INTERCULTURAL COMMUNICATION
* GOAL-SETTING
* NON-VERBAL
* TELEPHONE TECHNIQUES

* MEETING PROCEDURES
* FORMAL PRESENTATION OF REPORTS/PROPOSALS
* DESCRIBING A PRODUCT/SERVICE ORALLY
* CONSTRUCTION OF CHARTS/TABLES/GRAPHS
* CONCISE WRITING
* WRITING TECHNICAL DEFINITIONS
* WRITING AN EXPLANATION OF A PROCESS
* WRITING A DESCRIPTION OF A PRODUCT
* WRITING INSTRUCTIONS
* JOB APPLICATIONS AND RESUMÉS
* MEMORANDA AND LETTERS
* PARAGRAPHING
* APPLICATION OF RULES OF GRAMMAR
* FILLING IN BUSINESS FORMS
* EDITING

3.2.3 Respondents generally considered a provision in the engineering curriculum for the skills of writing, reading, speaking and listening to be probably the only formal educational opportunity for students to acquire a sound grasp of the basis of communication, which "*sadly the average school leaver does not possess*". One respondent said, "*Education should prepare not only for immediate post-education requirements but endow also for potential higher responsibilities.*"

3.2.4 Many of the respondents from the academic sector stated that technicians should not under-estimate the importance of communication skills in their workplace. Their success as technicians does depend on their communication ability, especially in today's "*information-hungry*" world where research is playing an increasingly important role, and the volume of technical information is increasing exponentially.

3.2.5 One respondent from industry made the following statement: "*Traditionally, engineers have accepted that they are not very good communicators. Filling*

in this questionnaire has demonstrated that communication skills are an integral part of consulting engineering. Since more of our appointments will come from the rural communities, it will be necessary to adjust and simplify our communication style in the future". This is by no means suggesting that qualification requirements will drop.

3.2.6 As far as general comments about communication are concerned, one respondent believes that an engineering technician must be able "*to handle anger without losing ground to the aggressor; he/she must be firm yet pacifying to control a potentially explosive situation, refrain from panic when a dangerous situation develops.*"

3.2.7 One respondent had the following comments to make about what an engineering technician needs to be:-

* AN EXCELLENT COMMUNICATOR AND DIPLOMAT
* AN EXCELLENT MANAGER WITH EFFICIENT TIME-MANAGEMENT SKILL
* AN EXCELLENT PROBLEM-SOLVER
* ABLE TO DEAL WITH ALL LEVELS OF SOCIETY
* ABLE TO MARKET HIMSELF/HERSELF AND THE COMPANY
* BE ETHICALLY BEYOND REPROACH AND POSSESS HONESTY AND INTEGRITY STANDARDS OF THE HIGHEST LEVEL.

3.2.8 Another respondent expressed the following view: "*Communication is a vital 'self' marketing tool sadly underestimated in, especially, engineering*". He went on to say that industry is forced to correct this situation at tremendous costs and waste of time which escalates unproductivity and makes the company uncompetitive against the rest of the world. He concluded with this statement: "*Hopefully this exercise* (referring to the present project) *will bear fruit in the shortest possible time*".

3.2.9 One respondent stated that it is important for an engineering technician to adjust the "*level*" of communication to the appropriate level of one's audience. In communication studies, this is referred to as "*register*".

Communication situations vary in that an engineering technician could be communicating with labourers, who are not formally educated; with militant representatives at union meetings, artisans and top management.

This means that a technician must be able to adjust his/her communication to the level of the receiver. Communication can also vary with regard to numbers; from one-to-one situations, to addressing a public gathering, to small group discussions. All these situations require specific skills that should be developed in the academic programme of an engineering student.

3.2.10 Some respondents stated that even engineering technicians sometimes assume managerial roles, and good communication skills on the part of these technicians are a positive indicator for more permanent promotional opportunities. It is generally agreed that a broad range of communication skills are "*critical to the success of any running operation*".

3.2.11 One significant comment made by a respondent was that the type of communication skill and the level of competence changes as workers in the organisational hierarchy become more technically advanced or specialised. This was confirmed during some interviews. In addition it was felt that assertive communication skills are important for an engineering technician.

3.2.12 Many respondents were of the opinion that communication skills are vital for all professions but even more so for the engineering technician who plays a leading role in the workforce as the interface between the more senior engineers and the artisan/labour workforce.

3.2.13 Respondents from industry expressed a great keenness to play a role in the engineering education of the technikon students. They believed that it was important for them to be part of the educational development of an engineering student.

3.3 Analysis of specific communication skills

More specific responses grouped according to the communication skills identified in the questionnaire will now be reported upon, as will the respondents' broad attitudes to communication proficiency and promotion, and to the length of the Communication Skills course presently offered to engineering students. A bar graph depicting the rating of the communication skills identified in the questionnaire (Appendix A) appears as Appendix C to this work.

3.3.1 Writing Skills

Writing skills today are important in almost every occupational field. According to Carnevale (1990), the quality of letters, progress reports, work orders, and other writing as done on the job is regarded as an indicator of the overall quality of an employee's work. The following are the significant findings of the questionnaires as far as writing skills are concerned:

3.3.1.1 Writing skills are considered to be very important for engineering technicians as a major portion of their work is providing/following written instructions, report writing, compiling project specifications and other varieties of business correspondence both upwards and downwards in the organisational network. The engineering technician, respondents believe, is "*a vital link between management and the workforce*".

3.3.1.2 According to some respondents, the professional image and reputation of the engineering consultant is closely tied to the quality and accuracy of the company's written and graphical publications.

3.3.1.3 Some respondents stated that a knowledge of formal, written presentation of research findings is critical in the engineering workplace.

3.3.1.4 All changes/improvements and projects involve human interaction and interpretation. Communication before, during, and after projects is acknowledged as critically important to success.

3.3.1.5 Many respondents considered well presented, clearly written and intelligible letters, reports and other business correspondence very important in portraying a professional image of the firm.

3.3.2 Reading Skills

Research by Mikulecky and Winchester (1983), as cited by Calhoun (1989), revealed that the ability to read and apply information obtained from complex textual and graphic materials is a major factor in determining success in the workplace. According to Briggaman and Silva (1988), as people move from entry level positions within business organisations, they spend more time reading both internally and externally generated business communication and need increasingly sophisticated reading skills. The following are the significant findings of the questionnaires as far as reading skills are concerned.

3.3.2.1 Respondents generally considered reading skills to be very important especially since these could play a significant role when considering the interpretation of instructions, particularly by non-mother-tongue speakers of English.

3.3.2.2 Respondents believe that the complex and competitive nature of the engineering industry means that all staff should keep abreast of developments in their fields through extensive reading.

3.3.2.3 Many respondents stated that an engineering technician is involved with a large volume of technical reading of journals, magazines, reports, specifications and proposals, and therefore needs to be adept at reading.

3.3.2.4 Respondents generally believed that much of the technician's time was spent researching new devices and product information, which had to be done efficiently and accurately. Specifications have to be interpreted accurately, instructions must be fully understood and followed precisely. Thus the importance of good reading skills.

3.3.2.5 A majority of the respondents believe that engineering technicians must be competent at screening and evaluating information pertinent to their field of work. They must be able to conduct the required research in their particular field of work.

3.3.3 Oral Skills

According to Grover at al (1990), among the skills most basic to individual and organisational success, the skill of communicating orally stands out. Furthermore, people who lack proficiency in the skills of oral communication are handicapped not only in communicating with other employees, but also in learning for personal and professional development. Workers who can express their ideas orally and who understand verbal instruction make fewer mistakes, adjust more easily to change, and more readily absorb new ideas than those who do not. The following are the major findings of the questionnaires as far as oral skills are concerned:

3.3.3.1 Oral/speaking skills proved to be very important to respondents. It was felt that liaising with customers formed an important facet of a technician's work. Misunderstanding a customer's requirements for a new design or misinterpreting a problem could "*cost a company dearly*".

3.3.3.2 One respondent said this about oral skills: "*So much of our work today is oral.*

More stakeholders are involved, and engineers are notoriously bad at oral communication. A company may be brilliant, but in essence it is only as good as those who talk on its behalf."

3.3.3.3 Since engineering is becoming more inclusive and community-based and consultative, verbal skills are increasing in importance.

3.3.3.4 Many respondents believe oral skills to be vital for technicians. The engineering technician is the link between the client and the workforce and as such must be able to communicate effectively at different levels.

3.3.3.5 It was felt that formal and informal oral skills are important especially for the explanation and description of tasks, projects and equipment. The ability to "*sift*" from an oral discussion or presentation and classify information into categories of importance requires excellent listening skills.

3.3.3.6 Many respondents noted that oral skills are vital to the engineering technician's job functions, because technicians have to get through to the layman as well as the expert. They have to explain to their colleagues and their clients what they are doing and, very important, why they are doing it.

3.3.4 Listening Skills

Listening skills in business and industry as in personal life allow insight into meanings and messages, according to Bennett and Olney (1988). Because most people have had no training in the critical skill of listening, employees' poor listening habits no doubt cost firms much money annually in productivity lost through misunderstandings and errors. Apart from this, there is no monetary value to assess the cost of physical and emotional stress that results from countless breakdowns in communication caused by poor listening habits.

The following are the major findings of the questionnaires as far as listening skills are concerned:

3.3.4.1 Respondents generally felt that "*only a receptive and finely disciplined mind can effectively comprehend, formulate and communicate information/ideas. Failure to listen with attention could result in disastrous outcomes*".

3.3.4.2 If listening skills are not developed, then an incorrect message or instruction may be carried through. This is not acceptable in industry, because the error would have to be rectified at great expense to the company.

3.3.4.3 One respondent stated that engineers are frequently criticised for not listening to clients' real problems and needs. Successful communication, it was felt, with clients and contractors is "*90% good listening, 10% good responding*".

3.3.5 Organisational Skills

According to Frey and Finan (1991), ineffective organisational skills are very costly. The time and effort spent to develop and nurture an effective system of organisational communication is well worth it in both human and corporate terms. According to Flad (1988 : 63), the abilities to work with employees both subordinates, equals and superiors, to develop collaborative and teamwork skills are often the determinants of career success. "*Without these skills, people offer little of value to an organisation regardless of their technical or functional abilities*". The following are the major findings of the questionnaires as far as organisational skills are concerned:

3.3.5.1 Many respondents believe that since projects in industry often require team effort to work with manageable units and to be able to put the

units together (in terms of time and cost limitations), it is important to give an orderly structure to the various projects, and to this end, good organisational skills are necessary.

3.3.5.2 Although the modern technician relies heavily on computer packages to organise his/her time and resources efficiently, he/she must be capable of controlling large projects, component ordering, equipment repair and acquisition and customer enquiries/problems. This requires astute organisational skills on the part of the engineering technician.

3.3.5.3 Since more work that was previously done by senior engineers is now done at technician levels, organisational skills have become more and more important. Presently, supervision of labour-based or community-based constructions requires greater planning, delegation, negotiation and task-setting skills; thus the importance of good organisational skills for the engineering technician.

3.3.5.4 One respondent stated that many employees these days are "insular" in their approach to work. Organisational skills are needed to ensure that the company grows at every level internally. Communication within disorganised communities, necessitates all interveners having good organisational skills.

3.3.6 Career Development Skills

The following are the major findings of the questionnaires as far as career development skills are concerned: A bar graph depicting the importance of communication skills for promotion appears as Appendix D to this work.

3.3.6.1 96% of all respondents considered communication skills to be very important for promotion in industry. Many felt that promotion usually is accompanied by partial or full transition from a hands-on/productive role to a managerial/organisational role.

This in turn places greater emphasis on the level and frequency of communication skills. Some respondents stated that the importance of communication skills increases with seniority and increased exposure to client negotiations. Certain respondents believe that good communication skills are fundamental to attracting clients, which in turn enhances promotional opportunities. One respondent stated quite emphatically that "*no matter how good you are technically, if you can't communicate you're not much use*".

3.3.6.2 A good communicator is a good leader and manager of people and tasks. Good communication skills therefore increase or enhance the quality of a technician, and promotion prospects for such a technician will therefore be very good, according to several respondents.

3.3.6.3 Some respondents considered that although technical ability would be the most important consideration in promotion, communication skills would determine how successful a technician was in his work generally and would thus have an indirect bearing on promotions.

3.3.6.4 One respondent stated that promotions are often based on results that are not always visible. "*You have to make people understand what you have achieved, its value to the company, how it was achieved ...*"

3.3.6.5 One respondent clearly and emphatically stated that from his twenty-five years of experience in consulting engineering practice, it was apparent to him that an engineering technician who has poor communication skills seldom achieves promotion above undertaking routine tasks, or rises to a management position.

3.3.7 Length of the present Communication Skills course

The following are the major findings of the questionnaires as far as the present length of the communication skills course is concerned.

3.3.7.1 Respondents generally felt that to structure a communication skills academic programme in one semester was problematic, in view of the vast array of skills that are needed in industry. It was felt that a modular format would be more viable to cover the depth, length and breadth of communication skills as required by industry for an engineering technician.

3.3.7.2 Many respondents touched on the question of non-mother tongue speakers of English. They believed that these students would certainly benefit from an extended communication skills programme.

3.3.7.3 Respondents from industry generally felt that the existing communication skills course should be expanded, to include areas like assertive communication skills, more oral projects, varieties of report writing, writing of proposals and a reading skills course. Communication skills should not be "crammed" into one semester, but rather, should be offered in modules throughout the engineering programme in a developmental way according to the cognitive levels of students.

3.3.7.4 Respondents from the academic sector expressed concern with the stringent demands of the technical subject areas, which result in a heavy course load and time-table load for students. This they feel makes it extremely difficult to increase the length of the communication skills course in the engineering programme. However,

they do acknowledge the importance of communication skills in the practice of engineering.

3.4 Responses to Interviews

Interviewees were selected from amongst the questionnaire respondents on the basis of convenience sampling. Where respondents indicated specific interest in the project, or suggested a wish to be further involved in the research, they were considered for interview.

Representatives of the following organisations were interviewed:

* SIEMENS
* TRANSTEL
* NCP
* TOYOTA MANUFACTURING S.A.
* CONLOG
* GRINAKER
* ENGEN
* DURBAN ELECTRICITY
* BOSCH INSTRUMENTATION AND CONTROL
* BKS
* ERSKINE CONSULTING ENGINEERS
* SILTEK DISTRIBUTION DYNAMICS
* SMITH'S MANUFACTURING

A broad description of the major findings now follows. Each of the ten questions asked is separately reported upon.

QUESTION 1: **How do you rate the importance of communication skills for an engineering technician in your company?**

* 90% of the interviewees considered communication skills to be just as important as technical skills; in fact some considered communication as the "*most important work skill because all other technical skills depend on it*".

They even went on to say that it was "*not worth*" having other skills without good communication skills. Interviewees stated that a person with good communication skills had a "*headstart*" in the company.

QUESTION 2: **What are the communication skills requirements for entry-level engineering technicians?**

* Here most of the respondents considered a wide array of skills to be necessary for entry-level technicians. Some of the skills identified were: reading, writing, speaking, listening, problem-solving, comprehension, logical thinking, social, interpersonal, presentational, technical writing, organisational and "*much much more*". One respondent stated that entry-level technicians must have a very good understanding of general terminology in communication.

QUESTION 3: **Does your company spend any time and money on in-house training or consultative services in communication skills? If so, how much time and money; if not, why?**

* All the companies visited engaged in in-house training and employ the services of consultants to upgrade the communication skills of their employees. Of-course, this is based on the particular needs of the company and the budget allocated.

* One company stated that in the past only supervisors and managers were recipients of this type of training; however, the situation presently is different - R30 000,00 had been budgeted for 1996 towards training programmes for employees (communication skills forming one part of this).

* Most of the companies were not able to divulge the actual figures set aside for training programmes for fear of breach of company confidentiality.

* In three companies, in-house training is conducted by the more experienced senior personnel. One example of a topic covered is "*Assertive Communication Skills*". Employees also attend courses run by external professional bodies from time to time, as and when the need arises.

* Another company considered it necessary to send their engineering technicians to a "*Presentation Skills*" course, for the purpose of enhancing confidence and promoting image building. Engineering technicians often attend courses in Technical Report Writing, an area that requires much attention.

* In one corporate company, the Human Resources Department conducts the training programmes for engineering personnel on all levels from time to time as and when the need arises. In this company approximately R50 000,00 to R60 000,00 was spent between 1995 - 1996 on upgrading different communication skills of employees at all levels.

* One international corporate industry has its own training centre that is fully housed with qualified staff and other resources, to run training programmes for the engineering personnel on an on-going basis. It spends between 1 - 2% of its income on the training of staff. This company believes that skill in communication is an "*industry requirement*" and as such continually upgrades the communication skills of its personnel.

* It is interesting to note that all the companies visited spend time and money on some form of communication skills training, either in-house via the services of consultants or sponsored attendance of training programmes.

QUESTION 4: **The engineering programme at the technikons currently allows for a one semester course in communication skills, mainly offered to students in the**

first year of the programme. Thereafter, students do not take any other communication skills courses. How do you feel about this?

* All persons interviewed considered the present status of communication skills being a one semester course as "*unacceptable*", "*problematic*", "*not good*", "*wrong*", "*not enough*". They felt strongly that communication skills should be a career-long process; that students would forget most of the skills by the time they completed their engineering programme.

* It was felt that communication skills must be developed throughout the study programme, or else students could become "*side-tracked*".

* Many respondents felt that basic skills in the important areas of speaking, writing, reading and listening must be nurtured early in the programme, and these could then be developed further in the students' senior years of study.

* It was felt that students in their more advanced years of study are mature and cognitively more able to practise and acquire the skills required by industry.

* One company believed that communication skills training should run "*parallel*" with technical training throughout the academic programme.

* Interviewees generally considered modularisation as an ideal way to expand the existing communication skills course over the entire period of study. A topic like Technical Writing could be covered in an elementary module perhaps in the first year; however, later modules could embark on more complex and advanced forms of technical writing.

* Companies generally considered the oral/spoken aspect of communication skills to be important and went on to say that there should be a "*big practical*" component because engineering technicians need to have good oral and

presentation skills to perform a variety of job functions. They even spoke about "*integrating*" communication skills with other technical skills.

QUESTION 5: If you were requested to make an input into the present communication skills course/syllabus for engineering students, what would you suggest (in broad terms) the content cover, and at what level should it be covered?

* Most of the interviewees considered the present syllabus to be inadequate in respect of content and time allocation. They commented on some aspects of communication skills like oral communication which they feel should be covered far more extensively than is presently the case; and felt that this should be developed throughout the engineering programme, beginning with basic speaking skills and developing to more advanced forms of presentation skills, small group discussion and assertive skills.

* Most of the interviewees maintained that the nature of the workforce is now changing. It is far more multi-cultural and multi-lingual in nature. Workers need to be able to adapt their level of communication to the level of the receiver.

* Interviewees also commented on the poor standard of basic skills in reading, writing and speaking on the part of non-mother tongue speakers of English, who are fast becoming a great part of the engineering workforce. In addition they felt that providing engineering students with only one semester of communication skills tuition is especially disadvantageous to the ESL student who is working side-by-side with English first language speakers. An extended programme of study would perhaps allow instructors to develop the skills required by industry in a more effective manner, and could also attend to the ESL student's needs more effectively.

* Interviewees considered the following areas of communication important, and ones that should be developed throughout the engineering programme: oral skills, logical thinking skills, problem-solving skills, low-key negotiation

skills, business correspondence, writing skills, technical writing skills, listening skills, interview skills, conflict management skills, inter-cultural skills, social skills, leadership and management skills, basic marketing skills, critical thinking and graphic skills.

* Interviewees believe that a broad range of communication skills are necessary for today's engineering technician. Particular skills like report writing, advanced business correspondence and complex problem-solving can be intensified at the advanced levels of study in an engineering programme.

QUESTION 6: **What is the proportion of spoken to written communication in one day in the job function of an engineering technician?**

* Most of the interviewees stated that there were far more demands made on good oral skills than written skills. Oral skills rated 65% and written skills 35%. This changes at different levels of the organisational hierarchy. However, it was noted that whatever written skills were required on the part of the engineering technician have to be of a high standard. In other words, although the quantity of written communication might be less than that of spoken communication, a high quality and standard had to be maintained in written communication.

* Interviewees also maintained that this situation should not be used as a measuring tool for weighting the oral and written skills in the syllabus and allocating time respectively. In many cases, the nature of a company is such that more emphasis is placed on oral skills in order to get through the first stage of a contract, in other instances the written skills become of primary importance to win a contract over.

* In consulting engineering companies, the spoken skills initially play a key role in obtaining a contract; once the contract is signed, written skills take over.

* It was generally noted that as an engineering technician advances in a company, more and more demands are made for an excellent standard of both spoken and written skills.

  On the other hand, engineering technicians who display excellent verbal and non-verbal communication skills enjoy better promotional opportunities.

QUESTION 7: **Will your company be willing to have academics from the Department of Communication monitor the communication skills of engineering trainee technicians?**

* Most of the interviewees welcomed the idea, although a few had reservations about the time constraints in industry which make monitoring rather difficult. However, many of them stated that proper arrangements must be made between the academic lecturer/instructor and the person in charge of the engineering technicians. Of course, they would require reports on individuals monitored. The frequency of visits and submission of reports could be mutually discussed and finalised. They believed that this kind of cooperative liaison could be beneficial to both the company and the academic institution.

* One interviewee maintained that this monitoring system could help solve some of the communication skills problems experienced by engineering technicians and also highlight areas of communication skills that need to be emphasised in the instructional programme of engineering students.

* Another important suggestion made was that academic specialists should familiarise themselves with the work that engineering technicians do in the specific company in which they are employed as it was felt that this would help in understanding the communication skills needed to accomplish specific tasks.

* One company stated that monitoring of communication skills of technicians would be a "*fantastic*" idea, as long as it were properly structured and managed. The company will do whatever it can to assist.

QUESTION 8: **How successful will an engineering technician be without good communication skills?**

* To this question, the following responses were made:

" ... *not be very successful* ... "
" ... *promotion is impossible* ... "
" ... *he will only get by 50%* ... "
" ... *it would affect upward mobility* ... "
" ... *can't make the grade* ... "
" ... *not successful at all* ... "
" ... *he will be limited* ... "
" ... *will be terrible* ... "

* Interviewees generally believed that communication is the "*key component of every day life*", that good communication skills "*pay the company dividends*" at the end of the day.

* Some interviewees felt that without good communication skills, an engineering technician would not be able to market ideas, and poor communication on the part of employees could prove to be very expensive for a company.

* One interviewee considered communication to be a "*critical*" skill; without it many doors were closed to employees.

* One interviewee felt that without communication skills, an engineering technician "*may get along*", but he/she would be "*static*", that promotional opportunities would be limited and the worker might find himself/herself on a plateau for a long time.

QUESTION 9: **What are the short-comings of engineering technicians in your company as far as communication skills are concerned?**

* Almost all persons interviewed identified a range of communication skills that were considered necessary, but which were lacking. Some of the skills mentioned were the following:
  * technical writing skills
  * organisational skills
  * problem-solving skills
  * time-management skills
  * social skills
  * learning-how-to-learn skills
  * intercultural communication skills
  * analytical skills
  * oral communication skills

* One interviewee stated that there were no major problems, but there was "*much room for improvement*".

* Another interviewee maintained that vast improvement was necessary in communication skills, from the senior management downwards. He added that engineering technicians should have a broad range of communication skills.

* Other interviewees expressed concern with the level of communication skills in the lower level workforce.

* Some interviewees expressed dissatisfaction with the standard of English of the non-mother tongue speakers. They needed much more practice in basic skills like speaking and writing, before even entering the job market.

* Many of the interviewees spoke about "*human relations*" skills that were lacking amongst engineering personnel in general.

QUESTION 10: **Is there any thing you wish to add? Any comments you wish to make?**

* Majority of the interviewees stated that there was a need for engineering technicians to have a technical vocabulary. However, most of the interviewees maintained that technical vocabulary need not be taught, because it was easily acquired as and when necessary on the job. If technical vocabulary is to be taught, it is difficult to imagine a predetermined syllabus which would provide students with word lists and reading exercises in all of the specified areas. Interestingly enough, this view is supported by the study of Holgate (1992) who concluded that it was doubtful whether undergraduates could acquire a sufficiently comprehensive vocabulary in their own language to assimilate a general vocabulary in another.

* Most of the interviewees stated that the main requirement was for a good basic knowledge of the English language and that technical vocabulary can be acquired quickly on the job as and if necessary.

The writer proceeds now to report briefly on the response to each question in the questionnaire answered by both academics and representatives of industry. The questionnaire appears as Appendix A of this dissertation, and contains 53 questions, the responses to which are summarised below:

QUESTION ONE

The data indicate that the fields of specialisation in the two groups of respondents (academics and industry) were strongly similar therefore one can conclude that all types of engineering were equally represented.

QUESTION TWO

The data indicate that the staff complement in both the academic and industrial sectors were very similar.

Question Three

The data indicate that the degree of importance placed on writing skills by academics and industry is fairly similar.

Question Four

The data indicate that the degree of importance placed on reading skills by academics and industry representatives is similar.

Question Five

The data indicate that the degree of importance placed on oral skills by academics and industry representatives is very similar.

96% of all respondents considered oral skills to be very important for engineering technicians.

Question Six

The data indicate that the degree of importance placed on listening skills by academics and industry representatives is fairly similar.

All respondents considered listening skills to be very important for engineering technicians.

Question Seven

The data indicate that the degree of importance placed on organisational skills by academics and industry representatives differs slightly, these being seen as more important by academics than by industry representatives.

Question Eight

The data indicate that academics and industry respondents differ on the degree of importance placed on communication skills for promotion purposes.

Question Nine

The data indicate that the degree of importance placed on punctuation and capitalisation by academics and industry is fairly similar.

93.1% of the respondents considered punctuation and capitalisation to be necessary for the job/a desirable skills that may enhance employment.

Question Ten

The data indicate that the degree of importance placed on spelling skills by academics and industry is fairly similar.

Question Eleven

The data indicate that the degree of importance placed on the application of rules of grammar by academics and industry is not strongly similar.

89.1% of all respondents considered application of rules of grammar to be necessary for the job/a desirable skill that may enhance employment. 10.9% believe that it is an optional skill that would seldom be needed.

Question Twelve

The data indicate that the degree of importance placed on clarity in sentence construction by academics and industry is not strongly similar.

Most of the respondents considered clarity in sentence construction to be necessary for the job. Only 6.9% felt that it was an optional skill that would seldom be needed.

Question Thirteen

The data indicate that the degree of importance placed on paragraphing by academics and industry are not strongly similar.

85.1% of all respondents considered paragraphing skills to be necessary for the job/a desirable skill that may enhance employment. 14.9% feel it is an optional skill that would seldom be needed.

Question Fourteen

The data indicate that the degree of importance placed on memoranda and letters by academics and industry are not strongly similar.

89.1% of all respondents considered memoranda and letter writing skills to be necessary for the job/a desirable skill that may enhance employment.

Question Fifteen

The data indicate that the degree of importance placed on job applications and resumés by academics and industry are fairly similar.

81.2% of all respondents considered job applications and resumés to be necessary for the job/a desirable skill that may enhance employment. The rest felt that it is an optional skill that would seldom be needed.

Question Sixteen

The data indicate that the degree of importance placed on filling in business forms by academics and industry are not strongly similar.

79.2% of all respondents considered filling in business forms to be necessary for the job/a desirable skill that may enhance employment. 20.8% believe it is an optional skill that would seldom be needed.

Question Seventeen

The data indicate that the degree of importance placed on writing instructions by academics and industry are not strongly similar.

89.1% of all respondents considered writing of instructions to be necessary for the job/a desirable skill that may enhance employment. 10.9% considered it to be an optional skill that would seldom be needed.

Question Eighteen

The data indicate that the degree of importance placed on writing a description of a product or mechanism by academics and industry are not strongly similar.

89.1% of all respondents considered writing a description of a product or mechanism to be necessary for the job/a desirable skill that may enhance employment. 10.9% considered it an optional skill that would seldom be needed.

Question Nineteen

The data indicate that the degree of importance placed on writing an explanation of a process by academics and industry are not strongly similar.

89.1% of the respondents considered writing an explanation of a process to be necessary for the job/a desirable skill that may enhance employment. The rest considered it to be an optional skill that would seldom be needed.

Question Twenty

The data indicate that the degree of importance placed on writing technical definitions by academics and industry are not strongly similar.

87.1% considered writing a technical definition to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-One

The data that the degree of importance placed on writing an analysis of a problem by academics and industry are not strongly similar.

An overwhelming majority of the respondents considered writing an analysis of a problem to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-Two

The data indicate that the degree of importance placed on writing simple proposals, reports and motivations by academics and industry are fairly similar with one another.

90.1% of all respondents considered writing simple proposals, reports, motivations to be necessary skills for the job/desirable skills that may enhance employment.

Question Twenty-Two

The data indicate that the degree of importance placed on writing simple proposals, reports and motivations by academics and industry are fairly similar with one another.

90.1% of all respondents considered writing simple proposals, reports, motivations to be necessary skills for the job/desirable skills that may enhance employment.

Question Twenty-Three

The data indicate that the degree of importance placed on editing skills by academics and industry are not strongly similar.

78.2% of all respondents considered editing skills to be necessary for the job/a desirable skill that may enhance employment. 28.8% considered it an optional skill that would seldom be needed.

Question Twenty-Four

The data indicate that the degree of importance placed on concise writing skills by academics and industry are fairly strongly related with one another.

86.2% of all respondents considered concise writing skills to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-Five

The data indicate that the degree of importance placed on construction of charts, tables and graphs by industry and academics fairly similar with one another.

88.1% of all respondents considered construction of charts, tables and graphs to be necessary skills for the job/a desirable skill that may enhance employment.

Question Twenty-Six

The data indicate that the degree of importance placed on summarising skills by industry and academics are fairly strongly similar with one another.

A great majority of all respondents considered summarising skills to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-Seven

The data indicate that the degree of importance placed on speaking English clearly by academics and industry are strongly similar.

An overwhelming majority of all respondents considered speaking English clearly to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-Eight

The data indicate that the degree of importance placed on orally describing a product or service by academics and industry are not strongly similar.

86.2% of all respondents considered describing a product or service orally to be necessary for the job/a desirable skill that may enhance employment.

Question Twenty-Nine

The data indicate that the degree of importance placed on orally explaining a process by academics and industry are fairly related with one another.

90.1% of all respondents considered explaining a process orally to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty

The data indicate that the degree of importance placed on orally applying problem solving techniques by academics and industry are fairly similar with one another.

92.1% of all respondents considered oral problem solving techniques to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-One

The data indicate that the degree of importance placed on decision-making skills by academics and industry are fairly related with one another.

A great majority of all respondents considered decision-making skills necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Two

The data indicate that the degree of importance placed on formal presentation of reports/proposals by academics and industry are fairly similar to one another.

89.1% of all respondents considered formal presentation of reports/proposals to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Three

The data indicate that the degree of importance placed on requesting help skills by academics and industry are fairly similar.

Most of the respondents considered requesting help skills to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Four

The data indicate that the degree of importance placed on meeting procedure by academics and industry are not strongly similar.

88.1% of all respondents considered meeting procedures to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Five

The data indicate that the degree of importance placed on telephone techniques by academics and industry are not strongly similar.

89.1% of all respondents considered telephone techniques to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Five

The data indicate that the degree of importance placed on interpersonal skills by academics and industry are strongly related to one another.

An overwhelming majority of all respondents considered interpersonal skills to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Seven

The data indicate that the degree of importance placed on the use of appropriate non-verbal communication skills by academics and industry are strongly similar with one another.

81.2% of all respondents considered non-verbal communication skills to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Eight

The data indicate that the degree of importance placed on reading and interpreting manuals by academics and industry are fairly similar to one another.

93.1% of all respondents considered reading and interpreting manuals to be necessary for the job/a desirable skill that may enhance employment.

Question Thirty-Nine

The data indicate that the degree of importance placed on reading and interpreting text manuals by academics and industry are strongly similar.

94.1% of all respondents considered reading and interpreting text manuals to be necessary for the job/a desirable skill that may enhance employment.

Question Forty

The data indicate that the degree of importance placed on comprehending vocabulary related to specific engineering fields by academics and industry are strongly related with one another.

Most of the respondents considered comprehending vocabulary related to specific field to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-One

The data indicate the degree of importance placed on reading and interpreting of charts, tables, graphs by academics and industry are fairly strongly related.

92.1% of all respondents considered reading and interpreting of charts, tables, graphs to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Two

The data indicate that the degree of importance placed on reading and interpreting technical reports by academics and industry are fairly similar.

93.1% of all respondents considered reading and interpreting technical reports to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Three

The data indicate that the degree of importance placed on reading and interpreting product information by academics and industry are fairly related with on another.

Majority of all respondents considered reading and interpreting product information to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Four

The data indicate that the degree of importance placed on critical thinking skills by academics and industry are fairly similar.

A vast majority of all respondents considered critical thinking skills to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Five

The data indicate that the degree of importance placed on goal setting by academics and industry are not strongly similar.

89.1% of all respondents considered goal setting to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Six

The data indicate that the degree of importance placed on teamwork skills by academics and industry are fairly strongly similar.

92.1% of all respondents considered teamwork skills to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Seven

The data indicate that the degree of importance placed on group discussion skills by academics and industry are fairly strongly similar

Most of the respondents considered group discussion skills to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Eight

The data indicate that the degree of importance placed on intercultural communication skills by academics and industry are not strongly similar.

85.1% of all respondents considered intercultural communication skills to be necessary for the job/a desirable skill that may enhance employment.

Question Forty-Nine

The data indicate that the degree of importance placed on negotiation skills by academics and industry are fairly related to one another.

84.1% of all respondents considered negotiation skills to be necessary for the job/a desirable skill that may enhance employment.

Question Fifty

The data indicate that the degree of importance placed on following instructions by academics and industry are fairly strongly similar.

An overwhelming majority of all respondents considered listening and following instructions to be necessary for the job/a desirable skill that may enhance employment.

Question Fifty-One

The data indicate that the degree of importance placed on following directions by academics and industry are fairly related.

93.1% of all respondents considered listening and following directions to be necessary for the job/a desirable skill that may enhance employment.

Question Fifty-Two

The data indicate that the degree of importance placed on aural comprehension skills by academics and industry are fairly related.

95.0% of all respondents considered aural comprehension skills to be necessary for the job/a desirable skill that may enhance employment.

Question Fifty-Three

The data indicate that the degree of importance placed on note-taking skills by academics and industry are fairly similar.

90.1% of all respondents considered note-taking skills to be necessary for the job/a desirable skill that may enhance employment.

Computer print-outs indicating the statistical analysis of responses to the various questions appear on pages 176 to 208.

In conclusion, it must be noted that in addition to the basic communication skills of speaking, writing and listening, the skills required to work with a variety of disciplines, organisations and management levels are required by today's engineering workforce. Treadwell (1989) believes that the new role of the engineering technician implies a communicator who may be part manager, part public relations specialist and part entrepreneur.

According to (Carnevale, 1990 : 10),

> "*although many workers have done well in the workplace despite skill deficiencies, it is increasingly apparent that such success in the future will be illusory for many workers if they continue to be ill-equipped in a broad spectrum of basic workplace skills*".

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

The Communication Skills 1 course at technikons in KwaZulu-Natal does not appear to satisfy the needs (in terms of content and time) of industry. The view is widely held that the literacy skill demands of jobs are increasing while the basic skills of the workforce are decreasing. This study investigated the cognitive and workplace requirements of engineering technicians with regard to communication skills. The findings of the questionnaire and interviews, as reflected in chapter three of this study revealed the great degree of importance placed by industry on a variety of communication skills for an engineering technician in the workplace. The following are the conclusions and recommendations arising from the study:

4.1 Only when an entire engineering faculty accept responsibility for improving the communication skills of their engineering students will they be facilitating the standards required by industry. This view is strongly supported by Maxam (1988 :109) wherein she states that, "*when all business educators in every course stress the importance of communication skills in an organized manner, the overall performance of engineering students can be improved.*"

4.2 In the report entitled "Related Skills in the Marketplace", Final Report (1989), it was found that most communication skills surveyed could be applied across all the engineering fields. However, the levels of application and the complexity may vary. This finding was reinforced in Campbell and Wood (1987), as cited in this report wherein it was concluded that communication skills are transferable across occupations. However, the practical application of skills in specific vocational fields is crucial to skill mastery.

4.3 Most engineering educators are familiar with the perceived inability of graduates to communicate effectively. Although the problem has received much lip service in recent years, the writer believes that little action has been devoted to its solution.

Like most problems, it will not correct itself. However, it should be noted that engineering educators are struggling within their own curricula to find enough time to keep abreast with the dynamic nature of their field, with the ever-changing technology. However, it is crucially important that engineering educators place greater emphasis on good and effective communication skills within their own courses and adapt teaching strategies that are more co-operative and collaborative in nature. This should prove very successful in the culturally and linguistically diverse classrooms in which educators in South Africa find themselves.

4.4 The contributions made by organisations such as industry, and the professional/technical institutions that have indirect contact with the educational process are significant. The efforts of these organisations are vital and may include such activities as evaluating the graduate and identifying trends that may influence curricula orientation.

4.5 In general, engineering curricula at tertiary level require that students take a course in written and oral communication. Such a course however, does not usually cover "*selling one's position.*" Additionally most engineering students and practitioners react with characteristic apprehension when faced with any type of communication other than technical. The end result of this situation is often a deficiency in the skills needed by the engineer to discharge his or her duties effectively. This deficiency is magnified in areas where much of an engineer's essential communication is with a public untrained in engineering matters.

4.6 Engineers need added skills in communication to enhance their effectiveness and develop self-confidence. This need can best be served by close co-operation between the industrial sector and the academic institution. But convincing engineers (especially the ones that have worked for a period of time) that such skills are needed throughout their careers is a more difficult problem. It is vital that practising engineers and educators stress the importance of communication skills to the students whilst they are in-service training.

4.7 The future vitality and competitiveness of engineering industries depend on widespread acceptance of activities that integrate formal education with workplace demands. Providing appropriate lifelong educational experiences for engineers at the workplace requires close collaboration between academic institutions and industry. The development of on-going curriculum evaluation in engineering and the development of engineering technicians in the workplace will require the initiatives of academics and professionals in industry. The shortsightedness of curriculum committees who undervalue communication courses for engineering students contributes to the number of poorly written communications generated by many decision makers in industry. This view is supported in the study by Bachman (1988).

4.8 Although all instructors/lectures from the engineering faculties are encouraged to make basic communication skills part of the teaching and learning process in their courses, increased teaching loads, large classes, administrative responsibilities, and pressure to research and publish papers in their own disciplines, may prevent engineering faculty staff from getting involved in communication skills instruction. Emphasis appears to be more on the product than on developing the process of achieving good and effective communication skills. The assigning of grades to test papers, assignments and projects takes much valuable time, leaving very little time for developing the students' potential in language communication. All these constraints and more, make it necessary and certainly justifiable to suggest that the engineering programme be extended, in particular the communication skills course, if vocational training institutions like the technikons are to meet the workplace and cognitive requirements and standards of local as well as international engineering companies/industries.

4.9 The general feeling that is being sounded out by policy makers in the education sector is that the student population should increasingly reflect the cultural composition of the wider community it serves. The present situation is that English Second Language students are predominating in most academic programmes on campuses throughout the country.

The points that follow reflect the implications of this for tertiary education, and in particular for students in a vocationally-orientated communication class:

* Because the ESL students have been exposed to an aberration of intonation patterns for years, the instructor's/lecturer's standards of English may sound 'foreign', in fact sometimes unintelligible. This seriously impairs listening and comprehension skills.

* The general vocabulary of ESL students is restricted and limited. Common words that English first language speakers take for granted are often not explained in a lecture. Furthermore, ESL learners generally have great difficulty with the figurative and idiomatic use of language. It seems reasonable to conclude that the average ESL student will therefore not understand a significant portion of the work, if the Communication Skills 1 course for engineering students is offered only as a one-semester programme.

* Because of poor reading/comprehension skills the average ESL student has to spend much longer than the English first language student on the same learning tasks. This places such students at a tremendous disadvantage when they eventually have to compete for jobs in the open market.

* While it is desirable, and indeed necessary for the English first language speakers to learn the mother tongue of the majority, all the technikons in KwaZulu-Natal are English medium institutions, and all the textbooks are in the medium of English. It is therefore imperative that every strategy be utilized, that every avenue be exploited to develop the communication skills of the ESL student.

* Although the eleven main languages spoken in the country at present have been promised equal status in the 'new' South Africa, a good standard of English proficiency will still be the key to the

empowerment of the majority. If technikons in the country fail to produce graduates who are able to participate effectively in debate and discussion and produce written documents of an acceptable standard the institutions will have failed in their educational objectives.

It seems reasonable to conclude that an extended Communication Skills 1 course for engineering students is justified.

4.10 Many engineering students do not understand and appreciate the importance of effective communication in industry and the present engineering curriculum provides limited time for students to enhance their communication skills for the entire engineering programme.

4.11 There have long been accusations from industry that although technically competent, graduate engineers have a narrow outlook and lack the necessary skills to take a significant leadership role within society. It seems reasonable to conclude that a Communication Skills course for engineering students should develop a variety of communication skills. This view is strongly supported by Hedges and Walley (1990).

4.12 Increasingly employers are discovering that their workforces need skills over and above the basic reading, writing and speaking skills. The findings of the present study indicates that the skills that employers are looking for now, apart from the basic writing, speaking and listening skills, include problem-solving, management and interpersonal skills, as well as the ability to conceptualize, organize and verbalize thoughts, to resolve conflicts and to work in teams - all of these are crucial. It is felt that undergraduate engineering education is not structured to provide a strong background in management. Better training is needed to respond to the changes in the profession especially in the area of engineering team organisation.

4.13 The engineer has to communicate convincingly,unambiguously, truthfully and with sound logic. Engineering practitioners, according to the findings of the questionnaires and interviews, believe that the acquisition of effective communication skills cannot

reasonably be achieved by an engineering student in one semester. The skills required to develop good and effective communication are too complex and broad to be taught to a student in just one semester. The words of an engineering practitioner at an interview conducted in this survey must certainly be noted:

> *"We can only aspire to instil into the student respect for the power and joy of good communication with a view to stimulating a lifelong habit of self-criticism and improvement in this important field."*

4.14 It seems reasonable to conclude from this study that for today's engineering profession, completion of a diploma/degree is insufficient to ensure career-long productivity or competence. These students need continuous professional development through career-long educational systems. Three of the reasons engineering practitioners give for not participating are : lack of perceived need, lack of payoff, and lack of company encouragement. This point of view according to the findings of the interviews, is in contrast to what management says is true, namely that keeping abreast with current developments through educational activities is vital to the engineer's career and to the company's growth. Either management is falling short in its efforts to support career-long education with a suitable infra-structure that links corporate philosophy with corporate practice, or the engineers' perception of the company is wrong, or there is some combination of the two extremes. What concerns industry the most, it seems, is not necessarily the money it spends on education and training but whether it is getting the best return on the investment. Some companies may have problems reconciling corporate philosophy with actual workplace practice.

4.15 Career-long education for engineers should address both the specialized needs for the practice of engineering and the knowledge needed for more non-technical, interdisciplinary activities required in the full duration of an engineering career. The latter areas of knowledge almost inevitably cannot be covered adequately in technikons, and for many engineers the only way to obtain the expertise is through continuing education and professional growth. It seems reasonable to suggest that this

be a shared responsibility of engineers, employers, universities/technikons, government and other interested groups.

4.16 When designing an engineering curriculum it seems important to consider the needs of each country and each community within it for technology appropriate to it. Any vocationally oriented curriculum should meet the social requirements of the country in which it operates. Titchener (1989) expresses the view that knowledge and skills taught should be broad so that they are transferable to new jobs likely to be held in the future. It is important to provide as broad an option as possible so that the future will be promising for an engineer who is part of an everchanging technology. However, the counter argument against designing a curriculum according to a set of specifications may result in an individual with a narrow horizon who is unable to compete within the international market. It seems that very little can be achieved if the major stakeholders, that is, the institution, the students and industry, work in isolation. All parties concerned should be committed towards satisfying the long and short term objectives of vocational institutions.

4.17 In view of the increased emphasis on a broader education for engineering students as reflected in chapter three of this study, it appears that an increase in the duration of the technikon engineering programme is warranted to provide sufficient breadth and depth in engineering education courses. In particular, communication skills need closer attention to adequately qualify a student to enter an engineering career.

4.18 The Communication Skills course in the present technikon engineering programme should be expanded and more carefully monitored so that "*optimal use is made of this time in accordance with the criteria which require that the programme reflect the aims and objectives of the engineering profession within the institution*" (Lundgren, 1986 :78).

4.19 A Vice President of a local power company stated that one of the biggest problems among employees in industry presently is the inability to communicate effectively. He went on further to say that he himself wrote notes which he could not understand

an hour later, and that he continually received memoranda with misspellings, incorrect grammar and irrelevant information.

It seems reasonable to suggest that the Communication Skills 1 course should be expanded and made available to engineering students throughout their engineering programme of study, so that business writing skills apart from other communication skills, can be addressed in greater detail. Interestingly, this was the suggestion make by ABET in Reid (1988). It is crucial to focus on an approach which satisfies the learner's communication and linguistic needs as well as the cognitive and academic needs of the discipline.

4.20 A one-semester course in communication skills will certainly not provide all the answers to improved communications skills. The findings of the questionnaires and interviews as reflected in chapter three of this study indicate quite clearly that engineering technicians today must be much more than good writers and speakers; they must be good listeners and they should be non-verbally sensitive. They must be able to interact interpersonally with others and they must possess good organizational skills. They have to be able to do whatever research is necessary to solve problems or respond to opportunities and challenges. In addition they are very likely to have to represent their companies and deal with people of diverse cultures and language.

> "*Realistically preparing students for their communication roles in business could conceivably take a multitude of course offerings*" (Bachman, 1988 : 138).

4.21 The optimum length of a training programme depends on a number of variables including the student's prior knowledge in each skill area, the required skill level for the job, the design of the curriculum and the commitment of academic staff. According to Carnevale (1990) the attainment of job-related competency can take from 40 hours to 5 years and should involve follow-up and evaluation once the employee is on the job, as well as refresher courses throughout the engineer's professional career. This is strongly supported by the following comments made by two engineering practitioners from two leading companies in KwaZulu-Natal :

"We have been alarmed at the low standard of English accepted for tests, assignments and projects from students of engineering. We believe that the position can only be improved if all parties concerned, that is academic institutions, industry and students resolve the problems together. We feel that the short semester course does not get to the root of the problem"

and

"We as a forward thinking company will do all within our powers to ensure that the situation is contained and hopefully in the near future we will be able to boast of the best communication."

4.22 The responsibility for the teaching of communication skills to engineering students should be an integrated team approach with communication as well as engineering faculty staff participating. The task is too mammoth and complex to be achieved by language specialists only.

4.23 Lecturers/instructors in other subject areas of the engineering curriculum should accept the following basic responsibilities:

* understanding the foundations of communication;
* developing specializations that strengthen communication skills instruction;
* teaching relevant communication skills in all the engineering courses.

The communication specialists could then widen their responsibilities in the following ways :

* They could conduct the required business communications research and train others to teach certain business communication content: for example, technical writing skills, advanced correspondence skills and other complex business writing skills as required by the engineering profession.

* The Communication Department could provide training programmes in communication skills to employees in industry, and perhaps offer consultative services to assist industry resolve their communication skills problems.

4.24 At the present time, with communication skills being offered as a one-semester programme, very little (if any) time can be devoted to the development of writing skills. In the light of the responses to the interviews and questionnaires as reported in chapter three, it is clearly evident that the development of writing skills should receive far more attention than is presently the situation. Ideally, writing skills should be developed throughout the engineering programme, beginning with simple forms of business writing, for example, short memoranda, simple business letters and written requisitions. This should lead towards more complex forms of business writing, like report writing, writing of proposals and motivations and advanced business correspondence which should be covered in the latter half of the engineering programme when the student is presumably more cognitively prepared and mature to handle that level of writing. It seems reasonable to suggest that writing skills should form a separate module of the communication skills course for engineering students.

4.25 Technical writing which includes report writing, writing of proposals and motivations could quite comfortably form a module on its own. It is highly desirable that a student be given a reasonable grounding in grammar and the ability to communicate clearly, both verbally and in writing right at the start of his/her career. The author suggests that in the light of the responses to the questionnaires and interviews, it would be more relevant and logical to cover the writing of reports, advanced business correspondence, decision-making and conflict management in the latter half of the engineering curriculum when it is more likely that an engineering technician may be called upon to use these skills. There should also be writing assignments in every engineering course with part of the course grade dependent upon exhibited writing ability.

4.26 Although specific coursework requirements serve as a foundation for writing competency in some institutions, the development and advancement of writing skills should be demonstrated through student work in engineering courses as well. The engineering faculty staff members should be encouraged to promote the development of skills by integrating communication challenges into class exercises.

4.27 It must also be noted that the classes within institutions in South Africa are generally multicultural and multi-lingual in composition, with the cognitive levels diverse as never before, which makes teaching and learning a complex and lengthy process. Herein also lies justification for skills such as writing to be developed at a slower pace throughout the engineering programme. The study of Fordyce and Robinson (1990) is significant in that it underpins the view of the author as well as the research findings reflected in chapter three, that communication skills are developmental and as such should be offered in sequential modules to students at all levels of the engineering programme. Fordyce and Robinson maintain that, "*a knowledge of skills may be able to be taught but an individual's ability to use a skill can only be developed*" (105).

4.28 Although a fair part of the semester for the present Communication Skills 1 course is devoted to spoken skills like oral presentations, job interviews and group discussions, lecturers/instructors are forced to rush through these projects in order to meet deadlines for assessments, thus very little (if any) development of oral/spoken skills can be accomplished. The emphasis appears to be on the end product rather than on the process, on quantity rather than quality. Research has revealed that oral/spoken communication skills like other skills in language communication should be developed in stages. There is very little time in the present engineering academic programme for the development of spoken skills. It is clear from the findings of the questionnaires and interviews, that the role of the engineering technician is becoming more and more broad, and that oral /spoken skills are needed to accomplish a variety of tasks in industry. Again, this cannot be accomplished in just two or three projects. It seems reasonable to suggest that oral/spoken communication skills should be given the importance they deserve and allow students more time to meet the ever-changing

needs of industry. Although the requirement in specific coursework may serve as a foundation for competency in oral communication, the author would like to suggest that the development of communication skills should be demonstrated by student work even in engineering subjects other than communication courses.

4.29 A reading component should be added to the Communication Skills course with a focus on content reading skills, and occupational reading skills meaning that the instructional materials to teach reading skills should be drawn from the respective fields that students will eventually enter.

4.30 It is suggested that language teaching should be functional in nature and should relate to the workplace. Language remediation should include fundamental usage, grammar and spelling. For the student whose mother-tongue is not English, the position is critical, certainly justifying an extended communication skills course.

4.31 It seems reasonable to suggest that there should be a balanced treatment of spoken, reading, writing and listening skills as these are the skills that have been identified by respondents as being of great importance in the practice of engineering.

4.32 The task of the communication lecturer/instructor at the earlier levels of the engineering programme should be to assist students to master the basic communication skills in all four categories (written, spoken, listening and organizational). This would form the foundation on which a communication specialist would develop higher skills later in the programme.

4.33 According to Berkowski and Koridze (1991), recent studies have shown that engineering graduates although adequately trained in the fundamentals of engineering, lack the knowledge that can be applied immediately at the workplace. This view was reflected in the findings of the interviews conducted in the present study. It seems reasonable to suggest that courses in communication skills should have a practical rather than an academic approach, while maintaining a strong intellectual base. The goal should be to produce well trained engineering technicians capable of making major technical contributions immediately upon joining the workforce.

4.34 Since the ability of engineering educators to adapt to change depends on encouragement and toleration of curricular and faculty flexibility, shared teaching across departmental boundaries, especially in an area like technical writing should be encouraged. The need for educational experimentation should be recognised and given institutional support.

4.35 The present engineering curricula provide limited scope for students to enhance their communication skills. Although specific coursework requirements serve as a foundation for such competency, the development and enhancement of communication skills should be demonstrated throughout the engineering curriculum. Furthermore, engineering staff could be encouraged by communication staff to promote development of skills by integrating communication challenges into class exercises and project work. Such staff, however, must be given proper training to enable them to thoroughly critique written reports and oral presentations. This can be mutually arranged between the communication and engineering lecturers/instructors. This practice is supported by many researchers worldwide, one of whom states "... *the infusion of communication skills throughout the business curriculum is one viable approach for strengthening communication skills for business*" (Scott ed, 1988 : 161).

4.36 Educators at technikons should provide their students with instructional materials that are relevant to industry. The educators at technikons should conduct the types of research that could strengthen their particular disciplines. They should also accept responsibility for addressing and finding solutions to communication problems as are expressed by employers, employees and members of consultative committees, constituting academics as well as engineering practitioners from business and industry.

4.37 Industry should continue to sound the alarm about how the lack of effective and good communication skills contributes to declining economic competitiveness and productivity, and support the overwhelming view to raise and strengthen the quality and quantity of communication skills courses in engineering programmes.

4.39 Motivating engineering students to accept communication skills as a critical complement to their technical skills could be facilitated by an active, diligent committee of industry advisors. These advisors could be employers who interview and select graduates to fill positions in local firms/industries. Proper minutes of meetings held must be recorded so as to be able to refer to these during curriculum evaluation exercises. The industry advisors could also add impact to their motivational messages by addressing students in their roles as future employers. In addition to this, technikon graduates could be invited by the Engineering faculty staff to address engineering students on aspects of workplace communication and other relevant areas of communication.

4.39 One method of moulding the student's attitude towards communication skills courses is requiring them to attend Advisory Committee Meetings which are made up of personnel from engineering companies, engineering and communication staff and training managers. The author believes that when the representatives from industry with whom the student may find employment state the need and importance of good communication skills, students may listen well and respond positively. Students will very likely do what is necessary for their specific profession, if the engineering practitioners themselves are calling for specific skills.

4.40 To assist the large numbers of engineering students with the motivation of having to do a communication skills course, the Departments of Engineering and Communication could jointly prepare some material in the form of handouts listing industry standards and requirements as far as communication skills are concerned. Industry could also be requested to make an input in this regard.

4.41 All engineering students should undertake a module of Information Studies to prepare them to handle the flow of information they receive, to solve engineering problems and to keep abreast of new technology. Such a module should have a strong practical emphasis and should concentrate on the value of information to the engineer. Technikons should aim to produce "information-literate" engineers (McElroy, 1991 : 251). This module should be designed, taught and assessed jointly by Library

Information and Communication specialists. One of the objectives of such a module would be to develop lifelong and transferable skills, for example, decision-making, alpha-numeracy and problem-solving, thereby to develop the students' ability to continue learning independently and keep pace with developments in their discipline.

4.42 If industry were to adopt a revised posture towards co-operative education and commit itself to shared responsibility for the education of the engineer, it could make a significant impact. Furthermore, an integrated approach would bring an innovative and constructive dimension to the education of the engineer. In order to enhance South African competitiveness, it is recommended that increased emphasis be placed on projects that are co-operatively sponsored by the technikons and the relevant industries. Such projects should contribute to curriculum and faculty development. In the light of the responses to the interviews as reported in chapter three, full advantage should be taken of industry's willingness to participate in such projects.

4.43 If fundamental engineering curricula needs are to be met, it is essential that industry and the academic institution work more closely and co-operatively with one another. The author believes that the costs of training programmes designed to close the gap between the academic sector and industry will be substantially lowered if institutions like the technikons and universities can anticipate more effectively the technical and communication needs of their graduates entering the labour force.

4.44 Employers will have to be convinced that there is a significant financial pay-off in initiating and maintaining workplace programmes in communication skills. In the United States, the Trade Unions are placing much pressure on industry to improve the literacy level of their workforce. This is also evident in South Africa. There should be a strengthening of interaction between the academic and industrial communities, a strong commitment from industry by way of student sponsorships and equipment to ensure its involvement in the research and education of the engineer. For today's engineering profession, the completion of a qualification is insufficient to ensure career-long productivity or competence. Students need continuous professional development through career-long educational systems. Industry has a definite role to play not only in the continuing education of their engineering

workforce, but also in terms of the educational standards students are required to meet and the quality of curricula to which students are exposed.

4.45 The social partners constituting the institution and industry should co-operate fully in vocational education based on in-service experiential work in which employer-based training is complemented by further education. Both time and standards should still be essential elements. Ongoing attention should be paid to communication needs during such co-operative exercises.

4.46 The author believes that it would be useful to know if employers are well informed with regard to the monitoring of students during their in-service training period. It would also be useful to ascertain if employers find existing arrangements for reporting progress satisfactory, and to what use the information is put, or could be in helping trainees who are having difficulties. Likewise the views of academic staff on the involvement of employers in monitoring student progress could be sought.

4.47 According to Sharif (1991), efforts are made to strengthen relations with industry through visits, training of students in industry, joint committees and conferences. Sharif maintains that one of the objectives of engineering education is to link study with workplace practices by choosing projects that solve real problems and working as a team. It seems reasonable to suggest that curriculum revision be done in close collaboration with industry by requesting feedback and comments from personnel in industry, encouraging visits of personnel from industry, and forming joint consultative committees constituting academics from institutions and personnel from industry. This practice is proving very successful in engineering institutions in Jordan, and would prove successful in South Africa too.

4.48 A Government-Technikon-Industry Research Roundtable, as exists in the United States should be created to provide a forum where engineers, scientists, administrators and policy makers from government, universities, technikons, colleges and industry can come together on an on-going basis to improve the undergraduate engineering programmes. Collaboration is important because

"*when you view science education as a dynamic process involving doing as opposed to telling, you learn very quickly that these resources need to come from many sources, since no educational institution can do it alone*" (Report: Nurturing Science and Engineering Talent. A Discussion Paper, 1987).

4.49 The philosophy of technikon education rests on the view that

"*suitable work experience provides the vital context for effective study of vocational subjects and for development of appropriate attitudes and understanding*" (Panckhurst and Wagner, 1986 :4).

In this regard department heads in both the engineering and communication departments should make provision on academic time-tables for lecturers/instructors to improve and enhance their understanding of engineering technicians through industry visits. The author would like to suggest that an in-service training component for the communication skills course be included in the time-table. This would ensure continuous course evaluation, an exercise that would bear fruit in the long run where industry can proudly boast engineering technicians who are not only technically skilled but who also are good and effective communicators.

4.50 Many academics from the engineering departments, as reflected in the responses to the questionnaires, are of the opinion that because so much technical knowledge needs to be taught, there is limited time on the time-table for more communication skills. However, it must be noted that a 1986 survey of representatives of private business and industry in Colarado Springs revealed that an estimated 85% of all employees fired were terminated not because they lacked technical knowledge, but because they lacked human relations skills (Troutt and Isberner, 1988). It would be reasonable and certainly a worthwhile suggestion to adopt a departmental policy on the importance of effective communication skills in engineering, and this should be included in the engineering students' study guides. The author believes that if students realize the importance the engineering departments assign to communication skills, they will

present the assignments and projects (written and spoken) in the professional manner that is required by industry.

4.51 The stringent demands of the technical subject areas result in a heavy professional course load and leave very little room for other social and human science courses. The language specialists should work closely with academics in the engineering faculty to be well versed in the technical communication requirements of specific engineering professions. The time has come for the humanist and the technologist to merge their expertise and provide the next generation of students with the tools necessary for productive and rewarding careers in the global workplace.

4.52 Today's best engineering students could rise to positions of leadership and power. In a world more dependent on systems and products that are safe, environmentally sound, and socially beneficial, engineers will shoulder new responsibilities and in order to fulfil these responsibilities, they will need as broad a range of intellectual skills and understanding as possible. In the United States, the Accreditation Board for Engineering and Technology (ABET) requires that a minimum of 12.5% or one semester of a student's coursework be in the humanities and social science areas. However, in South Africa, particularly in KwaZulu-Natal, limited time in the engineering programme appears to be one constraint, while another is that many engineering faculty staff apparently regard the humanities and social sciences with indifference and as unnecessary to the engineering programme. The author would like to suggest in the light of the responses to the interviews as reported in chapter three of the study, that a module incorporating the humanities and social sciences be offered to engineering students within the undergraduate engineering programme.

In conclusion it must be noted that technology is changing rapidly even more so in the communication-related field. The basic foundations of communication will remain the same, but technology will change the manner and speed with which communication occurs. The challenge facing the lecturer/instructor in a vocational education institution is to benefit from technology while building communication skills.

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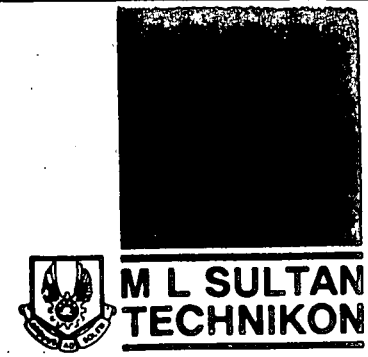
APPENDIX A



M L SULTAN TECHNIKON

41/43 Centenary Road, Durban 4001. P O Box 1334, Durban 4000. Fax: (031) 308 5194, Tel: (031) 308 5111

Dear Sir/Madam

AN APPEAL FOR INFORMATION: COMMUNICATION SKILLS FOR ENGINEERING TECHNICIANS

I am a lecturer in the Department of Communication at the M L Sultan Technikon, Durban. The Department of Communication offers both annual and semester courses in Communication in English to four faculties viz Engineering, Commerce, Arts and Human Sciences. I am presently undertaking a Master's study in Technology and my research topic is:

> **"An evaluation of the suitability of the course offering: Communication Skills 1 for engineering students at Technikons in Natal."**

The purpose of this project is twofold :

* To identify the communication skills that are required by the engineering technician for optimal job performance in the workplace.

* To determine to what extent these needs are reflected in the present undergraduate Communication Skills 1 course offering.

I would be most grateful if you would help me to draw upon the benefit of your knowledge and experience by completing the attached questionnaire or by arranging for its completion. The information provided by you will hopefully assist in making the syllabus more relevant and applicable to the cognitive and workplace demands of the engineering technician.

Your cooperation in achieving these objectives will be most appreciated. If you are interested in the results of this questionnaire, please let me know.

I thank you for your participation. A pre-addressed envelope is provided for the return of the questionnaire. If possible please return completed questionnaire by the end of April.

Yours faithfully

S D NARSEE (Mrs)
LECTURER
DEPARTMENT OF COMMUNICATION

OCCUPATIONAL PROFILE QUESTIONNAIRE

SECTION A

NAME :.....

JOB TITLE :.....

COMPANY :.....

INSTRUCTION:	PLEASE COMPLETE THIS SECTION BY PLACING AN "X" IN THE BLOCK OF YOUR CHOICE.

1. WHAT KIND OF BUSINESS OR INDUSTRY DO YOU REPRESENT ?

Electronic Engineering	1	
Mechanical Engineering	2	
Building Engineering	3	
Civil Engineering	4	
Architectural Engineering	5	
Surveying	6	
Town Planning	7	
Industrial Engineering	8	
Consulting Engineers	9	
Other (Please Specify)	10	

2. WHAT IS YOUR PRESENT WORKFORCE NUMBER ?

10-25		25-50		50-100		100-200		200-500		500+	
1		2		3		4		5		6	

3. HOW IMPORTANT ARE THE FOLLOWING COMMUNICATION SKILLS FOR THE ENGINEERING TECHNICIAN ?

INSTRUCTION:	USE THE RATING BELOW AND CIRCLE THE NUMBER OF YOUR CHOICE.

1 = Unimportant
2 = Not very important
3 = Important
4 = Very important
5 = Critically important

Writing skills	1	2	3	4	5
Reading skills	1	2	3	4	5
Oral skills	1	2	3	4	5
Listening skills	1	2	3	4	5
Organizational skills	1	2	3	4	5

4. PROVIDE REASONS FOR YOUR CHOICES IN QUESTION 3 ABOVE.

4.1 Writing skills:

.....

.....

.....

.....

4.2 Reading skills:

.....

.....

.....

.....

4.3 Oral skills:

.....

.....

.....

.....

4.4 Listening skills:

.....

.....

.....

.....

4.5 Organizational skills:

.....

.....

.....

.....

5. HOW IMPORTANT ARE COMMUNICATION SKILLS FOR PROMOTION IN YOUR COMPANY ?

Unimportant	1	
Not very important	2	
Important	3	
Very important	4	
Critically important	5	

6. PROVIDE REASONS FOR YOUR CHOICE IN QUESTION 5 ABOVE.

.....

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SECTION B

SPECIFIC COMMUNICATION SKILLS ARE LISTED IN THE MATRICES WHICH FOLLOW BELOW. PLEASE REVIEW THE SKILLS AND RATE THEIR IMPORTANCE TO THE ENGINEERING PROFESSION (SPECIFICALLY YOURS) USING THE CODE BELOW:

1 = NECESSARY FOR THE JOB
2 = DESIRABLE SKILLS THAT MAY ENHANCE EMPLOYMENT
3 = OPTIONAL SKILLS THAT WOULD SELDOM BE NEEDED

COMMUNICATION SKILLS	RATING		
WRITING SKILLS			
Punctuation and capitalization	1	2	3
Spelling	1	2	3
Application of rules of grammar	1	2	3
Clarity in setence construction	1	2	3
Paragraphing	1	2	3
Memorandums and letters	1	2	3
Job applications and resumes	1	2	3
Filling in business forms	1	2	3
Write instructions	1	2	3
Write a description of a product or mechanism	1	2	3

Write an explanation of a process	1	2	3
Write a technical definition	1	2	3
Write an analysis of a problem	1	2	3
Write simple proposals, reports, motivations	1	2	3
Editing skills	1	2	3
Concise writing	1	2	3
Construct charts, tables, graphs	1	2	3
Summarize information	1	2	3
ORAL SKILLS			
Speak english clearly	1	2	3
Describe a product or service	1	2	3
Explain a process	1	2	3
Apply problem solving techniques	1	2	3
Decision making skills	1	2	3
Formal presentation of reports/proposals	1	2	3
Request help	1	2	3
Meeting procedures	1	2	3
Telephone techniques	1	2	3
Interpersonal skills	1	2	3
Use appropriate non-verbal communication	1	2	3
READING SKILLS			
Read and interpret manuals	1	2	3
Read and interpret text manuals	1	2	3
Comprehend vocabulary related to field	1	2	3
Read and interpret charts, tables, graphs	1	2	3
Read and interpret technical reports	1	2	3
Read and interpret product information	1	2	3
Critical thinking skills	1	2	3
ORGANIZATIONAL SKILLS			
Goal setting	1	2	3
Teamwork	1	2	3
Group discussion skills	1	2	3
Intercultural communication	1	2	3
Negotiation skills	1	2	3
LISTENING SKILLS			
Follow instructions	1	2	3
Follow directions	1	2	3
Aural comprehension	1	2	3
Note-taking	1	2	3

ANY OTHER COMMUNICATION SKILLS			
	1	2	3
	1	2	3
	1	2	3
	1	2	3
	1	2	3

7. Please add any further comments you wish to make on Communication Skills for your profession.

INTERVIEW QUESTIONS

QUESTION ONE

How do you rate the importance of communication skills for an engineering technician in your company?

QUESTION TWO

What are the communication skills requirements for entry-level engineering techicians?

QUESTION THREE

Does your company spend any time and money on in-house training or consultative services in communication skills? If so, how much time and money; if not, why?

QUESTION FOUR

The engineering programme at the technikons currently allows for a one semester course in communication skills, mainly offered to students in the first year of the programme. Thereafter, students do not take any other communication skills courses. How do you feel about this?

QUESTION FIVE

If you were requested to make an input into the present Communication Skills course/syllabus for engineering students, what would you suggest (in broad terms) the content cover, and at what level should it be covered?

QUESTION SIX

What is the proportion of spoken to written communication in one day in the job function of an engineering technician?

QUESTION SEVEN

Will your company be willing to have academics from the Department of Communication monitor the communication skills of engineering trainee technicians?

QUESTION EIGHT

How successful will an engineering technician be without good communication skills?

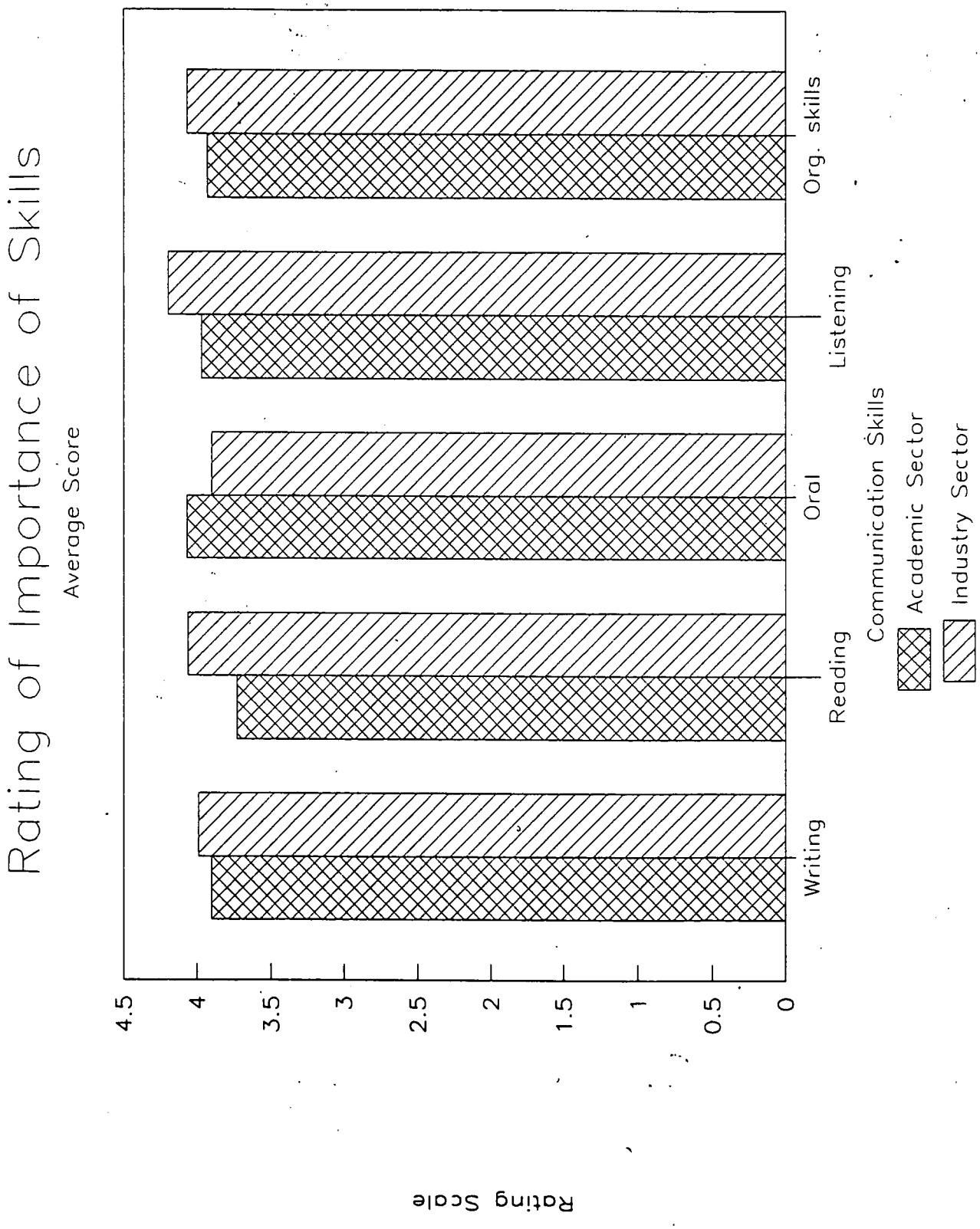
QUESTION NINE

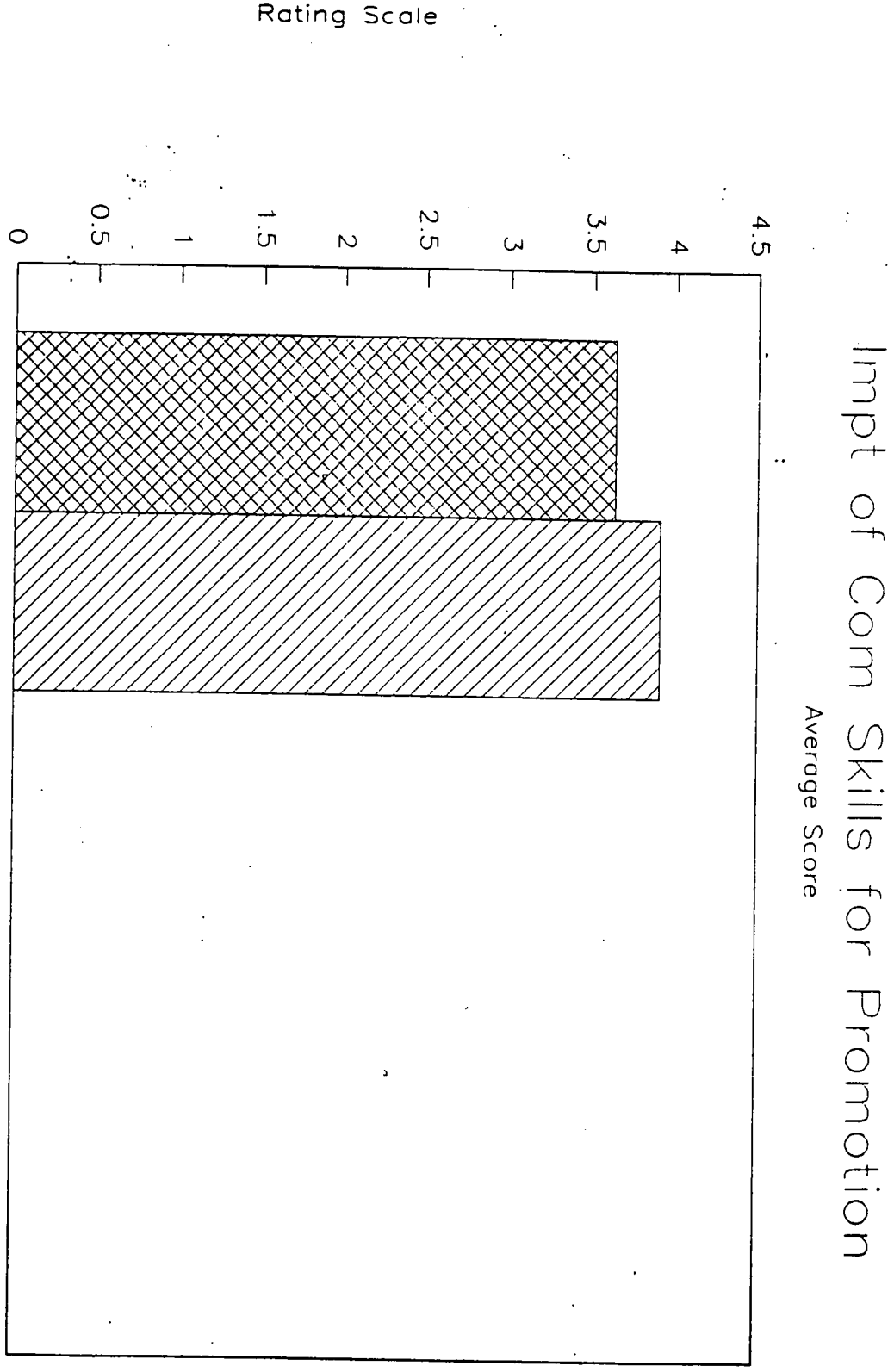
What are the short-comings of engineering technicians in your company as far as communication skills are concerned?

QUESTION TEN

Is there anything you wish to add? Any comments you wish to make?

APPENDIX C


Rating of Importance of Skills
Average Score
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Writing
Reading
Oral
Listening
Org. skills
Communication Skills
Academic Sector
Industry Sector
Rating Scale


Rating Scale
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Impt of Com Skills for Promotion
Average Score
Rate of Importance
Academic Sector
Industry Sector

crosstabs y by x1 to x53 /statistics=chisq.

Memory allows for 7,440 cells with 2 dimensions for general CROSSTABS.

Y by X1

Count	X1 1.00	2.00	3.00	4.00	5.00	Row Total
Y 1.00	6	6	2	5	3	30 29.7
2.00	5	7		4		71 70.3
Column Total	11 10.9	13 12.9	2 2.0	9 8.9	3 3.0	101 100.0

(Continued)

Y by X1

Count	X1 6.00	8.00	9.00	10.00	Row Total
1.00		1		7	30 29.7
2.00	1	5	7	42	71 70.3
Column Total	1 1.0	6 5.9	7 6.9	49 48.5	101 100.0

Chi-Square	Value	DF	Significance
Pearson	29.09685	8	.00030
Likelihood Ratio	31.81549	8	.00010
Mantel-Haenszel test for linear association	18.19721	1	.00002

Minimum Expected Frequency - .297
Cells with Expected Frequency < 5 - 13 OF 18 (72.2%)

Number of Missing Observations: 0

Y by X2

X2 Page 1 of 2

Count	1.00	2.00	3.00	4.00	5.00	Row Total
1.00	12	6	9	2		30 29.7
2.00	15	5	5	8	8	71 70.3
Column Total	27 26.7	11 10.9	14 13.9	10 9.9	8 7.9	101 100.0

(Continued)

Y by X2

X2 Page 2 of 2

Count	6.00	Row Total
1.00	1	30 29.7
2.00	30	71 70.3
Column Total	31 30.7	101 100.0

Chi-Square	Value	DF	Significance
Pearson	28.31923	5	.00003
Likelihood Ratio	33.53523	5	.00000
Mantel-Haenszel test for linear association	19.42541	1	.00001

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 4 OF 12 (33.3%)

Number of Missing Observations: 0

Y by X3

X3 Page 1 of 1

Count	2.00	3.00	4.00	5.00	Row Total
Y 1.00	2	7	13	8	30 29.7
2.00		17	38	16	71 70.3
Column Total	2 2.0	24 23.8	51 50.5	24 23.8	101 100.0

Page 10 SPSS/PC+ 4/17/96

Chi-Square	Value	DF	Significance
Pearson	5.32161	3	.14971
Likelihood Ratio	5.45371	3	.14143
Mantel-Haenszel test for linear association	.27877	1	.59751

Minimum Expected Frequency - .594
Cells with Expected Frequency < 5 - 2 OF 8 (25.0%)

Number of Missing Observations: 0

Page 11 SPSS/PC+ 4/17/96

Y by X4

Page 1 of 1

Count	X4 2.00	3.00	4.00	5.00	Row Total
Y 1.00	1	11	13	5	30 29.7
2.00		16	35	20	71 70.3
Column Total	1 1.0	27 26.7	48 47.5	25 24.8	101 100.0

Page 12 SPSS/PC+ 4/17/96

Chi-Square	Value	DF	Significance
Pearson	5.22705	3	.15591
Likelihood Ratio	5.29094	3	.15169
Mantel-Haenszel test for linear association	3.94020	1	.04715

Minimum Expected Frequency - .297
Cells with Expected Frequency < 5 - 2 OF 8 (25.0%)

Number of Missing Observations: 0

Y by X5

Count	X5 2.00	3.00	4.00	5.00	Row Total
1.00		10	8	12	30 29.7
2.00	4	14	38	15	71 70.3
Column Total	4 4.0	24 23.8	46 45.5	27 26.7	101 100.0

Chi-Square	Value	DF	Significance
Pearson	9.48460	3	.02350
Likelihood Ratio	10.67737	3	.01360
Mantel-Haenszel test for linear association	.86281	1	.35295

Minimum Expected Frequency - 1.188
Cells with Expected Frequency < 5 - 2 OF 8 (25.0%)

Number of Missing Observations: 0

by X6

Count	X6 3.00	4.00	5.00	Row Total
1.00	8	15	7	30 29.7
2.00	9	39	23	71 70.3
Column	17	54	30	101

Total	16.8	53.5	29.7	100.0

Chi-Square	Value	DF	Significance
Pearson	3.13125	2	.20896
Likelihood Ratio	2.96648	2	.22690
Mantel-Haenszel test for linear association	2.47234	1	.11587

Minimum Expected Frequency - 5.050

Number of Missing Observations: 0

Y by X7

Count	X7 2.00	3.00	4.00	5.00	Row Total
Y 1.00		10	12	8	30 29.7
2.00	2	19	22	28	71 70.3
Column Total	2 2.0	29 28.7	34 33.7	36 35.6	101 100.0

Chi-Square	Value	DF	Significance
Pearson	2.63625	3	.45117
Likelihood Ratio	3.23145	3	.35730
Mantel-Haenszel test for linear association	.54359	1	.46095

Minimum Expected Frequency - .594
Cells with Expected Frequency < 5 - 2 OF 8 (25.0%)

Number of Missing Observations: 0

Y by X8

Count | X8

	.00	2.00	3.00	4.00	5.00	Row Total
1.00	1	1	11	11	6	30 29.7
2.00		2	15	42	12	71 70.3
Column Total	1 1.0	3 3.0	26 25.7	53 52.5	18 17.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	6.51000	4	.16416
Likelihood Ratio	6.58955	4	.15924
Mantel-Haenszel test for linear association	2.20309	1	.13773

Minimum Expected Frequency - .297
Cells with Expected Frequency < 5 - 4 OF 10 (40.0%)

Number of Missing Observations: 0

by X9

X9 Page 1 of 1

Count

	1.00	2.00	3.00	Row Total
1.00	12	14	4	30 29.7
2.00	30	38	3	71 70.3
Column Total	42 41.6	52 51.5	7 6.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	2.74242	2	.25380
Likelihood Ratio	2.48741	2	.28831
Mantel-Haenszel test for linear association	.73831	1	.39020

Minimum Expected Frequency - 2.079

Chi-Square	Value	DF	Significance
Pearson	.91336	2	.63338
Likelihood Ratio	.91227	2	.63373
Mantel-Haenszel test for linear association	.05240	1	.81895

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X12

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Count	X12 1.00	2.00	3.00	Row Total
Y 1.00	20	9	1	30 29.7
2.00	41	24	6	71 70.3
Column Total	61 60.4	33 32.7	7 6.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.16803	2	.55765
Likelihood Ratio	1.28305	2	.52649
Mantel-Haenszel test for linear association	1.06205	1	.30275

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X13

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Count	X13

Y	1.00	2.00	3.00	Row Total
1.00	10	16	4	30 29.7
2.00	27	33	11	71 70.3
Column Total	37 36.6	49 48.5	15 14.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.39735	2	.81982
Likelihood Ratio	.39742	2	.81979
Mantel-Haenszel test for linear association	.02871	1	.86544

Minimum Expected Frequency - 4.455
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

by X14

Count	X14 1.00	2.00	3.00	Row Total
1.00	24	4	2	30 29.7
2.00	48	14	9	71 70.3
Column Total	72 71.3	18 17.8	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.63616	2	.44128
Likelihood Ratio	1.72343	2	.42244
Mantel-Haenszel test for linear association	1.54746	1	.21351

Minimum Expected Frequency - 3.267

Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X15

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Count	X15 1.00	2.00	3.00	Row Total
Y 1.00	12	16	2	30 29.7
2.00	28	26	17	71 70.3
Column Total	40 39.6	42 41.6	19 18.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	4.76465	2	.09234
Likelihood Ratio	5.40559	2	.06702
Mantel-Haenszel test for linear association	1.22859	1	.26768

Minimum Expected Frequency - 5.644

Number of Missing Observations: 0

Y by X16

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Count	X16 1.00	2.00	3.00	Row Total
Y 1.00	10	14	6	30 29.7
2.00	31	25	15	71 70.3
Column Total	41 40.6	39 38.6	21 20.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.28379	2	.52629
Likelihood Ratio	1.28022	2	.52723
Mantel-Haenszel test for linear association	.30767	1	.57911

Minimum Expected Frequency - 6.238

Number of Missing Observations: 0

Y by X17

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Count	X17 1.00	2.00	3.00	Row Total
1.00	25	2	3	30
				29.7
2.00	54	9	8	71
				70.3
Column Total	79	11	11	101
	78.2	10.9	10.9	100.0

Chi-Square	Value	DF	Significance
Pearson	.87316	2	.64624
Likelihood Ratio	.94125	2	.62461
Mantel-Haenszel test for linear association	.34821	1	.55513

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X18

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Count	X18	Row

Y	1.00	2.00	3.00	Total
1.00	24	4	2	30 29.7
2.00	50	12	9	71 70.3
Column Total	74 73.3	16 15.8	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.13279	2	.56757
Likelihood Ratio	1.20342	2	.54787
Mantel-Haenszel test for linear association	1.12106	1	.28969

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X19

Count Y	X19 1.00	2.00	3.00	Row Total
1.00	25	3	2	30 29.7
2.00	54	8	9	71 70.3
Column Total	79 78.2	11 10.9	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.87316	2	.64624
Likelihood Ratio	.94125	2	.62461
Mantel-Haenszel test for linear association	.84193	1	.35885

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X20

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Count	X20 1.00	2.00	3.00	Row Total
Y 1.00	21	4	5	30 29.7
2.00	49	14	8	71 70.3
Column Total	70 69.3	18 17.8	13 12.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.96299	2	.61786
Likelihood Ratio	.96830	2	.61622
Mantel-Haenszel test for linear association	.08080	1	.77621

Minimum Expected Frequency - 3.861
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

by X21

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Count	X21 1.00	2.00	3.00	Row Total
1.00	24	3	3	30 29.7
2.00	51	14	6	71 70.3
Column Total	75 74.3	17 16.8	9 8.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.42968	2	.48927
Likelihood Ratio	1.55031	2	.46063
Mantel-Haenszel test for linear association	.22611	1	.63442

Minimum Expected Frequency - 2.673
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X22

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Count	X22 1.00	2.00	3.00	Row Total
1.00	25	2	3	30
				29.7
2.00	53	11	7	71
				70.3
Column Total	78	13	10	101
	77.2	12.9	9.9	100.0

Chi-Square	Value	DF	Significance
Pearson	1.48284	2	.47644
Likelihood Ratio	1.65043	2	.43814
Mantel-Haenszel test for linear association	.36471	1	.54590

Minimum Expected Frequency - 2.970
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X23

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Count	X23	Row

	1.00	2.00	3.00	Total
1.00	9	16	5	30 29.7
2.00	20	34	17	71 70.3
Column Total	29 28.7	50 49.5	22 21.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.66367	2	.71761
Likelihood Ratio	.68895	2	.70859
Mantel-Haenszel test for linear association	.34632	1	.55620

Minimum Expected Frequency - 6.535

Number of Missing Observations: 0

X by X24

Count	X24 1.00	2.00	3.00	Row Total
1.00	17	11	2	30 29.7
2.00	26	33	12	71 70.3
Column Total	43 42.6	44 43.6	14 13.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	4.05048	2	.13196
Likelihood Ratio	4.20028	2	.12244
Mantel-Haenszel test for linear association	3.97309	1	.04623

Minimum Expected Frequency - 4.158
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X25

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Count	X25 1.00	2.00	3.00	Row Total
1.00	23	4	3	30 29.7
2.00	45	17	9	71 70.3
Column Total	68 67.3	21 20.8	12 11.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.82193	2	.40214
Likelihood Ratio	1.91490	2	.38387
Mantel-Haenszel test for linear association	1.09774	1	.29476

Minimum Expected Frequency - 3.564
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X26

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Count	X26 1.00	2.00	3.00	Row Total
1.00	23	7		30 29.7
2.00	44	19	8	71 70.3
Column Total	67 66.3	26 25.7	8 7.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	4.16300	2	.12474
Likelihood Ratio	6.40497	2	.04066
Mantel-Haenszel test for linear association	3.50690	1	.06111

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X27

Count	X27 1.00	2.00	3.00	Row Total
Y 1.00	22	6	2	30 29.7
2.00	50	16	5	71 70.3
Column Total	72 71.3	22 21.8	7 6.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.09159	2	.95524
Likelihood Ratio	.09252	2	.95479
Mantel-Haenszel test for linear association	.06128	1	.80448

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X28

Count	X28 1.00	2.00	3.00	Row Total

1.00	21	6	3	30 29.7
2.00	44	16	11	71 70.3
Column Total	65 64.4	22 21.8	14 13.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.73248	2	.69333
Likelihood Ratio	.76009	2	.68383
Mantel-Haenszel test for linear association	.72408	1	.39481

Minimum Expected Frequency - 4.158
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X29

Count	X29 1.00	2.00	3.00	Row Total
1.00	24	4	2	30 29.7
2.00	49	14	8	71 70.3
Column Total	73 72.3	18 17.8	10 9.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.28546	2	.52585
Likelihood Ratio	1.34237	2	.51110
Mantel-Haenszel test for linear association	1.17237	1	.27892

Minimum Expected Frequency - 2.970
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X30

Y \ X30 Count	1.00	2.00	3.00	Row Total
1.00	26	3	1	30 29.7
2.00	56	8	7	71 70.3
Column Total	82 81.2	11 10.9	8 7.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.32274	2	.51614
Likelihood Ratio	1.52112	2	.46740
Mantel-Haenszel test for linear association	1.20846	1	.27164

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X31

Y \ X31 Count	1.00	2.00	3.00	Row Total
1.00	22	7	1	30 29.7
2.00	51	13	7	71 70.3
Column Total	73 72.3	20 19.8	8 7.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.40920	2	.49431
Likelihood Ratio	1.60077	2	.44916
Mantel-Haenszel test for linear association	.34702	1	.55580

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X32

Count	X32 1.00	2.00	3.00	Row Total
Y 1.00	22	6	2	30 29.7
2.00	40	22	9	71 70.3
Column Total	62 61.4	28 27.7	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	2.60969	2	.27121
Likelihood Ratio	2.70598	2	.25847
Mantel-Haenszel test for linear association	2.36218	1	.12431

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X33

Count	X33 1.00	2.00	3.00	Row Total

1.00	19	8	3	30 29.7
2.00	37	27	7	71 70.3
Column Total	56 55.4	35 34.7	10 9.9	101 100.0

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Chi-Square	Value	DF	Significance
Pearson	1.26487	2	.53130
Likelihood Ratio	1.29378	2	.52367
Mantel-Haenszel test for linear association	.57469	1	.44840

Minimum Expected Frequency - 2.970
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

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by X34

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Count	X34 1.00	2.00	3.00	Row Total
1.00	15	11	4	30 29.7
2.00	38	25	8	71 70.3
Column Total	53 52.5	36 35.6	12 11.9	101 100.0

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Chi-Square	Value	DF	Significance
Pearson	.13810	2	.93328
Likelihood Ratio	.13685	2	.93386
Mantel-Haenszel test for linear association	.13613	1	.71216

Minimum Expected Frequency - 3.564
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X35

Count	X35 1.00	2.00	3.00	Row Total
Y 1.00	11	15	4	30 29.7
2.00	30	34	7	71 70.3
Column Total	41 40.6	49 48.5	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.41527	2	.81250
Likelihood Ratio	.40962	2	.81480
Mantel-Haenszel test for linear association	.40183	1	.52614

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X36

Count	X36 1.00	2.00	3.00	Row Total
Y 1.00	21	8	1	30 29.7
2.00	43	21	7	71 70.3
Column Total	64 63.4	29 28.7	8 7.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.49246	2	.47415
Likelihood Ratio	1.68759	2	.43007
Mantel-Haenszel test for linear association	1.31219	1	.25200

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X37

Count	X37 1.00	2.00	3.00	Row Total
Y 1.00	17	8	5	30 29.7
2.00	22	35	14	71 70.3
Column Total	39 38.6	43 42.6	19 18.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	6.24285	2	.04409
Likelihood Ratio	6.24080	2	.04414
Mantel-Haenszel test for linear association	3.22173	1	.07267

Minimum Expected Frequency - 5.644

Number of Missing Observations: 0

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by X38

Count	X38 1.00	2.00	3.00	Row Total

1.00	27	2	1	30 29.7
2.00	56	9	6	71 70.3
Column Total	83 82.2	11 10.9	7 6.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.81384	2	.40377
Likelihood Ratio	1.99631	2	.36856
Mantel-Haenszel test for linear association	1.69598	1	.19281

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 3 OF 6 (50.0%)

Number of Missing Observations: 0

by X39

Count	X39 1.00	2.00	3.00	Row Total
1.00	26	3	1	30 29.7
2.00	56	10	5	71 70.3
Column Total	82 81.2	13 12.9	6 5.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.91946	2	.63145
Likelihood Ratio	.98836	2	.61007
Mantel-Haenszel test for linear association	.90555	1	.34130

Minimum Expected Frequency - 1.782
Cells with Expected Frequency < 5 - 3 OF 6 (50.0%)

Number of Missing Observations: 0

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Y by X40

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Count	X40 1.00	2.00	3.00	Row Total
Y 1.00	27	2	1	30 29.7
2.00	44	20	7	71 70.3
Column Total	71 70.3	22 21.8	8 7.9	101 100.0

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Chi-Square	Value	DF	Significance
Pearson	7.96699	2	.01862
Likelihood Ratio	9.13298	2	.01039
Mantel-Haenszel test for linear association	6.34208	1	.01179

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

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Y by X41

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Count	X41 1.00	2.00	3.00	Row Total
Y 1.00	28	1	1	30 29.7
2.00	52	12	7	71 70.3
Column Total	80 79.2	13 12.9	8 7.9	101 100.0

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Chi-Square	Value	DF	Significance

Pearson	5.22517	2	.07334
Likelihood Ratio	6.21125	2	.04480
Mantel-Haenszel test for linear association	4.07489	1	.04353

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X42

Count

Y	X42 1.00	2.00	3.00	Row Total
1.00	27	2	1	30
				29.7
2.00	53	12	6	71
				70.3
Column Total	80	14	7	101
	79.2	13.9	6.9	100.0

Chi-Square	Value	DF	Significance
Pearson	3.01806	2	.22112
Likelihood Ratio	3.35894	2	.18647
Mantel-Haenszel test for linear association	2.58088	1	.10816

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 3 OF 6 (50.0%)

Number of Missing Observations: 0

Y by X43

Count

Y	X43 1.00	2.00	3.00	Row Total

1.00	24	4	2	30 29.7
2.00	45	19	7	71 70.3
Column Total	69 68.3	23 22.8	9 8.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	2.76352	2	.25114
Likelihood Ratio	2.93306	2	.23072
Mantel-Haenszel test for linear association	1.95436	1	.16212

Minimum Expected Frequency - 2.673
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

X by X44

Count

	X44 1.00	2.00	3.00	Row Total
1.00	25	4	1	30 29.7
2.00	48	17	6	71 70.3
Column Total	73 72.3	21 20.8	7 6.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	2.66047	2	.26441
Likelihood Ratio	2.86200	2	.23907
Mantel-Haenszel test for linear association	2.48529	1	.11492

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X45

Count	X45 1.00	2.00	3.00	Row Total
Y 1.00	20	7	3	30 29.7
2.00	46	17	8	71 70.3
Column Total	66 65.3	24 23.8	11 10.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.04580	2	.97736
Likelihood Ratio	.04629	2	.97712
Mantel-Haenszel test for linear association	.04435	1	.83320

Minimum Expected Frequency - 3.267
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X46

Count	X46 1.00	2.00	3.00	Row Total
Y 1.00	24	4	2	30 29.7
2.00	56	9	6	71 70.3
Column Total	80 79.2	13 12.9	8 7.9	101 100.0

Chi-Square	Value	DF	Significance

Chi-Square	Value	DF	Significance
Pearson	.09520	2	.95351
Likelihood Ratio	.09802	2	.95217
Mantel-Haenszel test for linear association	.04872	1	.82530

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

Y by X47

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Count	X47 1.00	2.00	3.00	Row Total
Y 1.00	21	7	2	30 29.7
2.00	45	20	6	71 70.3
Column Total	66 65.3	27 26.7	8 7.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.41064	2	.81439
Likelihood Ratio	.41658	2	.81197
Mantel-Haenszel test for linear association	.36600	1	.54519

Minimum Expected Frequency - 2.376
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X48

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Count	X48 1.00	2.00	3.00	Row Total
Y				

1.00	14	11	5	30 29.7
2.00	34	27	10	71 70.3
Column Total	48 47.5	38 37.6	15 14.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	.11168	2	.94569
Likelihood Ratio	.10970	2	.94663
Mantel-Haenszel test for linear association	.05841	1	.80903

Minimum Expected Frequency - 4.455
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X49

Count	X49 1.00	2.00	3.00	Row Total
1.00	15	9	6	30 29.7
2.00	33	28	10	71 70.3
Column Total	48 47.5	37 36.6	16 15.8	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.03350	2	.59646
Likelihood Ratio	1.03322	2	.59654
Mantel-Haenszel test for linear association	.02245	1	.88090

Minimum Expected Frequency - 4.752
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

Y by X50

Count	X50 1.00	2.00	3.00	Row Total
Y 1.00	27	1	2	30 29.7
2.00	53	14	4	71 70.3
Column Total	80 79.2	15 14.9	6 5.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	4.47763	2	.10658
Likelihood Ratio	5.59776	2	.06088
Mantel-Haenszel test for linear association	1.36055	1	.24344

Minimum Expected Frequency - 1.782
Cells with Expected Frequency < 5 - 3 OF 6 (50.0%)

Number of Missing Observations: 0

Y by X51

Count	X51 1.00	2.00	3.00	Row Total
Y 1.00	25	3	2	30 29.7
2.00	53	13	5	71 70.3
Column Total	78 77.2	16 15.8	7 6.9	101 100.0

Chi-Square	Value	DF	Significance

Pearson	1.12957	2	.56848
Likelihood Ratio	1.21185	2	.54557
Mantel-Haenszel test for linear association	.49345	1	.48239

Minimum Expected Frequency - 2.079
Cells with Expected Frequency < 5 - 3 OF 6 (50.0%)

Number of Missing Observations: 0

Y by X52

Count

Y	X52 1.00	2.00	3.00	Row Total
1.00	23	5	2	30
				29.7
2.00	46	22	3	71
				70.3
Column Total	69	27	5	101
	68.3	26.7	5.0	100.0

Chi-Square	Value	DF	Significance
Pearson	2.30697	2	.31554
Likelihood Ratio	2.43794	2	.29553
Mantel-Haenszel test for linear association	.56150	1	.45366

Minimum Expected Frequency - 1.485
Cells with Expected Frequency < 5 - 2 OF 6 (33.3%)

Number of Missing Observations: 0

by X53

Count

	X53 1.00	2.00	3.00	Row Total

1.00	18	10	2	30 29.7
2.00	32	31	8	71 70.3
Column Total	50 49.5	41 40.6	10 9.9	101 100.0

Chi-Square	Value	DF	Significance
Pearson	1.95463	2	.37632
Likelihood Ratio	1.97809	2	.37193
Mantel-Haenszel test for linear association	1.82168	1	.17711

Minimum Expected Frequency - 2.970
Cells with Expected Frequency < 5 - 1 OF 6 (16.7%)

Number of Missing Observations: 0

This procedure was completed at 12:04:58

bye.

End of Include file.