Use of information by Brazilian mechanical engineers working in academic institutions in the southern and central regions of Brazil

USE OF INFORMATION BY BRAZILIAN MECHANICAL ENGINEERS WORKING IN ACADEMIC INSTITUTIONS IN THE SOUTHERN AND CENTRAL REGIONS OF BRAZIL

BY

MARIA DEL CARMEN R. BOHN

A Doctoral Thesis

Submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of the Loughborough University of Technology
July 1990

CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENTS

The author wishes to express her gratitude to her supervisor Mr. Tom Whitehall who provided expert and generous assistance through each state of this thesis, and whose friendship and academic inspiration have been invaluable throughout her doctoral studies.

The author also wishes to thank Professor A. J. Meadows for his encouragement and for generously having made available the departmental facilities and services at the University of Loughborough so that this work could be completed.

The writer is indebted to her colleagues at the Department of Library and Information Studies of the University of Santa Catarina, Brazil, for the long period of leave of absence from her academic obligations. Special acknowledgment is extended to the University of Santa Catarina and to CAPES, whose financial support was crucial along the whole period of my doctoral studies.

The author also wishes to acknowledge the financial support of the British Council, whose financial assistance made it possible for the writer to have her viva voce examination in Loughborough, England.

The success of this project could not have been achieved without the cooperation of the mechanical engineers from the four institutions under study. The author owes a debt of gratitude to the mechanical engineers of these institutions and to the administrators of these four Schools of Engineering in Brazil.

Finally, very special gratitude must be expressed to my husband, Hilario, for his deep involvement in the project, for his help and most loving support. Thanks also to my children

Claudia Fernanda, Alexandre Bryan and Carla Michel who provided, love, patience, encouragement and understanding throughout the course of the entire project.

DECLARATION

THE WORK CONTAINED IN THIS THESIS IS THE RESPONSABILITY OF THE AUTHOR ALONE, IS ORIGINAL AND HER OWN AND HAS NOT BEEN SUBMITTED ELSEWHERE FOR A HIGHER DEGREE.

ABSTRACT OF THE THESIS

USE OF INFORMATION BY BRAZILIAN MECHANICAL ENGINEERS WORKING IN ACADEMIC INSTITUTIONS IN THE CENTRAL SOUTH REGION OF BRAZIL

This study was designed to examine various aspects of information use a selected sample of Brazilian mechanical engineers (BMEs) working in academic institutions in Brazil and to relate these findings to the influence of their personal, work and environmental factors.

A survey questionnaire was administered to groups of mechanical engineers working in four academic institutions (Federal and State) located in the central-south regions of Brazil. Data were gathered on the following aspects of information use: frequency of use of information sources and channels; number of hours spent reading and communicating; categories of locations consulted; categories of people consulted; problems encountered in information use; attitudes taken by engineers when information is needed but is not available; types of information used and the engineers perception of the availability and pertinence of various information services offered by the engineer's information system. Hypotheses on the interplay between information use and educational level, productivity, reading language ability, seniority, inter-institutional involvement, project type, accessibility of the source; problems on information use and institutional restrictions on the use of information were tested.

The findings of the study indicate that: (1) time spent reading by BMEs is closer to the number of hours reported for native English speakers than to the hours reported for non-English native speakers; (2) to obtain information BMEs most frequently use books and technical and scientific journals; they

most frequently use materials published in English; most frequently obtain written information sources from their institutional libraries and personal files; most frequently consult with colleagues in their own department; most frequently use the telephone and visit colleagues in their offices; (3) the problems they most frequently encounter are related to accessibility and availability of information; (4) When an information need is felt, they most frequently persist in looking for the information while they continue to work. (5) They see some information services they regard as pertinent as not being provided by their information systems.

It was found that the frequency of use of formal written information sources is positively related to the engineers' reading ability in the language in which the written information has been published. The hypotheses on the influence of the independent variables educational level, accessibility, and the engineers' perceived institutional restrictions on the frequency of use of information sources/channels were partially supported. In the same way, the hypothesis of the influence of educational level on the frequency of finding problems with information was also only partially supported. It was also found that seniority, productivity, type of work, were not strong determinants of frequency of use of information sources. From these findings suggestions for services were made and further research was suggested.

CHAPTER 1

INTRODUCTION

Availability and access to information sources seems to be one of the key issues in modern technological development. Significant efforts have been made in Brazil to provide the technological area with reliable and good quality information systems and services. Unfortunately the results, in an overall perspective, have so far been modest.

One of the solutions for the Brazilian information problem has been the adoption of models of scientific and technological services used in developed countries (DCs). Such a strategy assumes that Brazilian engineers behave in the same way as engineers in DCs with respect to information use. It also assumes that Brazilian engineers have available similar information infrastructures to engineers in DCs, and it furthermore assumes that the two groups of users work under similar economic, social and cultural conditions. Such assumptions can be responsible for gross misjudgments on information needs and wants of Brazilian engineers and they may signal the dangers and inadequacies of the unrestricted import of information models and services from DCs.

Some of the differences between Brazilian engineers and the engineers from DCs can be related to working condition differences and working habits. They can be furthermore related to the frequency of use of interpersonal information sources, written sources, or to problems encountered during information use and the attitudes taken when information is not found. None of the studies conducted on the use of information by Brazilian engineers have paid close attention to these differences, thus, they can easily be overlooked when services are planned or implemented. It is, for example, common knowledge that Brazilian information services and their infrastructure present deep deficiencies. Additionally the Brazilian bureaucracy puts severe restrictions on the use of telephone services, makes available very limited travel allowances, the mail services are relatively slow, there is low availability of bibliographic materials in Portuguese and acquisition processes are slow and costly in terms of money and time. Such restrictions and deficiencies may lead not only to different patterns of information use but they may also develop in Brazilian engineers different attitudes in overcoming problems than those of their counterparts in DCs. Unfortunately when planning and developing Brazilian technological information systems and services, in many situations, the differences between Brazil and DCs and Brazilian engineers and engineers from DCs are not considered. On the other hand, by the same token the critical differences between scientists and engineers pointed out in the literature in terms of use of information, professional activities, attitudes, orientation and even background (i.e. Allen, 1977; Rosenbloom and Wolek, 1970) have also been ignored.

It has also been observed that information experts and practitioners responsible for setting up information centers and services still lack reliable sources of research and data on which to anchor their decisions. The Brazilian state of the art on research on the need and use of information by BMEs is limited and there is a general lack of meaningful information and data required for the full comprehension of Brazilian engineers' needs and use of information. There seems, therefore, to be a genuine need for research studies that will provide data on the behaviour of the Brazilian user population, so that accurate assessments of needs of engineers can be made and systems that include services and tools appropriate to the priority of the users can be defined and provided.

This study, is undertaken with the objective of 1) drawing a careful profile of the Brazilian Mechanical Engineers (BMEs) working in the academic environment, so that parallelisms between studies can be drawn in the future; 2) identifying the actual patterns of use of information by BMEs working in academic institutions and 3) finding out about the engineers' problems and attitudes in the use of information.

1.1 The User Needs studies

Literature concerned with information needs and with the use of information is quite diverse. In developed countries there is an extensive number of studies on information needs and use of *information by scientists or by scientists and engineers*, but the information needs and use of information by engineers alone have been investigated to a less extent.

The surveys conducted on these topics in the 50's 60's and 70's are summarized in the Annual Review of Information Science and Technology of the American Society of Information Science. The post - 1978 review of literature on information needs and use was done by Dervin and Nilan (1986). The authors reviewed critical essays as well as empirical studies and concluded that, since the ARIST reviews on information needs and uses of information (1966-1978) a revolutionary and conceptual leap has been made but there is still a demand for inventing new ways of looking at users and linking systems to the users.

The main reviews of "user needs" literature on engineering research were done by Hanson (1974) and Wilkin (1981). While Hanson reviewed the literature on research engineering, particularly in mechanical engineering from 1965 to 1974, Wilkin reviewed the studies on engineers in general. The two main problems pointed out at time by Hanson (1974) still remain today. First, there were few significant investigations concerned mainly with mechanical engineering and second, the difficulty, because of data diversity, of comparing in a meaningful fashion the results of the different surveys carried out over the years.

In Brazil the studies on information needs have emerged very slowly. The few studies conducted were initiated in the late 70's. According to Pinheiro, with few exceptions, these studies also lack a cohesive theory, and the methodology reflects the lack of experience in research in this area (Pinheiro, 1982). Most of the Brazilian studies are based on research conducted by post-graduate students working on their Masters Thesis at the Instituto Brasileiro de Informação em Ciencia e Tecnologia (IBICT). The focus of these studies is on use and needs in academic libraries. The information needs and habits of Brazilian engineers have been studied to a lesser extent and in our review of literature we did not find any Brazilian studies concerned mainly with mechanical engineering.

1.2 Models of Information Behaviour

Various authors (e.g. Orr, 1970; Hoglund and Persson, 1975; Feinman et al, 1976; Mick et al, 1980; King and Palmour, 1980; Olaisen, 1985 and others) have proposed a series of models that show how information is used and identified the variables that affect the use of information. However as pointed out by Whitehall (1989), none of these models "explain exactly how these variables influence information use".

Wilson et al classified models of information behaviour in two main groups that reflect the shifting interest of researchers.

a) Early models, whose main concern was concentrated not in the characteristics of behaviour but rather on document seeking or library use;

b) Later models, based on the idea of a set of fundamental categories of human needs, which influenced by various environmental and role variables act as motivation towards information seeking behaviour (Wilson et al, 1982).

The first model is much a description of external behaviours of individuals when using or seeking information. The second model departs from the internal needs/expectations of the individuals and considers how their needs are influenced by variables such as roles and environment.

Mick et al (1980) developed a typology of the variables that affect information user's behaviour. The authors grouped these variables according to the individual, work environment and task attributes as follows:

- ***Individual attributes***

  Demography
  Training and professional background
  Organizational role and function
  Attitudes related to work and profession
  Attitudes related to the value of information

- ***Work environment attributes***

  Organizational demography
  Work teams
  Communication networks

- ***Task attributes***

  Basic vs. applied research
  Diffuseness of the task
  Rate of obsolescence of information
  Phase of the project
  Criteria for satisfactory completion of the task.

How these variables affected to a lesser or greater extent the use of information has been reported in various studies conducted in developed countries (e.g. Maizell, 1960; Wood, 1967; Rosenbloom and Wolek, 1970; Gibbons and Johnston, 1972; Ellen, 1979; Shuchman, 1981; Rosenberg and Cunha, 1981; Summers et al, 1983; etc.). We cannot say the same in relation to research done in developing countries. The few user studies conducted in Brazil, for example, for the most part have failed to address the question of how the variables already identified in the literature influenced the use of information of Brazilian scientists and engineers. This study is a step in this direction.

There are three main questions around which this study is organized:

By which means (sources/channels) is information used by Brazilian Mechanical Engineers (BME)?

How is source use frequency influenced by personal, work and environmental variables?

How is the frequency of facing information problems and how are the attitudes taken by engineers affected by some of these variables?

This study was conducted in Brazil - a country of continental dimensions with many contrasts and inner differences, making it very difficult and costly to study the whole population of engineers at once. Therefore, since most of the creative research work in Brazil is done at the Universities, we concentrated our study on the information needs of mechanical engineers working in academic institutions. The sample for this study was drawn from the Mechanical Engineering Department of two Federal Universities and two State Universities located in the central south regions of Brazil. All four Departments offer graduate and post-graduate courses (Masters and Ph. D.) and members of the four Departments are engaged in research projects and many of them work as consultants for the industry. These Departments are also well known in the country for their high academic standards and research in mechanical engineering.

1.3 Objectives of the Study

This research proposes:

1) To draw a careful educational and work profile of the Brazilian Mechanical Engineer (BME);

2) To outline a frequency picture of the information sources and channels used by BMEs;

3) To identify the most frequent problems that surface during acquisition and information use;

4) To outline a frequency picture of the BME attitudes when information is needed but is not available;

5) To relate the findings (of 2, 3 and 4) to some personal, work and environmental factors.

1.4 Dependent Variables

The dependent variables for this study are represented by categories for sources and channels of information, problems faced during information use and attitudes taken towards information seeking when information was not found. These variables are operationally defined in chapter 4. The categories of the dependent variables used in this study are listed below:

Information Sources and channels: Formal Written (FW) and Interpersonal sources/channels which include: Informal Written (IW), Formal Oral (FO) and Informal Oral (IO).

Location of sources: Using the criterion of their location, channels were considered as internal and external.

Problems. Two types of problems have been identified for this study: a) general problems in obtaining and use of information and b) problems related to language ability.

Attitudes taken by engineers: Three different attitudes have been identified for this study: a) continue to work without information, b) interrupt the work and wait for the information and c) continue to work and try again later.

1.5 Independent Variables

Many factors influence information use as pointed out in numerous studies (i.e Hoghlund and Persson, 1976; Werner, 1969; White, 1971; Orr, 1970; Garvey et al, 1970; Rosenbloom and Wolek, 1970; Gralewska-Vickery, 1976; Kremer, 1980; Rosenberg and Cunha, 1983; Goldstein, 1985; Olaisen, 1985 and others). However the present study focuses only on some of the more relevant factors commonly associated with this influence. These factors are listed below and have been used as independent variables:

Personal Factors:

Educational level
Productivity
Language ability
Seniority

Work Factors:

Inter-institutional involvement
Project type

Environmental Factors:

Accessibility of the source
Institutional restrictions

1.6 Clarification of Terms

The terms "information use", "information sources", "information channels", "information input" and "information needs" are used in the literature on user studies in a vague way and with different meanings. In this study they will be used with the following meanings:

Information Source - The medium which contains the message or information, whether formal written, formal oral, informal written or informal oral (Goldstein, 1985).

Information Channel - The place or means used to obtain information sources.

Information Input - The information needed by the engineer to carry out his tasks during his work (Whitehall, 1979).

Information Use - Information use only occurs if the individual is engaged with the source. This implies that if 1) the source is a human being, the subject must be speaking or listening, 2) if the source is a document form, the subject must physically have it in his hands and/or be able to read its contents and 3) if it is a library, a meeting or a seminar, the subject must physically be engaged with it i.e. inside the library building, in attendance to the meeting, seminar, etc. (Based on Moor, 1969).

Information Needs - A user's demonstrated preference for or use of information sources in terms of its form and language. Information need refers also to the use of information input in terms of the user's project (Partially based on Goldstein,1985).

Before we move into a more careful analysis of information use by BMEs, a further discussion on the definition of the engineer's profession and a description of his tasks seems necessary. This forms the subject of the next chapter.

CHAPTER 2

ENGINEER: DEFINITION OF THE PROFESSION

To understand the engineer, his position and responsibilities in modern society it is important to analyse the structure and the dynamics of his profession.

This analysis can be made from different perspectives:

1) One way is to look at the curriculum of the engineering schools and based on the content of the training the engineer receives to draw a profile of the professional;

2) Another way is to look at what engineers do in terms of functions and tasks in modern society;

3) A third way is to survey the present and prospective needs of modern society and define the role of the engineer in this society.

The first approach to define the engineer is basically static and inward-looking, therefore inadequate to fully define the profession. This does not mean that the content of the syllabuses of schools of engineering and research centers do not play an important role in molding the engineer in modern society. On the other hand, the basic theoretical (as opposed to applied) research done in these institutions relates more to the role of scientists than to engineers. Additionally, the engineer's activity does not necessarily reflect the needs of the community. It also seems that most engineering schools are not necessarily dynamic bodies and the training the future professionals receive also does not reflect the needs of society. It is a quite common fact that, depending on the system, country or region, engineers may have to be retrained by advanced engineering companies as soon as the graduates hit the professional market. This is more true in communities in which the training of professionals is constrained by central bureaucratic bodies that define the content of the curriculum. In Brazil this role is played by the Conselho Federal de Educação (CFE, a central decision making committee on all educational policies) which has the power to set, in an authoritarian way, the academic standards for engineering schools for the whole nation.

The second perspective to define the engineer through his functions and tasks, seems to be a more dynamic one because it is based on the needs generated by a dynamic industrial and mobile society.

According to Gerstl and Hutton the engineering profession as it is defined today is a result of the industrial revolution but "*its roots were laid in antiquity. Irrigation, mining, and metal-working, for example, go back thousands of years*" (1966:1).

Historically, looking back to what can be called the agricultural society, the needs of the members of such a society were few and quite well defined. Engineers would build roads, public monuments and buildings, and design irrigation projects. In more modern times engineering has also been related to military projects. According to Gerstl and Hutton Napoleon was "*a great patron of sciences and profoundly influenced engineering by establishing special schools to educate sufficient numbers of military engineers for his needs*" (1966:2). Again, according to Gerstl and Hutton, the work of engineers in the 19th century was quite obvious and well defined. It was basically limited to construct public buildings, railways, roads, bridges and steamships, but the "work of the professional engineer in the 20th century is masked by the complex technical and economic structure that has grown around him" (1966:5). According to Bazzo and Pereira do Vale (1988), the first activities related to engineering in Brazil started with the first buildings of fortresses in the colonial times.

Because of the variety of technological needs, and the development and appearance of new problems, engineering is normally divided into several branches. Different authors present different lists of specialities. For the traditional specialities David et al (1979) mention the following: civil, electrical, mechanical, industrial, marine engineering, architecture, geological, geodetical, mining engineering, metallurgical, casting engineering, shipbuilding, agronomy, chemical engineering, etc. Still according to David et al, the amount of engineering specialities may vary with the country and period. The authors point out that in some highly developed countries the number of specialities exceeds 150, and this number is continually increasing for two reasons: 1) by the *"development of existing branches, within which arise new specialities with a more profound thematic range"* and 2) by the *"need of engineering activity within new thematic range"* (David et al, 1979:5). Roadstrum (1967) considers that, although, specialization of the engineer is necessary because technology is so vast, when it comes to practice every engineer becomes also a generalist, so it would be more appropriate to say that in his practice the engineer emphasizes certain specialities.

In Brazil the different specialities in the field of engineering have been defined by the Conselho Federal de Educação. This governmental agency published in April of 1976 a regulation (No 48/76) which divided engineering into the following branches and specialities:

Civil Engineering (Civil, Production, Industrial, Sanitary and Cartography);

Electrical Engineering (Electrical, Production and Industrial);

Mechanical Engineering (Mechanical, Naval, Production and Industrial);

Metallurgical (Metallurgical, Production and Industrial Engineering);

Mining (Mining, Production and Industrial);

Chemical Engineering (Chemical, Production, Industrial and Food) (Bazzo and Pereira do Vale, 1988).

As a consequence of this variety of functions and because of the interrelationships of the different groups of engineers and the interdependencies of the different professions, it has become increasingly more difficult to narrowly define the profession of an engineer and more specifically of a mechanical engineer. By the same token the word "profession", because of the ill-defined boundaries of the different professions, needs to be constrained in definition (For a comprehensive definition of "profession" see Gerstl and Hutton, 1966:4 and 5).

The complexity of industrial, commercial, and economic organization in general, makes short and long range planning one of the characteristics of contemporary society and it can be said that today, engineers are not only responsible for solving immediate technical problems in making machines, apparatus, etc, but they are called to make predictions on future technological problems. This is when their work starts to overlap with the responsibility of the scientists.

This takes us to the third perspective of how to define the engineer in modern society, his predictive responsibility. Here he is not only involved in the solution of technical problems, but his work is confused with the work of scientists who are interested in generating knowledge and making hypotheses about social, economic and scientific aspects of the environment. The confusion between the two areas can generate distortions because in the classical view the scientist is interested in knowledge and the engineer "is concerned with creating devices that will be useful; that will, moreover, in most cases sell at an economic price" (Gerstl and Hutton, 1966).

It is easy to see that the engineer as a consumer will need science, but on the other hand, science depends on engineers who manufacture instruments and apparatus that help scientists to push their hypotheses and research further. There seems to be a close relationship and interdependence between scientists and engineers, but it is the engineers that translate the latest scientific discoveries into meaningful products for society and the general public to enjoy. Thus, the engineer is sometimes seen as *"a member of a tripartite team comprising the scientists, the engineer and the technician"* (Sabaratnam, 1983).

> *"Although, therefore, science and engineering are interdependent, and must remain so, the engineer always approaches his task with a practical objective and with a philosophy different from that of a scientist* " (Gerstl and Hutton, 1966:6).

The value of the engineer's work is industrial and has economical relevance. Engineer's research must construct a product which is demanded by society. In this process of construction most engineers will add some technological information, but this is not technology for technology's sake, the engineer's work has the purpose of meeting a human need (Roadstrum, 1967). It seems, therefore, that the best way to define engineering and an engineer (and more narrowly a mechanical engineer), would be to make an analysis of the tasks he performs, and in terms of prediction, the tasks he will be asked to perform in the future.

The functions of the engineer, in spite of the overlapping of the professions and the existence of different specialities, have been reasonably well defined in the literature. Thus for example, Fletcher and Shoup (1978) and David et al (1979) divided the engineering functions as follow:

Research - searching for new knowledge, teaching at advanced levels;

Development - initial stage in implementing a new idea;

Design - planning and creating new products;

Production - operations and sales final realization of the idea as useful, saleable product or process;

Management - leadership roles and responsibilities for decision making on matters of an engineering nature;

Education - training and helping others to learn about engineering problem solving;

These functions are universal, but according to David et al (1979) in some developing countries the distribution of the engineering community by functions is different from the developed countries. The authors estimate that 95% of engineers in developing countries are divided into three main groups or functions:

Functions of directing and managing, either industrial or general economic areas;

Functions of production and exploitation of factories, workshops, agricultural enterprises, etc.;

Functions of studying and realizing industrial units" (David et al 1979:37/38).

The authors also point out that in developing countries the tendency for engineers to get involved in research (basic or applied) and on university teaching activities remains marginal. The engineer's tasks within his functions are complex because of the technological base of the engineer's work. Roadstrum (1967) describes the engineer's tasks in larger companies as a five process engineering cycle:

Conceive	:	get new ideas;
Experiment	:	try them out;
Design	:	work out the details on paper;
Make	:	build one or more from the design;
Test	:	try out.

Within this process recycling may take place anywhere and should be repeated until a satisfactory result is obtained.

It seems that the definition forwarded by the Council of Engineering Institutions summarizes the functions, tasks, responsibilities and capabilities of an engineer:

> "*The professional who is competent by virtue of his fundamental education and training to apply the scientific method and outlook to the analysis and solution of the engineering problems. He is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in research, designing, construction, manufacturing, superintending, managing and in the education of the engineer. His work is predominantly intellectual and varied, and not of a routine mental or physical character. It requires the exercise of original thought and administrative work of others.*" (Council of Engineering Institutions 1975:15).

Engineering is defined as *"the application of technical knowledge to meet man's needs."* (Roadstrum (1967).

In this research we look at the factors that affect the use of information by mechanical engineers working in academic institutions in Brazil. These engineers perform a diversity of functions such as teaching, research, consulting and also practical work. The profile of these engineers may be quite different from the ones that have been defined in the literature. Different may also be the attitudes taken, the problems they have and the tasks they are asked to perform.

CHAPTER 3

REVIEW OF LITERATURE

One of the main problems found when reviewing the literature on user information studies has been the difficulty in comparing results. This difficulty has been pointed out in previous studies and has been attributed by different authors (e.g. Werner, 1969; Hanson, 1974; Wilkin, 1981; Bitz and Owen, 1981 and Negus, 1982, Dervin and Nilan, 1986) to different causes. Among them the following seem the most salient ones.

a) Differences on the population surveyed;

b) Lack of uniformity or standardization in the categories and terms used in the questionnaires;

c) Methodologies adopted, which have produced data in many cases difficult to compare;

d) Availability in the literature of raw data for use in proposition testing.

Some of the Brazilian user studies reviewed in the process of writing this thesis have a limited value for our study. However they were included in our review of literature because we believed that although they were not conducted on the subject field of engineering, they provide us with useful insights into the ways Brazilians use information. Since the Brazilian studies have produced little empirical data on the subject, a review of the literature of studies conducted in other countries as well as in Brazil seems to be appropriate.

The literature review covers the following topics: 1) Use of information sources, 2) Use of information channels, 3)

Problems in information use and 4) Factors that affect the use of information.

3.1 Use of Information Sources and Channels

Various distinctions have been made in the literature in relation to sources. Some authors distinguish between sources inside (internal) and outside (external) the organization. Other authors classify sources as formal and informal. These classifications are based on the audience, content of information and in the way information is stored and retrieved. Formal information sources are directed to large audiences, the information content is relatively old, allow little feedback and generally is stored and permanently retrieved. On the other hand, informal information sources have small audiences, involve direct interchange between the selected audience and the source, supply up-to-date information, utilize considerable feedback and they are neither permanently stored nor retrieved (Garvey and Griffith 1968). Formal and informal information sources could be oral and written.

When the distinction of sources is made to characterize them, in terms of importance during the inter-organizational transfer of production innovations, Ettlie (1976) distinguishes between personal-impersonal and internal-external sources. The first distinction refers to people in contrast to written sources; the second category distinguishes between sources inside the organization and groups from outside the organization. According to Wilkin (1981), other authors even subdivide these broad categories further. She summarized the types of sources used in the various studies she analysed as follows: textbooks; handbooks; professional, trade and abstract journals; conference proceedings; patents; British standards; data sheets; government and non government reports; vendors; catalogs; customers; consultants; contractors; trade shows; formal courses and societies; associations; computer programs; codes of practice; drawings; maps; serials; photographs; bibliographies; theses, personal files; notes; meetings and visits.

Various investigations (e.g. Shuchman, 1981; Sabaratnam, 1983; Raitt, 1984 and Angell et al, 1985) revealed that engineers rarely find the information they need in one source. While Wilkin (1981) considers this as not necessarily competition between sources because different classes and levels of needs will lead to use different sources, Orr (1970) has an opposite view. He argues that information sources and channels are in effect alternatives competing to supply the limited amount of information sought and should be seen as such.

Earlier studies had suggested that engineers are less print oriented than scientists and that they do prefer oral to written communication sources (e.g. Slater and Fisher, 1969; Hanson, 1974; Shuchman, 1981; Bitz and Owen, 1981). However studies conducted by Johnston and Gibbons (1975), Raitt (1984), Angell et al (1985) noted that some printed sources were equally used by scientists and engineers.

The literature also points out that when interpersonal communication sources are used, immediate colleagues inside the engineer's own organization are preferred to external personal sources (Lufkin and Miller, 1966; Rosenbloom and Wolek, 1970; Kremer, 1980 and Bitz and Owen, 1981). In contrast to other professionals, engineers are less aware of the literature of their speciality and they are not prepared to make a special effort to comprehend published literature (Faibisoff and Ely, 1976 and Bitz and Owen, 1981). Bitz and Owen (1981) analysed different studies and concluded that mechanical engineers rely on their own knowledge and experience on trial and error research for solving problems rather than consulting the literature.

Various studies look at the use of information by engineers working in environments other than academic. Thus, for example, the major survey in the area of mechanical engineering in the U.K. was carried out by Wood and Hamilton (1967). This study was conducted among engineers working in a wide variety of British industries, 2.4% of the sample worked for a University/C.A.T. This study found that mechanical engineers rely heavily on personal contacts and technical information sources from their own institution. Other non-documentary sources (e.g. research organizations, learned or professional organizations) were in comparison used with lower frequency. Similar results were reported by Shuchman (1981). He found that engineers working for USA industries were primarily dependent on informal communication for most new technical information and that they made low use of published technical sources. Still according to Shuchman, engineers commonly integrated information from several sources including intuition, colleagues and proprietary reports, but they did not consult a written source until they had talked the problem over with a colleague. In Shuchman's study 4% of the population indicated teaching as a secondary activity. Furthermore Rosenbloom and Wolek (1970) found that engineers communicate more with individuals within their own organization, whereas a larger number of scientists communicate with individuals outside their organizations. Contrary to their findings Raitt (1984) revealed that in general it was engineers rather than scientists who got information from people outside the establishment.

The Slater and Fisher (1969) study investigated the use made of technical libraries by a large number of library users which included engineers and scientists. Their results indicate that the overall most commonly used sources were textbooks, periodicals, abstracts journals and indexes. The sources used by scientists and engineers were in general similar, but while engineers used more handbooks, data books, standards and specifications, scientists used more periodicals and abstract journals.

In Rosenbloom and Wolek's (1970) study documentary sources were about equally used by scientists and engineers. Engineers made greater use of corporate reports and trade sources (i.e. trade magazines, commercial catalogues, and technical reports of other organizations), while scientists tended to consult more the professional literature (articles and books). This study was conducted among scientists and engineers working in industrial research and development organizations.

Sabaratnam (1983) studied Singapore engineers from various engineering functions and disciplines, using a self-administered questionnaire. Her findings indicate that engineers seem to place a great reliance on information around them. They rely on sources that they keep in their offices as well as on the ones kept in offices of immediate colleagues and supervisors. Singapore mechanical engineers considered informal sources such as immediate colleagues, supervisors, manufacturers/sale representatives, customers, colleagues from other industries and consultants outside the firm, as "very moderately important". Printed sources considered as very moderately important were: in house reports, specifications, standards, catalogues, handbooks, tables, textbooks, government laws/regulations, conference papers, proceedings and trade literature, patents, dissertations, marketing services, abstracts and indices.

Raitt (1984) investigated through a self-administered questionnaire the information seeking and the use habits of scientists and engineers working in international organizations based in Europe and in European National Aero space Research Establishments. His survey reveals that:

Scientists and engineers tend to get more of the information needed from colleagues than from the library information centre;

Oral sources were used equally by engineers and scientists;

Information needed is very often obtained from colleagues working in the same project but not in the same division.

In disagreement with other authors (e.g. Slater and Fisher, 1969; Hanson, 1974; Shuchman, 1981; Bitz and Owen, 1981) Raitt's (1984) investigation, points out that oral sources were used "equally by scientists and engineers" and with the exception of meetings reports, abstract journals and computer files, engineers are rather more print oriented than scientists.

In an attempt to identify the mechanisms (both formal and informal) used by engineers and scientist in the acquisition of technical information, Angell et al (1985) sent a questionnaire survey to engineers employed in the British industry. The results of this study are consistent with previous findings, in which work colleagues were the most used source for technical information for problem solving and for background knowledge. In Angell's study a great percentage of engineers used trade magazines as a source of background information and made frequent use of abstract indexes and patents. Although published information sources were more frequently used by scientists than by engineers, this study does not back up the view that personal contacts dominate published sources. Technical journals, books, trade magazines and science magazines were used frequently by both scientists and engineers for obtaining information for problem solving and for background knowledge. External publication sources were used frequently at least once by 64% of respondents in problem solving and 74% for background knowledge. The authors noticed that external people were highly rated for quality but they did not find evidence to support the argument that team work involved the greater use of this source.

Through a survey questionnaire Goldstein (1985) investigated various aspects of information use by electrical engineers working as researchers in the Instituto de Investigaciones Electricas (IIE) and practitioners in the Comision Federal de Electricidad (CFE) in Mexico. Her main findings show that:

Researchers (IIE) use formal written information sources significantly more than do practitioners (CFE);

The most consulted category of people by IIE researchers and CFE practitioners are internal colleagues or co-workers;

The most frequently used written sources by IIE. researchers are books/manuals, technical journals dictionaries and work notes;

The most frequently used written sources by CFE practitioners are books, manuals, newspapers and dictionaries.

Some studies in Brazil have also examined the use of information sources. Souza et al (1977) investigated the interests and information habits of engineers and other professionals with university degrees working in THE PETROBRAS (The Brazilian Petroleum Company). The author selected 58 professionals from 19 different professions, 19 members of the sample were engineers. The study revealed that the written information sources mostly used by the respondents involved in industrial production and design projects were books, journals and reports. Personal contacts with colleagues and own notes were the second and fifth sources mostly used by the respondents respectively. Personal contact as a source for keeping up-to-date was used by a large proportion (77.6%) of the members of the group under study.

Almeida and Falkenbach's (1977) study revealed that users of the libraries and information centers of the Empressas de Energia Eletrica in Brazil (ELETROBRAS, ELETROSUL, CELF, CBEE and Light) report themselves as using more frequently for their work books, journals, technical reports and personal contacts.

In her study of the demands of technical information of Brazilian "extensionistas" working in the State of Espirito Santo, Borgues (1982) concluded that the information sources mostly used by "extensionistas regionais" were books, bibliographies and technical journals. Extensionistas estaduais and the ones working of the main headquarters used more frequently bibliographies and journals.

Andrade (1981) studied the information needs of the engineering group involved in basic research and development in PETROBRAS. This group of professionals graded internal and external reports of projects as the first and second most used sources of information. Personal notes came in third place.

Kremer (1984) conducted a study on the users of libraries of the Pontificia Universidade Catolica do Rio de Janeiro. Her data revealed that academic users (lecturers) graded foreign books (monographs and textbooks) and foreign journals, as the most important sources of information followed by national books (monographs and textbooks) and journals, proceedings, thesis and dissertations, personal contacts with colleagues and indexes and bibliographies. All the Brazilian studies collected their data through a self administered questionnaire, exception to this was the work conducted by Andrade who used the critical incident technique.

In the use of information channels the literature indicates that personal files, records and collections (Allen, 1977; Shuchman, 1981; Raitt, 1984; and Goldstein, 1985) and in-house libraries (Herner, 1954; Hogg and Smith, 1959) are the most consulted channels by scientists and engineers when they obtain information for their work.

In view of the literature we can conclude that engineers don't find the information they need mainly from a unique source. Interpersonal sources are normally preferred by engineers in opposition to written sources. When using interpersonal sources engineers prefer get information from internal colleagues or co-workers. Personal files, records and collections and in-house collections are the places preferred to look and get written information.

3.2 Problems Found in Information Use

Some user studies have examined the types of problems faced by scientists and engineers in their attempt to obtain and find information for their work. These studies included different categories of problems. Thus, for example, while in Raitt (1984), Summers et al (1983), Tornudd (1959) and the University of Michigan Studies (1954) "lack of time to look for information" was the problem pointed out by the majority of respondents, "too much information available" was a problem for USA physiologists (University of Michigan, 1954). The last problem was also experienced by engineers and scientists working in International Organizations as reported in Raitt (1984). On the other hand, an opposite finding, "not enough information available" was reported for engineers from Singapore by Sabaratnam (1983).

"Getting information quickly enough", was the information problem pointed out by the majority of teachers, administrators and support personnel, in British Columbia, Canada (Summers et al, 1983) and by Mexican engineers (Goldstein, 1985). Mexican engineers also cited as most frequent problem "received information too late for use" and "unable to get information quickly" (Goldstein, 1985).

A study conducted by Lingwood and McAnany (1971) revealed that the main problems found by Brazilian chemists in information use were "lack of published literature" and "lack of money for library resources and services."

Shuchman (1981) pointed out that the two main obstacles found by engineers working in industries in the USA were "to identify specific piece of missing data" and "locate this data after their identification."

A problem in using foreign language works because of language difficulties was faced by a large number of British scientists and engineers (Wood, 1966 and Ellen, 1979). However Wood and Hamilton (1967) reported a very low percentage of British mechanical engineers facing this problem. The big differences between the findings of the Wood study (1966) and the later study (Wood and Hamilton, 1967) is attributed by the later authors to the *"differences in phrasing and precise meaning of the questions used"* (Wood and Hamilton, 1967:16) in the different studies. On the other hand, language difficulties in using foreign works is a problem faced infrequently by the majority of Mexican engineers (Goldstein, 1985).

3.3 Factors that Affect the Use of Information

3.3.1 Personal Factors

A number of personal characteristics seem to affect the use of information. Many investigations have attempted to explain the use of information in terms of personal characteristics.(e.g. Moor, 1969; Rosenbloom and Wolek, 1970; Shuchman, 1981; Goldstein, 1985, etc) Some of the most common factors associated with these characteristics are: educational level, productivity, language ability, seniority, status, age, stage of the career, sex, past work, etc. For the purpose of this study we reviewed the literature on the first four factors.

3.3.1.1 Educational Level

Educational degree and/or scientific formal training could be expected to influence the use of information. Earlier studies, for example, reported an increase in reading with increase in education (e.g. Scates and Yeomans, 1950; Scott and Wilkins, 1960 and Maizell, 1960). Rosenbloom and Wolek (1970) observed that engineers with higher degrees (Ms and Ph. D.) used more sources outside the company than engineers with less formal education. Moor (1969) conducted a study in the research divisions of the Chicago area industrial organizations. He found a positive relationship between educational level and the use of interpersonal sources, and between educational level and the use of information related to the advancement of the state of knowledge, in opposition to the use of the information concerned with the application of knowledge to the solution of technical problems. Rosenbloom and Wolek (1970) observed that engineers with post-graduate degrees (master and Ph. D.) used more the following sources: persons employed by the same institution (other corporate sources); external sources (sources outside the firm); and trade sources (suppliers catalogues, trade magazines, unpublished technical reports), than their colleagues with a bachelors degree. In Maizell's study (1960) research chemists within the most creative group who held Ph. D. degrees, showed a tendency towards more extensive consultation of the literature than did individuals who did not hold a Ph. D. degree.

Gibbons and Johnston (1972) focused their study on the resolution of technical problems arisen during the process of development leading to innovation. The research was conducted in British industries. The authors found that problem solvers with a university degree acquire more information from outside the company, from scientific literature and from scientists in universities, whereas, problem solvers with an industrial education relied on their own expertise based on education, experience and industrial contacts to resolve technical problems. In Angell et al's study (1985) there was a clear relationship between the frequency of use of library information services and educational attainment. Their data show that the more qualified the respondents the more use is made of library information services in opposition to their colleagues with bachelors degrees'.

Herner (1954) found that education was not much related to information gathering patterns of pure and applied scientists at Hopkins University. Similarly Shuchman's (1981) study revealed that for USA industrial engineers neither educational degree nor date of degree made much difference in the engineer's perception of the value of sources of information. Summers et al (1983) conducted a study among educational practitioners in British Columbia, Canada. Their findings reveal that while the use of nearly all the sources increases with post-graduate university degrees, there is little or no difference in the use of sources between those who have no university degree and those who have no more than a bachelor's degree.

The findings of the several studies on the relation between degree and the use of information do not seem to signal a clear pattern. While some studies seem to favour a strong relationship other indicate to a more homogeneous use of information.

3.3.1.2 Seniority

The number of years that engineers and scientists work in an institution has been explored as an influencing variable in the use of information in some studies. Fishenden's (1959) findings indicate that reports were used more frequently by senior researchers than by their junior colleagues. Other types of information sources were similarly used by both groups of researchers. Maclaughlin et al (1965) and Rosenbloom and

Wolek (1970) found that the incidence of use of sources within the firm varies with the respondents seniority. Individuals with more than ten years tenure use corporate sources one and a half times more frequently than individuals with brief tenure. Furthermore, professional publications were used by the group with more tenure only half as often as by individuals with lesser tenure. In Garvey and Griffith's (1967) study, junior researchers were more dependent on all types of information sources, while senior researchers tended to use more frequently informal information sources than other sources. Paisley (1974) and Meadows (1974) reported that senior researchers tend to use more informal oral sources than junior researchers. We did not find studies conducted in less developed countries (LDC) that included this variable.

3.3.1.3 Language Ability

Several studies (Wood, 1967; Hutchins et al, 1971; Ellen, 1979; Gordon and Santman, 1981) have shown that British scientists and engineers tend to rely only on English publications, and that when they are able to read other languages than their own, these languages are generally German and French. Furthermore, no correlation has been found between reading ability and the use of non-English publications. However, the findings of the Sheffield study (Hutchins et al, 1971) suggest that the use of foreign publications by British scientists and technologists is correlated to the intrinsic value of the research in the relevant country. Thus for example, the faculty of engineering had a poor knowledge of German and Russian, but because relevant research on the field of engineering was conducted in these countries, the engineers' use and citation of foreign papers in these two languages seemed not to be greatly affected by the engineer's lack of ability in these languages.

In studies conducted in non-English speaking countries, scientists and engineers were reported as having reading ability in more than one foreign language (e.g Tornudd, 1959-Scandinavian research and scientific workers; Gordon and Santman, 1981-Dutch numerical control engineers; Licea, 1981-faculty of the Mexican schools of Agriculture and Veterinary; Goldstein, 1985-Mexican electrical engineers: researchers and practitioners; and Raitt 1985-scientists and engineers from international organizations based in Europe) In countries where the mother tongue is a minority language the availability of information in the mother tongue is not sufficient, thus individuals have to look for information in languages in which there is a worthwhile body of scientific and technical information. Goldstein (1985) reviewed various surveys and indicated that a correlation has been found between language ability of scientists and engineers whose language is not English and the use on non-native publications, in languages considered to have a worthwhile output. But in spite of this fact, studies conducted in Brazil by Rosenberg and Cunha (1981) and in Mexico by Goldstein (1985) pointed out that there are indications that members of their sample have a preference for reading information in their native language, regardless of their language ability in other languages.

3.3.1.4 Productivity

The determination of a possible relationship between creativity/productivity and information gathering habits has been reported in various studies. Maizell (1960), for example, identifies some studies (i.e.Von Zelst and Kerr, 1951 and a Fortune's Survey, 1956) in which, although creativity is defined in different ways, and the studies did not have as a primary objective to look into this relationship, it is shown that information gathering patterns may play some role in the creative process.

Later survey results consistently have also suggested that creative scientists use information differently from other scientists. In Maizell's study, for example, the use of technical literature by "most" creative and "less" creative chemical researchers *"was significantly different in depth and quantity* (Maizell 1960:9). Some of the main differences found in this study were:

Most creative scientists:

1) Spend more hours in their job reading scientific and technical literature;

2) Examined more journals available through company facilities;

3) Found monographs and advanced treatises valuable aids in solving research problems;

4) Found company notebooks, reports and correspondence as important aids in solving technical problems;

5) Found handbooks of less value as an aid in solving technical problems;

6) Would like to do more reading of technical literature than they were able to read.

Allen et al (1977) reported that highly rated teams tended to be more consistent in the use of technical staff for information than were poorer teams. He also found that highly productive teams kept close contact with outside information sources through the life of the project, while poorer teams consulted outside sources only when they were in difficulty. Lufkin and Miller (1966) found that engineers who published papers spent more time in reading contract reports and reviewing journals than the ones that did not. Kasperson (1978) noted that creative/productive scientists used periodicals which report original research significantly more frequently than other scientists. Noncreative scientists found superiors more useful as information sources than creative scientists, and consulted fewer people outside their own area of speciality. Ikpaahindi (1985) looked at the relationship between the frequency of use of various information sources and the scientific productivity of Nigerian veterinary surgeons. Contrary to the findings of the previous studies mentioned he did not find a significant correlation between the frequency of use of information sources and productivity.

3.3.2 Work Factors

In reviewing the literature concerned with the effect of individual's work/tasks upon his information behaviour, a large number of related variables emerge (e.g. scientists vs. engineers; type of research: applied vs. basic; phases of the project, diversity of the task set, etc). The general evidence suggests that these groups of variables strongly influence the use of information. Among the variety of variables two were selected to be tested in this study.

3.3.2.1 Inter-Institutional Involvement

The influence of this variable upon information use has received little attention in the literature. According to Werner (1969), Menzel (1958) was the first to suggest (but not test) that the individual's interaction with organizations other than his own (e.g. lecturers, services in committees, etc.) influences his use of information. Werner (1969) looked at the effect of this variable upon information related behaviour. His hypothesis (Moor's data) on the positive relation of this variable to the dimension "organizational distance to origin" (external system) was not supported.

3.3.2.2 Types of Activity: Research and Development

The influence of type of activity upon information use has been recognized in various studies. Wood and Hamilton (1967) for example, reported that among British mechanical engineers activity was the most important factor in determining their pattern of information needs and use. Engineers engaged in research and teaching, used scientific and technical journals, textbooks, abstracts, journals review journals and reports with high frequency. On the other hand, engineers engaged in activities of design, testing and maintenance used data sheets, handbooks and trade journals more frequently. Likewise, when Slater and Fisher (1969) analysed their findings on the use of technical libraries according to work activity (type and level of job) they reported that in the frequency of use of libraries and information, work activity had more influence than discipline and has as much effect as the variable employer. Of the five variables (industry, discipline, job activity, degree and date of degree) used in Shuchman's study (1981) to evaluate the responses of engineers working in USA industries job activity and industry made the most constant difference on the ranking of the value of information sources. The studies reviewed above indicate that activity has a decisive influence upon information use, even if the various studies have related different types of activities to information use.

3.3.3 Environmental Factors

Two variables related to the environment in which the individual is located were defined for this study: accessibility and institutional restrictions. These variables were thought to influence the individuals use of information because of the constrains they place upon the individual in terms of available resources and in terms of required behaviour.

3.3.3.1 Accessibility

The availability of information was studied by authors in its various aspects, such as: accessibility, technical quality, location, ease of use, user knowledge of information systems, costs, etc.

Rosenberg (1967) studied the channel selection strategy of professional research workers in government and industrial organizations. Clarifying that information sources considered to be easy to use were also accessible, he concluded that regardless of the orientation of the users' research the ease of use of an information gathering method was more important than the amount of information that was likely to be obtained.

Gertsberger and Allen (1968) investigated the relationship between the frequency of use of nine channels and their perceived accessibility, ease of use, technical quality, and the engineer's degree of experience with the channel. The authors found that accessibility and ease of use were strongly correlated with channel use by engineers. No support was found for the hypothesis that channels perceived as high in technical quality are those more frequently used. The authors' conclusions were:

1. *Accessibility is the single most important determinant of the overall extent to which an information channel is used.*

2. *Both the accessibility and perceived technical quality influence the choice of first source.*

3. *Perception of accessibility is influenced by experience. The more experience an engineer has with a channel, the more accessible he perceives it to be."* (Gertsberger and Allen, 1968:279).

Another important finding drawn from this study indicates that engineers select information channels, not maximizing gain, but rather minimizing loss in terms of effort, either physical or psychological, which must be expended in order to gain access to the information channel.

Likewise, Kremer (1980); Kaufman (1981) and Herron (1986) found that accessibility was an important determinant in the use of channel/sources. In Kremer's study the frequency of use was determined first by the perceived technical quality of the source, and secondly by the engineer's experience with the source. Kaufman's (1981) findings indicate that for engineers involved in problem solving tasks, accessibility (ease of getting information source) and familiarity or experience based on prior knowledge or previous use, were important factors for determining the use of literature, but engineers' most useful sources were chosen because of their high technical quality and relevance to the problem.

In accordance with previous studies Angell et al (1985) found that the accessibility of a source, both physical and intellectual, influence its use. The findings of this study differ from others because Angell's et al data indicate that the location of the source. (internal or external to the organization) has more significant influence on its use than does its form (oral or written). Goldstein (1985) identified some studies (Hardy, 1982 and Swanson, 1982) in which accessibility was not the primary factor influencing the use of information sources. Assessment of effort (Hardy) and the source itself (Swanson), are the factors that together with accessibility influence the use of sources. In Giffin's (1967) study individuals chose information by the trueworthness of the source rather than by the quality of information. Goldstein (1985) found that the frequency of use of certain types of technical documents such as professional literature and reference sources were related to their perceived accessibility.

When looking at locations some studies reported that locations more accessible were consulted first. Allen (1977) revealed that most of the materials read by engineers were located in the vicinity of their desks. Likewise Shuchman (1981) found that USA engineers consult their own technical information before they turned to the library. The influence of geographical distance in a potential information exchange was studied by

Arndt et al (1980). The authors found that the larger the geographic distance the smaller the probability of exchange. A work conducted by Slater and Fisher (1969) found a negative correlation between library use and distance from the library. Culnan's survey (1980) showed that distance did not deter people from library use. In this study "use" refers to personal and telephone contacts, telephone contacts being the most frequently source used.

A tendency to consult the most accessible sources was also found in the studies conducted in Brazil. Souza's et al ((1977) figures reveal that the majority of engineers preferred to look for information in their own location at work and consulted first the nearest information center. Likewise, a study conducted by the "Instituto Nacional de Tecnologia, Nucleo de Informação sobre corroção" (1986), found that Brazilian engineers and technicians consult first their private collections.

3.3.3.2 Institutional Restrictions

Shilling et al (1964) investigated the effect of several environmental factors upon information behavior and research output. The environmental factors investigated by Shilling et al were: phone restrictions, travel restrictions, payments of travel expenses to presenting papers, availability of assistants, paid consultants, visiting scientists, discussion groups, and others. He found a negative correlation between success in obtaining information and the availability of assistants and consultants participation in a group project. He also found that the availability of paid consultants and participation in group projects are negatively correlated with "lucky accidents" in obtaining information.

Halbert and Ackoff (1959) found that the more available the literature is to the individual through his company library and through circulation to his desk the more time he spends reading the material.

In Developing countries there are no studies that explored the effect of this variable on the use of information but we expect a negative relationship between the frequency of use of channels and the "perceived limitation" to their use.

CHAPTER 4

OPERATIONAL DEFINITIONS AND HYPOTHESES

This chapter presents the definitions of terms used in this study and outlines the hypotheses that have been formulated.

4.1 Operational Definitions

Important terms used in this study have been defined as follows:

Engineer

Professional employees in any of the four Mechanical Engineering Departments where we conducted our study whose activities are related to the functions of research, academics, administration and extension as defined in function type.

Information Sources

Information sources have been divided into four categories: formal written (FW), informal written (IW), informal oral (IO) and formal oral (FO). This division of sources as well as the categories included in each group are derived from several user studies and reviews, particularly from Kremer (1980); Shuchman (1981) and Goldstein (1985). Below we outline the sources categories.

Formal Written Information Sources (F.W.)

- Technical literature and scientific journals
- Conference proceedings
- Books
- Handbooks
- Tables
- Technical reports (internal) from the engineer's institution
- Technical reports (external) to the engineer's institution
- Laws and regulations
- Specifications and standards
- Newspapers
- Indexes, bibliographies and abstracts
- Patents
- Catalogues (manufacturers literature)
- Bulletins published by the industry
- Theses and dissertations

Information Channels

It is very difficult to define sources to the exclusion of channels, because there is a close relationship between them. This difficulty becomes greater when interpersonal channels are considered. For example, the information source telephone conversation is associated with the information channel telephone. Thus, for the purpose of this work sources and channels are only distinguished for written sources. For interpersonal sources the terms are used interchangeably. Using the criterion of their location rather than the origin of the source, channels were classified as internal and external. Internal channels are the ones located in the engineer's own institution and external are the channels located in institutions other than the engineer's. Within the internal and external channels we distinguished different categories of people and locations consulted by engineers to acquire the information needed for their work.

Interpersonal Information Channels

Interpersonal sources involve interpersonal interaction between the user and the source, but face to face verbal interaction is not necessary (Werner, 1969). Interpersonal sources include three types of the four types of information sources: informal oral (IO), formal oral (FO) and also informal written (IW) information sources such as letters and telexes.

The Informal Written Information Channels (I.W) are:

- Personal notebooks
- Unpublished papers
- Written communication with colleagues which include:
  - Letters
  - Telexes

The Formal Oral Channels (F.O) are:

- Encounters in courses, seminars and industrial exhibitions
- Lectures and presentations in courses, seminars and industrial exhibitions.

The Informal Oral Channels (I.O.) are:

- Telephone (conversations)
- Visits in offices (to colleagues)
- Talks in corridors
- Meetings for institutional projects
- Visits to industries
- Visits to research and academic institutions

Categories of People Used as Internal and External Information Channels

Based on the categories of previous studies (Kremer, 1980; Shuchman, 1981 and Goldstein, 1985) a number of categories of people have been defined for this study. These categories distinguish engineers inside the subject's institution (internal) from subjects outside (external) the institution.

Internal

- Colleagues from the engineer's department
- Colleagues from the engineer's institution
- University librarian (from engineer's institutional library and nucleos)

External

- Colleagues from other institutions
- Consultants
- Vendors or manufacturers
- Customers
- Other librarians

Categories of Locations used as Internal and External Information Channels

Internal

- Personal files, records and collections,
- COMUT (Interlibrary provision of photocopies of articles)
- Files, records and collections from institutional colleagues
- Departmental files, records and collections
- Files, records and collections from the engineer's Institutional libraries and nucleos

External

- Files, collections and records from colleagues from other institutions
- Files, collections and records from colleagues from libraries other than institutional
- Files, collections and records from colleagues from professional organizations
- Bookstores

Frequency of Use of Sources/channels

The frequency with which the engineers used the sources/channels was measured on a five point scale:

- Seldom or never
- At least once a trimester
- At least once a month
- At least once a week
- At least once a day

Information Services

All elements of information service are offered by the libraries of the institutions where the research was conducted. The category data banks, although only offered in one institution, was included in the study because we wanted to check on the perception of the need of this service by engineers. The elements of an information service are operationally defined as:

- Question and answer services (quick reference)
- Preparation of bibliographies
- Literature search on the "state-of-the-art"
- Translation of technical documents
- Provision of photocopies of written materials
- ALERT (circulation of bulletins including indexes of technical and scientific journals)
- Reference services (guidance to other sources of information: written and personal)
- Loan of bibliographic materials (books, journals and patents, etc.)
- Access to data banks

Information Input

Information input is the information used by the engineer during his project work. The following categories of information inputs have been defined for this study:

- Information on the "state of the art"
- Economic/administrative information
- Market information (consumer needs, availability and demand)
- Information on equipment

- Information on raw materials
- Processing of industrial refuse
- Processing technology
- Production, planning and control
- Technological innovation
- Standards and specifications, laws and regulations
- Quality control
- Packing and transport
- Industrial and product safety
- Pollution control
- Conservation of energy
- Product development/ industrial design

Problems

The list of problems in obtaining and using information is based on the problems mentioned in other studies (e.g. Shuchman, 1981; Goldstein, 1985)

- Did not find current information
- Did not have access to unpublished information
- Did not find relevant information
- Did not know where to look
- Found language too technical
- Received information too late for use
- Did not find information in Portuguese
- Information was expensive
- Lacked professional help to find information
- Found information but it was classified

The frequency with which engineers found these problems was measured on a five-point scale:

- Seldom or never (00% to 20% of the time)
- Occasionally (21% to 40% of the time)
- Often (41% to 60% of the time)
- Frequently (61% to 80% of the time)
- Most of the time or always (81% to100% of the time)

The frequency with which engineers come across a paper they were unable to read because of language difficulties was measured on the following five-point scale:

- Seldom or never
- At least once a semester
- At least once a month
- At least once a week
- At least once a day

Attitudes Taken by the Engineer

Attitudes refer to the action(s) taken by the engineer when he faces problem (s) in using or finding information. These actions were listed as:

- Continue to work without information
- Interrupt the work and wait for information
- Continue to work and try again later

The frequency with which the engineer takes these actions was measured on a five-point scale:

• Seldom or never	(00 to 20%	of the time)
• Occasionally	(21 to 41%	of the time)
• Often	(41 to 60%	of the time)
• Frequently	(61 to 80%	of the time)
• Most of the time/always	(81 to100%	of the time)

Personal Factors

Personal factors are those associated with the characteristics of the individuals. Four personal factors have been operationally defined for this study: educational level, seniority, language ability and productivity. These factors as well as the categories within each group are based on previous studies (e.g. Hoglund and Persson, 1977; Shuchman, 1981 and Goldstein, 1985).

Educational Level

Educational level refers to the formal education that the engineer has received. On an operational level this variable was measured by the highest degree received (Werner, 1969).

- Ph. D. or Doctor's degree
- Master's
- Certificate/Diploma (Especialização)
- Bachelor's

Seniority

Seniority refers to the length of time that the individual has been associated with the University. This variable was measured by the number of years that the engineer has been employed in the present institution.

Language Ability

As other studies (i.e. Wood, 1967 and Goldstein, 1985), this study considered only the "language reading proficiency" of the respondents. The other linguistic abilities such as speaking, comprehending oral language and writing were excluded. Respondents whose answer fell between categories "read using dictionary approximately 5 times per chapter or article" and "reads fluently", were considered to have reading ability, the others were not. Five categories were included in the questionnaire to measure the ability to read:

- Do not read at all
- Read using dictionary more than 10 times a page
- Read using dictionary approximately 5 times a page
- Read using dictionary approximately 5 times per chapter or article
- Read fluently.

Productivity

Productivity refers to the engineer's creative output. This output can be books, articles, etc. that engineers have published or have had accepted for publication, number of internal works (i.e. reports) and number of patents applied for or granted.

On an operational level this variable was measured by the "productivity score". This score was obtained for each respondent in the following way:

a) For sole or joint authorship, weights were assigned to each publication listed in Q9a and Q9b, according to the values listed below;

b) For patents the engineer's whole career was considered. The advantages that an engineer with many years within the profession might have over his relative younger colleagues by patent counting was partially nullified by dividing the "patents total" by the respondent's number of years within the profession. This value was then multiplied by 5 (corresponding to the last 5 years in the institution);

c) The overall "score of productivity" for each respondent was obtained by adding up the publications and patents values and dividing this total by the highest score obtained in the index. This result was then multiplied by a hundred.

The following weights, partially adopted from White's study (C.F White, 1971:25), were used in our work.

Patent	10
Books, as author	09
Books, as editor	06
Journal articles	03
Projects	03
Standards and technical specifications	03
Technical reports	01

Halved weights were assigned for works in collaboration.

Work Factors

Work factors are related to the characteristics of the engineer's work. The work factors defined for this study are inter-institutional involvement, functions and project type.

Inter-institutional Involvement

Inter-institutional involvement refers to the engineer's degree of interaction with other organizations than his own. It was measured in terms of hours per month.

Functions

The various functions in which the engineer is involved were defined on the basis of the activities associated with the engineer's professional position. These functions are: research, academic, administration and extension.

The engineer's degree of participation for each activity was defined in the following way: an engineer was considered to have participation in the activity if his answer fell in the category "participant" as defined by the criteria listed below. Otherwise, he was considered as not a participant. The criterion used to define participation (number of hours) was based on what in practice and in the opinion of a group of engineers was considered as the engineer's average weekly/hours of participation in the activity been defined.

Function Research

Research (individual or group)	8 weekly hours or more

Function Academics

Supervision of Theses	2 weekly hours or more
Lecturing (in own or other	

organizations)	4 weekly hours or more
Supervision of practical work	4 weekly hours or more

Function Administration

Working in committees	2 weekly hours or more
Administration	8 weekly hours or more

Function Extension

Consulting	2 weekly hours or more
Visiting industries	2 weekly hours or more

Types of Projects

Five different types of projects were defined: Research, development, design, problem solving and technical services.

The projects are defined in this study by the activities that describe them best. The definitions are based on the works of Rosenbloom and Wolek (1970) and Tushman (1978).

Research - is defined as the formulation and testing of scientific theories, concepts, models or empirical investigation of physical phenomena. It involves the formulation and testing of hypotheses and the production of a technical report or article.

Development - is defined "as the combination of existing or feasible concepts, perhaps with new knowledge, to provide a distinctly new product or process. It involves the application of known facts and theory to solve a particular problem through exploratory study, design and testing of new component or system" (Tushman, 1978:631).

Design - is defined as the combination and integration of generally available designs or components into desired products, processes and test procedures, or refinements of existing products, processes or test procedures. It involves the application of existing devices to a particular situation. It involves a design for an end-product.

Problem Solving - is defined as the combination of existing or new knowledge in order to discover the reason(s) for the malfunction of an existing system. It involves a hypothesis and a solution (Whitehall, 1989).

Technical Service - is defined as the use of existing knowledge to improve the cost/performance for existing products, processes or systems; for the recombination, modification and testing of systems and opening new markets for existing products (Tushman, 1978:632).

Project Tasks

The following tasks have been operationally defined for the projects defined above:

- Proposal writing
- Problem formulation and definition of the problem
- Theory construction
- Hypothesis and reformulation
- Data collection
- Analysis of data
- Design of equipment
- Performing tests and modifying prototype
- Constructing a prototype
- Writing up results
- Plan packing /presentation
- Implementation/commercialization

Environmental Factors

These variables are concerned with the characteristics of the environment in which the individual is located. In our study they refer to institutional rules (institutional restrictions), and resources available in the institutions where the research was conducted.

Accessibility

Accessibility was defined for this study as the engineer's perception of distance to the source. The level of accessibility was measured by the user's perception of displacement out of his work area (department). A four-point scale was used to measure accessibility (Based on Moor, 1969 and Herron, 1986).

Simple access - requires no displacement from the user's personal area (department), nor does it require the use of telephone;

Easy access - requires no displacement from the user's personal area (department), but does require the use of telephone;

Accessible - requires displacement from the user's personal area (department), but inside the building;

Difficult access - requires displacement outside the building.

Institutional Restrictions

Institutional restrictions are defined as the perception of limitations imposed by the institution on the use of certain means normally used to obtain or use information. The following categories of means have been defined for this study:

- Local phone calls

- Long distance phone calls
- Travel to other cities to attend encounters, courses, Seminars, industrial exhibitions, etc.
- Travel to other cities to present papers in conferences, courses, seminars, exhibitions, etc.
- Use of mail
- Use of telex
- Use of duplication facilities (photocopy services)
- Use of outside consultants
- Talks in corridors
- Visits in offices (to colleagues)
- Participation in meetings for institutional projects

A five point scale is included in the questionnaire to measure the level of perception of restrictions or limitations on the use of channels:

- No limitation
- Few limitations, (up to 25% of the time)
- Some limitation, (26 to 50% of the time)
- High limitation, (51 to 75% of the time)
- Very high limitation, (76 to100% of the time)

4.2 The Formulation of Hypotheses

The purpose of this section is to outline the hypotheses that have been formulated for this study. The hypotheses are, for the most part, based upon the literature discussed in chapter 3. However, in some cases no data are available about the potential influence of the dependent variables on the independent variables, thus, some hypotheses are formulated on speculative bases. The independent variables are related to the personal, work characteristics of the individuals under study and the environmental characteristics of the institution where engineers work. The dependent variables are: information sources, information problems, and attitudes taken by engineers when facing information problems.

4.2.1 Personal Factors

The personal factors surveyed in this study are: educational degree, seniority, language ability and productivity.

a) Hypotheses on the Influence of Educational Degree

A review of the literature concerned with the influence of degree upon use of information, shows a lack of consistency between the findings of the different studies. While several results have shown that educational degree leads to differential use of information sources (e.g. Moor 1969; Rosenbloom and Wolek, 1970; Maizell, 1960; Summers, 1983), other studies, as the one conducted by Shuchman (1981) for example, suggest that: *"a higher degree in engineering is not related to an increased value for the written word, or for that matter for the mechanical means of transferring information"* (Shuchman, 1981:193).

Based on the results of these studies and on the fact that University education provides individuals with a greater capability to extend their expertise and gives them the opportunity to use a variety of information sources; and on the assumption that individuals use the sources of information they learn via their education, we could expect that engineers with higher degrees would use written sources (FW and IW) and external channels more frequently than their colleagues with lower degrees.

Although we did not find any research that looked at the influence of degree on the frequency of encountering problems with information seeking and attitudes taken by engineers when faced with information problems, we expected that degree would influence both. It was hypothesized that engineers with higher degrees would face problems with different frequency than their colleagues with lower degrees.

This expectation is because the work done by engineers with higher degrees will generate information needs different from their colleagues with lower degrees.

Engineers with post-graduate courses are highly qualified and usually have a broader academic background and experience than their colleagues without post-graduate training. Thus, it was expected that engineers with post-graduate degrees would continue to work without information with more frequency than those with lower degrees. On the other hand, it seemed that the effect of degree on the attitude to "continue to work without information and try again later" would not be affected by the amount of formal education, so degree would make little or no difference in the frequency with which engineers would take this action. We have formulated the following main hypotheses:

NULL HYPOTHESIS 7a: Educational degree does not influence the frequency of use of formal written (FW) information sources by engineers.

ALTERNATE HYPOTHESIS 7a: Educational degree makes a difference in the frequency of use of formal written (FW) information sources by engineers.

NULL HYPOTHESIS 8a: Educational degree does not influence the frequency of use of informal written (IW) information channels by engineers.

ALTERNATE HYPOTHESIS 8a: Educational degree does influence the frequency of use of informal written (IW) information channels by engineers.

NULL HYPOTHESIS 8e: Educational degree does not influence the frequency of use of external channels by engineers.

ALTERNATE HYPOTHESIS 8e: Educational degree makes a difference in the frequency of use of external channels by engineers.

NULL HYPOTHESIS 9a: There is no difference in the frequency of encountering problems in obtaining and using information with respect to educational degree.

ALTERNATE HYPOTHESIS 9a: There is a difference in the frequency of encountering problems in obtaining and using information with respect to educational degree.

NULL HYPOTHESIS 9d: There is no difference in the frequency with which engineers take attitudes a) continue to work without information and b) continue to work without information and try again later, with respect to educational degree.

ALTERNATE HYPOTHESIS 9d: Degree makes a difference in the frequency with which engineers take attitudes a) continue to work without information and b) continue to work without information and try again later, with respect to educational degree.

b) Hypotheses on the Influence of Seniority

Studies conducted in developed countries (e. g. Mclaughlin et al 1965; Garvey and Griffith, 1967 and Rosenbloom and Wolek, 1970) have shown that seniority influences the use of information sources. We did not find any study that explored the influence of this variable in populations from less developed countries. Due to the characteristics of our population, BMEs are not a mobile group, we believed that engineers with a greater number of years within an institution would have better chances to become familiar with the organization as a whole and with the sources available to them. Thus, seniority level would influence the BME's frequency of use of sources, frequency of encountering problems and attitudes taken by the engineers when information is not available. We expected that:

Senior engineers would use written sources and internal locations more frequently than their colleagues with fewer years within the institution.

Senior engineers would face problems such as: did not know where to look, did not find relevant information and lack professional help to find information, less frequently than their colleagues with fewer years within the institution.

Senior engineers would continue to work without information with less frequency than their colleagues with fewer years within the institution.

The main hypotheses to test this variable are:

NULL HYPOTHESIS 7b: Seniority level does not influence the frequency of use of formal written information sources by engineers.

ALTERNATE HYPOTHESIS 7b: Seniority level does influence the frequency of use of formal written information sources by engineers.

NULL HYPOTHESIS 8b: Seniority level does not influence the frequency of use of interpersonal information channels by engineers.

ALTERNATE HYPOTHESIS 8b: Seniority level does influence the frequency of use of interpersonal information channels by engineers.

NULL HYPOTHESIS 8f: Seniority level does not influence the frequency of use of internal information channels by engineers.

ALTERNATE HYPOTHESIS 8f: Seniority level does influence the frequency of use of internal information channels by engineers.

NULL HYPOTHESIS 9b: There is no difference in the frequency of encountering problems in obtaining and using information with respect to seniority level.

ALTERNATE HYPOTHESIS 9b: There is a difference in the frequency of encountering problems in obtaining and using information with respect to seniority level.

NULL HYPOTHESIS 9e: There is no difference between engineers with different levels of seniority in the frequency of taking the action continue to work without information.

ALTERNATE HYPOTHESIS 9e: There is a difference between engineers with different levels of seniority in the frequency of taking the action continue to work without information.

c) Hypotheses on Language Ability

The literature quotes language ability as one of the main barriers to use of potentially useful foreign language materials. Studies conducted among English speaking scientists and engineers did not show a correlation between reading ability in a foreign language and the use of non-English language publications. On the other hand, for languages in which there is considered to be a worthwhile body of scientific and technological information, a correlation was found between language ability and the use of non-native language publications by scientists and engineers whose language is not English. Based on these findings, we will expect that engineers with greater language ability would:

a) Use information sources more frequently than those with lesser language ability and,

b) Use information sources in those languages in which the engineer has a linguistic ability.

The main hypoheses to test this variable are:

NULL HYPOTHESIS 7c: In the frequency of use of formal written information sources there is no difference between engineers with "low" and "high" foreign language reading ability level.

ALTERNATE HYPOTHESIS 7c: In the frequency of use of formal written information sources there is a difference between engineers with "low" and "high" foreign language reading ability level.

NULL HYPOTHESIS 7g: There is no relationship between the engineers reading ability in five languages a) English, b) French, c) German, d) Spanish and e) Italian and the frequency of use of formal written information sources in these languages.

ALTERNATE HYPOTHESIS 7g: There is a relationship between engineers reading ability in five languages a) English, b) French, c) German, d) Spanish and e) Italian and the frequency of use of formal written information sources in these languages.

d) Hypotheses on the Influence of Productivity

Studies conducted in developing countries have found that productivity influences the use of information sources (i.e. Tornudd, 1959, Maizell, 1960, Bottle, 1973, Allen 1966). On the other hand, a study conducted by Ikpaahindi (1985) among Nigerian veterinary surgeons did not find any correlation between the frequency of use of information sources and productivity. We did not find in the literature studies that would shed any light into the influence of this variable on the use of information by Brazilian scientists and engineers. We expect that productivity level would influence the frequency of use of written sources. "Productivity level" would also influence the frequency of use of external locations, frequency of encountering problems and continue to work without information. Higher producers would use external locations, report themselves as encountering problems and continuing to work without information with more frequency than their colleagues with lower productivity scores.

The main hypotheses to test this variable are:

NULL HYPOTHESIS 7d: There is no difference in the frequency of use of formal written information sources between engineers with "low", "medium" and "high" productivity level.

ALTERNATE HYPOTHESIS 7d: There is a difference in the frequency of use of formal written information sources between engineers with "low", "medium" and "high" productivity level.

NULL HYPOTHESIS 9c: Productivity does not influence the frequency with which engineers encounter problems in obtaining and using information.

ALTERNATE HYPOTHESIS 9c: Productivity does influence the frequency with which engineers encounter problems in obtaining and using information.

NULL HYPOTHESIS 9f: There is no relationship between the frequency of taking the action to "continue to work without information" and level of productivity.

ALTERNATE HYPOTHESIS 9f: Productivity level and the frequency to continue to work without information are related.

4.2.2 Work Factors

Work factors are concerned with variables related to the work that the engineer performs. In this study we look at the frequency of use of information sources in relation to the engineer's inter-institutional involvement with external organizations to his own and to type of project in which the engineer was involved.

a) Hypotheses on the Influence of Inter-institutional Involvement

This hypothesis is based in Werner's (1969:106) proposition that: as the individual's task involves more interaction with outside organizations, the compositions of the total set of sources used by the individual will become more organizationally distant (more external). Although Werner's proposition was not supported (Werner, 1969) and there are no other data available to support this hypothesis, we are interested in finding out if the engineers' degree of inter-institutional involvement influences their frequency of consultation of external channels (people and locations).

NULL HYPOTHESIS 8i: Inter-institutional involvement does not influence the frequency of use of external channels by engineers.

ALTERNATE HYPOTHESIS 8i: Inter-institutional involvement does influence the frequency of use of external channels by engineers.

b) Hypotheses on the Influence of Project Type

It was expected that the type of project in which the engineer was involved would influence the frequency of use of information sources.

NULL HYPOTHESIS 7e: There is no difference in the frequency of use of FW information sources, between engineers involved in project research and engineers involved in project development.

ALTERNATE HYPOTHESIS 7e: In the frequency of use of formal written information sources, there is a difference between engineers involved in project research and engineers involved in project development.

NULL HYPOTHESIS 8d: There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of interpersonal channels.

ALTERNATE HYPOTHESIS 8d: There is a difference between engineers involved in project research and engineers involved in project development in the frequency of use of interpersonal channels.

NULL HYPOTHESIS 8g: There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of internal and external channels.

ALTERNATE HYPOTHESIS 8g: There is a difference between engineers involved in project research and engineers involved in project development in the frequency of use of internal and external channels.

4.2.3 The Environmental Factors

Environmental factors are concerned with variables such as organizational rules, norms, resources available, etc. (Werner 1969). The organizational variables tested in this study are related to the accessibility and availability of institutional resources used by individuals to acquire information. These factors are: a) perceived accessibility of the source/channels and b) perceived degree of restriction of institutional resources.

a) Hypotheses on the Influence of Perceived Accessibility of the Source/channel

Studies conducted in developed as well as in developing countries have shown that accessibility is a determinant factor in the selection of sources. Allen (1977) have demonstrated that in addition to the value of a given channel there is certain cost associated with using it. In our study this cost was measured in terms of distance to the source. The considerable support that our population has towards decentralized collections with distance to the library as short as possible led us to hypothesize that the frequency with which a channel/source is used is determined by the engineer's perception of distance (accessibility) to the source/channel. Thus accessibility would be a determining factor in the selection of sources used by engineers.

To test the relationship between perceived accessibility of the source/channel of information and their frequency of use we have formulated the following main hypotheses:

NULL HYPOTHESIS 7f: There is no relationship between the frequency of use of formal written information sources and their perceived accessibility to their use.

ALTERNATE HYPOTHESIS 7f: There is a relationship between the frequency of use of formal written information sources and their perceived accessibility to their use.

NULL HYPOTHESIS 8h: There is no relationship between the frequency of use of internal and external channels and their perceived accessibility to their use.

ALTERNATE HYPOTHESIS 8h: There is a relationship between the frequency of use of internal and external channels and their perceived accessibility to their use.

b) Hypotheses on the Influence of Institutional Restrictions

No user studies that explored the effect of this variable on the use of information were found for Brazil. However, studies conducted by Shilling (1964) found a negative relationship between institutional restrictions and the use of some means of getting information. We expect that the greater the restrictions the lower the frequency of use of channels.

NULL HYPOTHESIS 8c: There is no relationship between the frequency of use of interpersonal channels and the perceived limitation to their use.

ALTERNATE HYPOTHESIS 8c: There is a relationship between the frequency of use of interpersonal channels and the perceived limitation to their use.

NULL HYPOTHESIS 8j: There is no relationship between the frequency of use of external channels and the perceived limitation to the use of four means of contacting people: a) local phone calls, b) long distance calls, c) use of mail and d) use of telex.

ALTERNATE HYPOTHESIS 8j: There is a relationship between the frequency of use of external channels and the perceived limitation to the use of four means of contacting people: a) local phone calls, b) long distance calls, c) use of mail and d) use of telex.

CHAPTER 5

METHODOLOGY

5.1 Introduction

To collect the data for this study we used self-completed questionnaires rather than other forms of data collection, such as observations, interviews, diaries, etc., because the information sought refers to the individual's characteristics, the perception of his work and institutional restrictions in his access to information.

Some of the advantages of using questionnaires for the present study are:

1) The format and content of the questionnaires are constant;

2) They may be administered to groups of people in different places at the same time;

3) Allows to gather data quickly;

4) Assures that the environment is a relative constant for a given sample of participants.

The questionnaire was applied to mechanical engineers working in four Academic Institutions in the Center-South of Brazil. This chapter presents information on the development of the questionnaire, on the subjects and their working conditions, on the sampling procedures and sample selection, on questionnaire application and return, on the limitations of the study and finally a short description of the statistical analysis performed on the data.

5.2 Development of the Questionnaire

The questionnaire was developed originally in English, based both on questionnaires from similar user studies found in the literature and on the hypotheses to be tested. Considerable attention was given to the instrument devised being appropriate for use in the Brazilian reality, and being a valid and reliable measure of the mechanical engineers' use of information on their activities related to teaching, research and consultancy. The questionnaire was translated into Portuguese, and then reviewed by mechanical engineers for ambiguities and mistranslations.

5.2.1 The Pilot Study

An initial version of the Portuguese questionnaire was pre-tested in a pilot study conducted among Brazilian engineers engaged in academic activities in Brazil, and working on their Ph. D. in British Universities. Some modifications were made and the resulting version was subsequently subjected to further testing in a pilot study with a group of six mechanical engineers working in one of the Brazilian institutions selected for the research.

To avoid bias that may have resulted from the discussion of the questionnaires among the participants of the pilot study and the members of the sample, we requested the former members not to discuss the questionnaire with their departmental peers.

5.2.2 Changes to the Questionnaire

Based on the results of both pilot studies we made some modifications in the questionnaire, such as:

a) Rewrite and correct some of the questions in order to avoid misinterpretation. For example Q 11 on the actions taken by engineers when faced with information problems, was reworded;

b) Include in some of the questions additional categories that had been suggested by the participants of the pilot study. For example, the categories "Bulletins published by industry and theses and dissertations" was added in Q13A. The category " Found information but it was classified" was added to Q10;

c) Delete categories that had been found repetitive or confusing by respondents. For example, we deleted from the final questionnaire categories "unable to get information quickly" and "did not find appropriate information", because they were considered repetitive of the categories "received information too late for use" and "did not find relevant information", respectively;

d) Shift the order in the measurement scale, organizing the categories from lower to higher frequencies, i.e. Q3a, Q13b, Q14a and Q14b;

e) Change the time span from three years to one year, in Q5.

5.2.3 The Final Version of the Questionnaire

The final version of the questionnaire was divided into six sections:

a) Personal description and professional experience;

b) Problems in the use of information;

c) Use of information sources: a) written and b) oral;

d) Use of information;

e) Information services: perception of availability and pertinence;

f) Description of types of projects and phases of the project.

All terms used in the questionnaire have been operationally defined in Chapter 4. The numbers in parentheses refer to the number of the questions as presented in the final version of the questionnaire.

a) Personal Description and Professional Experience

The objective of this section was to obtain data for certain independent variables about personal and work variables that may influence the engineers' use of information. Data were obtained on **educational level, productivity, language ability** and **seniority.**

Questions were also asked on work variables such as information on the engineers' **functions,** degree of participation in nine activities and on their **inter-institutional involvement,** the number of hours that they spend monthly interacting with institutions other than their own. In addition, in this section we included questions that were designed to provide information on the number of hours that engineers spend per week reading or communicating with colleagues for the activities of keeping up to date and solving technical problems.

b) Problems in Information Use

The objective of this section was to determine the frequency with which mechanical engineers working in Brazilian Academic Institutions encounter problems when they use information. First, respondents were asked to indicate the frequency with which they encounter problems when they require information and they were also asked what actions they take when they deal with these problems.

The next section dealt specifically with language problems. Respondents were asked to indicate how often they encountered documents that they would have liked to read but they did not, because they had problems with the language used in the document.

c) Use of Information Sources

c.1) Written Information Sources and Channels

The purpose of this section was to determine in detail the frequency of use of 17 written information sources. It includes questions on the frequency of use of nine information channels (e.g. personal and institutional files), and also collects information on the independent variable "**accessibility of sources and channels**".

c.2) Oral Information Sources and Channels

This section of the questionnaire contains four questions. Question 14a determined the frequency of contact with 8 categories of people; the next question (Q.14b) presents 10 means of contacting people, and the last question of this section (Q.14c) dealt with the degree of limitation that the engineer's may encounter when they use these means of contacting people. It collects data for one of the independent variables related to **environmental factors and institutional restrictions.**

d) Use of Information

The purpose of this section was to determine the frequency of use of information as input to the engineers' work.

e) Information Services

The question on information services provides additional information for the engineers' information profile. The objective of this question was to determine the engineers' perceived availability and pertinence of the information services offered by their institutional system.

f) Description of Types and Phases of the Projects

The last section of the questionnaire was directed only to engineers that had been involved in a project during the last three years. The objective of this section was to collect data for: **type of project,** and **phases of the project.** Respondents were asked to select among 5 definitions the one which described best the objective of their project and then indicate within this perspective their degree of participation in the different phases of the project.

The final version of the questionnaire was 20 pages long, was made up of 18 basic questions among which were distributed over 400 variables. Respondents spent on average 60 minutes to answer it.

5.3 Description of the Subjects

The four departments selected for our study offer graduate (BA) and post-graduate courses (masters and Ph. D.) in the field of Mechanical Engineering. The respondents are engaged in teaching activities, research projects and most of them work or have been working as consultants for the industry Two Departments belong to Federal Universities and two belong to State Universities.

While Federal Universities are subordinated administratively and are financially supported by the Brazilian Federal Government through the Ministry of Education, the State

Institutions are similarly subordinated to the local State Government through educational Committees and are funded by the State. All institutions, whether Federal of State funded, are academically subordinated to the Federal Committee on Education for academic standards, legislation on courses, and degrees offered. Table 1 shows the distribution of engineers by school with indication of the kind of link (full time or part time) that the engineer has with his institution. This table also shows the number of people present or absent during the time of the application of the questionnaire.

TABLE 1

DISTRIBUTION OF ENGINEERS BY INSTITUTION AND WORK LOAD

WORK LOAD	INSTITUTIONS				
	ONE	TWO	THREE	FOUR	TOTAL
Full time	52	16	58	30	156
Part time	01	10	15	31	57
Not in Institution	10	02	10	03	25
Total	63	28	83	64	238

The four Schools of Mechanical Engineering employ 238 engineers. From this population, 156 (65.%) work on a full time basis, 57 (24%) work part time (from 4 to 20 hours a week), and 26 engineers (11%) were on leave of absence. This study concentrates on the population working on a full time basis.

In the four schools under study, library and information services are available to the engineers through central libraries located at walking distance from the departments. Institution 4 also has a branch library in the floor below the engineering department.

The following information services are offered by the libraries in the four schools:

1) Direct access to collections of books, journals, manuals, proceedings, catalogs, etc.;

2) Lending of bibliographic material (including journals) for in and out of the library use;

3) Photocopy of materials (paid for by the users);

4) In library reference service;

5) COMUT (interlibrary photocopy service, provision of photocopies of materials, mainly articles of journals that are not available in the engineer's institution library (photocopies are paid for by the user);

6) Acquisition of bibliographic material requested by the engineer;

7) Communication of recent acquisitions through letters send to heads of departments;

8) Limited manual bibliographic searching.

5.4 Sample Selection

Initially, we planned to include in our research the full population of engineers (238) whether working on a "full" or "part" time basis in the four schools selected for our study and that were available at the time we were conducting our research (July/August, 1988). After a third contact with all four schools we realized that for several reasons it was impossible to reach a representative number of engineers working on "part time" basis. We were also limited by time and money. Thus, we dropped this category from our sample and concentrated on the category "full time". Engineers working "full time" have a 40 hours/week contract with their

Universities, in contrast to "part time" engineers who work from 2 to 20 hours a week. The group under study included academic staff with teaching commitments, engineers engaged in research work and also engineers working as consultants for the industry.

5.5 Questionnaire Application

Aware of the difficulties that some researchers have encountered in finding institutions to participate in projects with no official backing and having in mind the need to have a reasonable return of questionnaires, we took some actions that would minimize these problems. First, we met individually with the heads of each Mechanical Engineering Department from the four institutions selected for our study. Since the researcher was not known in three of these institutions, a letter from one of the most outstanding members of the Brazilian National Committee of BMEs was used as an introduction letter for each meeting (see appendix 1). During this first encounter the researcher explained the objectives of the research and emphasized the future gains that the department may get from the study. The four departments contacted agreed to participate in the project through the approval of each Departmental Head. During the meetings it was also agreed that the appropriate number of questionnaires would be left with the Head of each Department and they would be distributed internally and collected after two weeks by the secretaries of each School. At the end of the two weeks period, this deadline was extended for an extra week. Because the secretaries were not directly involved in the project, we were afraid that their lack of motivation and other commitments would keep them away from chasing and reminding the engineers to return the questionnaires. Thus, during the whole period of collecting data we maintained long telephone conversations with each secretary, asking for their help and pointing out the importance of getting back a representative number of questionnaires completed in a proper way. We collected these questionnaires from each institution personally.

In total, 91 (58.8%) questionnaires were returned. With the exception of one department in which the return was only 50%, in all other institutions we got a response rate of over 50%. This response rate was good considering the following:

1) Not much interaction was possible between the researcher and the respondents of the institutions located hundreds of miles away from the researcher's own establishment;

2) The researcher was not known in three out of the four institutions;

3) The administrators of all four institutions were aware that the number of engineer's man-hours used for answering the questionnaire had no immediate compensation;

4) The majority of respondents were engaged in various activities and were pushed by time, so in order to answer a lengthy questionnaire, in which they did not have any personal interest, the engineers had to take time from other activities;

5) The secretaries in charge of collecting the questionnaires were not directly involved in the project.

Our response rate was also good in relation to other user studies such as the Kremer study (1984), 41.1%, realized in Brazil and other studies conducted by Angell et al (1985), 51%; Raitt (1984), 25.93% and Goldstein (1985), 62.40%. The distribution of returned questionnaires by institutions is summarized in table 2.

The representativeness of engineers by organization is shown in table 3 Engineers from State (53.90) and Federal (46.10%)

Institutions are about equally represented within the group under study.

TABLE 2
DISTRIBUTION OF RETURNED QUESTIONNAIRES BY INSTITUTION

INSTITUTION	NUMBER OF ENGs*	NUMBER OF RETURNS	RETURNED
Institution 1	52	29	55.76%
Institution 2	16	13	81.25%
Institution 3	58	29	50.00%
Institution 4	30	20	66.66%
TOTAL	56	91	58.33%

* Only engineers working full time were included.

TABLE 3
REPRESENTATIVENESS OF ENGINEERS BY INSTITUTION

INSTITUTION	NUMBER OF ENGs*	IN SAMPLE%	INSTITUTION % FEDERAL	STATE
Institution 1	29	31.90%		
Institution 2	13	14.20%	46.10%	
Institution 3	20	22.00%		
Institution 4	29	31.90%		53.90%
TOTAL	91	100.00%		

*Only engineers working full time were included.

5.6 Limitations of the Study

The objective of this research is to study the influence of personal, work and environmental factors on the information used by mechanical engineers working in academic institutions in Brazil. Brazil is a country with many contrasts and inner differences, it would be almost impossible to study the whole population of engineers working in academic institutions. For this reason we concentrated our study on four schools of mechanical engineering located in the central-southern regions of Brazil. The engineers working in the institutions selected for our study are neither necessarily a true representation of all mechanical engineers working in Brazilian academic institutions, nor are they a representation of mechanical engineers working in academic institutions in developed or developing countries. Thus, we do not aim to extrapolate the results of this study to the rest of Brazil or to other developing countries.

5.7 Statistical Methodology

The statistical analysis was started by assigning a number to each questionnaire and by codifying the data on card sheets to be subsequently entered into the computer. In order to check the data for discrepancies between the ones already entered in the data file and the ones written in each questionnaire all the information was manually checked for accuracy by two persons. The master file data were then processed into a format appropriate for the statistical analysis with the SAS version 5 software package and SPSS version H. The analysis provided us with the frequencies and the statistical information necessary for the acceptance or rejection of hypotheses. In chapter 6 we present the results on the profile and characteristics of BMEs, and the results on the use of information, problems encountered and actions taken by the engineers are presented in chapters 7, 8 and 9 respectively.

CHAPTER 6

PROFILE OF BRAZILIAN MECHANICAL ENGINEERS

This chapter presents data on the engineers' personal characteristics, work characteristics and environmental factors that may influence the BMEs information use. A summary of the main findings is presented at the end of the chapter.

6.1 Personal Characteristics

In this section the personal characteristics of the BME's are examined. Data are presented on: a) Educational degree; b) Seniority; c) Language ability; and d) Productivity. The first four characteristics are later used as dependent variables to test several hypotheses on information use, problems on information use and attitudes taken by engineers when they do not find information. A careful description of the profile of the engineer seems important so that comparisons can be established with previous and future studies.

6.1.1 Educational Degree

Question 1 provided data on the engineers' educational degree, year, country and institution from where the degree was obtained. Table 4 shows that the majority of our respondents (82.40%) have post-graduate degrees; 48.30% have a Ph. D. degree and 34.10% have a Master's degree. "Especialização" (this level is equivalent to English/British diploma) is held by 4.40 % of the sample. A minority of the subjects (13.20%) holds a Bachelor's degree. Studies conducted among engineers working for industry and other non-academic organizations (Shuchman, 1981; Sabaratnam, 1983; Andrade, 1981 and Goldstein, 1985) reported that the degree held by the majority of the engineers working in these institutions was a Bachelor of Science. However the literature reports that the majority of scientists have a doctorate degree. The educational level of BMEs is similar to the educational level of scientists reported in other studies. This is not a surprising result if we consider that academic staff in Brazilian universities are highly motivated to pursue post-graduate education.

TABLE 4
DISTRIBUTION OF ENGINEERS BY DEGREE*

DEGREE	INSTITUTIONS State 1	State 2	Federal 1	Federal 2	Engs No	Sample %
Ph. D. or Doctor's degree	31.80	20.40	36.40	11.40	44	48.30
Master	32.30	12.90	38.70	16.10	31	34.10
Certificate/ diploma	25.00	75.00	00.00	00.00	04	04.40
Bachelor's	33.35	33.35	08.30	25.00	12	13.20

* Only highest degree was counted
Sample Size = 91

TABLE 5
DISTRIBUTION OF ENGINEERS BY CAREER STRUCTURE WITHIN THE UNIVERSITIES

POSITION	ENGINNERS No	IN SAMPLE %
Lecturer	07	08.00
Assistant Professor	33	36.70
Associate Professor	29	32.00
Full professor	18	20.00
"Libre Docente"	03	03.30

Effective sample size = 90

Any academic staff member who goes for a post-graduate degree in the country itself or abroad, does not only get his full salary during this training time, but also his tuition fees and travelling expenses are covered by Brazilian institutions such as Coordenação de Aperfecionamento de Pessõal de Nível Superior (CAPES) and Conselho Nacional de Pesquisa (CNPq). In both groups of Universities, Federal and State, the structure of promotion within the many levels of the hierarchy and concomitant policy of promotion is through seniority and merit. However when it comes to the evaluation of the engineer's whole merits, while a post-graduate degree in State Universities is a requirement for any promotion within the institution, in Federal Universities "Full Professorship" is the only position requiring a Ph. D. degree. Table 5 shows that only 20.00% of the engineers are within the category "full professor", although a larger group 48.30% holds a Ph. D. degree, sine qua non requirement for this position. Having said this, it would be reasonable to assume that the faculty of State Universities would hold a concentration of higher degrees than Federal Institutions, because degree is one of the requirements for promotion. However, the results of our study show that this is not the case. A difference of only 4.40% Ph. D. exists in favour of State Universities. That most degrees have been obtained in foreign institutions is understandable if we consider that Engineering Post-Graduate Programmes in Brazil have been created only in the last two decades. Engineers with academic interests different from the specializations offered by Brazilian Institutions have to look for alternative Universities and Colleges in foreign countries for their training.

For statistical analysis the four categories of degrees listed in the questionnaire were reduced to 3: Ph. D., Master's and Bachelors' degree. All respondents were grouped into the different categories on the basis of the highest degree received. The subjects with diploma were not included in the analysis of the influence of the variable degree on the dependent variables use of information sources, frequency of encountering problems, and actions taken by engineers when face information problems.

6.1.2 Seniority

In our study, seniority refers to the length of time that an engineer has been associated with the present institution. In our study, this variable is assumed to be an indicator of the engineer's familiarity with his information system.

The data show that our respondents have been working in the present institution from 1 to 25 years. For analytical purposes engineers were grouped first into five groups: 1 to 5 years; 6 to 10; 11 to 15; 16 to 20 and more than 20 years (Table 6). Later, for the statistical analyses these groups were collapsed into 3 groups: The junior group from 1 to 5 years. The medium group, from 6 to 15 years and the senior group, from 16 years or more of institutional experience.

The distribution of the sample shows that most of the respondents (72.20%) have been with their current employer for 6 years or more, only 27.80% have worked from 1 to 5 years. Of the 90 engineers, 45.54% have been working 11 years or more. In contrast in Kremer's study (1981) the highest percentage of engineers (65%) working for the same institution corresponds to engineers who have been in the institution from 1 to 5 years. Furthermore, in Scott and Wilkins' (1960) study, the median time reported to be spent by industrial technologists in their institution was from 7 to 8 years. In Wolek's study (1970) a time of 10 years or more was reported for scientists and engineers employed in a large corporation's research central laboratory and in a division of the same corporation which manufactured large mechanical systems. Although we have not included any specific question on previous jobs held or engineer's age, our data suggest that the mechanical engineers of our sample are not specially mobile and that when they have chosen an institution, most do not move during their professional career. This is similar to the pattern reported by Shuchman (1981) in relation to the mobility of engineers working for USA industries, where over half have been in the same firm for 10 years or more. It is important to notice that 25% of Shuchman's sample were under 35 years of age.

TABLE 6
DISTRIBUTION OF ENGINEERS BY NUMBER OF YEARS WITHIN THE INSTITUTION

YEARS IN THE INSTITUTION	No OF ENGINEERS	IN SAMPLE %
01 to 05 years	25	27.80
06 to 10 years	24	26.66
11 to 15 years	17	18.88
16 to 20 years	10	11.11
More than 20 years	14	15.55

Effective sample size = 90

It may be interesting to point out that mobility does not imply loss of salary or status. Academic staff working in Brazilian Federal Institutions may get their transference from one institution to another without loss of seniority or cuts in salary, provided that there is an open position in the Department and that the applicant's request is approved by the department that has the vacancy. On the other hand there aren't any financial gains either.

6.1.3 Language Reading Ability

In this section respondents were asked to estimate their ability to read five different languages: English, French, Spanish, German and Italian. Although the mastery of a language includes oral comprehension, reading, speaking and writing, we were only interested in the engineer's reading ability. This ability was measured in terms of times a dictionary was used. A respondent was considered to have "reading ability/proficiency" if his answer fell in the last two categories of the questionnaire ("reading using the dictionary approximately five times per article or chapter", "read fluently"). The other respondents whose answers fell in the other categories of the questionnaire (i.e. "do not read at all", "read using dictionary more than 10 times a page" and "read using dictionary approximately 5 times a page"), were considered as not having reading ability. Table 7 shows the engineers' linguistic ability in five different languages. While French seems to be the foreign language which most of the English speaking scientists and technologists read, English (96.7%) and Spanish (88.7%) were the languages fluently read by the majority of members of our sample. Only three engineers read English using a dictionary more than 10 times a page. A high proportion of engineers (46%) also claims to be able to handle French in a fluent way. Within the category "other languages" 4 engineers indicated that they read fluently Japanese, 2 engineers claim to have reading proficiency in Dutch, and Russian and Hungarian were claimed by one engineer. The majority of engineers of our sample indicated that they have reading proficiency in more than one foreign language. Table 8 shows these results. In Raitt's study (1984) of scientists and engineers working in international organizations the number of languages read by respondents whose mother tongue was Italian or Spanish was higher when compared to people whose mother tongue was English. Tornudd (1959) reported that in her study all Scandinavian respondents were able to read technical literature in Norwegian, Swedish and German. English was read by 100% of the Danish and 98% of the Finish. French was read by 74% of the Danish and by 23% of the Finish. Our results show that 89.01% of our engineers read two or more foreign languages fluently and more that half of our respondents (51.65%) read fluently 3 or more foreign languages (excluding their mother tongue).

TABLE 7
DISTRIBUTION OF ENGINEERS BY READING ABILITY IN FOREIGN LANGUAGES

LANGUAGES	READ FLUENTLY		DO NOT READ FLUENTLY		
	NUMBER OF ENGINEERS	IN SAMPLE PERCENTAGE	NUMBER OF ENGINEERS	IN SAMPLE PERCENTAGE	N
English	88	96.7%	03	03.3%	91
Spanish	78	88.7%	10	11.3%	88
French	40	46.0%	47	54.0%	87
Italian	23	27.1%	62	72.9%	85
German	12	14.0%	74	86.0%	86

N= Effective sample size

TABLE 8
DISTRIBUTION OF ENGINEERS BY THE NUMBER OF LANGUAGES IN WHICH THEY HAVE READING ABILITY

NUMBER OF LANGUAGES	ENGINEERS No	IN SAMPLE %
One language	10	10.99%
Two languages	34	37.36%
Three languages	29	31.87%
Four languages	14	15.38%
Five languages	04	04.40%

*Excluding Portuguese
Number of respondents = 91

6.1.4 Productivity

Over the past years several techniques have been used to measure research and performance output. Nonetheless there is still not a widely accepted measure. According to Werner

(1969:57) the different techniques used to measure either research development output or creativity can be grouped into two main categories:

"1) Performance ratings by superiors, peers, outside groups, etc." (e.g. Maizell, 1958, 60 and Pelz, 1956) and ;

"2) a count of the number of things produced by the individual-- number of publications, papers presented, patents, etc." (e.g. Von Zelst and Kerr, 1951; Tornud, 1958; Scates and Yeomans, 1950; White, 1971).

Occasionally tests of creativity or other techniques have been used to supplement one or both of the above techniques. However in the view of the author none of these techniques is a true measure of productivity, but they are all measures to at least limited extent.

For the purpose of this study, to be considered creative or productive, an engineer was required to show evidence of a productive output, i.e. have published books, journal articles, or have produced technical reports, projects, standards and technical regulations, or to have had a creative output such as patented inventions. The measurement scale for the engineer's output productivity relies on publications and patents counting. We recognize that quantity of publications does not necessarily correlate with quality and that simple publication and patent counting might not bring out all the engineer's potential. However this measure was selected because it has been a universally applicable measure of productivity. There are other measures, such as citations received from publications over a period of time and subject evaluation by colleagues which are also limited in one way or another.

In question 9a, 9b and 9c, respondents were asked for information on the number of works published or accepted for publication in the last five years for books and journal articles;

in the last year for technical reports, projects and technical regulations and in the engineer's professional life time for patents. Table 9 shows the distribution of engineers according to their index of productivity.

TABLE 9
DISTRIBUTION OF ENGINEERS BY INDEX OF PRODUCTIVITY

HIGH		MEDIUM		LOW	
Number of Engineers	In Sample Percentage	Number of Engineers	In Sample Percentage	Number of Engineers	In Sample Percentage
18	19.78%	51	56.04%	22	24.18%

Sample size = 91

Separate categories were provided for sole or joint authorship. The number and types of publications are summarized in table 10 and 11. These tables show that within the category "sole authorship" 48.35% published articles in journals and 58.25% produced technical reports. Patents were produced to a lesser extent (10.10%). Within the category "joint authorship" journal articles were published by 79.12% of the engineers and 47.25% produced technical reports and projects. Within a period of five years only 8.79% of the engineers have written or edited book(s) alone and only 13,18% have published or edited book(s) in collaboration. Our survey results show BMEs as a group with variations in the amounts of their contribution in terms of publications. However in all instances only a few engineers have contributed to a large proportion of what was published. Thus, for example within the category sole authorship, 27.27% of the engineers are responsible for 72.50% of the publications of journal articles, 18.90% are responsible for 70.63% of the projects and 20.75% are responsible for 65.50% of the technical reports produced. These results are, in certain ways, similar to the findings of Ladd and Lipset (1975) who after studying a representative sample of American higher education institutions have concluded that over half of all full time faculty members had never written or edited any sort of book alone or in collaboration. More than one third of the full time academics had never published an article and more than one quarter had never published a word.

TABLE 10
PERCENTAGE AND NUMBER OF PUBLICATIONS BY BME'S
(Sole authorship)

PUBLICATIONS	PERCENTAGE OF ENGINEERS WHO PUBLISHED	NUMBER OF PUBLICATIONS
* Books, as author	07.70%	09
* Books, as editor	01.09%	01
* Journal articles	48.35%	309
** Technical reports	58.25%	299
** Projects	40.66%	252
** Technical regulations	06.60%	49
*** Patents granted	05.50%	08
*** Patents applied for	05.50%	07

Number of respondents = 91
* Time lapse = 5 years
** Time lapse = 1 year
*** Time lapse = the engineer's professional life.

For statistical analysis purposes and in order to have a better picture of the engineer's output in terms of publications and patents, a "productivity score" was designed for this study. It is based on weights and partially adopted from White's study (1971). On the basis of this score three levels of productivity were determined: 1) low productivity level grouped engineers who scored 5 or less, 2) medium productivity level grouped engineers who scored 5.1 or up to 20 and 3) high productivity level, grouped engineers who scored 20.1 or more. (For an explanation of the productivity score, see chapter 4.1 under productivity). Table 9 shows the distribution of productivity level across the respondents. As was expected productivity was not evenly distributed among members of our target population. Only 19.78% qualified as "high producers", 24.18% fell within the category "low productivity" and the majority of our engineers 56.04% were "medium producers". This finding is consistent with previous research (i.e. Schorr, 1975; Rogge, 1976, Lotka, 1926) which reported that some scientists are more productive than others.

TABLE 11
PERCENTAGE AND NUMBER OF PUBLICATIONS BY BME'S
(Joint authorship)

PUBLICATIONS	PERCENTAGE OF ENGINEERS WHO PUBLISHED	NUMBER OF PUBLICATIONS
* Books, as author	12.08%	20
* Books, as editor	01.10%	03
* Journal articles	79.12%	675
** Technical reports	47.25%	149
** Projects	47.25%	167
** Technical regulations	07.70%	31
*** Patents granted	14.28%	28
*** Patents applied for	07.70%	12

Sample Size = 91
* Time lapse = 5 years
** Time lapse = 1 year
*** Time lapse = the engineer's professional life.

6.2 Work Factors

In this section we analyze data collected on some variables related to the work done by engineers. The variables are: a) the engineers degree of involvement with external institutions and

b) project type. In addition, data are presented on type of activity and project tasks.

6.2.1 Inter-institutional Involvement

Engineers working in academic institutions interact with various external institutions. Question 5 provided information on the number of hours that engineers spent a week interacting with organizations other than their own. The results indicate that the engineer's degree of inter-institutional involvement varies from 0 to 24 hrs/per month. For data analysis purposes, engineers were distributed in 5 groups: 1) zero hrs of involvement; 2) from 1 to 5 hrs.; 3) from 6 to 10 hrs.; 4) from 11 to 16 hrs. and 5) 16 or more hours of involvement. Data displayed in table 12 show that most subjects in the sample have inter-institutional involvement with external institutions from 1 to 10 hours a month. Only 13.20% of subjects of the sample do not have any inter-institutional contact. No data comparable with these results have been found in the literature. Later for statistical analysis the last two categories were collapsed.

TABLE 12
DISTRIBUTION OF ENGINEERS BY THE NUMBER OF HOURS OF INVOLVEMENT WITH EXTERNAL INSTITUTIONS

NUMBER OF MONTHLY/HOURS	ENGINEERS NUMBER	IN SAMPLE %
00 Hours	12	13.20
From 1 to 5 hours	30	33.00
From 6 to 10 hours	36	39.60
From 11 to 16 hours	02	02.20
More than 16 hours	11	12.00

Sample size = 91

6.2.2 Type of Activities and Functions

Type of activity seems to be one of the main factors influencing the use of information (e.g. Wood and Hamilton, 1967; Mick et al, 1980; Shuchman, 1981). In question 4 respondents were asked to estimate the time they spent on 8 different activities: research, supervising theses, lecturing, supervision of student's practical work, working in committees, administration, consulting and visiting industries. Due to the differing nature of activities used as indicators, the threshold for participation in each activity was not defined on the basis of a common number of hours, but on the basis of what in practice and in the engineers' opinion was considered as their average weekly hours of participation in the activity being defined. Thus, the number of hours used as the basis to define participation varies from one category to another. For example, an engineer who is engaged in lecturing activities for less than 4 hours a week was not considered as having participation in this activity because the average lecturing load for "full time" academic staff varies from 4 to 8 hrs/week. On the other hand, an engineer who spent 2 hours per week visiting industries was considered as having participation in this type of activity. For a complete explanation on how participation was defined, see chapter 4, under "function type". The percentage of the engineers' participation in each activity is summarized in table 13. Since a respondent might have been engaged in more than one activity, it was not expected that the sum of the proportions would be 100%. Data presented in table 13 show that lecturing is still the main activity for the majority (86.8%) of members of our sample. The extent of participation in research (67.1%) and committees (62.7%) is about equal, whereas in the other activities, the engineer's participation is below 50%.

TABLE 13
DISTRIBUTION OF ENGINEERS BY ACTIVITY

ACTIVITY	NUMBER OF ENGINEERS	IN SAMPLE PERCENTAGE	No OF HOURS USED TO DEFINE PARTICIPATION
Research (individual/group)	01	67.1%	8 hrs/week
Orientation of theses	40	43.4%	2 hrs/week
Lecturing	79	86.8%	4hrs/week
Student supervision for practical work	36	39.6%	4 hrs/week
Working in committees	57	62.7%	2 hrs/week
Administration	19	20.9%	8 hrs/week
Consulting	23	25.3%	8 hrs/week
Visiting industries	39	42.9%	2 hrs/week

Sample size = 91

TABLE 14
DISTRIBUTION OF ENGINEERS BY NUMBER OF ACTIVITIES

NUMBER OF ACTIVITIES	NUMBER OF ENGINEERS	IN SAMPLE %
One activity	04	04.40%
Two activities	08	08.79%
Three activities	23	25.27%
Four activities	33	36.26%
Five activities	16	17.58%
Six activities	05	05.49%
Seven activities	02	02.21%

Effective sample size = 91

TABLE 15
DISTRIBUTION OF ENGINEERS BY FUNCTION

FUNCTIONS	NUMBER OF ENGINEERS	IN SAMPLE %	ACTIVITIES THAT DEFINE FUNCTIONS
Academics	88	96.70	Lecturing in own or other organizations, or supervision of theses, or supervision of practical work
Administration	63	69.20	Working in committees, or administration
Extension	55	60.40	Consulting or visiting industries
Research	61	67.00	Research

Sample size = 91

However a percentage close to 50% (over 40%) of the engineer's time is dedicated to activities such as "orientation of theses" and "visiting industries". When the different activities were grouped by functions (table 15) as defined in chapter 4 our results show that 96.70% of our sample is involved in any of the activities listed under academics, 69.20% participate in administration, 60.40% are involved with activities related to extension and 67% do research. Table 14 shows the percentage of engineers against the number of activities in which they reported to have had participation.

6.2.3 Project Type

The last part of the questionnaire (Q17 and Q18) was directed at engineers who had completed a project during the last three years. Only 64.83% (59 engineers out of 91), answered these questions. Question 17 provided data on the engineer's participation in five different types of projects: research, development, design, problem solving and technical services. The number and types of projects listed in table 16 do not represent the whole range of projects developed in the institutions under study. Engineers were asked to choose just "one project" from the variety in which they had been involved in the last three years. Table 16 shows the number of engineers by types of projects selected. Development was the most common type of project selected by the respondents.

TABLE 16
DISTRIBUTION OF ENGINEERS BY PROJECT TYPE

TYPES OF PROJECTS	NUMBER OF PARTICIPANTS	IN SAMPLE %
Research	19	32.20
Development	29	49.20
Design	08	13.60
Problem solving	01	01.70
Technical services	02	03.30

Effective size = 59

6.2.4 Project Tasks

Question 18 collected data on the engineer's degree of participation in 12 different tasks: 1) proposal writing, 2) problem formulation and definition of the problem, 3) theory construction, 4) hypothesis and (re)formulation, 5) data collection, 6) analysis of data, 7) design of equipment, 8) performing tests and modifying prototype, 9) constructing a prototype, 10) writing up results, 11) plan packing and presentation and 12) implementation and commercialization. As explained before, engineers were asked to choose "just one completed project" from the various projects they had been involved in the last three years and indicate their degree of participation in the different tasks within that project.

For discussion purposes, engineers were divided in 3 groups on the basis of their degree of participation on each task. The high participants group gathered engineers whose answers fell within the categories: "somewhat" and a "great deal". The low participants group gathered engineers whose answer fell within the categories "small amount", and the non-participants group gathered engineers whose answers fell within the category: "not at all".

The data displayed in tables 17A to 17E show that within the projects research, development and design, the majority of respondents, have had a "high level" of participation in almost all stage. Exception to this generalization are the stages: constructing a prototype; plan packing and presentation; and implementation and commercialization of the product.

TABLE 17A
DISTRIBUTION OF ENGINEERS BY PROJECT/TASKS WITHIN RESEARCH

TASKS	ENGINEERS' DEGREE OF PARTICIPATION HIGH	LOW	NONE	RESPONDENTS No WITHIN TASKS	N
Proposal writing	73.70	26.30	00.00	19	58
Formulation and definition of the problem	94.70	05.30	00.00	19	59
Theory construction	94.70	05.30	00.00	19	58
Hypothesis and reformulation	89.50	10.50	00.00	19	57
Data collection	84.20	10.50	05.30	19	57
Analyses of data	100.00	00.00	00.00	19	58
Design of equipment	50.00	11.10	38.90	18	52
Performing tests and modifying prototype	41.20	17.60	41.20	17	50
Constructing a prototype	40.00	06.70	53.30	15	49
Writing up results	100.00	00.00	00.00	18	58
Plan packing and presentation	07.70	07.70	84.60	13	44
Implementation an commercialization	15.40	00.00	84.60	13	43

N= Total number of respondents

TABLE 17B
DISTRIBUTION OF ENGINEERS BY PROJECT/TASKS WITHIN DESIGN

TASKS	ENGINEERS' DEGREE OF PARTICIPATION HIGH	LOW	NONE	RESPONDENTS No WITHIN TASKS	N
Proposal writing	85.70	10.70	03.60	28	58
Formulation and definition of the problem	86.50	13.50	00.00	29	59
Theory construction	82.10	17.90	00.00	28	58
Hypothesis and reformulation	85.10	11.10	03.80	27	57
Data collection	81.50	14.80	03.70	27	57
Analyses of data	96.50	03.50	00.00	29	58
Design of equipment	85.20	05.30	09.50	24	52
Performing tests and modifying prototype	74.00	13.00	13.00	23	50
Constructing a prototype	54.20	25.00	20.80	24	49
Writing up results	89.70	10.30	00.00	29	58
Plan packing and presentation	17.40	13.00	69.60	23	44
Implementation and commercialization	13.70	22.70	63.60	22	43

N = Total number of respondents

TABLE 17C
DISTRIBUTION OF ENGINEERS BY PROJECT/TASKS WITHIN DEVELOPMENT

TASKS	ENGINEERS' DEGREE OF PARTICIPATION HIGH	LOW	NONE	RESPONDENTS NUMBER WITHIN TASKS	N
Proposal writing	87.50	00.00	12.50	08	58
Formulation and definition of the problem	87.50	12.50	00.00	08	59
Theory construction	50.00	12.50	37.50	08	58
Hypothesis and reformulation	50.00	12.50	37.50	08	57
Data collection	75.00	25.00	00.00	08	57
Analysis of data	87.50	12.50	00.00	08	58
Design of equipment	85.70	00.00	14.30	07	52
Performing tests and modifying prototype	57.20	00.00	42.80	07	50
Constructing a prototype	42.90	14.30	42.80	07	49
Writing up results	87.50	12.50	00.00	08	58
Plan packing and presentation	16.70	00.00	83.30	06	44
Implementation/ commercialization	16.70	00.00	83.30	06	43

N = Total number of respondents

TABLE 17D
DISTRIBUTION OF ENGINEERS BY PROJECT/TASKS WITHIN PROBLEM SOLVING

TASKS	ENGINEERS' DEGREE OF PARTICIPATION			RESPONDENTS NUMBER WITHIN TASKS	N
	HIGH	LOW	NONE		
Proposal writing	100.00	00.00	00.00	01	58
Formulation and definition of the problem	100.00	00.00	00.00	01	59
Theory construction	100.00	00.00	00.00	01	58
Hypothesis and reformulation	100.00	00.00	00.00	01	57
Data collection	100.00	00.00	00.00	01	57
Analyses of data	00.00	00.00	00.00	00	58
Design of equipment	100.00	00.00	00.00	01	52
Performing tests and modifying prototype	100.00	00.00	00.00	01	50
Constructing a prototype	100.00	00.00	00.00	01	49
Writing up results	100.00	00.00	00.00	01	58
Plan packing and presentation	00.00	00.00	00.00	00	44
Implementation/ commercialization	00.00	00.00	00.00	00	43

N = Total number of respondents

TABLE 17E
DISTRIBUTION OF ENGINEERS BY PROJECT/TASKS WITHIN TECHNICAL SERVICES

TASKS	ENGINEERS' DEGREE OF PARTICIPATION HIGH	LOW	NONE	RESPONDENTS NUMBER WITHIN TASKS	N
Proposal writing	50.00	50.00	00.00	02	58
Formulation and definition of the problem	100.00	00.00	00.00	02	59
Theory construction	100.00	00.00	00.00	02	58
Hypothesis and reformulation	100.00	00.00	00.00	02	57
Data collection	100.00	00.00	00.00	02	57
Analyses of data	100.00	00.00	00.00	02	58
Design of equipment	100.00	00.00	00.00	02	52
Performing tests and modifying prototype	50.00	00.00	50.00	02	50
Constructing a prototype	50.00	00.00	50.00	02	49
Writing up results	100.00	00.00	00.00	02	58
Plan packing and presentation	00.00	50.00	50.00	02	44
Implementation/ commercialization	50.00	00.00	50.00	02	43

N = Total number of respondents

6.3 Environmental Factors

The third aspect in this profile section are factors related to the user's environment. In this research two factors are studied: a) accessibility of sources/channels and b) institutional restrictions.

6.3.1 Accessibility of the Sources and Channels

Studies conducted by Rosenberg (1967), Gerstberger and Allen (1968), Kremer (1980), Angell et al (1985) found that accessibility is a powerful influence on the selection of information sources/channels. The first two studies also found that individuals tend to minimize the cost of obtaining information, sacrificing if necessary the quality of information received. According to Orr (1970) the quality of information is the most important consideration in selecting an information source/channel. In a later study Hardy (1982) presented evidence that accessibility exclusively does not determine the frequency of use of sources/channels of information, he argues that qualities such as content and speed are as important as accessibility. He also argues that sources are selected on the basis of an evaluation of costs and benefits, and not benefits alone as Gertsberger and Allen (1968) maintain.

In this study we wanted to determine if accessibility is a determinant factor in the selection of sources/channels used by BMEs. We measured accessibility by its perceived cost. According to Gerstberger and Allen (1968) cost "may consist of many dimensions - economic, psychological, and physical". For this study we have chosen the physical dimension of cost. Thus, accessibility was defined on the basis of the respondent's perception of distance to the source. This section presents data on the degree of perception of accessibility by BMEs of the different sources and channels used. For discussion purposes "accessible sources/channels" are the ones which fell within the questionnaire categories "simple access" and "easy access". Sources/channels with "low accessibility" are the ones which fell in the category "accessible"; and "inaccessible sources" were the ones that fell in the category, "difficult access".

The perceived accessibility of 32 information sources and channels were investigated and the results are presented in table 18, 19a and 19b. Only one written source and two channels have been noticed as "accessible" by the majority of engineers. They are 1) personal notebooks (87.80%), 2) personal files, records and collections (73.00%) and 3) colleagues from the engineers own department (64.20%). In Kremer's (1980) study colleagues from inside the company and own notebooks were also indicated as the most accessible sources, these sources were ranked by engineers as, first and second, respectively. The majority of members of our sample noted as "not accessible" the following FW information sources: technical and scientific journals; indexes, bibliographies and abstracts; specifications and standards; bulletins published by industry; external technical reports; laws and regulations and patents .Unpublished papers were perceived as "difficult to access" by 67.60% of the respondents. Among internal channels, the majority of the BMEs considered as "difficult access" the channels: "files records and collections from the engineer's institutional libraries and nucleos" and "librarians from the engineers institutional libraries and nucleos". All external channels are perceived as having "difficult accessibility" by the majority of the BMEs. Tables 18, 19a and 19b display these data.

TABLE 18
ENGINEERS' PERCEIVED ACCESSIBILITY OF FORMAL WRITTEN INFORMATION SOURCES

FORMAL WRITTEN SOURCES	DEGREE OF ACCESSIBILITY			
	ACCESSIBLE	LOW	DIFFICULT ACCESS	N
Books	31.80	26.10	42.10	88
Technical and scientific journals	26.90	22.50	50.60	89
Tables	41.30	26.20	32.50	80
Handbooks	34.20	24.10	41.70	79
Indexes, bibliographies and abstracts	19.80	21.00	59.20	81
Conference proceedings	24.20	28.40	47.40	84
Catalogues, manufactures literature	26.80	25.40	47.80	71
Newspapers	29.50	26.20	44.30	61
Specifications and standards	18.20	16.90	64.90	77
Technical reports (internal)	48.00	33.30	18.70	75
Theses, Dissertations	30.00	25.00	44.00	84
Bulletins published by industry	26.80	15.00	58.20	67
Technical reports (external)	10.60	08.20	81.20	69
Laws and regulations	07.60	15.20	77.20	66
Patents	18.40	07.90	73.70	38

TABLE 19A
ENGINEERS' PERCEIVED ACCESSIBILITY OF CHANNELS

CHANNELS	DEGREE OF ACCESSIBILITY			
	ACCESSIBLE	LOW	DIFFICULT ACCESS	N
INFORMAL WRITTEN				
Personal notebooks	87.80	01.40	10.80	74
Unpublished papers	20.60	11.80	67.60	34
INTERNAL CHANNELS				
Personal files/records and collections	73.00	09.40	17.60	74
Files records/collections from the engineer's institutional libraries and nucleos	14.80	27.20	58.00	81
Files records/collections from institutional colleagues	39.70	36.80	23.50	68
Departmental files records/ collections	44.80	44.80	10.40	67
Colleagues from the engineer's department*	64.20	30.90	04.90	81
Colleagues from the engineer's institution	44.60	27.00	28.40	74
Librarians from the engineer's institution and nucleos	21.70	15.90	62.40	69

TABLE 19B
ENGINEERS' PERCEIVED ACCESSIBILITY OF EXTERNAL CHANNELS

EXTERNAL CHANNELS	DEGREE OF ACCESSIBILITY			
	ACCESSIBLE	LOW	DIFFICULT ACCESS	N
Files/records and collections from professional organizations	19.50	07.30	73.20	41
Bookstores	06.40	09.00	84.60	78
Files/records and collections from libraries other than institutional	03.00	03.00	94.00	66
Files/records/collections,from colleagues of other institutions	16.40	03.60	80.00	55
Colleagues from other institutions	23.10	07.70	69.20	65
Customers	32.50	07.50	60.00	40
Vendors or manufacturers	40.80	07.40	51.80	37
Other librarians	11.30	05.70	83.00	38

* Accessible sources
N = Number of respondents

6.3.2 Institutional Restrictions

There is an apparent difference in what a person actually does, and what he thinks he would do if certain restrictions were not present in his institution. The degree of perception of institutional restrictions on the use of means to get information was thought to influence the frequency of use of information sources.

The questionnaire (Q14c) collected data on the limitation imposed by the engineer's institution on the use of 11 channels normally used to obtain information. These channels are: local phone calls; long distance phone calls; travel to other cities to attend seminars, courses, visits to industry, etc; travel to other cities to present papers in seminars; use of mail; use of telex; use of duplication services; use of external consultants; talks in corridors; visits in offices and participation in meetings for projects in the engineer's institution.

For the purpose of discussion, three degrees of restriction were established: 1) None; 2) low limitation (categories few limitation and some limitation); and 3) high limitation (categories much limitation and very much limitation).

Only five channels were perceived by the majority of the sample as not having any institutional limitation in their use: local phone calls; use of mail; visits to colleague's offices and talks in corridors and participation.on meetings for projects from the engineers institution. A low degree of restriction was perceived by the majority for the channels: long distance calls; use of telex and the use of photocopy services. Travel to other cities to attend courses, seminars was perceived as "low limited" by 47.00% of the respondents. However, a similar percentage of engineers, (42.20%) perceived these channels as having a high degree of restriction. The use of outside consultants received the highest percentage of limitation within the category "high limitation". Table 20 shows the different degrees of restrictions of the channels as perceived by the engineers.

TABLE 20
PERCENTAGE OF ENGINEERS PERCEIVING INSTITUTIONAL RESTRICTIONS IN THE USE OF CHANNELS

CHANNELS	DEGREE OF LIMITATION HIGH %	LOW %	NONE	NUMBER OF RESPONDENTS
Local phone calls	08.10	34.90	57.00	86
Long distance phone calls	23.00	52.90	24.10	87
Travel to other cities to attend courses, seminars,industrial exhibitions	42.20	47.00	10.80	83
Travel to other cities to present papers in conferences, seminars, courses, etc.	26.30	60.00	13.70	80
Use of mail	01.20	36.00	62.80	86
Use of telex	07.00	47.90	45.10	71
Use of photocopy services	16.90	51.60	31.50	89
Use of outside consultants	48.60	34.30	17.10	35
Talks in corridors	02.30	24.50	73.20	86
Visits to colleagues' offices	01.10	20.70	78.20	87
Participation in meetings for institutional projects	10.00	35.00	55.00	80

6.4 Summary on Profile of Respondents

6.4.1 Personal Characteristics

The results of our study clearly show that the majority of the BMEs working in the Brazilian Universities hold either a doctorate (48.40%) or a master's degree (34.10%), hence 82.50% of the engineers hold a post-graduate degree. In terms of seniority the data show that most engineers (75%) have been working for their institutions for 6 years or more, a time span long enough for them to be fully aware of and to understand the information services available in their institutions. The subjects under study also show good competence in foreign language reading. Over 89% read two or more foreign languages; 96.70% have reading ability in English. Another important factor that may influence the use of information is productivity. The data refer to journal articles, books, reports and projects published in the last five years and patents during respondent's professional life. For all categories of publication we get an average of 10 publications per engineer for the last five years, which is an average of two publications per engineer per year. This seems a reasonably high result but not an unexpected one if we look at the qualifications of the subjects in our sample. As emphasized elsewhere (6.1.4), the contribution of some engineers to such a high average is much greater than for others. For example, 18.90% of the engineers are responsible for 70.63% for all the journal articles produced over the five years. Only 19.78% of the engineers fall in the high index of productivity bracket while 66.04% have medium index of productivity.

6.4.2 Work Factors

When we defined the engineer and discussed the tasks we realized that the activities engineers may be involved in are almost unlimited. But BMEs working for academic institutions have their activities constrained because of the specificity of the functions that have to be performed in these institutions. The results of our data show that 86.80% of the subjects do have a certain inter-institutional involvement. In terms of activities, lecturing (86.90%), research (67.10%) and working in committees (62.70) have the broadest participation of the engineers. Many (43.40%) also spend time at least two hours a week, supervising students' research. Most engineers (86.81%) participate in three or more activities, the greatest number participate in four activities. This shows a good diversity of functions in which the engineers use their 40 contracted labour hours a week. When we look at the engineers involvement in projects we notice that the highest participation is in development and research. Projects in technical services and problem solving only had together an overall percentage of 5.00% of participation.

6.4.3 Environmental Factors

Perceived accessibility and institutional restrictions have been considered important variables in the way information is used.

Only three sources of information were considered accessible by the BMEs: personal notebooks, personal files, records and collections of colleagues from the department. The results on the perceived accessibility of the numerous sources submitted to the engineers for their judgment of accessibility gives the information experts important insights of the difficulty users have to access information stored in the information centers and libraries. Technical and scientific literature, indexes and abstracts and bibliographies, specifications and standards, external technical reports, laws and regulations, bookstores, collections and files of other libraries are among some of the information sources to which engineers find it especially difficult to have access in terms of institutional restrictions the problems seem to lie particularly in the use of outside consultants, to travel to other cities, to attend courses, seminars and present papers and the use of the telephone for long distance calls. These difficulties seem all to be related to financial resources.

CHAPTER 7

RESULTS ON THE USE OF FORMAL WRITTEN INFORMATION SOURCES BY BRAZILIAN MECHANICAL ENGINEERS

This chapter 1) presents results on the frequency use of 15 types of formal written information sources (FW) by BMEs and relates them to findings of previous studies; 2) analyses the relationship between the use of FW sources and some of the personal, work and environmental characteristics of the sample; 3) discusses the number of hours that BMEs spend reading for problem solving and keeping up-to-date and 4) presents data on the languages in which the literature is used. After the presentation of results a discussion on the main tendencies of the use of FW information sources by BMEs follows. Finally a short summary of the main findings on the frequency of use of FW information sources is presented.

7.1 Use of Formal Written (FW) Information Sources

For discussion purposes "frequent" use is defined as used on at least a weekly basis (questionnaire categories "at least once a day", "at least once a week"); "infrequent" use is defined as used on a monthly basis or less frequently (categories "at least once a month", "at least once a trimester" and "rarely or never"). This section presents results on the use of FW information sources and compares them with previous research. The comparison of our results with other studies can only be speculative because of the variations in the different studies in data collection, terminology used, variables considered and methodologies used in data analysis. While table 21 presents the percentages of sources used "frequently", table 22 presents the percentages of engineers using sources with different frequencies.

7.1.1 Frequency of Use of Formal Written (FW) Information Sources and its Relation to Previous Studies

The data analysis (table 21) shows that only two FW information sources, technical and scientific journals (78.10%) and books (85.70%), are frequently used by the majority (over 50%) of respondents.

Studies conducted in the USA (Allen, 1977), in Mexico (Licea, 1981 and Goldstein, 1985) and in Brazil (Souza et al, 1977; Almeida and Falkenbach, 1977 and Kremer, 1984) have also reported that these sources were highly used by scientists and engineers. However, some researchers found different results. For example, Andrade (1981), in Brazil reported that engineers from PETROBRAS (The Brazilian National Petroleum Co.), rated, among 29 other sources, books and journals in 9th and 10th places of importance, respectively. Similarly Raitt (1984) in his study of scientists and engineers working in international organizations found that nearly half of the engineers rarely used books. Additionally, Slater and Fisher (1969) in their study of users of technical libraries reported that academic users in England made the heaviest use of textbooks but only an average use of periodicals. In their study periodicals were used by engineers less than by scientists. Wood and Hamilton (1967) have also reported that British mechanical engineers in general made heavy use of scientific, technical and trade journals, however, journals, were used predominantly by engineers engaged in research and teaching. From the literature it seems that work function has a heavy influence on the use of books and scientific and technical journals by engineers.

Handbooks are used frequently by 36.30% of our sample, but on a monthly basis this source is used by 72.60% of the respondents. Slater and Fisher (1969) found that engineers use handbooks more frequently than scientists. In Wood and Hamilton's (1967) study a high percentage of engineers reported frequent use (at least once a month) of this source. Furthermore, Kremer (1980) found that handbooks were ranked as very important sources of information by engineers working in a USA enterprise. Our findings seem to be in harmony with these studies. Tables are used frequently by 47.30% of the BMEs, but on a monthly basis they are used by 71.50% of the sample. In Shuchman's (1981) study both sources (handbooks and tables) were also ranked as very important sources of information by mechanical engineers working in USA industries.

On the use of abstracting services the results reveal that a minority (36.30%) of BMEs use these sources frequently, however on a monthly basis this source is used by a majority of engineers (59.40%). Different results were found by authors discussing the use of abstracting services by scientists and engineers. While some surveys (Herner, 1959 and Martyn, 1964 and 1987) noted that scientists look upon abstracting services as an effective way to get informed, other studies conducted among engineers found that engineers do not use indexes and abstracts regularly (Wood and Hamilton, 1967 and Hanson, 1974) or they used them infrequently (Raitt, 1984 and Goldstein, 1985). In Kremer's study (1984) Brazilian academic lecturers listed these sources as very important means of information, while in Almeida and Falkenback's (1977) survey less than half percent of the engineers working for electrical companies in Brazil reported to use bibliographies as sources of information.

TABLE 21
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY*

SOURCES	NUMBER OF ENGINEERS	IN SAMPLE %
Books	78	85.70
Technical and scientific journals	71	78.10
Tables	43	47.30
Handbooks	33	36.30
Indexes, bibliographies and abstracts	33	36.30
Conference proceedings	27	29.70
Catalogues, manufactures literature	23	25.30
Newspapers	22	24.20
Specifications and standards	17	18.70
Technical reports (internal)	15	16.50
Theses and dissertations	13	14.30
Bulletins (published by industry)	10	11.00
Technical reports (external)	10	11.00
Laws and regulations	09	09.90
Patents	01	01.10

*Frequently = at least on a weekly basis
Number of respondents = 91

TABLE 22
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES WITH DIFFERENT FREQUENCIES

SOURCES	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
Books	45.10	40.70	13.10	01.10	00.00
Technical and scientific journals	35.20	42.90	16.50	03.20	02.20
Tables	17.60	29.70	24.10	16.50	12.10
Handbooks	12.10	24.20	36.20	16.50	11.00
Indexes, abstracts and bibliographies	06.60	29.70	23.10	23.10	17.50
Conference proceedings	05.50	24.20	38.50	24.20	07.60
Catalogues, manufacturers literature	04.40	20.80	19.80	25.30	29.70
Newspapers	14.30	09.90	16.50	07.70	51.60
Specifications/standards	05.50	13.20	17.60	39.50	24.20
Technical reports (internal)	02.20	14.30	15.40	28.50	39.50
Theses and dissertations	01.10	13.20	28.60	35.20	22.00
Bulletins (published by industry)	00.00	11.00	17.50	26.40	45.10
Technical reports (external)	00.00	11.00	18.60	34.10	36.30
Laws and regulations	02.20	07.70	12.10	30.80	47.20
Patents	00.00	01.10	03.30	16.50	79.10

Number of respondents = 91

A total of 29.70% of our sample use conference proceedings frequently, but a majority of 68.20% use them on a monthly basis. Infrequent use by engineers for this source was also reported in works conducted by Goldstein (1985), and still lower use was reported in works conducted by Angell et al (1985), Raitt (1984), Souza et al (1977), Almeida and Falkenbach (1977), Allen, (1977) and Wood and Hamilton (1967). However, conference proceedings were considered very important sources of information by Brazilian lectures in Kremer (1984).

The majority of our respondents (74.70%) do not use catalogues (manufacturers literature) on a frequently basis, but these sources are used by the majority (70.30%) of the sample on a trimester basis. In Slater and Fisher (1969), 9% of the engineers (in comparison to 3% of scientists) were reported to use this source. Similar low use results were found by Raitt (1984) for engineers from international organizations and aerospace establishments. However, in Shuchman's (1981) survey mechanical engineers valued sales materials (information gathered from manufacturers or sales representatives, trade shows, catalogues) as moderately or very important. Bulletins published by industry were frequently used by only 11.00% of the BMEs.

Newspapers were claimed to be used frequently by 24.20% of the sample of BMEs; but 51,60% claim that they seldom or never use them. This source was considered not an important source of information by Brazilian lectures (Kremer, 1984) and American engineers from the Clark, Dietz-Engineers, Inc. (Kremer, 1980). Similarly, in Angell's et al (1985) study the majority of engineers working for UK industries also used newspapers infrequently as a source for background knowledge.

Theses and dissertations are used frequently by 14.3% of the respondents, but when considered on a trimester basis the use increases to 78%. In Kremer's study (1984) these sources were considered extremely important by Brazilian lecturers, but Angell et al (1985) on the other hand, found that these sources were infrequently used by scientists and engineers working for UK industries.

Our results further show a low frequency use of reports: 16.50% for internal and 11% for external reports. These results indicate that, as in the Allen's study (1977) reports generated within the institution were used more frequently than external reports. However, the non-use of this source (seldom or never used) by over one third of the BMEs also seems to indicate that these sources were not considered very useful by our sample, contrary to other studies (Hogg and Smith, 1959; Shuchman, 1981; Sabaratnam, 1983 and Raitt, 1985). Research conducted in Brazil by Souza et al (1977) among engineers working for PETROBRAS (National Petroleum Co.) and by Almeida and Falkenbach (1977) among engineers working for electrical companies, revealed that both populations of engineers had a very high percentage of use of reports. However, the distinction between internal and external reports has not been made in either of the studies. Our results compare very well with Goldstein's findings (1985) who reported that the majority of Mexican engineers, researchers and practitioners, use these sources infrequently (less than on a monthly basis).

The majority of our sample (90%) used laws, regulations, specifications and standards infrequently. These results match with Goldstein's (1985) findings. Her figures show that the majority of Mexican engineers and technicians also used these sources infrequently. Furthermore, these sources were ranked very low by Brazilian lecturers (Kremer, 1984). Contrary to these results, data on the perception of the importance of laws, regulations, specifications and standards among USA (Shuchman, 1981) and Singapore (Sarabatnam, 1983) engineers indicate that these sources were ranked as very important by mechanical USA engineers and moderately important by Singapore engineers. Both sources of information were also considered as most needed by USA engineers in Kremer's study (1980).

Patents were used frequently by only 1% of the subjects in our sample. A percentage of 79.10% reported non-use (seldom or never) of this source which contains much of the information on technological innovation Studies conducted in England (Slater and Fisher, 1969; Wood and Hamilton, 1974 and Angell et al, 1985), in Brazil (Andrade, 1981, Kremer, 1984 and Araujo, 1982) and in the USA (Kremer, 1980 and Shuchman, 1981) indicate that the majority of engineers surveyed in these studies also reported either a very low use of patents or considered them as an unimportant source of information.

In the next section 7.1.2 we will relate the use of these FW information sources with personal, work and environmental variables. The general discussion of these results will be made in section 7.2.

7.1.2 Frequency of Use of Formal Written Information Sources Related to Personal, Work and Environmental Variables

Various hypotheses have been formulated on the influence of personal, work and environmental factors on the use of written information sources. To test these hypotheses the five categories of frequency of use of written information sources listed in Q13a were collapsed into two categories: a) "frequent use", defined as used on at least on a weekly basis (questionnaire categories "at least once a day", b) "at least once a week" and b) "infrequent use" defined as used on a monthly basis or less frequently (categories "at least once a month", "at least once a trimester" and "rarely or never"). The hypotheses were formulated on six variables: a) educational level, b) seniority, c) reading ability, d) productivity, e) project type and f) accessibility.

a) Hypothesis on Educational Degree and the Use of Formal Written (FW) Information Sources

Level of formal education has been reported as one of the factors that influences use of information. In the present study we expected that the frequency of use of written information sources would be influenced by degree. Thus, engineers with higher degrees would use written information sources more frequently than their colleagues with lower degrees.

We hypothesized that:

Hø 7a Educational degree does not influence the frequency of use of written formal written (FW) information sources by engineers.

To test this hypothesis we used data provided by Q.13a and Q1. For analysis, and on the basis of highest degree, all respondents were grouped in three different categories: bachelor, masters, and Ph. D. Chi-square tests were run in 15 FW information sources. The results show that, although engineers with different degrees use information with different frequencies, as presented in table 24, these differences are statistical significant only for two of the 15 written information sources tested (table 23). Thus, the null hypothesis can be rejected only for two sources: technical and scientific journals and proceedings. This means that the frequency of use of these two sources varies according to the engineer's educational degree. The frequency of use of the other 13 sources, at least on weekly basis, is not significantly influenced by the engineer's degree. Since the information provided by scientific journals and proceedings is generally more up dated than the information provided in books for example, it is possible to suggest that the age of information is more a concern for Ph. D. users than for engineers with lower degrees. Although our results show that educational degree is not a major influence on the frequency of use of written information sources by engineers, the careful reader will find interesting information on the tendencies of use of FW information sources by BMEs in relation to degree in table 24. These data indicate that:

a) Ph. D. degree tends to extend the number of FW sources used by the engineer. Thus, engineers with doctoral degree use "frequently" a larger number of FW sources than their colleagues with lower degrees;

b) Scientific literature was used on a larger scale by Ph. D. engineers than by their colleagues with other degrees. Scientific literature was used in the form of reports of external institutions, theses and dissertations, scientific journals, conference proceedings, books, indexes, bibliographies and abstracts;

c) Literature which provided information on the existence of materials with particular properties, or the properties of specific materials (handbooks) as well as information about products (trade literature), was used more frequently by engineers with only a bachelor's degree. This group of engineers also used more frequently trade contacts such as customers and vendors than their colleagues with higher degrees.

TABLE 23
FORMAL WRITTEN INFORMATION SOURCES FOR WHICH USE VARIES WITH DEGREE

IW SOURCES	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Technical and scientific journals	17.05	0.000	REJECTED
Proceedings	13.104.	0.001	REJECTED

Effective sample size = 87

d) As degree increases the frequency of use of handbooks and manufacturers literature decreases.

e) Engineers with a bachelors degree seem to make a lot more use of internal reports.

TABLE 24
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY* BY DEGREE

FW SOURCES	Percentage of Engineers Using FW Sources by Degree Ph. D. N=44	MASTER N=31	BACHELOR N=12
Books	90.91	80.65	83.33
Technical and scientific journals	95.45	58.06	58.33
Tables	43.18	51.61	50.00
Handbooks	29.55	38.71	50.00
Indexes, bibliographies and abstracts	43.18	25.81	33.33
Conference proceedings	47.73	19.35	00.00
Catalogues, manufactures literature	20.45	25.81	33.33
Newspapers	29.55	09.68	33.33
Specifications and standards	15.91	19.35	16.67
Technical reports (internal)	13.64	12.90	25.00
Theses and dissertations	18.18	12.90	25.00
Bulletins (published by industry)	09.09	12.90	08.33
Technical reports (external)	13.64	06.45	08.33
Laws and regulations	06.82	12.90	00.00
Patents	02.27	00.00	00.00

Effective sample size = 87
N = Number of respondents within each degree
*Frequently = Use at least on weekly basis or more frequently

b) Hypothesis on Seniority and the Use of Formal Written (FW) Information Sources

It was expected that seniority would influence the use of written information sources. It has been hypothesized that:

Hø7b Seniority level does not influence the frequency of use of formal written information sources by engineers.

Question 3 and Q13a items 1 to 14 and 17 provided the data to test this hypothesis. Chi-square tests were run for 14 FW sources. Eight of these sources: books, specifications and standards, technical reports, internal and external, theses and dissertations, bulletins published by industry, laws and regulations, and patents were eliminated from the analysis because 33% or more of the expected frequencies were less than five. None of the six remaining sources tested significantly with seniority (table 25).

TABLE 25
FORMAL WRITTEN INFORMATION SOURCES FOR WHICH USE DOES NOT VARY WITH SENIORITY

FW INFORMATION SOURCES	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Technical and scientific journals	2.122	0.346	accepted
Tables	3.651	0.161	accepted
Handbooks	0.662	0.718	accepted
Indexes, bibliographies and abstracts	3.612	0.164	accepted
Conference proceedings	0.112	0.945	accepted
Catalogues, manufactures literature	0.523	0.770	accepted
Newspapers	4.523	0.104	accepted

Effective sample size = 87

On the basis of this analysis, the Null Hypothesis *is accepted for* six information sources. This means that the frequency of use of technical and scientific journals, tables, handbooks, indexes bibliographies and abstracts, conference proceedings, manufacturer literature, and newspapers is not influenced by seniority.

TABLE 26
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY* BY SENIORITY

FW INFORMATION SOURCES	Percentage of Engineers Using Formal Written Sources by Number of Years JUNIOR (1-5 Years) N=25	MEDIUM 6-15 years) N=41	SENIORITY (+15 years) N=24
Books	80.00	87.60	87.50
Technical and scientific journals	88.00	73.17	75.00
Tables	36.00	58.54	41.67
Handbooks	40.00	36.59	29.17
Indexes, bibliographies/abstracts	52.00	29.27	33.33
Conference proceedings	28.00	31.71	29.17
Catalogues, manufactures literature	28.00	21.95	29.17
Newspapers	28.00	14.63	37.50
Specifications and standards	24.00	12.20	25.00
Technical reports (internal)	20.00	09.76	25.00
Theses and dissertations	12.00	17.07	12.50
Bulletins published by industry	12.00	07.32	16.67
Technical reports (external)	20.00	07.32	08.33
Laws and regulations	12.00	04.88	16.67
Patents	04.00	00.00	00.00

Effective sample size = 90
N= Number of respondents within each category
*Frequently use at least on weekly basis or more frequently

Table 26 displays the overall results on the frequency of use of FW information sources by seniority and shows some tendencies in use:

a) Literature such as technical and scientific journals, indexes bibliographies, abstracts, handbooks and external reports were used more frequent by junior engineers than by their colleagues from the other two seniority groups;

b) When compared with the other two groups of engineers, a major percentage of senior engineers used with higher frequency: newspapers and internal technical reports;

c) When compared with the senior and junior groups, a major percentage of engineers in the middle group used with higher frequency: tables, and theses and dissertations;

e) As the number of years within the institution increases, the frequency of use of handbooks decreases.

c) Hypothesis on Reading Ability in Foreign Languages and the Use of Formal Written Information Sources

Because the majority of written information sources used by BMEs are published in a language other than Portuguese, it was believed that engineers with reading ability in a major number of foreign languages would be likely to use written information sources with different frequencies than their colleagues with reading ability in fewer foreign languages. In order to investigate whether these differences were significant, we formulated the following null hypotheses:

Hø 7c In the frequency of use of formal written information sources there is no difference between engineers with "low" and "high" foreign language reading ability level.

To test this hypothesis engineers were placed in two levels according to their "reading ability" in five languages: English, French, German, Spanish and Italian. Those in a "higher level" have reading ability in 3, 4, and 5 languages. Engineers within the "lower level" have reading ability in 1 and 2 languages. Chi-square tests were run on 15 written information sources.

TABLE 27
RESULTS ON THE CORRELATION ON THE USE OF FORMAL WRITTEN INFORMATION SOURCES BY READING ABILITY IN FOREIGN LANGUAGES

FW INFORMATION SOURCES	CHI-SQUARE (d.f. = 1)	PROB.	LEVEL OF ACCEPTANCE 0.05
Books	0.183	0.669	accepted
Technical and scientific literature	0.116	0.734	accepted
Tables	0.111	0.740	accepted
Handbooks	0.728	0.393	accepted
Indexes, bibliographies/abstracts	0.795	0.372	accepted
Conference proceedings	0.235	0.628	accepted
Manufacturers literature	0.293	0.586	accepted
Newspapers	1.670	0.196	accepted
Specifications and standards	1.427	0.232	accepted
Theses and dissertations	0.029	0.864	accepted
Technical reports (internal)	0.178	0.673	accepted

Sample size = 91

Four FW sources: external technical reports; laws and regulations; patents and bulletins published by industry were eliminated from the analysis because 50% of the expected frequencies counted less than 5. Of the 11 sources tested none showed significant difference on use in relation to the engineers' greater or lower foreign language ability level. On the basis of these results the null hypothesis is accepted for all the formal written information sources listed on table 27. This means, against our expectations, that the frequency of use of

TABLE 28
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY* BY READING ABILITY IN FOREIGN LANGUAGES

FW INFORMATION SOURCES	Engineers Using Sources by Reading Ability	
	Higher Ability** N=47	Lower Ability*** N=44
Books	87.23	84.09
Technical and scientific journals	76.60	79.55
Tables	48.94	45.45
Handbooks	40.43	31.82
Indexes, bibliographies and abstracts	31.91	40.91
Conference proceedings	31.91	27.27
Catalogues, manufactures literature	27.66	22.73
Newspapers	29.79	18.18
Specifications and standards	23.40	13.64
Technical reports (internal)	25.33	18.18
Theses and dissertations	14.89	13.64
Bulletins published by industry	12.76	09.09
Technical reports (external)	10.64	11.36
Laws and regulations	10.63	09.09
Patents	00.00	02.27

Sample Size = 91
* Frequently = Used at least on weekly basis
** Groups engineers with reading ability in 3, 4 and 5 languages
*** Groups engineers with reading ability in 1 and 2 languages.

these written sources is not influenced by the engineer's different "language ability level" in foreign languages. It is possible that these results are highly influenced by the fact that the majority of BMEs rely greatly (table 36) upon materials written in English, a language that most of the subjects of our sample read with good fluency (table 7).

Table 28 shows the frequency of use of FW sources by language ability level. Thus, it seems that if individuals have reading ability in a language which has a worthwhile body of scientific and technological information, additional reading ability in other languages may increase very little the frequency of use of FW information sources.

d) Hypothesis on Productivity Level by Use of Formal Written Information Sources

Engineers look for information in a variety of sources. Studies conducted in developed countries have found that engineers (e.g. Luftkin and Miller, 1966) and scientists (e.g. Kasperson, 1968) who published more or are more creative use written information sources differently from those who do not. A study conducted in Nigeria (Ikpaahindi, 1985) has found that there is no correlation between frequency of use of written sources by veterinary surgeons and their productivity (publications). In this study we wanted to investigate whether different "productivity levels" led to statistically significant differences in the frequency of use of FW information sources by BMEs.

It has been therefore hypothesized that:

Hø 7d There is no difference in the frequency of use of formal written information sources between engineers with "low", "medium" and "high" productivity level.

Using responses to questions 9a, 9b and 9c a "productivity score" was computed (for details see chapter 4). Three levels of productivity were determined: 1) low productivity level, grouped engineers who scored 5 or less on the score ; 2) medium productivity level, grouped engineers who scored 5.1 or up to 20, and high productivity level, grouped engineers who scored 20.1 or more. Information sources listed in Q13a were also used to test this hypothesis. Chi- square tests were run on 15 written information sources. Ten of these sources: books, technical and scientific journals, specifications and standards, technical reports internal and external, theses and dissertations, bulletins published by industry, laws and regulations and patents were eliminated from the analysis because 33% or more of the expected frequencies were less than five. Of the five remaining sources only newspapers tested significantly with productivity at the level of 0.01 (x2 = 8.579, d.f. 2 prob 0.014). On the basis of this analysis, the Null Hypothesis is rejected for this source, meaning that "productivity level" influences the frequency of use of newspapers. However, in the frequency of use of tables, handbooks, conference proceedings, indexes and bibliographies, and manufacturers literature there is not a statistically significant difference between the three groups of engineers (table 29).

TABLE 29
FORMAL WRITTEN INFORMATION SOURCES FOR WHICH USE DOES NOT VARY WITH PRODUCTIVITY

FW INFORMATION SOURCES	CHI- SQUARE (d.f.= 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Tables	1.641	0.440	accepted
Handbooks	2.711	0.258	accepted
Indexes, bibliographies and abstracts	0.449	0.799	accepted
Conference proceedings	2.292	0.318	accepted
Catalogues, manufactures literature	0.670	0.715	accepted

Sample size = 91

TABLE 30
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY* BY PRODUCTIVITY

FW INFORMATION SOURCES	Percentage of Engineers Using FW Sources by Productivity Level Low N=22	Medium N=51	High N=18
Books	95.45	84.31	77.78
Technical and scientific journals	63.64	82.35	83.33
Tables	59.09	43.14	44.44
Handbooks	40.91	29.41	50.00
Indexes, bibliographies and abstracts	40.91	33.33	38.89
Conference proceedings	27.27	35.29	16.67
Catalogues, manufactures literature	31.82	23.53	22.22
Newspapers	22.73	15.69	50.00
Specifications and standards	22.73	11.76	33.33
Technical reports (internal)	18.18	15.69	16.67
Theses and dissertations	18.18	15.69	05.56
Bulletins (published by industry)	16.34	07.84	16.67
Technical reports (external)	09.09	09.80	16.67
Laws and regulations	18.18	01.96	22.22
Patents	00.00	00.00	05.56

*Frequently = use at least on weekly basis or more frequently
Sample size = 91
N= Number of respondents within each productivity level

Nonetheless, an overall analysis of the influence of productivity (table 30) on the use of FW information sources revealed the following tendencies in the frequency of use of FW information sources:

a) As the level of productivity increases, there is also a gradual increase in the frequency of use of technical and scientific literature and a decrease in the frequency of use of books, theses and dissertations;

b) A major percentage of higher producers make frequent use of literature such as handbooks, newspapers, specifications and standards and external technical reports, as compared to the other groups. On the other hand they make less use of conference proceedings and theses and dissertations;

c) Higher producers do not make frequent use of indexes and abstracts and internal reports to a greater extent than the other groups;

d) A major percentage of medium producers use conference proceedings more frequently than their colleagues outside this group;

e) Engineers in the low and medium group of producers do not use patents. This source is only used frequently by a small percentage of high producers;

e) Hypothesis on Project Type and the Use of Formal Written (FW) Information Sources

It was expected that engineers involved in "project research" would show a different pattern in the frequency of use of written information sources than engineers involved in "project development".

It was hypothesized that:

Hø 7e There is no difference in the of use of FW information sources between engineers involved in project research and engineers involved in project development.

In order to test this hypothesis chi-square tests were run on the use of 15 FW information sources as shown in table 32.

Eight of these sources, specifications and standards, internal and external technical reports, theses and dissertations, laws and regulations, catalogues (manufactures literature), bulletins published by industry and patents were eliminated from them analysis because 50% of the expected frequencies were less than five. None of the seven remaining sources tested significantly with project type (table 31). On the basis of this analysis, the Null Hypothesis is accepted for eight information sources. This means that the frequency of use of technical and scientific journals, books, tables, handbooks, indexes bibliographies and abstracts, conference proceedings and newspapers is not influenced by project type. Although project type is not a statistically significant factor on the frequency of use of FW information sources, data presented in table 32 reveal the following tendencies in the pattern of frequency of use of FW information sources by engineers when the variable project type is considered:

TABLE 31
FORMAL WRITTEN INFORMATION SOURCES FOR WHICH USE DOES NOT VARY WITH PROJECT TYPE

FW INFORMATION SOURCES	CORRECTED CHI-SQUARE (d.f. = 1)	PROB.	LEVEL OF ACCEPTANCE 0.05
Technical and scientific journals	0.000	1.000	accepted
Books	0.645	0.421	accepted
Tables	0.233	0.628	accepted
Handbooks	1.757	0.184	accepted
Indexes, bibliographies and abstracts	0.001	0.990	accepted
Conference proceedings	0.387	0.533	accepted
Newspapers	0.000	1.000	accepted

TABLE 32
PERCENTAGE OF ENGINEERS USING FORMAL WRITTEN INFORMATION SOURCES FREQUENTLY* BY PROJECT TYPE

FW INFORMATION SOURCES	Percentage of Engineers Using FW Sources by Project	
	RESEARCH N=19	DEVELOPMENT N=29
Books	89.50	75.90
Technical and scientific journals	73.70	72.40
Tables	36.80	48.30
Handbooks	15.80	37.90
Indexes, bibliographies and abstracts	36.80	41.40
Conference proceedings	36.80	24.10
Catalogues, manufactures literature	05.30	20.70
Newspapers	21.10	17.20
Specifications and standards	00.00	17.20
Technical reports (internal)	15.80	03.40
Theses and dissertations	15.80	10.30
Bulletins (published by industry)	00.00	06.90
Technical reports (external)	00.00	06.90
Laws and regulations	00.00	10.30
Patents	00.00	03.40

*Frequently = Use at least on weekly basis or more frequently
Sample size = 48
N= Number of respondents within each project type

a) Engineers involved in project development use "frequently" a larger number of types of written sources than their colleagues involved in project research;

b) Scientific literature was used more "frequently" by engineers involved in project research than by their colleagues involved in project development. Scientific literature was used in the form of conference proceedings, books and theses and dissertations. Other sources of information such as internal technical reports were also used more frequently by engineers involved in research;

c) Sources which provided information on the existence of materials particular properties, or the properties of specific materials (handbooks) as well as information about products such as catalogues, were used more frequently by engineers involved in project development. Tables and standards and specifications were also used more frequently by this group of engineers;

d) Engineers involved in development used FW information sources such as technical reports (external), patents, laws and regulations, standards and specifications and bulletins published by industry;

e) Engineers involved in both research and development relied to a great extent on books and scientific and technical journals and to a lesser extent on all other formal written sources of information.

f) Hypothesis on Accessibility and the Use of Formal Written (FW) Information Sources

It has been hypothezised that the engineers' perception of distance to the information sources (accessibility) would influence their frequency of use. A positive relationship was expected between use and perceived accessibility.

To test this variable we have formulated the following hypothesis:

Hø 7f "There is no relationship between the frequency of use of formal written information sources and the perceived accessibility to their use.

Spearman correlation coefficients were found for the FW information sources listed on table 33. The source for the data on information sources was Q13a items 1 to 13, The source of data on accessibility was Q13c items 1 to 14 and 17. Seven out

TABLE 33
RESULTS ON THE CORRELATION ON THE USE OF FORMAL WRITTEN INFORMATION SOURCES AND THEIR PERCEIVED ACCESSIBILITY

FW INFORMATION SOURCES	SPEARMAN CORRELATION (r)	SIG.	LEVEL OF ACCEPTANCE 0.05	N
Books	0.2908	.003	REJECT	88
Technical and scientific journals	0.1090	.031	REJECT	89
Tables	0.4755	.001	REJECT	80
Handbooks	0.2584	.011	REJECT	79
Indexes, bibliographies and abstracts	0.1716	.063	accept	81
Conference proceedings	0.1379	.105	accept	84
Catalogues, manufactures literature	0.3879	.001	REJECT	71
Newspapers	0.0129	.461	accept	61
Specifications and standards	0.1754	.064	accept	77
Technical reports (internal)	0.2317	.023	REJECT	75
Theses and dissertations	0.0874	.215	accept	84
Bulletins (published by industry)	0.3872	.001	REJECT	67
Technical reports (external)	0.0343	.390	accept	69
Laws and regulations	0.1902	.063	accept	66
Patents	0.1292	.220	accept	38

N = Number of respondents

of the 15 sources show correlation coefficients significant at the level of 0.05. Thus, on the basis of these results the null hypotheses can be rejected for the following written sources: books, technical and scientific journals, tables, handbooks, catalogues (manufacturers literature), internal technical reports and bulletins published by industry. This means that the frequency of use of these sources is positively related to their perceived accessibility. However, the frequency of use of sources such as indexes, bibliographies and abstracts, conference proceedings, theses and dissertations, newspapers, specifications and standards, external technical reports, laws and regulations, and patents is not influenced by their perceived accessibility.

Thus, the data indicate that for BMEs working in academic settings perceived accessibility is an influencing factor on the frequency of use of written sources which an engineer keeps in his office/laboratory and for books and journals. However accessibility is not an overriding influence in the use of the majority of sources that engineers use in the library. For example, indexes, bibliographies and abstracts, conference proceedings and theses and dissertations, are used on trimester basis by the majority of engineers (table 22) in spite of the perception of their difficult accessibility (table 18). Technical quality, content of information, experience with the source may be the factors that influence the frequency of use of these sources. Further research could be conducted to explore which of these and other factors affect the frequency of use of these sources. Table 33 summarizes the results of the correlation between frequency of use of FW information sources and their perceived accessibility.

7.1.3 Hours Spent Reading

Question 6a asked the respondents how many hours a week they spent reading for two activities: keeping up-to-date and solving technical problems. The great majority of members of our sample (97.80%) spends two or more hours a week reading for keeping up-to-date. A percentage of 87.40% spends more than two hours/week for problem solving activities. Table 34 summarizes the number of hours spent by the engineers for both activities. Goldstein, (1985) found that 43.10% of electrical engineers in research and 40.10% of electrical engineers (practitioners) spend 5 or more hours a week reading for keeping up-to-date, a percentage of 60.90% of the researchers and 40.01% of the practitioners spend 5 or more hours a week reading for problem solving.

TABLE 34
PERCENTAGE OF ENGINEERS BY NUMBER OF HOURS SPENT READING

ACTIVITY	PERCENT OF ENGINEERS READING			
	Less than 1 Hours/week	2 - 4 Hours/week	5 - 7 Hours/week	More Than 7 Hours/week
Keeping up-to-date*	2.2	50.5	18.7	28.6
Problem Solving **	12.5	38.6	19.3	29.5

* Number of respondents = 91
** Number of respondents = 88

In Shuchman's study (1981) an analysis of the reading habits of engineers showed that the majority of the subjects (70%) found it most important to read for keeping current in their field, only 20% found it most important to read in order to answer specific technical questions. Our data indicate that BMEs spend more time reading for keeping up-to-date than do electrical Mexican engineers (practitioners and researchers). On the other hand, BMEs spend less time reading for problem solving than do Mexican researchers. However, BMEs spend more time reading for problem solving than do Mexican practitioners. To determine if there was a significant difference between the number of hours spent reading for problem solving and the number of hours spent reading for keeping up with current activities the categories listed in the questionnaire were collapsed into two groups: 1) from less than one hour to four hours a week, and 2) more than four hours a week. A chi-square test shows that there is a significant difference ($x2 = 13.100$, d.f = 1, $p < 0.05$) between the amount of time that engineers spend reading for problem solving and the number of hours spent for keeping up-to-date.

The literature shows that the weekly average number of hours spent reading by English speaking scientists and social scientists (e.g. Bernal, 1948 - 5hrs; Shaw, 1956 - 3 to 5 hrs; Halbert and Ackoff, 1959 - 1_ to 2hrs; Martin and Ackoff, 1963 less than 3 hrs; Hale, et al. 1972 - 3 to 4 hrs; Vickery, 1961 - 4 to 5 hrs) is lower than the average time spent by non-English speaking scientists (e.g Tornudd, 1959- 9 hrs; Voight; 1959 - 5 to 10 hrs., Almeida and Falkenbach,- 10 hrs 1977). The range used in the measurement scale in question 6, does not allow us to compute an average number of hours that BMEs spend reading per week. However, the concentration of the major percentage of respondents between the range 2-4 hours per week (table 34), indicates that BMEs spent about the same number of weekly hours for reading as do native English-speaking engineers. This number of hours is lower than the figures reported by Tornudd (1959) in Scandinavia, Almeida and Falkenbach (1977) in Brazil and by Goldstein (1985) in Mexico.

7.1.4 Language in which Literature is Used

Question 8 asked BMEs the frequency with which they used, during the last year of work, written documents in six different languages. For discussion, "frequent use " is defined as use at least on weekly basis (questionnaire categories "at least once a day", at least once a week"); "Infrequent use" is defined as use on a monthly basis or less frequently (categories of the questionnaire "at least once a month", "at least once a trimester" and "rarely or never").

Our data indicate that the universal tendency to read in one's own language at the expense of other languages is not present among members of our sample, 92.30% of engineers claim to use frequently English written materials and 86.80% claim to use documents published in Portuguese (table 35). These results are contrary to findings of studies conducted among scientists and engineers whose native language is English.

TABLE 35
LANGUAGES IN WHICH LITERATURE IS USED FREQUENTLY*

LANGUAGES	No OF ENGINEERS	IN SAMPLE PERCENTAGE
English	84	92.30
Portuguese	79	86.80
Spanish	19	20.90
German	12	13.20
French	11	12.10
Italian	01	01.10

*Frequently = At least on weekly basis
Number of respondents = 91

Data collected for these studies (e.g Fishenden, 1959; Wood an Hamilton, 1967; Hutchins et al, 1971 and Ellen, 1979) show that English speakers rely almost completely upon documents published in their native language, neglecting documents published in foreign languages. Our results (table 35) indicate that the majority of our engineers (92.30%) rely on information published in English as much or more than they do rely on information published in Portuguese for their work activities. Goldstein (1985) investigated the frequency with which engineers encounter information (not necessarily read) in Spanish and other foreign languages. Her results show that while 39.7% of the engineers encounter information in their native language (Spanish), 96.30% did encounter information in

English. Of all our respondents 20.90% had used information in Spanish. Fewer than 14% of the BMEs (13.20%) claimed to have used information in German and only 1% has used information in Italian.

TABLE 36
PERCENTAGE OF ENGINEERS USING FORMAL WRITTTEN INFORMATION SOURCES IN SIX LANGUAGES WITH DIFFERENT FREQUENCIES

LANGUAGES	FREQUENCY OF USE OF LANGUAGES				
	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
English	68.10	24.20	02.02	02.32	03.36
Portuguese	71.40	15.40	04.40	03.30	05.50
Spanish	03.20	17.60	25.30	18.70	35.20
German	05.50	07.70	06.60	07.70	72.50
French	02.20	09.90	23.10	30.80	34.00
Italian	00.00	01.10	05.50	20.90	72.50

Sample Size = 91

Table 36 summarizes the different frequencies of use of FW information sources by BMEs in six different languages.

g) Hypothesis on Language Ability and the Use of Literature in Five Different Languages

It has been hypothezised that there is a positive relationship between linguistic ability and the frequency of use of sources in those languages in which engineers have linguistic ability.

We formulated the following hypothesis:

Hø 7g There is no relationship between the engineers reading ability in five languages a) English, b) French, c) German, d) Spanish and e) Italian and the frequency of use of written information sources in these languages.

To test this hypothesis Spearman correlation coefficients were computed for the use of written information sources in: English, French, German, Spanish and Italian and the engineer's linguistic ability in each of these languages. For all five languages tested the correlation coefficients are significant. Thus, on the basis of these results the null hypotheses can be rejected for all. This means that the frequency of use of written sources in English, French, German, Spanish and Italian is positively related to the engineer's linguistic ability in the language of the written source that had been used (table 37). These findings once more confirm the consensus in the literature (Large, 1983; Hutchins et al., 1971; Ellen, 1979; Rosenberg and Cunha, 1983) which points out that under-utilization of foreign sources is primarily caused by lack of proficiency in foreign languages. People who speak Portuguese can also easily read Spanish. Does the lower correlation still significant between use of materials in Spanish and linguistic ability in this language, mean lower availability or quality of information in this language?

TABLE 37
RESULTS ON THE CORRELATION BETWEEN LANGUAGE ABILITY AND THE USE OF LITERATURE IN FIVE DIFFERENT LANGUAGES

LINGUISTIC ABILITY AND THE USE OF WRITTEN SOURCES IN:	SPEARMAN CORRELATION (r)	SIG.	LEVEL OF ACCEPTANCE 0.01	N
English	0.5405	.001	REJECT	91
French	0.5482	.001	REJECT	91
German	0.7718	.001	REJECT	91
Spanish	0.2203	.018	REJECT	91
Italian	0.3869	.001	REJECT	91

N = Number of respondents

7.2 Discussion of Results

Results of this research indicate that BMEs working in universities depend for their daily work more on information published in books and technical and scientific journals than any other single source. This pre-eminence could be partially explained by the fact that books and articles in journals are more effective transmitters of primary information than the other written sources. Probably, the characteristics of the engineers daily work within universities, which encourages the continual investigation of new ideas within existing practice lead engineers to use journals heavily. Contrary to literature findings which point to the engineers' difficulty in understanding the material published in journals as one of the main causes for little use of them (Allen, 1977), literature published in journals seem to be understandable to the majority of members of our sample, since only a minority reported difficulties with technical language (tables 66 and 67). The frequency of use of books and technical and scientific journals is influenced by their perceived accessibility. Similarly educational degree has a significant effect on the degree of frequency of use of technical and scientific journals, but seniority, reading ability in foreign languages and project type do not. On the other hand, the frequency of use of books is not affected by educational level, reading ability in foreign languages and project type either.

The majority of respondents using handbooks and tables use them on a trimester basis rather than "frequently". The frequency of use of both sources is related to their accessibility, but educational degree, seniority, reading ability in foreign languages, productivity level and project type do not influence their frequency of use. While degree and seniority level increase, there is a tendency for the frequency of use of handbooks to decrease. Tables tend to be used more frequently by engineers with master's degrees, medium seniority level, lower reading ability level, low productivity level and engineers involved in development projects. On the other hand, handbooks tend to be used more frequently by engineers with bachelor's degrees, junior level, higher reading ability level, high productivity level and engineers involved in development projects.

The low use of indexes, bibliographies and abstracting services by the majority of engineers suggests that BMEs are using other sources to get their references. The engineers tendency to neglect abstracting services in favour of personal recommendations, references, reading notes or casual browsing was pointed out by Hanson (1974). While the use of journals is related to their perceived accessibility, the use of indexes, bibliographies and abstract services by BMEs cannot be attributed to the perceived accessibility (physical distance) of these sources to the engineers (table 33). This tendency may be due to other factors such as the engineer's lack of proper training in the use and frequency of availability of these sources. It may also be attributed to the frustration caused by not having many items immediately available for use, or to the engineers lack of awareness of the value of these sources as means to obtain references to potentially useful papers, or to the engineers' preference in getting their references directly rather than through secondary sources. These causes were not investigated in the present study, further investigation would be necessary. Educational level, seniority, reading ability in foreign languages, productivity level and project type do not influence the frequency of use of indexes, bibliographies and abstracting services.

Trade catalogues tend to be infrequently used by the majority of the BMEs. and their frequency of use was found to be related to their perceived accessibility. It was also found that educational level, reading ability in foreign languages, seniority and productivity level do not influence the frequency of use of catalogues. However, a tendency to decrease the frequency of use of this source was noticed, with an increase in educational degree and productivity level. It might be argue that these publications are less frequently used because various difficulties are experienced by the user. Thus for example, the availability of catalogues (national and foreign) is reduced in Brazilian academic libraries because these publications are ephemeral, very difficult and expensive to acquire. Therefore, in many libraries these sources are low on the priority lists for acquisition. In general, national trade catalogues in particular are not only few, but they are hardly described in any type of secondary source. Finally, catalogues are not necessarily the best organized sources within libraries. Though the low figures in our results for frequent use may suggest that these sources are not of great importance for BMEs, they do not provide a firm basis for such a conclusion, especially as the frequency of use of this source on trimester basis increases to 70.40%.

Over half per cent of the respondents did not use newspapers. The frequency of use of this source is not related to accessibility, educational degree, seniority, reading ability in foreign languages and project type.

Sources such as reports, commonly used by engineers working in environments other than academic are used infrequently by more than two thirds of our sample. The differences in use of these sources between engineers working in academic environments and engineers working in other environments may be found in the source itself (content) or in inadequate bibliographic control and availability. Within universities a great number of internal reports are usually written to fulfil bureaucratic requirements of sponsor agencies and as such they do not include much technical information. When reports have valuable information, in many cases, they are labelled "confidential" and as such their use is restricted. In addition, independently of content, reports as a rule do not have proper bibliographic control, making it quite difficult to acquire and have access to them. There is a significant positive relationship between frequency of use of internal reports and perceived accessibility (table 33) but the frequency of use of external reports is not related to their perceived accessibility. When the influence with each of the other variables is considered in relation to the frequency of use of both sources, there are no significant differences in the frequency of use of reports (internal, external) and educational level and internal reports and linguistic ability (reading).

Respondents, who used legal regulations, standards and specifications, used them on a trimester basis rather than "frequently". There are still deficiencies in the Brazilian technological infrastructure especially with regard to the generation and diffusion of national standards (Erber, 1981) which makes acquisition, accessibility and availability of this type of information difficult. Similarly, foreign standards are not only expensive but rather difficult to acquire. It is possible that the non-use of these publications may reflect a cultural trait of the Brazilian society, which is still in its shaping, in which needs are many times a stronger driving force than regulations. The respondents' perception of proximity to this source (accessibility) is not related to their use. The relation of the frequency use of the source to educational degree, seniority, reading ability in foreign languages, productivity level and project type has not been possible to be examined with a chi-square test because 50% or less of the expected frequencies were less than five. However, the percentages of frequency of use indicate that there is a tendency for specifications, standards and laws and regulations to be more likely used frequently by engineers from the masters' group, higher reading ability levels, high productivity level and from the development project type groups.

Only one respondent used patents frequently, but 20% of the respondents used patents on at least a trimester basis. The comparison of this percentage against the percentage of engineers that applied or got patents granted (5% of the respondents, tables 10 and 11) suggests that this source is being used not only by BMEs involved in patenting. This is an interesting finding considering that to retrieve information from patents is not necessarily compatible with the engineer's skills. Accessibility is not related to frequency of use of patents. The relation of frequency of use of patents to educational degree, seniority, reading ability in foreign languages, productivity level and project type has not been possible to be examined with a chi-square test because 50% of the expected frequencies were less than five.

An interesting pattern of frequency of use arises when we observe the most frequent percentage of use of each written source. This pattern of frequency of use seems to be closely related to the pattern of frequency of arrival of each bibliographic source to the library. Conference proceedings for example, arrive at the library on a monthly basis. This may explain, why the majority of engineers use this source for current awareness on a monthly, rather than on a weekly basis. A similar comment can be made in relation to theses and dissertations. These sources are only used by 14.3% of the respondents, on weekly basis, while on a trimester basis the use increases to 78.1%. Theses and dissertations produced during the year are usually sent to the library by the end of each term. The engineers' pattern of frequency of use of theses and dissertations "on a trimester basis" rather than "on a weekly basis", together with the use of proceedings (monthly), technical literature and scientific journals (weekly), books (daily), does suggest that there is a tendency among engineers of our sample to use at least certain sources in close connection with the frequency that the sources arrive at the library. This could indicate that in our results some of the patterns of use of information may not reflect the engineers need for information but rather a pattern of the availability of information.

When educational level is considered Ph. D. (table 24) engineers show a tendency to rely on a larger number of information sources than their colleagues with lower degrees. Engineers who have attained a Ph. D. degree are more likely to use frequently technical and scientific journals, books, conference proceedings, indexes bibliographies and abstracts and external reports. On the other hand, literature which provided information on the existence of materials with particular properties, or the properties of specific materials (handbooks) as well as information about products (trade literature), was more frequently used by engineers with a bachelor's degree. This group of engineers also used more frequently trade contacts such as customers and vendors, than their colleagues with higher degrees. There was a small tendency for engineers who hold a master's degree to use literature on standards, specifications, laws and regulations more frequently than engineers with other degrees.

Whereas seniority is not a major influence in the frequency of use of FW information sources, engineers with more years showed a tendency to use more frequently sources such as trade literature (manufacturer's catalogues, bulletins published by industry), newspapers, specifications and standards, laws and regulations and internal technical reports; engineers in the middle group used more tables, conference proceedings and theses and dissertations. Junior engineers used technical and scientific journals, indexes, bibliographies and abstracts and handbooks more frequently (table 26).

No significant relationship was found between productivity and the frequency of use of the FW sources tables, handbooks, indexes, bibliographies and abstracts, conference proceedings and manufacturers literature. However an overall analysis of the influence of productivity (table 30) on the use on FW information sources revealed that a major percentage of higher producers use more frequently technical and scientific journals. This finding provides support for Kasperson's (1978) speculations that creative/productive scientists used periodicals more frequently than other scientists.

Table 32 shows the responses of engineers classified according to the type of project in which they were involved during the last three years of their work. Engineers involved in project development show a tendency to rely on a larger number of information sources than their colleagues involved in project research. Sources which provided information on specific properties of materials as well as information about products such as catalogues, were used more frequently by engineers involved in project development.

In this study we related accessibility to the frequency of use of formal information sources. We expected that the sources which were perceived as more accessible (closer to the engineers area of work) would be selected for use because smaller costs in terms of physical effort would be involved in the process of using them. Our expectations proved to be true mainly for FW sources books, technical and scientific journals, tables, handbooks, catalogues, internal reports, bulletins published by industry for which a significant positive relationship was found between use and perceived accessibility. All these sources, with the exception of books and technical and scientific journals, are used as quick reference sources. Thus it can be argue that accessibility and the frequency of use of formal written information sources might be, at least in part, related to the information content of the source. Furthermore our study reveal that engineers are buying their own materials.and that a great percentage of engineers do not find delays in receiving information a major problem. These findings suggest that although speed and financial cost might have their weight in determining the frequency of use of information sources, they do not seem to be as strong determinants as the information that engineers expect to get from the sources. However these considerations require further research.

Comparative data on the number of hours spent for reading have revealed that English native speakers spent fewer hours reading than engineers or scientists whose languages is not English. Among others, the following reasons are noted for these differences: a) relatively high dependence on literature as a source of information as opposed to verbal sources (Tornudd, 1959), b) lack of professional journals published in Latin American countries (Sandoval, 1978 and Goldstein, 1985), c) literature in foreign languages requires more reading time (Tornudd, 1959 and Goldstein, 1985) and d) scarcity of professionals who could weed out unnecessary material and the low degree of use of such existing services (Tornudd, 1959). Although all these facts can be also noted as common within the Brazilian information environment, the number of hours that BMEs spend reading per week is close to the number of hours reported to be used by native English speakers (2 to 5 hrs. a week). This finding is in disagreement with results reported in the literature (Tornudd, 1959; Almeida and Falkenbach, 1977 and Goldstein 1985) which indicate that non-English speakers spend more hours reading than English speakers. Some of the reasons for the difference of these results with results of studies conducted among non-native English populations can be probably found in the characteristics of engineers under study. The majority of the BMEs have a high linguistic ability in English, the language in which their main literature is published, most of them hold a post-graduate degree and a large percentage of them received their degrees in developed countries.

Our findings indicate that BMEs have a heavy dependence on foreign publications. Similar findings were found in studies conducted in Brazil by Kremer (1984) among lectures and by Rosenberg and Cunha (1983) among users of the libraries of BIREME (Biblioteca National de Medicina), BINAGRI (Biblioteca Nacional de Agricultura) and EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria). Goldstein (1985) found similar results for the Mexican Engineers. BMEs rely heavily on literature published in English (table 35 and 36), language in which also the majority of the sample has good reading proficiency level. It seems that because of this English language proficiency, reading publications in this language easily becomes part of the engineer's daily professional life. Overall the BME's willingness to follow up sources in the other languages tested is not high. Our results also show that 88.70% of our respondents read Spanish fluently (table 7), but only a moderate (20.90%, table 34) frequent consultation of documents published in this language suggests that for engineers of our sample, language proficiency is not by itself the only cause for minor or major use of sources published in other languages than Portuguese. The quantitative availability and qualitative significance of the language (English) in scientific communication may also have influenced the selection of the language in which literature was most frequently used by our respondents. After all, a high percentage of the world's scientific and technical literature is published in English. However, our population, like the English speaking population, seems to under use or not use at all other materials published in a language different from English. Thus, the question of how serious the losses are resulting from this behaviour still remains to be researched for both populations.

7.3 Summary of Main Findings

This study found that BMEs when looking for written information, use books and technical and scientific journals as the main sources of information. These were the only sources used on a "frequently" basis by the majority of BMEs. On the other hand, patents is the source most infrequently used by the majority of respondents. Apart from educational level which influences the frequency of use of technical and scientific journals and proceedings, and productivity level which influences the frequency of use of newspapers, the frequency of use of the other written sources tested cannot be attributed to educational level and seniority. Similarly, level of reading ability in foreign languages and project type do not influence the frequency of use of FW information sources either. However, some interesting tendencies were noticed in the frequency of use of these sources when their frequency of use was observed in relation to these variables. The linking of frequency of use of FW sources to the engineers perceived accessibility reveals that while accessibility influences the use of quick reference sources such as tables, handbooks, catalogues (manufacturers literature), internal technical reports and bulletins published by industry and sources such as books and technical and scientific journals, the frequency of use of other sources such as , indexes, bibliographies and abstracts, conference proceedings, newspapers, specifications and standards, thesis and dissertations, external reports and laws and regulations is not.

The number of hours that BMEs spend reading per week is closer to the number of hours reported for native English speakers (2 to 5) than to the number of hours reported for non English native speakers. There is a significant difference between the number of hours spent reading for problem solving and the number of hours spent reading for keeping up-to-date.

BMEs use materials published in English to a larger extent than they use documents published in Portuguese, their native language. The frequency of use of written sources in languages other than Portuguese is positively related to the engineer's reading ability in the language in which the written source has been used.

CHAPTER 8

RESULTS ON THE USE OF INTERPERSONAL AND INTERNAL AND EXTERNAL INFORMATION CHANNELS BY BRAZILIAN MECHANICAL ENGINEERS

This chapter 1) presents results on the frequency use of interpersonal and internal and external channels by BMEs and relates these frequencies to findings of previous studies; 2) analyses the relationship between the use of these channels and some of the personal, work and environmental characteristics of the sample and 3) discusses the number of hours that BMEs spend communicating for problem solving and keeping up-to-date. After the presentation of the results a discussion in the main tendencies in the use of interpersonal and internal and external channels by BMEs follows. Finally a short summary of the main findings on the frequency.use of interpersonal and internal and external channels is presented.

8.1 Use of Interpersonal and Internal and External Information Channels

This topic is divided into three sub-sections: a) frequency of use of interpersonal channels and its relation to previous studies; b) frequency of consulting different categories of internal and external channels and c) number of hours spent by BMEs communicating for problem solving and keeping up-to-date. This chapter follows the same organization as the previous chapter where along with the presentation of use of channels, the use is related to the independent variables for the discussion of hypotheses.

8.1.1 Frequency of Use Of Interpersonal Channels and its Relation to Previous Studies

The interpersonal information channels included informal written (IW), informal oral IO) and formal oral (FO) channels. The frequency of use of these information channels was explored in Q13a, items 15 and 16, Q14a and Q14b. For the purpose of discussion "frequent use" was defined as use "at least on weekly basis" (categories of the questionnaire "at least once a day", "at least once a week"). The use of channels within the other categories is defined as "infrequent use" (use "on monthly basis" or "less frequently").

From the 12 interpersonal channels analyzed, only three IO channels, (telephone conversations, talks in corridors and visits to colleagues' offices) were used frequently by the majority of BMEs. The remaining channels were used on a weekly basis by 45.10% of the respondents or less. Table 38 presents the percentages of engineers consulting these channels frequently and table 39 presents the percentage of engineers using channels with different frequencies.

Comparing our results with Goldstein's (1985) we observe that none of the interpersonal channels which we tested and which we listed in our study were used frequently, on a weekly basis, by the majority of Mexican engineers. However on monthly basis a majority of Mexican research engineers used the same interpersonal channels as frequently as engineers of our sample. The majority of Mexican engineers (practitioners) used frequently the first two channels (telephone conversations and visits to offices). Shuchman (1981) found a similar pattern. In his study 50% of the engineers working for USA industries used telephone contacts weekly. Furthermore, Raitt (1984) found that 56% of his sample (scientists and engineers working in international organizations in Europe) used frequently telephone conversations for information transfer activities. Corridor conversation has been documented in various studies as an important channel of information for engineers. Our results reinforce this consensus. Over half percent of BMEs (56.10%) used this channel frequently. However some authors (e.g Shuchman 1981) point out that corridor conversations at conferences of engineers and scientists employed by industry are rather cautious. It seems that engineers working in academic environments are not as reluctant as engineers working in industry in providing information that could be used in the work of others.

Other IO channels such as visits to industries and visits to academic institutions and the FO channels such as encounters at courses, conferences, seminars and industrial exhibitions; and presentations and lectures at conferences, seminars and industrial exhibitions; metings for projects' from the engineers' own institution were used by a minority of engineers on a weekly basis. However 41.80% or more of our respondents used these channels on a trimester basis, which is the frequency with which most of these events are organized and take place. Visits to industries and academic institutions are also generally organized on a trimester basis.

The IW source "personal notebooks" is used on a weekly basis by 45% of the respondents. This figure is lower than the figure (54.3%) reported, also on a weekly basis, for Mexican engineers (Goldstein 1985). Furthermore, in Andrade's (1981) study, Brazilian engineers from PETROBRAS ranked "personal notebooks" as the third most important source. In Almeida and Falkenbach (1977) 80% of the engineers claimed to use this channel of information. Letters were used frequently by 35.20% of our sample as compared with 20% of Shuchman's (1981) and 45% or less of the sample studied by Raitt (1984) who pointed out as the main reason for the frequent use of this channel the convenience of providing a record and references. In spite of being more speedy and permitting a rapid response, telexes were used frequently only by 9.90% of the respondents of our sample. However 61.10% of the engineers said they used telexes with other frequencies. Unpublished papers or prepublications are reported in the literature as one of the means of interaction between members of academic institutions. They were used frequently by 3.30% of our respondents and 76.90% indicated that they seldom or never use these channels.

TABLE 38
PERCENTAGE OF ENGINEERS USING INTERPERSONAL CHANNELS FREQUENTLY*

INFORMAL ORAL	NUMBER OF ENGINEERS	IN SAMPLE %
Telephone	74	81.30
Visits to colleagues' offices	63	69.30
Talks in corridors	51	56.00
Meetings for institutional projects	26	28.60
Visits to industry	03	03.30
Visits to research and academic institutes	01	01.10
FORMAL ORAL		
Encounters at conferences, courses seminars and industrial exhibitions	03	03.30
Lectures and presentations at conferences, courses seminars and industrial exhibitions	02	02.20
INFORMAL WRITTEN		
Telexes	09	09.90
Letters	32	35.20
Personal notebooks	41	45.10
Unpublished papers	03	03.30

*Frequently = Used at least on weekly basis
Number of respondents = 91

TABLE 39
PERCENTAGE OF ENGINEERS USING INTERPERSONAL CHANNELS WITH DIFFERENT FREQUENCIES

CHANNELS INFORMAL ORAL	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
Telephone	50.50	30.80	11.00	04.40	03.30
Talks in corridors	26.40	29.60	24.20	14.30	05.50
Visits to colleagues' offices	25.30	44.00	08.80	15.40	06.50
Meetings for institutional projects	02.20	26.40	27.50	27.40	16.50
Visits to industry	00.00	03.30	25.30	41.80	29.60
Visits to research/ academic institutes	00.00	01.10	11.00	53.80	34.10
FORMAL ORAL					
Encounters at courses conferences/seminars industrial exhibitions	00.00	03.30	06.60	64.80	25.30
Lecturers at courses/ conferences/seminars/ industrial exhibitions	00.00	02.20	09.90	59.30	28.60
INFORMAL WRITTEN					
Telexes	01.00	08.80	33.00	23.10	34.10
Letters	04.40	30.80	37.40	15.40	12.10
Personal notebooks	19.80	25.30	13.20	17.69	24.01
Unpublished papers	02.20	01.10	06.60	13.20	76.90

Number of respondents = 91

8.1.2 Frequency of Use of Interpersonal Information Channels Related to Personal and Work Variables.

This section presents the hypotheses formulated on the influence of: a) educational level, b) seniority, c) institutional restrictions and d) project types on the frequency of use of interpersonal channels. When the hypotheses were tested using chi-square test, the five categories of frequency of use of interpersonal channels listed in Q13a and Q14a and Q14b were collapsed into two categories. "frequent" defined as use "at least on weekly basis" (categories of the questionnaire "at least once a day", "at least once a week") and "infrequent" defined as use on monthly basis or less frequently (categories of the questionnaire "at least once a month", "at least once a trimester" and "rarely or never").

a) Hypothesis on Educational Degree and the Use of Informal Written (IW) Information Channels

It was expected that degree would not affect the use of (IW) information channels. We hypothesized:

Hø 8a Educational degree does not influence the frequency of use of informal written (IW) information channels by engineers.

Channels listed in Q13a, items 15 and 16 and in Q14b, items 1 and 2, provided the data for the dependent variables. The 5 categories of frequency of use were collapsed into 2 categories: frequent and infrequent. From the 4 channels, telexes and unpublished papers were eliminated from the analysis because 50% of the expected frequencies were less than five. Chi-square tests were run on the remaining two IW channels: personal notebooks and letters. From these two IW channels, only letters tested significantly with degree (table 40). Therefore, the null hypothesis is rejected for the channel letters, meaning that the frequency of use of letters is influenced by degree. On the other hand, in spite of a strong tendency for higher use of personal notebooks by engineers with master degrees this difference is not statistically significant.

TABLE 40
RESULTS ON THE USE OF INFORMAL WRITTEN CHANNELS BY DEGREE

IW CHANNELS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Letters	5.993	0.050	REJECTED
Personal notebooks	4.765	0.092	Accepted

Effective sample size = 87

TABLE 41
PERCENTAGE OF ENGINEERS USING INFORMAL WRITTEN CHANNELS FREQUENTLY* BY DEGREE

INFORMAL WRITTEN CHANNELS	Percentage of Engineers Using Informal Written Channels by Degree		
	Ph. D. N=44	MASTER N=31	BACHELOR N=12
Letters	47.73	25.81	16.67
Telexes	11.36	06.45	16.67
Personal notebooks	38.64	58.06	25.00
Unpublished papers	06.82	00.00	00.00

Effective Sample Size = 87
Number of respondents within each category of degree
*Frequently, use at least on weekly basis or more frequently

b) Hypotheses on Seniority and the Use of Interpersonal Channels: IO and IW

It was expected that seniority would not influence the frequency of use of interpersonal channels (IO and IW).

It was hypothesized that:

Hø 8b Seniority level does not influence the frequency of use of interpersonal information channels by engineers.

This hypothesis was divided into two sub-hypotheses:

Hø 8b1 Seniority level does not influence the frequency of use of IO channels by engineers.

Hø 8b2 Seniority level does not influence the frequency of use of IW channels by engineers.

Question Q14b provided the data for the dependent variables. The number of years that the engineer worked in his present institution was provided by Q3. Chi-square tests were run on 6 IO channels and 4 IW channels. Telephone conversations, visits to industries and to research and academic institutions were eliminated from the analysis because 33% or more of the expected frequencies were less than five. According to our expectations none of the three IO channels and the four IW sources listed in table 42 tested significantly with seniority. On the basis of this analysis, the Hø 8b1 and Hø 8b2 are accepted for the IO and IW channels listed in table 42, meaning that their frequency of use is not significantly influenced by seniority. In the same way statistical differences were not significant either in the frequency of use of IO sources when seniority was considered.

TABLE 42
INTEPERSONAL CHANNELS FOR WHICH USE DOES NOT VARY WITH SENIORITY

CHANNELS INFORMAL ORAL	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Talks in corridors	2.745	0.254	accepted
Visits to colleagues' offices	0.635	0.728	accepted
Meetings for institutional projects	0.345	0.842	accepted
INFORMAL WRITTEN			
Letters	0.565	0.754	accepted
Telexes	0.536	0.765	accepted
Personal notebooks	3.434	0.180	accepted
Unpublished papers	1.217	0.544	accepted

Effective sample size= 90

However data provided by the analyses (table 43) show some tendencies in the frequency of use of IO channels by BMEs when seniority is taken into consideration. Some of these tendencies are:

a) As the number of years within the institution increases there was a gradual decrease in the number of engineers who used the channels: telephone, talks in corridors and visits to offices. On the other hand as the number of years within the institution increases there was a gradual increase in the numbers of engineers who frequently used the channel letters.

b) Engineers in the junior group did not make frequent use of the IO channels: visits to industry, research centers, academic institutions, and presentations in seminars and congresses.

TABLE 43
PERCENTAGE OF ENGINEERS USING INTERPERSONAL CHANNELS FREQUENTLY* BY SENIORITY

INFORMAL ORAL CHANNELS	Percentage of Engineers Using IO Channels by Number of Years JUNIOR (1-5) N=25	 MEDIUM (6-15) N=41	 SENIOR (+15) N=24
Telephone	84.00	82.93	75.00
Talks in corridors	64.00	58.54	41.67
Visits in offices	72.00	70.73	62.50
Meetings for institutional projects	28.00	31.71	25.00
Visits to industry	00.00	02.44	08.33
Visits to research and academic institutes	00.00	02.44	00.00
INFORMAL WRITTEN CHANNELS			
Letters	32.00	34.00	41.67
Telexes	08.00	07.32	12.50
Personal notebooks	60.00	36.59	45.83
Unpublished papers	00.00	02.44	00.00

*Frequently, used at least on monthly basis or more frequently
Effective sample size = 90
N= Number of respondents within each category

c) Hypotheses on Institutional Restrictions and the Use of Interpersonal Channels: IW and IO

No studies that explored the influence of this variable have been found for Brazil or other developing countries. However we expect that institutional restrictions would influence the frequency of use of interpersonal channels. The lower the institutional restriction the more frequent the use of the channel. The source for data on the frequency of use of channels is question 14b and the source of data on restrictions is question 14c.

It has been hypothesized that:

Hø 8c There is no relationship between the frequency of use of interpersonal channels and the perceived limitation to their use.

The hypothesis is divided into two sub-hypotheses.

Hø 8c1 There is no relationship between the frequency of use of the informal written channels letters and telexes and the perceived limitation to the use of mail and telexes;

Hø 8c2 There is no relationship between the frequency of use of the informal oral channels a) telephone conversations, b) talks in corridors, c) visits in offices, and d) meetings for projects from the engineer's institution and the perceived limitation to their use.

In order to test the null hypotheses Hø 8c1 Spearman correlation coefficients were computed for two of the five information channels defined as IW: letters and telexes. The same test was computed for Hø 8c2 to test the correlation of four of the six information channels defined as IO: telephone conversations, talks in corridors, visits in offices and meetings for institutional projects. Table 44 displays these data. Hø 8c1 is rejected for both channels and Hø 8c2 is partially rejected because, two of the correlation coefficients are significant at a 0.05 level. This means that the frequency of use of the IW channels letters and telexes is related to the low perception of restrictions in the use of the post services and telexes. Similarly the use of the channels talks in corridors and visits in offices correlates significantly with the perception of restrictions in their use (table 44). Thus, inter-institutional restrictions is an influencing factor in the frequency of use of IW and IO channels. The frequently use of the channel telephone, regardless of whether or not it is perceived to be restricted (for local and long phone calls) is understandable, because this channel is daily used by more than 50% of the engineers (table 20) and it is favoured in its frequency of use over the other channels. It is also understandable that the frequency of use of the channel participation in meetings and projects from the engineer's institution is not related to perceived restrictions in their use.

TABLE 44
RESULTS ON THE USE OF INTERPERSONAL CHANNELS AND THE PERCEIVED INSTITUTIONAL RESTRICTIONS TO THEIR USE

RELATIONSHIP BETWEEN IW CHANNELS LETTERS AND TELEXES AND RESTRICTIONS ON THE USE OF:	SPEARMAN CORRELATION (r)	SIG.	LEVEL OF ACCEPTANCE 0.05	N
Use of mail	0.2741	.005	REJECT	86
Use of telex	0.3111	.004	REJECT	71
RELATIONSHIP BETWEEN INFORMAL ORAL CHANNELS AND RESTRICTIONS ON THE USE OF:				
Local phone calls	0.0148	.446	accept	86
Long distance calls	0.0571	.300	accept	87
Talks in corridors	0.2173	.022	REJECT	86
Visits in offices	0.2254	.018	REJECT	87
Meetings for institutional projects	0.1139	.157	accept	80

N = Number of respondents

d) Hypotheses on Project Type and the Use of Interpersonal Channels: FO, IO and IW

It was expected that engineers involved in project research would show a different pattern in the frequency of use of oral channels (FO and IO) and IW than their colleagues involved in project development.

It was hypothesized that:

Hø 8d There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of interpersonal channels.

This hypothesis is divided into three sub-hypotheses:

Hø 8d1 There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of informal oral channels.

Hø 8d2 There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of formal oral channels.

Hø 8d3 There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of informal written channels.

Questions 13a items 15 and 16 and Q14b provided the data for the dependent variables. The data on project type was provided by Q17. Chi-square tests were run on FO, IO and IW channels listed in table 46. Three of these: visits to industries, visits to research and academic institutions, presentations and lectures at conferences, seminars and industrial exhibitions and one IW channel unpublished papers were eliminated from the analysis because 50% of the expected frequencies were less than five. None of the remaining channels listed in table 45 tested significantly with project type. On the basis of this analysis Hø 8d1 is accepted for the IO channels telephone conversations, talks in corridors; visits to colleagues' offices and meetings for institutional projects. Hø 8d2 could not be tested because 50% of the expected frequencies were less than five and 8d3 is accepted for the source personal notebooks. Meaning that the frequency of use of these channels is not influenced by project type. Data provided through these statistical analyses show (table 46) the following tendencies in the frequency of use of interpersonal channels by BMES when project type is taken into consideration:

a) Engineers involved in project research used "frequently" a larger range of interpersonal channels than their colleagues involved in project development because they visited academic institutes and went to seminars, conferences, courses and industrial exhibitions. Engineers involved in project development did not use these channels;

b) For engineers involved in research, the use of visits to research centers, academic institutions, conferences, seminars, industrial exhibitions and lectures in courses, seminars and industrial exhibitions as means to contact people was low;

c) Similar numbers from both groups of engineers used meetings for institutional projects as frequent means to contact people;

d) More engineers involved in development made frequent use of the telephone than research engineers.

TABLE 45
INTERPERSONAL CHANNELS FOR WHICH USE DOES NOT VARY WITH PROJECT TYPE

IO CHANNELS	CORRECTED CHI-SQUARE (d.f. = 1)	PROB.	LEVEL OF ACCEPTANCE 0.05
Telephone	1.422	0.2329	accepted
Talks in corridors	0.112	0.9112	accepted
Visits in offices	0.457	0.4988	accepted
Meetings for institutional projects	0.000	1.0000	accepted
IW CHANNELS			
Personal notebooks	0.379	0.537	accepted

Effective sample size= 48

TABLE 46
PERCENTAGE OF ENGINEERS USING INTERPERSONAL CHANNELS FREQUENTLY* BY PROJECT TYPE

INFORMAL ORAL CHANNELS	Percentage of Engineers Using Oral Channels by Project	
	RESEARCH N=19	DEVELOPMENT N=29
Telephone	63.20	82.80
Talks in corridors	52.60	58.60
Visits in offices	78.90	65.50
Meetings for institutional projects	31.60	31.00
Visits to industry	00.00	06.90
Visits to research and academic institutes	05.30	00.00
FORMAL ORAL CHANNELS		
Encounters and lectures at conferences, seminars and industrial exhibitions	05.30	00.00
IW CHANNELS		
Personal notebooks	31.60	44.80
Unpublished papers	10.50	03.40

Sample size = 48
N= Number of respondents within each project type
*Frequently, used at least on monthly basis or more frequently

8.1.3 Frequency of Consulting Internal and External Channels and their Relation to Previous Studies

This group included: 1) internal and external categories of people contacted to get oral information and 2) internal and external locations used to look for written information sources.

8.1.3.1 Categories of People

Again, for discussion purposes "frequent use" is defined as used on at least a weekly basis (questionnaire categories "at least once a day", "at least once a week"); "infrequent use" is defined as used on a monthly basis or less frequently (categories "at least once a month", "at least once a trimester" and "rarely or never").

From the 9 categories of people listed in Q14a "colleagues from the engineer's own department " were consulted frequently by the majority (71.50%) of BMEs. Furthermore, within internal oral categories of people, BMEs tend to consult more the individuals with whom they are organizational closer grouped (department). The other categories of people were consulted frequently by 36.30% or less (table 47). It is interesting to note that if we look at the frequency of use on a monthly basis rather than weekly (table 48), the categories of people consulted by the majority of respondents only increased in one category: "colleagues from the engineer's own institution". The other categories were still only consulted frequently by 36% or less of the engineers. However what calls the analyst's attention is that a high percentage of engineers "seldom or never" used the other external categories of people as a channel of information (table 48). The literature reports that scientists and engineers from developed countries use internal and external people as a frequent source of information. However engineers rely more on internal people of their organization than do scientists (e.g. Allen, 1977; Shuchman, 1981; Angell et al, 1985). Our data are partially in agreement with these findings, BMEs communicate most frequently with colleagues within their own institutions. But the BMEs consult individuals external to their organization infrequently, the majority of members of our sample are relatively closed to contacts with individuals external to their institutions.

TABLE 47
PERCENTAGE OF ENGINEERS USING INTERNAL AND EXTERNAL CHANNELS (CATEGORIES OF PEOPLE) FREQUENTLY*

CATEGORIES OF PEOPLE INTERNAL	NUMBER OF ENGINEERS	IN SAMPLE %
Colleagues from the engineer's department	65	71.50
Colleagues from the engineer's institution	33	36.30
Librarians from the engineer's nucleos and institutional libraries	11	02.10
CATEGORIES OF PEOPLE: EXTERNAL		
Colleagues from other institutions	04	04.40
Customers	11	12.10
Vendors or manufacturers	06	06.60
Consultants	02	02.20
Other librarians	03	03.30

*Frequently = Used at least on weekly basis
Number of respondents = 91

TABLE 48
PERCENTAGE OF ENGINEERS USING INTERNAL AND EXTERNAL CHANNELS (PEOPLE) WITH DIFFERENT FREQUENCIES

CATEGORIES OF PEOPLE INTERNAL	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
Colleagues from the engineer's department	22.00	49.50	13.20	11.00	04.30
Colleagues from the engineer's institution	04.40	31.90	22.00	24.20	17.50
Librarians from the engineer's institution and nucleos	00.00	12.10	24.20	30.80	33.00
EXTERNAL					
Colleagues from other institutions	00.00	04.40	19.80	33.00	42.80
Customers	00.00	12.10	07.70	14.30	65.90
Vendors or manufacturers	00.00	06.60	16.50	25.30	51.60
Consultants	00.00	02.20	04.40	18.70	74.70
Other libraries	00.00	03.30	09.90	18.70	68.10

Number of respondents = 91

Our findings are different from Kremer's (1984) where contacts with external individuals were found to be more important for Brazilian lectures than the internal ones. Although BMEs complain constantly about the lack of descriptive information on materials and equipment and their components or subsystems, trade contacts such as vendors and manufacturers were use infrequently by the majority of our sample. Similarly customers, consultants and librarians were used frequently only by 12% or less of the engineers.

8.3.1.2 Locations in which Written Sources Were Consulted

Question 13b explored the frequency with which 10 different locations were consulted by BMEs when looking for written information sources (FW and IW) for their work. "Frequent consultation" is defined as consulting locations on monthly basis or more frequently (questionnaire categories "at least once a day", "at least once a week", "at least once a month"). "infrequent use" is defined as use on "less than on a monthly basis" (questionnaire categories "at least once a trimester", "rarely or never"). Table 49 presents the percentage of engineers using these channels on frequently basis. Table 50 presents the percentages of engineers consulting the locations with different frequencies.

Data displayed in table 49 show that only two internal locations were consulted "frequently" by the majority of our respondents: 1) Collections and files from libraries and Nucleos from the engineer's own institution and 2) Personal records and collections. The first named location was the overall most consulted source, 80.30% of the respondents used this location on monthly basis. Personal records and collections were consulted frequently by 78.00% of the sample. However personal files were consulted daily by a considerable higher percentage of respondents than collections and files from the library (41.80% compared with 08.80%). Our findings are similar to Goldsteins's (1985), where the channels most frequently used by Mexican electrical engineers (researchers) were also libraries and personal records and collections.

TABLE 49
PERCENTAGE OF ENGINEERS CONSULTING INTERNAL AND EXTERNAL CHANNELS (LOCATIONS) FREQUENTLY*

INTERNAL LOCATIONS	NUMBER OF ENGINEERS	IN SAMPLE %
Files, records and collections from the engineer's institution: libraries and Nucleos	73	80.30
Personal files/records and collections	71	78.00
Files records and collections from institutional colleagues	41	45.10
Departmental files records and collections	35	38.50
COMUT	22	24.20
EXTERNAL LOCATIONS		
Files and records and collections from libraries other than institutional	19	20.90
Files and records and collections from colleagues of other institutions	11	12.10
Files and records and collection from professional organizations	10	11.00
Bookstores	27	29.70

Frequently = Use at least on monthly basis
Number of respondents = 91

In a study conducted by the "Nucleo" of Corrosão of the Instituto Nacional de Tecnologia in Brazil (Instituto Nacional de Tecnologia, 1986), the results showed that Brazilian engineers and technologists also favoured personal records and collections as the first place to look for written sources. Many studies conducted in developed countries also have reported personal collections as the first or one of the first places where engineers look for written information (e.g. Allen, 1968; Harris, 1966; Kenney, 1966 and Jahoda et al, 1966). The preference in the use of this location by members of our sample did not come as a surprise considering that this source is of easy accessibility and usually contains updated collections that reflect the engineer's personal interests.

Engineer's institutional colleagues files and/or collections were consulted frequently by 45.10% of our sample, but 68% said they used them at any frequency. The frequency of consultation of this source, on the same monthly basis, by Mexican engineers/researchers was 15.60% and it was 18.20% for practitioners.

Bookstores were the external channels most consulted by engineers; 29.70% of the sample used this location frequently on monthly basis or more frequently. This percentage is superior to the one reported by Goldstein (1985), in her study only 10% of the Mexican engineers (researchers) used bookstores on monthly basis. Furthermore, previous studies indicated that engineers tend to have their books purchased by the company, while scientists tend to create their own library (Allen, 1977). In Hogg and Smith's work (1959) 48% of their sample of applied scientists bought their own books. The percentage of 63.80% of our respondents who used bookstores on a trimester basis (academic term) or more frequently as means to get written information indicates that BMEs have in relation to books a pattern of behaviour similar to scientists.

TABLE 50
PERCENTAGE OF ENGINEERS CONSULTING CHANNELS (LOCATIONS) WITH DIFFERENT FREQUENCIES

INTERNAL LOCATIONS	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
Files records and collections from the engineer's institution libraries and nucleos	08.80	36.30	35.20	15.40	04.40
Personal files/records and collections	41.80	24.20	12.10	04.40	17.60
Files records and collections from institutional colleagues	01.10	24.20	19.80	23.10	31.90
Departmental records files and collections	06.60	15.4	16.50	19.80	41.80
COMUT	01.10	03.30	19.80	34.10	41.80
EXTERNAL LOCATIONS					
Files and records and collections from other libraries	01.10	04.40	15.40	40.70	35.80
Files and records and collections from colleagues of other institutions	01.10	03.30	07.70	24.20	63.70
Files and records and collections from professional organizations	01.10	04.40	05.50	15.40	73.60
Bookstores	00.00	03.30	26.40	34.10	36.30

Number of respondents = 91

This may also suggest that the engineers' institutional libraries are not necessarily providing written information sources relevant to the engineers work. Our respondents' preference to consult internal rather than external locations is in agreement with studies reported in the literature. However it was surprising to find that a great percentage of BMEs seldom or never consult external locations such as: collections, files and records from colleagues' from other institutions (63.70%) and files and records from professional organizations (73.60%) in order to get written information for their work (table 50). The low accessibility of locations reported by the respondents (table 19) is probably among the reasons for the low use of these channels.

Despite the fact that scientific and technical journals are the second most frequent used sources of information, only few (24.20%) engineers make frequent use of the COMUT service (interlibrary provision of photocopies) as a channel to get written materials. This result came as a surprise because through COMUT engineers have the opportunity to get photocopies of journal articles available in other university libraries and research centers around the country.

8.1.4 Frequency of Use of Internal and External Information Channels Related to Personal Work and Environmental Variables

This section presents the hypotheses formulated on the influence of a) educational degree, b) seniority, c) accessibility and d) inter-institutional involvement on the frequency of use of internal and external channels: locations and different categories of people consulted by BMEs to obtain information for their work. For statistical analysis, when the chi-square test was used, the five categories of frequency of use of people collapsed into two: a) "frequent use" on at least a weekly basis (questionnaire categories "at least once a day", "at least once a week") and "infrequent use" on a monthly basis or less frequently (categories "at least once a month", "at least once a trimester" and "rarely or never"). The five categories of frequency of use of locations did also collapse into two: a) locations frequently used are the ones used on a monthly basis or more frequently (categories of questionnaire: "at least once a day", "at least once a week", and "at least once a month") and b) infrequently used locations are the ones used on less than a monthly basis (questionnaire categories: "at least once a trimester" and "rarely or never").

e) Hypothesis on Educational Degree and the Use of External Channels

It was observed in previous studies that individuals with post-graduate degrees tend to use more channels outside their organization than their colleagues with bachelor degrees. In this study we expected that degree would influence the frequency of use of external channels, thus individuals with higher degrees would use external channels differently from those with lower degrees.

It was hypothesized that

Hø 8e Educational degree does not influence the frequency of use of external channels by engineers.

To test this hypothesis chi-square tests were run for external locations listed in question 13b, items 6 to 9; and categories of people listed in Q14a items 3 to 6 and 8 (see tables 51 and 52). The five categories of external people and two locations a) collections, files and records from professional organizations and b) collections, files and records from colleagues of other institutions) were eliminated from the analysis because 50% of the expected frequencies were less than 5. The frequency of consultation of the remaining two locations did not vary with educational degree. Thus, the null hypothesis was accepted for two external locations: Bookstores and collections, files/records from other libraries (table 51), meaning that the difference in the frequency of use of these two locations is not influenced by degree.

TABLE 51
EXTERNAL CHANNELS (LOCATIONS) FOR WHICH USE DOES NOT VARY WITH DEGREE

CHANNELS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Bookstores	0.949	0.622	accepted
Collections, files/records from libraries other than institutional	2.426	0.297	accepted

Effective sample size = 87

TABLE 52
PERCENTAGE OF ENGINEERS CONSULTING EXTERNAL CHANNELS (LOCATIONS) FREQUENTLY* BY DEGREE

EXTERNAL LOCATIONS	Percentage of Engineers Consulting External Locations by Degree Ph. D. N=44	MASTER N=31	BACHELOR N=12
Bookstores	27.27	29.03	41.67
Collections, files/records from libraries other than institutional	02.73	12.90	33.33
Collections, files and records from colleagues of other institutions	13.64	06.45	08.33
Collections, files and records from professional organizations	09.00	12.90	08.33

Effective sample size = 87
N = Number of respondents within degree
*Frequently = use at least on monthly basis or more frequently

Tables 52 and 53 show the frequency of consultation of external locations and categories of people by different degrees. These two tables show the following tendencies in the use of locations in relation to degree:

a) *Personal files records and collections from colleagues* from institutions external to the engineers' were used by

Ph.D. engineers on a larger scale than they were used by engineers with lower degrees;

b) Engineers with bachelor degrees use bookstores and customers more often than those with masters and Ph. D. degrees, who used them to about the same extent. On the other hand, engineers with a Bachelor's degree do not use external people, with the exception of trade contacts (customers, vendors and manufacturers);

c) It was also noticed that as degree increases fewer engineers used bookstores frequently as a mean to get written information sources.

TABLE 53

PERCENTAGE OF ENGINEERS CONSULTING EXTERNAL CHANNELS (PEOPLE FREQUENTLY)* BY DEGREE

EXTERNAL PEOPLE	Percentage of Engineers Consulting External People by Degree		
	Ph. D. N=44	MASTER N=31	BACHELOR N=12
Colleagues from other institutions	09.09	00.00	00.00
Customers	09.09	09.68	16.67
Vendors or manufacturers	06.82	03.23	08.33
Consultants	00.00	00.00	00.00
Other librarians	02.27	03.23	00.00

Effective sample size = 87
N = Number of respondents within degree
* Frequently = use at least on weekly basis or more frequently

f) Hypothesis on Seniority and the Use of Internal Channels

Studies conducted in developed countries that discussed the influence of seniority on information use have observed that the use of internal channels varies with the respondents seniority. Similar results were expected in this study. It was hypothesized that:

Hø 8f Seniority level does not influence the frequency of use of internal information channels by engineers.

Question Q13b items 1 to 5 and Q14a items 1 to 3 and 7 provided the data for the dependent variables. The number of years that the engineer worked in his present institution was provided by Q3. From the 8 channels the categories librarians from the engineer's institutional libraries and Nucleos, and collections, files and records from libraries from the engineer's Nucleos and institutional libraries, were eliminated from the analysis because 33% of the expected frequencies were less than five. Chi-square tests were run in four internal locations and one category of internal people (table 54). From these internal channels only "collections files and records from colleagues from the engineer's department" tested significantly with seniority. On the basis of this analysis, the Null Hypothesis is rejected for this internal channel, meaning that the frequency of use of "Collections files and records from colleagues from the engineer's department" is influenced by seniority. The frequency of use of: personal collections, files and records; collections, files and records from colleagues from the engineer's institution; colleagues from the engineer's department and colleagues from the engineer's institution are not significantly influenced by seniority. However data presented in tables 55 and 56 show the following tendencies in the use of internal channels by engineers when the different levels of seniority are considered:

a) As the number of years within the institution increases there is a gradual decrease in the number of engineers who use departmental files, records and collections; and collections, files and records from the engineer's Nucleos and institutional libraries. On the other hand, as the number of years within the institution increases there is also a gradual increase in the frequency of use of personal files, records and collections;

b) Equal number of engineers in the medium and senior groups make frequent use of collections, files and records from the engineers' institution;

c) As the number of years within the institution increases there is a gradual decrease in the percentage of engineers consulting colleagues from the engineer's department and colleagues from the engineer's institution;

d) The percentage of engineers consulting librarians from the engineer's institution and Nucleos increased up to the medium level. However, these channels are not used at all by senior engineers.

TABLE 54
RESULTS ON THE USE OF INTERNAL CHANNELS (LOCATIONS) BY SENIORITY

INFORMATION CHANNELS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Collections files and records from colleagues from the engineer's department	9.676	0.008	REJECTED
Personal collections/files/records	0.427	0.808	Accepted
Files and records from colleagues from the engineer's institution	1.523	0.407	Accepted
COMUT	0.313	0.855	Accepted
Colleagues from the engineers' department	5.537	0.063	Accepted

Effective sample size = 90

TABLE 55
PERCENTAGE OF ENGINEERS CONSULTING INTERNAL CHANNELS (LOCATIONS) FREQUENTLY* BY SENIORITY

INTERNAL LOCATIONS	Percentage of Engineers Using Internal Locations by Number of Years		
	JUNIOR (1-5) N=25	MEDIUM (6-15) N=41	SENIOR (+15) N=24
Personal collections files and records	76.00	78.05	83.33
Collections, files, records from colleagues from the engineer's institution	56.00	41.46	41.67
Collections, files, records from colleagues from the engineer's department	60.00	39.02	16.67
Collections, files, records from the engineer's Nucleos and institutional libraries	92.00	85.37	62.50
COMUT (interlibrary provision of photocopies of articles)	28.00	21.95	25.00

Effective sample size = 90

N= Number of respondents within each category

*Frequently, use at least on monthly basis or more frequently

TABLE 56
PERCENTAGE OF ENGINEERS CONSULTING INTERNAL CHANNELS (PEOPLE) FREQUENTLY* BY SENIORITY

INTERNAL CATEGORIES OF PEOPLE	Percentage of Engineers Using Internal Categories of People by Number of Years JUNIOR (1-5) N=25	MEDIUM (6-15) N=41	SENIOR (+15) N=24
Colleagues from the engineer's department	88.00	68.29	58.33
Colleagues from the engineer's institution	44.00	39.02	25.00
Librarians from the engineer's institution and nucleos	19.51	00.00	12.00

Effective sample size = 90
N= Number of respondents within each category
*Frequently, use at least on weekly basis or more frequently

g) Hypothesis on Project Type and the Use of Internal and External Categories of People

It was expected that engineers involved in project research would show a different pattern in the frequency of use of internal and external categories of people than their colleagues involved in project development.

It was hypothesized that:

Hø 8g There is no difference between engineers involved in project research and engineers involved in project development in the frequency of use of internal and external channels.

Question Q14a provided the data for the dependent variables. The data on project type were provided by Q17. Chi-square tests were run in 7 oral channels, but five of these channels (colleagues from other institutions, customers, vendors and manufacturers, consulters and librarians from the engineers institutional libraries and Nucleos) were eliminated from the analysis because 50% of the expected frequencies counted less than 5. Neither of the remaining two internal sources (table 57) tested significantly with project type. On the basis of this analysis, the Null Hypothesis is accepted for these two internal channels, meaning that the frequency of use of colleagues from the department and colleagues from the engineers institution is not influenced by project type. Nevertheless, data provided by these analyses (table 58) show for example that:

a) Engineers involved in project development used frequently a larger number of categories of external people than their colleagues involved in project research because they used customers, vendors, manufacturers and consultants. These are sources not used on a "frequent" basis by engineers involved in project research;

b) With the exception of librarians from the engineers' institution and other librarians, fewer engineers involved in project research used frequently all external and internal categories of people than colleagues involved in project development;

c) Compared with research project engineers, twice as many engineers working on development projects made frequent use of colleagues from their department but within their institute.

TABLE 57
INTERNAL AND EXTERNAL CHANNELS (PEOPLE) FOR WHICH USE DOES NOT VARY WITH PROJECT TYPE

CHANNELS	CORRECTED CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Colleagues from the engineer's department	0.387	0.533	accepted
Colleagues from the engineer's institution	1.892	0.168	accepted

TABLE 58
PERCENTAGE OF ENGINEERS CONSULTING INTERNAL AND EXTERNAL CHANNELS (PEOPLE) FREQUENTLY* BY PROJECT TYPE

EXTERNAL CHANNELS	Percentage of Engineers Consulting External people by Project Type RESEARCH N=19	DEVELOPMENT N=29
Customers	00.00	17.20
Vendors or manufacturers	00.00	06.90
Consultants	00.00	03.40
Other librarians	05.30	03.40
INTERNAL CHANNELS		
Colleagues from the department	63.20	75.90
Colleagues from the engineer's own institution	21.20	44.80
Librarians from the engineer's institution and Nucleos	15.80	06.90

* Frequently = Used at least on weekly basis
Sample Size = 48

h) Hypotheses on Accessibility and the Use of Internal and External Channels

A positive correlation between accessibility and the frequency of use of internal and external channels was expected. The data on the frequency of use of locations has been provided by questions 13a and 13b and the data on their accessibility has been provided by questions 13c items 18 to 26. Similarly data on the frequency of use of the different categories of people was provided by answers to Q14a, and the data for their accessibility was provided by the answers to Q 13c items 28 to 32.

It has been hypothesized that:

Hø 8h There is no relationship between the frequency of use of internal and external channels and their perceived accessibility to their use.

This hypothesis is divided into two sub-hypotheses for testing purposes:

Hø 8h1 There is no relationship between the frequency of use of internal channels and their perceived accessibility to their use.

Hø 8h2 There is no relationship between the frequency of use of external channels and their perceived accessibility to their use.

In order to test Hø 8h.1 Spearman correlation coefficients were computed for 8 channels defined as internal: a) personal files/records and collections, b) files records and collections from colleagues from the engineers' institution, c) departmental files records and collections, d) collections, files records and collections from the engineers' institutional libraries and Nucleos, e) COMUT (interlibrary photocopy service), f) colleagues from the engineers' department, g) colleagues from the engineers' own institution, and h) librarians from the engineer's own institution. Our data indicate that 3 coefficients, corresponding to the internal locations personal files, records and collections and COMUT and to the external channel vendors and manufacturers, are significant at the level of 0.05. On the basis of these results, H~ 8h1 can be rejected for the internal locations personal files/records and collections and COMUT. Meaning that the frequency of use of these two internal channels is positively related to their perceived accessibility. On the other hand, the frequency of use of the other internal channels is not related to their perceived accessibility (table 59).

Using the Spearman correlation test, Hø 8h2 was tested. Four channels defined as external and listed in table 60 were tested. Only one coefficient corresponding to the channel vendors and manufacturers showed a positive correlation between frequency of use and accessibility. On the basis of these results the Hø 8h2 is rejected for this channel, meaning that the

TABLE 59
RESULTS ON THE USE OF INTERNAL CHANNELS AND THEIR PERCEIVED ACCESSIBILITY

LOCATIONS	SPEARMAN CORRELATION (r)	SIG.	LEVEL OF ACCEPTANCE 0.05	N
Personal files records and collections	0.3199	.003	REJECT	74
Files records/collections from colleagues from the *engineers' institution*	0.1864	.064	*accept*	68
Departmental files records and collections	0.1181	.171	accept	67
Collections, files records and collections from the engineers' institutional libraries and Nucleos	0.0153	.446	accept	81
COMUT (Interlibrary provision of photocopies)	0.2349	.038	REJECT	58
CATEGORIES OF PEOPLE				
Colleagues from the engineer's department	0.1335	.117	accept	81
Colleagues from the engineers' institution	0.1581	.089	accept	74
Librarians from the engineers' institution and nucleos	0.1572	.098	accept	69

N = Number of Respondents

frequency of use of vendors and manufacturers is positively related to its perceived accessibility. The frequency of use of the other external channels is not (table 60). Thus, accessibility is not an overriding influencing factor in the frequency of use of internal and external channels. For example the external channels: customers, consultants, institutional and librarians from other institutions were infrequently used by the majority of the engineers (table 47) whether or not they were perceived to be accessible (table 18). Further research is necessary to explore what other factors most influence the frequency of use of internal and external channels. Thus, the claim that geographical distance (physical accessibility is a determminantin the use of sources/channels (e.g. Auerbach Corporation user needs study, 1965; Souza et al, 1977; Allen, 1977; Shuchman,1981; Angell et al, 1985 among others) has not been confirmed in this study. Other factors appear to play an important role in the use of locations by BMEs. For example, consideration of the results of accessibility for collections and files of libraries and Nucleos and use of the internal sources of departmental files/collections shows low percentage of accessibility for both channels. However, the high frequency of consultation of library files in opposition to departmental files, suggests that in this case, the frequency of use of a source is determined not by the physical ease with which the location can be reached (accessibility), but by the ease with which engineers could obtain information from it (ease of use). In academic institutions there is little or no bibliographic control of materials in locations other than the library.

i) Hypothesis on Inter-institutional Involvement and the Use of External Channels

It was thought that the engineers' institutional involvement with organizations other than their own, would increase the engineers' awareness of channels available in external institution and their opportunity for the use of external categories of people. Therefore, engineers' with higher number of hours of external institutional contact would use external

channels more frequently than their colleagues with fewer number of hours of external institutional contact.
It has been hypothesized that

Hø 8i Inter-institutional involvement does not influence the frequency of use of external channels by engineers.

According to their degree of inter-relation, engineers were grouped into four categories: The 1st group included engineers who reported themselves as having 0 hrs. of weekly inter-institutional involvement; the second one grouped engineers who inter-related with external organizations from 1 to 5 hrs a week; the third group included engineers with 6 to 10 hrs of weekly inter-institutional involvement and 4th grouped engineers with 11 or more hrs. of weekly inter institutional involvement. To test the hypothesis chi-square tests were run for external locations listed on question 13b, items 6 to 9; and categories of people listed in Q14a items 3 to 7. The five categories of external people and two locations: a) collections, files and records from professional organizations; b) collections, files and records from colleagues of other institutions were eliminated from the analysis because 50% of the expected frequencies were less than 5. The frequency of consultation of the remaining two locations did not vary with inter-institutional involvement. Thus, the null hypothesis was accepted for two external locations: Bookstores and collections, files/records from other libraries (table 61), meaning that difference in the frequency of use of these two locations is not influenced by inter-institutional relation or involvement.

Table 62 and 63 show the following tendencies in the frequency of use of external channels when the engineers' degree of inter-institutional involvement is taken into consideration:

TABLE 60

RESULTS ON THE USE OF EXTERNAL CHANNELS AND THEIR PERCEIVED ACCESSIBILITY

LOCATIONS	SPEARMAN CORRELATION (r)	SIG	LEVEL OF ACCEPTANCE 0.05	N
Files, collections and records from colleagues from other institutions	-0.1447	.146	accept	55
Files, collections and records from professional organizations	-0.0032	.492	accept	41
Files, collections and records from libraries other than institutional	0.0763	.271	accept	66
Bookstores	-0.0974	.198	accept	78
CATEGORIES OF PEOPLE				
Colleagues from other institutions	-0.1172	.176	accept	65
Customers	0.1811	.132	accept	40
Vendors or manufacturers	0.2369	.042	REJECT	54
Consultants	-0.1250	.241	accept	34
Other librarians	-0.0113	.468	accept	53

N = Number of respondents

a) The majority of engineers commonly use bookstores frequently whatever their degree of inter-institutional involvement;

b) Few engineers who do not spend time in inter-institutional involvement make frequent use of collections, files and records from other libraries;

c) While the number of hours of inter-institutional involvement increases, the frequency of using the channel collections, files and records from other institutions also increases;

d) No engineers in the first group used any of the categories of external people;

e) Although engineers in the fourth group spent 11 or more hours per week in inter-institutional involvement, none of them consulted customers, vendors and consultants frequently.

TABLE 61
EXTERNAL CHANNELS (LOCATIONS) FOR WHICH USE DOES NOT VARY WITH INTER-INSTITUTIONAL INVOLVEMENT

CHANNELS	CHI-SQUARE (d.f. = 3)	PROB.	LEVEL OF ACCEPTANCE 0.05
Bookstores	3.442	0.330	accepted
Collections, files/records from other libraries	1.966	0.579	accepted

Sample Size =91

TABLE 62
PERCENTAGE OF ENGINEERS CONSULTING EXTERNAL CHANNELS (LOCATIONS) FREQUENTLY* BY INTER-INSTITUTIONAL INVOLVEMENT

EXTERNAL LOCATIONS	Percentage of Engineers Consulting External Locations by Inter-institutional Involvement 0 hrs N =12	1-5 hrs N=30	6-10 hrs N=36	11 or more hrs. N=13
Bookstores	66.70	60.00	80.60	69.20
Collections, files/records from other libraries	08.30	20.00	22.20	30.80
Collections, files and records from colleagues of other institutions	25.00	03.30	13.90	15.40
Collections, files and records from professional organizations	25.00	03.30	11.10	15.40

Effective sample size = 91
N = Number of respondents within degree of involvement
*Frequently, use at least on monthly basis or more frequently

TABLE 63
PERCENTAGE OF ENGINEERS CONSULTING EXTERNAL CHANNELS (PEOPLE) FREQUENTLY* BY INTER-INSTITUTIONAL INVOLVEMENT

EXTERNAL PEOPLE	Percentage of Engineers Consulting External People by Inter-institutional Involvement 1st 0 hrs N =12	2nd 1-5 hrs N=30	3th 6-10 hrs N=36	4th 11 or more N=13
Colleagues from other institutions	00.00	00.00	08.30	07.70
Customers	00.00	13.30	19.40	00.00
Vendors or manufacturers	0.000	03.30	03.90	00.00
Consultants	00.00	03.30	02.80	00.00
Other librarians	00.00	03.30	02.80	07.70

Sample size = 91
N = Number of respondents within degree of involvement
*Frequently, use at least on weekly basis or more frequently

j) Hypothesis on Institutional Restrictions to the Use of IO channels and the Use of External Categories of People

It was expected that the greater the institutional restrictions the lower the frequency of use of external people. It has been hypothesized:

Hø 8j There is no relationship between the frequency of use of oral external channels and the perceived limitation to the use of four means of contacting people: a) local phone calls, b) long distance phone calls, c) use of mail and d) use of telex.

The source of data on the frequency of use of channels is question 14a, items 3 to 6 and 8; and the source for data on restrictions is question 14c, items 1, 2, 5 and 6.

TABLE 64
RESULTS ON THE USE OF EXTERNAL CHANNELS AND THE PERCEIVED INSTITUTIONAL RESTRICTIONS TO THE USE OF IO CHANNELS

Relationship between COLLEAGUES FROM OTHER INSTITUTIONS and:	SPEARMAN CORRELATION (r)	SIG.	LEVEL OF ACCEPTANCE 0.05	N
Local phone calls	-0.6311	.282	accept	86
Long distance calls	-0.0316	.386	accept	87
Use of mail	-0.0497	.325	accept	86
Use of telex	0.1092	.182	accept	71
Relationship between CUSTOMERS and:				
Local phone calls	0.0515	.319	accept	86
Long distance calls	-0.0014	.497	accept	87
Use of mail	0.1229	.130	accept	86
Use of telex	-0.0173	.439	accept	71
Relationship between VENDORS OR MANUFACTURERS and:				
Local phone calls	0.1065	.165	accept	86
Long distance calls	0.1821	.046	REJECT	87
Use of mail	0.1844	.045	REJECT	86
Use of telex	0.0770	.252	accept	71
Relationship between CONSULTANTS and:				
Local phone calls	0.0212	.423	accept	86
Long distance calls	-0.0275	.437	accept	87
Use of mail	-0.0044	.484	accept	86
Use of telex	-0.1441	.115	accept	71
Relationship between OTHER LIBRARIANS and:				
Local phone calls	0.1221	.131	accept	86
Long distance calls	0.0910	.201	accept	87
Use of mail	-0.0368	.368	accept	86
Use of telex	-0.0638	.299	accept	71

in order to test Hø 8j, Spearman correlation coefficients were computed between each one of the channels defined as external (listed in table 64) and the degree of institutional restrictions to the use of telephone (for local and long distance calls), use of mail and use of telexes On the basis on the results, Hø 8j can be rejected for channel vendors and manufactures because the correlation is significatively related to the perceived restrictions to the use of telephone for long distance calls and letters at the .05 level. The use of the other external channels such as colleagues from other institutions, customers, consultants and librarians from external libraries is not related to the perception of institutional restrictions.

8.2 Number of Hours Spent Communicating with other People

Question 6a asked the respondents how many hours a week they spent communicating for the activities keeping up to date and solving technical problems. A majority of members of our sample (80%) spent up to four hours a week communicating for keeping up-to date and communicating for problem solving activities. Table 65 presents these data.

A chi-square test was run to see if there was a significant difference between the number of hours spent communicating for problem solving and the number of hours spent communicating for keeping up-to-date. The categories of hours listed in the questionnaire collapsed into two groups: 1) from less than 1 hour to 4 hours a week, and 2) more than four hours a week. The results indicate that there is a significant difference ($x2 = 49.617$, d.f. = 1, $p < 0.05$) between the amount of time the engineers spend communicating for problem solving and the number of hours spend for keeping up-to-date. However these results should be interpreted with caution because 25% of the expected frequencies counted less than five.

Mick et al (1980) found that researchers spend 8.5 hrs a week in technical discussions and Goldstein's (1985) results showed that the majority of (64.20%) electrical engineers/ researchers spent between 1 to 4 hours a week communicating for keeping current, and 52% of the researchers spent between 3 to 10 hrs a week for problem solving. On the other hand, the majority of practitioners (55.5%) spent more than 3 hours per week communicating for problem solving and 63.3% spent less than 2 hours a week communicating for keeping up-to-date. Our results are more in line with Goldstein's findings for research engineers.

TABLE 65
PERCENTAGE OF ENGINEERS BY NUMBER OF HOURS SPENT COMMUNICATING

ACTIVITY	PERCENTAGE OF ENGINEERS COMMUNICATING				N
	Less than 1 Hr./week	2 - 4 Hrs/week	5 - 7 Hrs/week	More Than 7 Hrs/week	
Keeping up-to-date	34.40	45.60	13.30	06.70	90
Problem solving	28.40	52.30	09.10	10.20	88

N= Number of respondents

8.3 Discussion of Results

The interpersonal channels included in this study are: informal written (IW), formal oral (FO) and informal oral (IO). The different categories of people and locations consulted by BMEs to acquire information were identified as internal and external channels.

Four (IW) information sources were considered in this study. These sources were letters, telexes, personal notebooks and unpublished papers. Although among these sources the greater incidence of frequent use was claimed for notebooks, it was somehow unexpected to find that this source, which has such an easy physical accessibility and high degree of reliability, had been seldom or never used by 25% of the BMEs. Further research could determine if this result is an indicator of the engineer's satisfaction with the availability of written materials. Engineers are also well known for their lack of organization with their personal notebooks, therefore, maybe engineers are not willing to make the effort that this source would require to become a competing source of information.

Although telexes are faster and permit a rapid response, they were less frequently used by a larger number of engineers than letters. Some of the reasons for more frequent use of letters may lie in the convenience offered by letters. Letters are cheaper, more private, and provide more space for detailed descriptions so the chance for misinterpretation is reduced and they also provide a record and are signed by the sender (Raitt, 1984). The hypothesis that educational level influences the frequency of use of letters was supported, indicating that increased educational level leads to an increase in the use of letters. Although the relationship between seniority and use of letters was not supported a similar increased tendency in the use of letters was noticed when engineers' seniority was considered (tables 40 and 43).

The low percentage of use of unpublished papers or prepublications might stand as an indication that the majority of the subjects of our sample do not circulate their papers among their colleagues prior to their presentation in seminars or submission for publication. The tendency towards a non-use of unpublished papers by master's and bachelor's groups in relation to Ph. Ds was stronger (Table 41). The literature does not present any data on how much scientific information is bottled up because of this attitude. Furthermore, no mention is made about possible concerns that leads to this behaviour. But it seems clear from our figures that the lack of flow of information contained in unpublished papers, which usually report on on going and completed research, may be leading BMEs to reinvent the wheel many times in different or even in the same academic institutions.

In spite of a strong tendency towards a more frequent use of the channel personal notebooks, by the masters group, this difference in the frequency of use was not statistically significant (Table 40).

Seniority does not influence the frequency of use of all four IW sources (table 42). The frequency of use of letters and telexes is independent to the perception of institutional restrictions on the use of mail and telexes.

The formal oral channels a) encounters and b) lecturers' presentations at conferences, courses, seminars and industrial exhibitions was used to contact people weekly by a small proportion of BMEs, however on trimester basis, over 70% of the engineers use these events as a way to contact people. Institutional restrictions to attendance at these events are not experienced by the majority of engineers (table 20). It has not been possible to examine the influence of project type on the frequency of use of conferences and events with a chi-square test because 50% of the expected frequencies were less than five. However the percentages of frequency of use indicate that engineers involved in project research used frequently a larger range of intewrpersonal channels than their colleagues involved in project development (table 45).

Turning to informal oral channels, it was found that the channel telephone was more frequently used than other forms of interpersonal channels such as telex or letters. This preeminence in use is not just explained by the improvement in communication or by the "law of least effort". The channel telephone itself offers several advantages over other channels. In Raitt's (1984) study, for example, respondents pointed at some of these advantages: telephone conversations, although informal, are still personal and permit the establishment of a direct and immediate reply. They are efficient, easy to use, not expensive and allow us to cover a long distance easily. No correlation was found between the frequency of use of telephone conversations and the engineers' perception of restrictions in the use of local and long phone distance calls.

Most information-users in developed countries get information for their work through informal media such as preprints and meetings (Garvey, 1979). However, the results of this study show that the majority of BMEs do not use unpublished papers/preprints as a source of information for their work. This result may be because accessibility to this type of source was among the main problems reported by engineers on information use. Furthermore, BMEs who have access to this type of source consider that the information contained unpublished papers is not public and as such can not be used until it is formally presented in an article or report. To admit use of information presented in unpublished papers may appear unethical and unprofessional behaviour and as such may affect the engineer's professional reputation. It was found that visits to research and academic institutions and visits to industries on a weekly basis was very low. However over 70% of the engineers use these channels to contact people on trimester basis. Similarly, the FO channels encounters and presentation in lectures, conferences,etc., were used on trimester basis by the majority of the engineers (table 39).

The majority of BMEs contacted individuals weekly through corridor conversations and visits to colleagues' offices. The frequency of use of both channels and the channel meetings for institutional projects was not according to statistical tests influenced by seniority or involvement in project research or development. However there was a marked indication that more senior engineers made less use of the telephone, conversations in corridors and visits to colleagues' offices. It was also noticed (table 43) that as the number of years within the institution increases there was a gradual decrease in the numbers of engineers who used frequently the channels:

telephone, talks in corridors and visits to offices. Engineers in the junior group did not make frequent use of the IO channels: visits to industry and research centers and academic institutions. More development engineers made frequent use of the telephone than research engineers and while research engineers use visits to academic institutions and research institutes to get oral information, they do not use frequently visits to industries for the same purpose. The opposite is true for engineers involved in development projects, who contact individuals through visits to industries, but they do not use visits to academic and research institutes as means to contact people to get their oral information.

There is evidence in the literature (e.g Rosenbloom and Wolek, 1970) that engineers communicate with more people internal to their institution while scientists communicate more with individuals outside their institutions. Our results reveal that the majority of BMEs "seldom or never" consult colleagues or other categories of people outside their own organization (table 49). The only exception to this generalization is that consultation of colleagues from other institutions, although not used frequently, is reported to be used by 57.10% Furthermore, when looking for oral information interchange, many more BMEs used colleagues within their own department than colleagues within their own institution (table 49). It might be argued that BMEs do not look for outside channels because they have the support they need through internal consulting. This may be true because of the high qualification and ability of the engineers from the departments of Mechanical Engineering of the institutions under study, which are most highly regarded in Brazil. There might be other reasons, as for example financial costs involved in the use of external channels. When information channels lie outside the institution they are frequently more expensive to tap than other channels. Fear to damage his reputation of technical competence among colleagues from external institutions might have lead also to these results. There is evidence (Allen 1977) that in the process of consulting to get the information needed individuals pay a price in terms of prestige among their colleagues. In developed countries the cost paid for consulting colleagues in terms of technical performance or reputation for competence is less if external rather than internal colleagues are consulted. It seems that for engineers of our sample the opposite is true. The fact that BMEs fill their information gaps by consulting with internal rather than external people, may indicate that to lose some reputation among internal colleagues is less costly than to lose it externally. Furthermore, these results could also reveal that information collected from external channels (people) may be seen as unreliable. Negus (1982) for example, refers to a study (O' Brien et al 1954) quoted by Stuart 1979), conducted in a small business manufacturing firm, where 45% of the respondents claimed that information found through personal contacts was: "non-factual, inaccurate, invalid, unreliable, misleading, biased and exaggerated". Nevertheless, whatever the reasons, our data reveal that the majority of our respondents are closed to contacts with colleagues from external institutions. Since people play an important part in the information transfer process both by providing information and referring users to other sources (Rosenbloom and Wolek, 1970), it is necessary to investigate in further research why the engineers' communication with external channels is inhibited, and to find out if engineers are using any other kind of interpersonal channels for cross fertilization.

Engineers with Ph. D. degrees consult more external categories of people than engineers with a masters and bachelors degrees. As it turns out, none of these last two groups of users consult colleagues from external institutions on a frequent basis. Seniority does not influence the frequency of use of the internal channels colleagues from the engineers' department and colleagues from the engineers' institution either. However it was noticed that there was a tendency for frequent use of colleagues within the department and institution to decrease over the years (table 56). Librarians within the institution were not frequently used by the most senior group of engineers. The differences within engineers involved in research and project development in relation to the use of internal and external channels are not statistically significant at the 0.05 level for all categories of people. However, the comparison (table 58) of the percentages of communication through external channels by both groups of users indicates that engineers involved in project development used frequently a larger number of categories of external people than their colleagues involved in research projects. This might indicate that BMEs working in academic environments are more prepared to support research projects through internal consulting than development projects.

BMEs depend heavily on published sources to get information for their work and although there are various locations where engineers may find these sources, institutional libraries are the locations more consulted by the majority of engineers. This finding is in agreement with the literature, in which is reported that libraries and personal collections are the channels most frequently used by engineers and scientists to obtain written information sources. Data displayed in table 49 show both channels of information as frequently used by the majority of our respondents. Although no single external channel was frequently used by the respondents, files and records and collections from other libraries and bookstores were used with some frequency by over 80% of the respondents (table 50). The lowest frequency of use is for files and records and collections from professional organizations and files and records and collections from colleagues from other institutions which are seldom or never used by over 60% of the respondents (table 50).

The differences in the frequency of consulting internal channels (categories of people and locations) for engineers with different levels of educational degree are not statistically significant at the 0.05 level. However as degree increased fewer engineers used bookstores frequently as means to get written information sources. It could be argued that this decrease in the use of bookstores is a result of the increase in the sophistication, and consequently in price, of the information needed by users with higher degrees. The fact that the problem "information was expensive" increased with educational level seems also to reinforce this argument.

The differences in the frequency of consulting internal channels (locations) to acquire written information by engineers with different levels of seniority are statistically significant at the 0.05 level only for the category collections files and records from colleagues from the engineer's department. However the comparison of the percentages of engineers using internal channels in relation to seniority show that there is a tendency among junior engineers to use internal channels more frequently (locations and categories of people). The only exceptions to this generalization are the internal channels personal files and records which are more frequently used by the senior group and the consultation of librarians from the engineers institutional libraries and Nucleos, which are more frequently used by the medium group (table 55 and 56).

Inter-institutional involvement (table 63) does not make a significant difference in the frequency of use of bookstores and collections, files and records from other libraries. However it was noticed that engineers who do not have any inter-institutional involvement do not use frequently any of the categories of external people. Similarly, few engineers who do not spend time in inter-institutional involvement make frequent use of collections, files and records from other libraries.

The majority of engineers spend about the same time communicating for keeping up-to-date and for problem solving. Although we can not determine from our data how much of this time is spent with external contacts, the "seldom or never" used response of the majority of BMEs to people external to their organization suggests that most of this time might be spent with internal contacts.

8.4 Summary of Main Findings

In this chapter we analyzed the frequency of use of interpersonal channels (IW, IO and FO) by BMEs working in academic environments in Brazil. Our findings supplement the findings of earlier works on the use of interpersonal channels and on some of the factors that influence their information use.

Engineers employed by universities in Brazil use a variety of interpersonal channels to communicate with other individuals in order to obtain information for their work. In the use of interpersonal channels (IW, IO and FO), telephone conversations, visits to colleagues' offices and talks in corridors were the only interpersonal channels used frequently. However several other channels such as telexes, letters, visits to industries, academic and research institutes, meetings for projects institutional projects, encounters and presentations in conferences, courses, seminars, industrial exhibitions were used with certain frequency by BMEs. Unpublished papers are reported to be seldom or never used by the majority of the BMEs.

Internal channels, both people and locations were consulted with different frequencies by the majority of engineers. However on a frequent basis the only internal category of people used was colleagues from the department. Personal files records and collections and files, records and collections from the engineers' institution libraries and Nucleos were the only internal channels used on frequent basis. Within internal channels (people) BMEs tend to consult more the individuals with whom they are closer institutionally grouped (department). With the exception of "colleagues from other institutions" all other external categories of channels are seldom or never used by the majority of engineers.

Use of letters is related to the level of educational degree. All other interpersonal channels are not influenced by degree, seniority or project type. The engineers' perception of institutional restrictions of informal oral channels is not related to their frequency of use. Educational degree, seniority, project type and inter-institutional involvement are not determinant factors in the differences of frequency of use of internal and external sources. Exception to this generalization is the influence of seniority on the frequency of use of collections, files and records from colleagues from the engineers department. Differences in the frequency of use of internal and external channels when related to these variables revealed very interesting tendencies in their use. The perceived accessibility of a channel influences the frequency of use of personal files, records and collections and COMUT, but the other categories of internal and external channels are not related to this variable.

Engineers spent about the same number of hours communicating for problem solving and keeping up-to-date.

CHAPTER 9

RESULTS ON INFORMATION PROBLEMS AND ACTIONS TAKEN BY BRAZILIAN MECHANICAL ENGINEERS

In this chapter we 1) present results on the frequency with which engineers face information problems when they are obtaining and using information for their work and how these results relate to previous studies; 2) analyse the effect that personal characteristics have on the users when they face these problems; 3) discuss the results on the actions taken by BMEs when information needed is not immediately available; 4) analyse the effect that personal characteristics of users have on the frequency with which these actions are taken, and 5) present the results on information services and information input used by BMEs. As in the previous chapters, after the presentation of results there is a discussion of the main tendencies on the frequency of encountering problems and actions taken by BMEs during information use. Along with the presentation of results the dependent variables are related to the independent variables for the discussion of the hypotheses. The comparison of results with the findings of other studies is also done, on a speculative basis.

9.1 Frequency of Encountering Information Problems and Previous studies

In this section we collected data on information problems that surface when engineers are obtaining and using information for their work. Questions 10 and question 12 provided the data on general problems and language related-problems. Engineers were considered to encounter a problem frequently if they faced the problem 41% of the time or more (categories of the questionnaire "sometimes", "frequently", "most of the time or always"). Engineers were considered to have faced the problem infrequently, if they faced the problem 40% of the time or less, (questionnaire categories, "occasionally", "seldom or never"). Our results show that (table 66) "information was expensive" is seen as a problem by the majority of our respondents. This problem was noted as frequent by more that half (55%) of the BMEs. Contrary to this finding Summers et al (1983), report that for Canadian educators financial costs was not a major problem in finding or using information. When the means of ten different problems were compared for this Canadian group of users financial costs came 6th.

The problems "did not find current information" and "did not have access to unpublished information" were noted as frequent by over 40% of the respondents. In addition "did not find relevant information" was reported as a frequent problem

TABLE 66
PERCENTAGE OF ENGINEERS ENCOUNTERING INFORMATION PROBLEMS FREQUENTLY*

PROBLEMS	No OF ENGINEERS	IN SAMPLE %
Did not find current information	40	44.00
Did not have access to unpublished information	41	45.10
Did not find relevant information	29	31.90
Did not know where to look	06	06.60
Found language too technical	04	04.40
Received information too late for use	22	24.20
Did not find information in Portuguese	71	78.00
Information was expensive	50	55.00
Lacked professional help to find information	27	29.70
Found information but it was classified	09	09.09

Sample size = 91
* Frequently = Facing the problem 41% of the time or more frequently

by 31.90% of the sample. Lack of accessibility to published materials was also noted as one of the main problems for scientists and engineers in studies conducted in Scandinavia by Tornudd (1959); in Mexico by Villareal (1980) and Goldstein (1985); in Singapore by Sabaratnam (1983) and in Brazil by Lingwood and McAnany (1971) and Kremer (1984).

A less frequent problem among BMEs was "found information but it was "classified", only 09.09% of the sample found this a frequent problem and 64.80% seldom or never faced this problem. The number of BMEs facing this problem frequently is higher than the figure noted by Raitt (1984) In his study "information was confidential", was pointed out as a frequent problem by 2% of the engineers in international organizations against 72% that considered this as a rare problem However in Kremer's study (1984) 73% of her total sample (users of libraries from the Pontificia Universidade do Rio de Janeiro) had problems in obtaining information because it was "classified".

Few BMEs engineers (06.60%) face frequently the problem of "not knowing where to look for information". Likewise "lack of professional help to find information" was noted as an infrequent problem by 29.70% of BMEs. Our figures for both problems are lower than the ones reported by Goldstein (1985). Her percentages are 22.90% and 16.20% for the first and second problem respectively for Mexican research engineers, and they are 24.50% and 16.20% for Mexican practitioners. "unhelpful library staff" was rarely a problem for 72% of Raitt's (1984) sample.

"Receiving information too late for use" seems not to be very a crucial problem among BMEs. Results show 24.20% of the respondents facing frequently this problem against the percentage of 75.80% who reported to find this problem infrequently. Studies conducted in Mexico by Villarreal (1980) and Goldstein (1985) reported late arrival of documents as a problem encountered frequently by the majority of Mexican engineers. A survey conducted by Houghton and Prossner (1974) reveals that for British users "delay" in receiving documents was not considered a critical factor. Similar results were reported by Raitt (1984) for engineers in international organizations. In Raitt's (1984) study only a handful of engineers (9%) noted to have problems with delays getting in materials. In Slater and Fisher's (1969) 1% of the total sample of users of British technical libraries reported getting materials too late to be used, within the group of academics only 2% reported this problem. When these figures were analysed in terms of groups of scientists and engineers, the former group appears to have slightly more problems with "information too late to be used" (1%) than engineers (2%). According to our data, delay is not considered a critical problem by BMEs, but when comparing our results with results from other studies it is important to indicate that what might be considered a reasonable time by Brazilians, might be considered a great delay by users in countries like the UK and the USA. Expectations on time of arrival may be quite different because of the differences in the information infrastructure of the countries.

Availability of information in the engineers' mother tongue. "did not find information in Portuguese" was a problem found frequently by 78% of the respondents. A great percentage of Mexican engineers also encountered this problem on a frequently basis. However the Mexican figures are lower than ours, 48.60% of the researchers and 51.90% of the practitioners (Goldstein, 1985) found this problem frequently. Nevertheless, in spite of these differences in percentages it is clear that this problem is common in countries like Mexico and Brazil which do not have a large body of scientific literature produced in their native language and where the bibliographic control of the scientific output is still in the process of being organized.

TABLE 67
PERCENTAGE OF ENGINEERS ENCOUNTERING INFORMATION PROBLEMS WITH DIFFERENT FREQUENCIES

PROBLEMS	SELDOM NEVER 0 to 20% of the time	OCASION ALLY 21% to 40% of the time	OFTEN 41 to 60% of the time	FREQUEN TLY 61% to 80% of the time	MOST OF THE TIME 81% to 100% of the time
Did not find current information	22.00	34.00	26.40	14.30	03.30
Did not have access to unpublished information	39.50	15.40	16.50	14.30	14.30
Did not find relevant information	37.40	30.80	20.90	09.90	01.10
Did not know where to look	67.00	26.40	06.60	00.00	00.00
Found language too technical	85.70	09.90	03.30	01.10	00.00
Received information too late for use	39.60	36.20	11.00	12.10	01.10
Did not find information in Portuguese	15.40	06.50	12.10	20.90	45.10
Information was expensive	23.00	22.00	22.00	19.80	13.20
Lacked professional help to find information	46.20	24.10	17.60	05.50	06.60
Found information but it was classified	64.80	25.30	06.60	03.30	00.00

Sample size = 91

Clearly, the majority of our population does not face problems in understanding technical language or being unable to read a paper because of language difficulties. Only 4.40% of respondents found frequently "language too technical" (table 66) and a percentage of 20.88% BMEs had come across a paper that they were unable to read because of language difficulties

66) and a percentage of 20.88% BMEs had come across a paper that they were unable to read because of language difficulties on a monthly basis or more frequently (table 68). This last figure is lower than the ones reported by Wood and Hamilton (1967), by Wood (1966), by Hutchins, W. J. et al. (1971) and by Ellen (1979). Ellen noted that 76% of her total sample of scientists, technologists and researchers in the social sciences and humanities had faced this problem with publications in a foreign language. In the Sheffield survey the figure reported for this problem for scientists and technologists was 77% (Hütchins, W. J. et al., 1971). Lower figures (8.5%) were reported by Wood and Hamilton (1967) for British mechanical engineers. The differences in figures between our survey and the Wood and Hamilton survey (1967) is probably in the way the questions were phrased. While we use the phrase to describe a foreign paper, "like to have read" Wood and Hamilton use the phrase "believe is potentially valuable".

TABLE 68
FREQUENCY WITH WHICH ENGINEERS FIND RELEVANT INFORMATION THAT ARE UNABLE TO READ BECAUSE OF LANGUAGE PROBLEMS

FREQUENCY	NUMBER OF RESPONDENTS	PERCENTAGE
At least once a day	02	02.20
At least once a week	03	03.30
At least once a month	19	20.88
At least once a semester	35	38.46
Seldom or never	32	35.16

Sample size = 91

9.1.2 Frequency of Encountering Information Problems Related to Personal Variables

Various studies have examined the problems faced by scientists and engineers in their attempt to find information (e.g. Tornudd, 1959; Lingwood and McAnany, 1971; Sabaratnam, 1983; Summers et al, 1983; Kremer, 1984 and Goldstein, 1985). The main concern of these studies was with the problems users have in seeking and using information. None of them looked at, for example, the effect that personal characteristics of the user, type of work and environmental factors might have on the frequency with which users face these problems. In this section the frequency of encountering problems by BMEs is related to the personal characteristics of the user. The variables educational degree, seniority and productivity are used in the analysis. Three hypotheses were formulated to explore this relation. For statistical analyses the categories listed in the questionnaire for the independent variables were grouped as follows:

a) Educational degree.- Three categories of level of education were considered: bachelor's, masters and Ph. D.;

b) Seniority.- The number of years that engineers worked for their present institution were grouped into the categories: junior (1 to 5 years); medium (6 to 15 years) and senior (over 15 years) and;

c) Productivity.- Three levels were used for the analysis: low medium and high.

The five categories of frequency of encountering problems in acquiring and using information collapsed into two. Frequent, if engineers faced the problem 41% of the time or more frequently, (categories of the questionnaire sometimes, frequently, most of the time or always). Engineers were considered to face the problem infrequently if they found it

40% of the time or less, (questionnaire categories, occasionally, seldom or never).

a) Hypothesis on Problems on Information Use by Educational Degree

The influence of degree on the frequency of encountering problems when obtaining and using information was tested for problems listed in Q10.

It was hypothesized that :

Hø 9a There is no difference in the frequency of encountering problems in obtaining and using information with respect to educational degree.

To test this hypotheses Chi- square tests were run on Q.10, and Q2. Three problems "did not know where to look", "found information but it was "classified" and "found language too technical", were eliminated from the analysis because 5O% of the expected frequencies counted less than five. Of the seven categories of problems tested only one, "did not have access to unpublished information" tested significantly with degree (table 69). On the basis of these results the null hypothesis can be rejected only for this problem, meaning that the frequency with which engineers encountered the problem of accessibility to "unpublished information" is influenced by degree. The frequency with which the other problems listed in table 70 are faced by engineers when obtaining and using information is independent of degree. Although the problems "found information but it was classified" and "found language too technical" could not be statistically tested by chi-square tests, the comparison of the percentage differences of the three groups of engineers (table 70) reveals some interesting tendencies in the frequency with which engineers encounter these problems when degree is taken into consideration. For example, while the difference in the frequency of finding both problems between engineers with post-graduate degrees is slight, these differences are larger between the group of engineers with post-graduate degrees (Masters or Ph. D.) and the group of those who have no more than a bachelor's degree. Similar differences were noticed for the problem "information was expensive", but the difference in the frequency of facing this problem by the three groups of engineers proved not to be significant either.

TABLE 69
RESULTS ON THE CORRELATION OF FINDING PROBLEMS BY DEGREE

TYPES OF PROBLEMS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Did not find current information	0.303	0.85	Accepted
Did not have access to unpublished information	6.720	0.035	REJECTED
Did not find relevant information	0.724	0.696	Accepted
Received information too late for use	2.370	0.306	Accepted
Did not find information in Portuguese	1.009	0.604	Accepted
Information was expensive	1.160	0.560	Accepted
Lacked professional help to find information	0.100	0.951	Accepted

Effective sample size = 87

Table 70 also shows the following tendencies when comparing the three groups of engineers:

a) When degree increases there is a gradual decrease in the frequency of encountering the problem "did not find relevant information"; On the other hand, while degree increases there is a gradual increase in the frequency of encountering the problem "information was expensive";

TABLE 70
PERCENTAGE OF ENGINEERS ENCOUNTERING INFORMATION PROBLEMS FREQUENTLY* BY DEGREE

TYPE OF PROBLEMS	Percentage of Engineers Encountering Problems by Degree Ph.D. N=44	 MASTER N=31	 BACHELOR N=12
Did not find current information	47.73	41.94	41.67
Did not have access to unpublished information	59.09	29.03	41.67
Did not find relevant information	29.55	35.48	41.67
Did not know where to look	02.27	16.13	00.00
Found language too technical	04.55	00.00	16.67
Received information too late for use	31.82	16.13	25.00
Did not find information in Portuguese	75.00	83.87	03.33
Information was expensive	59.09	54.84	41.67
Lacked professional help to find information	31.82	29.03	33.33
Found information, but it was classified	09.09	06.45	25.00

Effective Sample Size = 87
N= Number of respondents facing problems within each degree.
*Frequently, facing the problem 41% of the time or more frequently

b) A major percentage of PhDs faced the problems: "did not find current information", "did not have access to unpublished information", "received information too late for use" and "information was expensive";

c) A major percentage of engineers with a Bachelor's degree faces the problems "did not find relevant information", "found language too technical", "lacked professional help to find information" and "found information but it was "classified";

d) A major percentage of engineers with a Master's degree faces the problem "did not know where to look for information". Bachelors did not find this a frequent problem.

b) Hypothesis on Problems on Information Use by Seniority

The influence of seniority on the frequency of encountering problems was tested for 10 different problems.

It was hypothesized that:

Hø 9b There is no difference in the frequency of encountering problems in obtaining and using information with respect to seniority level.

The source of data on seniority is question 3 and the source of data for problems found in obtaining and using information is question 10. Chi-square tests were performed to test this hypothesis. Three problems: "did not know where to look", "found language too technical" and "found information but it was classified", were eliminated from the analysis because 50% of the expected frequencies counted less than five. Of the seven categories of problems tested none varies significantly with seniority. On the basis of these results the null hypothesis is accepted for all seven problems listed in table 71. This means that seniority is not a significative influencing factor in the frequency with which engineers find problems when acquiring or using information.

The comparison of percentages presented in table 72 shows some interesting tendencies in the frequency with which engineers found these problems when they are related to seniority level. Thus for example:

a) The problem of economical accessibility "found information expensive" tended to increase with seniority;

b) The problem of finding the language "too technical" tended to decrease with seniority;

c) The problem "information was classified" is mainly felt in the early years of an engineer's career;

d) "Did not know where to look" for information and "found language too technical" were not seen as frequent problems by the senior group;

e) The junior group tended to encounter the problem "did not find information in Portuguese" more frequently than did the medium and senior groups. However the difference between the junior and senior groups in opposition to a larger difference between the junior and master groups should be noted.

TABLE 71
RESULTS ON THE FREQUENCY OF FINDING PROBLEMS BY SENIORITY

PROBLEMS	CHI-SQUARE (d.f = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Did not find current information	2.810	0.245	Accepted
Did not have access to unpublished information	3.159	0.206	Accepted
Did not find relevant information	0.821	0.663	Accepted
Received information too late for use	0.676	0.713	Accepted
Did not find information in Portuguese	5.087	0.079	Accepted
Information was expensive	0.657	0.720	Accepted
Lack professional help to find information	0.112	0.945	Accepted

Effective sample size = 87

TABLE 72
PERCENTAGE OF ENGINEERS ENCOUNTERING INFORMATION PROBLEMS FREQUENTLY* BY SENIORITY

TYPE OF PROBLEMS	Percentage of Engineers Encountering Problems Frequently by Seniority JUNIOR (1-5) N=25	MEDIUM (6-15) N=41	SENIOR (+15) N=24
Did not find current information	40.00	53.66	33.00
Did not have access to unpublished information	48.00	51.22	29.17
Did not find relevant information	24.00	34.15	33.33
Did not know where to look	04.00	12.20	00.00
Found language too technical	08.00	04.88	00.00
Received information too late for use	28.00	19.51	25.00
Did not find information in Portuguese	92.00	68.29	79.17
Information was expensive	52.00	53.66	62.50
Lacked professional help to find information	28.000	31.71	29.17
Found information, but it was classified	20.00	07.32	04.17

Effective Sample Size = 87
N= Number of respondents facing problem within each degree.
*Frequently, facing the problem 41% of the time or more frequently

c) Hypothesis on Problems on Information Use by Productivity

Data from question 9 and 10 were analysed using chi-square tests in order to see if productivity influences the frequency with which BMEs. face ten different problems in obtaining and using information. Four problems: 1) did not know where to look, 2) found language too technical, 3) could not find information in Portuguese, 4) found information but was classified, were eliminated from the analysis because 33% or more of the expected frequencies counted less than five.

It was hypothesized that:

Hø 9c Productivity does not influence the frequency with which engineers encounter problems in obtaining and using information.

The null hypothesis has been accepted because none of the problems tested significantly with productivity. This means that productivity is not responsible for the differences in the frequency with which engineers encounter the problems listed in table 73.

The percentages on table 74 show certain tendencies in the frequency of encountering problems that are worthwhile pointing out:

a) Language related problems such as "found language too technical" and "did not find information in Portuguese" are problems faced more by medium producers. High and low producers did not find these language problems on a frequent basis;

b) Economical accessibility "information was expensive", "did not have access to unpublished information" and "find relevant information" are more problems for high producers than they are for any of the other two groups;

c) "Found information but it was classified" is more a problem for medium and high producers than it is for the low producer group;

d) The frequency of "not finding relevant information" tended to increase as level of productivity increased;

e) "Delay in getting information" is slightly more a problem for "low producers" than it is for any of the other two groups.

TABLE 73
RESULTS ON THE FREQUENCY OF FINDING PROBLEMS BY PRODUCTIVITY

TYPES OF PROBLEMS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Did not find current information	0.235	0.889	Accepted
Did not have access to unpublished information	2.337	0.31	Accepted
Did not find relevant information	3.681	0.159	Accepted
Received information too late for use	0.164	0.921	Accepted
Information was expensive	1.875	0.392	Accepted
Lacked professional help to find information	2.127	0.345	Accepted

Sample Size = 91

TABLE 74
PERCENTAGE OF ENGINEERS ENCOUNTERING INFORMATION PROBLEMS FREQUENTLY*BY PRODUCTIVITY

TYPES OF PROBLEMS	Percentage of Engineers Encountering Problems by Productivity		
	Low N=22	Medium N=51	High N=18
Did not find current information	45.45	45.10	38.89
Did not have access to unpublished information	40.91	41.18	61.11
Did not find relevant information	31.82	25.49	50.00
Did not know where to look	13.64	03.92	05.56
Found language too technical	00.00	07.84	00.00
Received information too late for use	27.27	23.53	22.22
Did not find information in Portuguese	77.27	80.39	72.22
Information was expensive	59.09	49.02	66.67
Lacked professional help to find information	36.36	23.53	38.89
Found information, but it was classified	04.55	11.76	11.11

Sample size = 91
N = Number of respondents within each productivity level
*Frequently, if they faced the problem 41% of the time or more frequently.

9.2 Frequency of Actions Taken by Engineers when Information Needed is not Available

Question 11 identified the frequency with which three different actions are taken by engineers when the information needed is not immediately available. The action is considered "frequent", if it has been taken 41% of the time or more (categories of the questionnaire sometimes; frequently and most of the time or always); "Infrequent" if the action has been taken 40% of the time or less, (categories of the questionnaire: occasionally, and seldom or never).

This study found that the attitude most frequently taken by the majority (82.50%) of BMEs was "to continue to work without information and try again later". Other actions such as "to continue to work without information" and "interrupt the work and wait for the information", were taken frequently by 66 % and 9.90% of the respondents, respectively.

TABLE 75
PERCENTAGE OF ENGINEERS TAKING ACTIONS FREQUENTLY*

ACTIONS	Number of Engineers	In Sample Percentage
Continue to work without information	60	66.00
Interrupt the work and wait for information	09	09.90
Continue to work and try again later	75	82.50

Number of respondents = 91
* Frequently = More than 40% of the time

Table 75 displays the percentage of engineers taking the 3 different actions on a frequently basis. Table 76 shows the different frequencies with which these actions are taken.

TABLE 76
PERCENTAGE OF ENGINEERS TAKING ACTIONS WITH DIFFERENT FREQUENCIES

ACTIONS	SELDOM NEVER 0-20% of time)	OCCASIONALLY (21-40% of time)	SOMETIMES (41-60% of time)	FREQUENTLY 61-80% of time)	MOST OF THE TIME (81-100% of time)
Continue to work without information	13.20	20.90	18.70	22.00	25.30
Interrupt the work and wait for information	71.40	18.70	07.70	02.20	00.00
Continue to work and try again later	07.70	09.90	17.60	24.20	40.70

Number of respondents = 91

9.2.1 Frequency of Actions Taken by BMEs Related to Personal Variables

No studies that examine the different attitudes taken by users when they face problems in the availability of information were found in the literature. In this study we explore how personal factors as measured by variables such as educational degree, seniority and productivity relate to the frequency with which engineers take different actions when the information needed is not immediately available. Three hypotheses were formulated to explore this relation. For statistical analyses the categories listed in the questionnaire for the independent variables were grouped as follows:

d) Educational degree - three levels of education were considered: bachelor's, masters and Ph. D.;

e) Seniority - engineers were grouped into three categories: junior (1 to 5 years); medium (6 to 15 years) and senior, (more than 15 years in the institution);

f) Productivity - three levels were used for the analysis: low medium and high.

The 5 categories of frequency with which each one of the three different attitudes were taken by engineers collapsed into two groups: a) frequently, if the respondent took the attitude 41% of the time or more (categories of the questionnaire sometimes, frequently, most of the time or always) and b) infrequently, if the engineers took the attitude 40% of the time or less (questionnaire categories, occasionally, seldom or never).

d) Hypotheses on Actions Taken by Educational Degree

It was expected that engineers with more advanced degrees would continue to work without information with higher frequency than those with lower degrees. On the other hand, we expected that degree would not influence the attitude of "continue to work without information and try again later".

It was hypothesized that:

Hø 9d There is no difference in the frequency with whichengineers take attitudes a) continue to work without information and b) continue to work without information and try again latter, with respect to educational degree.

This hypothesis was sub-divided into two sub hypotheses:

Hø 9d1 There is no difference in the frequency to "continue to work without information" with respect to educational degree.

Hø 9d2 There is no difference in the frequency to "continue to work without information and try again later" with respect to educational degree.

A series of chi-square tests were performed on educational degree (Q1) and the actions listed in Q11 items 2 and 3 to find out if degree affected the frequency with which these two actions were taken by our respondents. Hø 9d1 was rejected, meaning that degree makes a difference in the frequency to continue to work without information. On the other hand, Hø 9d2 was accepted meaning that the frequency with which engineers continue to work without information and try later is independent of degree (table 77).

TABLE 77
RESULTS ON THE FREQUENCY WITH WHICH ACTIONS ARE TAKEN BY DEGREE

ACTIONS	CHI-SQUARE (d.f. = 2)	PROB.	LEVEL OF ACCEPTANCE 0.05
Continue to work without Information	6.985	0.030	REJECTED
Continue to work without information and try again later	2.641	0.267	Accepted

Effective Sample Size = 87

TABLE 78
PERCENTAGE OF ENGINEERS TAKING ACTIONS FREQUENTLY* BY DEGREE

TYPE OF PROBLEMS	Percentage of Engineers Taking Different Actions Frequently by Degree		
	Ph. D. N=44	MASTER N=31	BACHELOR N=12
Continue to work without information	72.73	70.97	33.30
Interrupt the work and wait for the information	09.09	06.45	16.67
Continue to work and try again later	84.09	87.10	66.67

Effective Sample Size = 87
N= Number of respondents within each degree.
*Frequently, taking attitude 41% of the time or more frequently

These results were somehow anticipated because engineers with post-graduate degrees would rely more heavily and frequently on their own knowledge and experience to continue to work without information than the bachelors group. Furthermore it is interesting to note that engineers with only a bachelors degree were more likely than the other groups to interrupt their work and wait for needed information and much less likely to continue their work without the information. This may be a indication that engineers without a bachelors degree have greater need for the information demanded than their colleagues with higher degrees. This may be motivated by their lower confidence in their own knowledge and experience.

e) Hypothesis on Actions Taken by Seniority

It was believed that the familiarity that engineers develop with their institution because of their "institutional age" would lead to differences on the frequency of the actions taken "continue to work without information". It was expected that senior engineers would take this action less frequently than their colleagues with fewer years with the institution.

It was hypothesized that:

> Hø 9e There is no difference between engineers with different levels of seniority in the frequency of taking the action continue to work without information.

A chi-square test was run on Q11 item 1 and seniority Q3, to find out if seniority affects the frequency with which the respondents take the action: "continue to work without information". Contrary to our expectations, and although engineers from the senior group took this action 23.89% less frequently than the medium group and 5.83% less frequently than the junior group, these differences in frequency are not statistically significant. Thus, the Hø 9e is accepted ($x2 = 4.578$, $d.f. = 2$. $P > 0.101$), meaning that seniority does not influence in a statistical meaningful way the frequency with which engineers "continue to work without information".

When the figures presented in table 79 are analysed we can see that the junior group of engineers was more likely to interrupt their work and wait for the information than the more senior group. The junior group of engineers also took the attitude "continue to work and try again latter" slightly less frequently than the other two groups, but these differences are not significant either. Thus, the results show that seniority is not related to the frequency with which BMEs took all three attitudes.

TABLE 79
PERCENTAGE OF ENGINEERS TAKING ACTIONS FREQUENTLY* BY SENIORITY

ACTIONS	Percentage of Engineers Taking Actions Frequently by Seniority JUNIOR (1-5) N=25	MEDIUM (6-15) N=41	SENIOR (+15) N=24
Continue to work without information	60.00	78.05	54.17
Interrupt the work and wait for information	16.00	04.88	08.33
Continue to work and try again later	76.00	82.93	87.50

Effective Sample Size = 87
N= Number of respondents within each degree.
*Frequently = Action taken 41% of the time or more frequently

f) Hypothesis on Actions Taken by Productivity

It was believed that different productivity levels would lead to differences in the frequency of the action taken "continue to work without information". We expected that engineers with a higher productivity level would take this action more frequently than their colleagues with medium and lower levels of productivity.

It was hypothesized that:

Hø 9f There is no relationship between the frequency of taken the action "to continue to work without information" and level of productivity.

To test this hypothesis an index of productivity level was computed using responses to questions 9a, b and c. The procedure for computing this index is described in chapter 4. Q11, item 1 provided the source for the action tested. A chi-square test was performed to test the relationship between the frequency with which this action was taken by our respondents and their productivity level. Contrary to our expectations the Null hypothesis was accepted (x2 = 3.485 d.f. = 2, Prob. 0.175) meaning that productivity level and the frequency with which engineers "continue to work without information" are unrelated.

The differences with which this attitude is taken frequently by the three groups of respondents (table 80) show that medium producers have a tendency to take this attitude more frequently than the other two groups of engineers. However the variation with which this attitude is taken was less marked between the medium and high producers group than it was between the low producers group and the groups with higher productivity level (medium and high). This finding indicates that it is not the quantity of publications which influences the frequency with which engineers continue to work without information.

Data presented in table 80, reveal that the differences in the frequency with which engineers with medium and high level of productivity take actions "continue to work without information" and "continue to work and try again later" is little.

TABLE 80
PERCENTAGE OF ENGINEERS TAKING ACTIONS FREQUENTLY* BY PRODUCTIVITY

TYPE OF ACTIONS	Percentage of Engineers Taking Different actions by Productivity Low N=22	Medium N=51	High N=18
Continue to work without information	50.50	72.55	66.67
Interrupt the work and wait for information	13.64	07.84	11.11
Continue to work and try again later	68.18	88.24	83.33

Sample Size = 91
N= Number of respondents within each productivity level
*Frequently = When attitude was taken 41% of the time or more.

9.3 Perception of Availability and Pertinence of Information Services

The user's perception of the services offered by his information system and the perception of pertinence of these services was investigated through Q16. With the exception of the service "accessibility to data banks" which are offered in three of the institutions all the other services are offered on a permanent basis by the information systems of the four institutions under study.

As seem from data displayed in table 81 "literature search on the state-of-the-art" was perceived by a minority of engineers (16.10%), as a service offered, as compared to 69.30% of the group who perceived this service as necessary. Loan (58.90%) and photocopy services (62.20%) have been perceived as available by the majority of respondents. High figures have also been found for the perception of availability of services such as ALERT (58.60). A majority of our sample (55.20%) also perceived that a "question and answer service" was provided by their libraries, and (48.90%) perceived this service as pertinent to their information needs. Other personal services were perceived as available by 35% or less percent of the respondents. As a whole and with the exception of the service of quick reference, all the percentages related to " pertinence of services" were higher than the "percentages for the perception of availability of services" offered by the engineers libraries. Loan (78.40%) and photocopy services (79.50%) together with

TABLE 81
PERCEPTION OF AVAILABILITY AND PERTINENCE OF INFORMATION SERVICES BY BMEs

	PERCENTAGE OF ENGINEERS	
TYPES OF SERVICES	AVAILABILITY	PERTINENCE
Question and answer (quick reference)	55.20	48.90
Preparation of bibliographies	35.60	72.70
Search on "the state-of-the-art"	16.10	69.30
Translation of technical documents	10.30	39.80
Photocopy of written materials	63.20	79.50
ALERT (circulation of bulletins including indexes of technical and scientific journals)	58.60	02.70
Loan of bibliographic materials (books,journals, patents, etc.)	59.80	78.40
Accessibility to data banks	23.00	76.10
Reference services (guidance to other people or written sources)	32.20	47.70

Effective sample Size = 88

"accessibility to data banks" (76.10%) are perceived by engineers as the most pertinent services offered by their systems. Translations of technical documents is perceived as offered by 10.30% but 39.10% of the BMEs consider this service as pertinent. As a whole, the results of the present survey show a population of engineers who look at libraries not only as organizations that concentrate their activities on classical aspects of librarianship (lending materials and providing photocopies) but libraries are seen as institutions which are able to offer personal services that the engineers feel pertinent to their needs. Unfortunately, because no comparative data were found, these results can not be compared to results of other studies.

9.4 Frequency of Use of Different Types of Information During the Last Year of Work

For discussion purposes "frequent use" is defined as used on at least on a monthly basis (questionnaire categories "at least once a day", "at least once a week" and "at least once a month"); "infrequent use " is defined as used on a trimester basis or less frequently (categories "at least once a trimester" and "rarely or never"). The data analysis (Table 82) shows that from the 16 types of information listed, only four types of information (information on the state of the art, on equipment, on technological innovation and processing technology) were used frequently by 48% or more of BMEs in connection with their work during the last year. On the other hand, four types of information were rarely or never used by the 84% or more of respondents: packing and transport, industrial and product safety, processing of industrial refuse and pollution control. Nearly 25% of the sample frequently used market information (consumer needs, availability and demand) and information on production planning and control. The other types of information were used frequently by over 25% or more of the BMEs. It is difficult to compare our results of other studies because "use" and "categories of information" are defined differently. For example, Wood and Hamilton (1966) define 3 types of information: "competitive products, improvements in technical performance or "know-how", and new technical ideas. Rawdin (1975) used categories such as: facts/data, concept and ideas, facts and ideas. Shuchman (1981) included 16 different types of information, and Raitt's (1984) reduced his original list of types of information to four categories: facts, ideas, advices and opinions.

TABLE 82
PERCENTAGE OF ENGINEERS USING TYPES OF INFORMATION FREQUENTLY*

TYPES OF INFORMATION	No OF ENGINEERS	IN SAMPLE %
Information on the "state of the art"	59	64.90
Economic/administrative information	36	39.60
Market information	21	23.10
Information on equipment	52	57.20
Information on raw materials	29	31.90
Processing of industrial refuse	11	12.10
Processing technology	44	48.40
Production, planning and control	21	23.60
Technological innovation	55	60.50
Standards and specifications, laws and regulations	29	31.90
Quality control	25	27.50
Packing and transport	04	04.40
Industrial and product safety	06	06.60
Pollution control	14	15.40
Conservation of energy	33	36.30
Product development/industrial design	30	33.00

* Frequently, use at least on monthly basis or more frequently
Number of respondents = 91

TABLE 83
PERCENTAGE OF ENGINEERS USING TYPES OF INFORMATION WITH DIFFERENT FREQUENCIES

LESS THAN	AT LEAST ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	ONCE A TRIMESTER	RARELY OR NEVER
Information on the "state of the art"	09.90	26.40	28.60	27.50	07.60
Economic /administrative information	05.50	17.60	16.50	23.00	37.40
Market information	01.10	07.70	14.30	26.40	50.50
Information on equipment	09.90	19.80	27.50	31.80	11.00
Information on raw materials	02.20	17.60	12.10	34.00	34.10
Processing of industrial refuse	00.00	03.30	08.80	18.70	69.20
Processing technology	08.80	18.70	20.90	20.80	30.80
Production, planning and control	00.00	06.60	16.50	17.60	59.30
Technological innovation	05.50	22.00	33.00	22.00	17.50
Standards/laws, specifications regulations	00.00	07.70	24.20	35.10	33.00
Quality control	02.20	08.80	16.50	23.0	49.50
Packing/transport	00.00	02.20	02.20	15.40	80.20
Industrial and product safety	00.00	03.30	03.30	19.80	73.60
Pollution control	00.00	04.40	11.00	26.40	58.20
Conservation of energy	05.50	16.50	14.30	20.90	42.80
Product development industrial design	05.50	4.30	13.20	22.00	45.00

Number of respondents = 91

9.5 Discussion of Results

a) Problems on Information Use and Actions Taken

BMEs were asked to indicate the frequency with which they faced ten different problems when they were obtaining or using information in their work. They were also asked to indicate the frequency with which they took three different actions when information needed was not immediately available. The problem or action was considered to be frequent if it was faced or taken 41% of the time or more, otherwise it was considered infrequent.

The problem of not finding information in Portuguese was the most frequent problem faced by the members of our sample. It becomes clear from this study that although BMEs have a high reading ability in foreign languages (table 7), especially English (96.70%) and use literature published in this language more than they use publications in Portuguese (table 37), they would like to have more information in Portuguese. One explanation for the high incidence of this problem is that it is possible that the international scientific and technical literature does not necessarily focus adequately the problems Brazilian engineers want or have to solve. The lack of availability of information in the BMEs' mother tongue is not only due to the lack of adequate Portuguese language sources, but it may also be due to the poor bibliographic control (at a national and international level) of the publications in Portuguese. There is evidence in the literature that Brazilian scholars find it easier to reach their own national colleagues publishing in foreign journals than using Brazilian publications (Rosenberg and Cunha, 1983). This is possibly due to the better bibliographic control in foreign publications. The incidence of the problem of not finding information in Portuguese is at a high level in all the subgroups of the sample, and although not significant, differences were found when degree seniority and productivity level were considered. It is evident that this problem is more critical among medium producers, junior engineers and engineers with masters and bachelors degrees.

The problem of "finding information expensive" .is also critical for BMEs. Our data reveal that books and journals are predominantly used over other forms of written sources and that the majority of BMEs use their institutional library and Nucleos as locations to look for the written sources needed (table 49). It could be argued that this behaviour is a result of the engineers' perception of the expensive prices paid by libraries to acquire these materials especially when imported. Usually imported materials when sold in Brazil will cost twice as much as the original price paid in the country of their publication. While this is true, the likehood of expensiveness of information seems to be also related to the engineers' concern with the money they have to spend personally acquiring the materials that libraries can not provide. The high percentage of engineers using bookstores and personal files and collections to look for the sources needed (table 49) gives support to this explanation. This situation raises additional questions. For example, if one of the basic functions of the library is the provision of documents and information needed by their users, to what extent are libraries accomplishing this basic function? Or, in countries in which budgeting is not a tradition, how can head librarians and administrators make sure the basic bibliographic materials can be purchased? This situation calls the attention of managers to the need not only for appropriate library budgets but mainly for independent budgeting. Attempts have been made in this direction by various University libraries in Brazil, but they have failed because library administrators do not have the independence to implement budgets or the funds allocated are corroded by inflationary processes. As a consequence needed materials can not be acquired and services such as provision of photocopies of materials not available in the library and requested by the user free of charge or with minimum charges can not be offered. At present, library budgets are still part of the institutional central budget which suffers continuous changes, and cuts are common due to inadequate planning and to the inflationary spiral. When cutbacks have to be made in the general budget it is not unusual that the library budget is the first one to be affected. As a consequence initial library planning for acquisitions can not be successfully accomplished.

The results also reveal that there is a high percentage of engineers that take the action "continue to work without information" when problems are faced and although the percentage of engineers who persist in looking for information while continuing to work is also high, there is still the issue of how this problem affects the BMEs productivity. There is evidence in the literature that authors from less developed countries (LDC) experience higher rejection rates in materials submitted for publications than authors from more advanced countries. According to Gordon (1979) these rejections are directly related to the low level of "current awareness" among scientists from LDCs. The fact that high producers face problems such as "unable to get current information", "did not have access to unpublished information" and "information was expensive" (table 73) with higher frequency than engineers with low and medium productivity reinforces Gordon's view.

The literature showed that a quantitative analysis of scientific papers published in journals indexed by the Institute of Scientific Information, indicated that between 1967 and 1974 the number of Brazilian authors indexed had practically quintupled, however the number was still insignificant in the world total share 3%. In relation to the total population of the country there are around six authors per one million inhabitants (Morel, 1977). It can be argued that the Brazilian productivity of articles is only included in foreign index services to a small extent and probably since Morel's study these figures of 3% have increased. But undoubtedly, Brazilian scientific productivity is still small in relation to standards of developed countries. We did not investigate the scientific and technical contribution of BMEs in relation to scientists and engineers from other areas in Brazil, however our data indicate that the engineers under study are a group of good contributors to the Brazilian scientific and technical production system (table 10 and 11). To what extent the contribution of BMEs to the Brazilian scientific and technical information output is inhibited in its quality and quantity by information problems is not clear.

The frequency with which respondents face problems in finding current and relevant information and the lack of accessibility to unpublished data reflects the poor information infrastructure of the Brazilian library services. In developed countries where the tools of information access are numerous and efficient it is likely that relevant information can be brought to the users' attention. Brazil lacks tools of basic bibliographic control and does not have efficient document delivery services, although many efforts have been made by Brazilian institutions such as IBICT (Instituto Brasileiro de Ciencia e Tecnologia) to provide the country with a National Union Catalogue of Periodicals and COMUT and BICENGE (Biblioteca de Engenheria) to organize a back up document delivery service of photocopies of articles of journals. A long road has to be travelled for these services to have the quality and consistency the users require. National data bases and a Union Catalogue of Monographs and other types of publications are still in the process of being created. Similarly, completed collections of journals are being built up in certain libraries around the country, to make photocopy services of articles requested a possibility. Technological information such as patents and legal specifications and standards is provided by INPI (Instituto Nacional de Informação em Normas e Patentes) through CEDIN (Centro de Documentação e Informação Technologica) and the ABNT (Associação Brasileira de Normas

Técnicas). Both institutions are also in the process of improving the accessibility to patents and legal specifications and standards. The main impact of automation in Brazil is still in the area of technical process functions. Very few libraries make use of computers to put together bibliographies for serials or monograph publications. Likewise, on-line bibliographic foreign data bases are used by few libraries. At present the storage, bibliographic control and dissemination of scientific and technological work completed or in progress in Brazilian Institutions, especially Universities and Research Institutes, is minimal.

The percentage of BMEs facing the problem "lacked professional help to find information" (29.70% against 70.40% who claimed this problem as infrequent) could be taken as an indication of very good standards of library assistance. However the infrequent use by the majority of engineers of librarians, internal and external to the engineers institution (table 49) and the figures for the problem "did not know where to look" for information seem more to indicate that BMEs are self-sufficient about finding the information they need and have a tendency to search for it personally. In the case of searches in the state-of-the-art, self searching seems to be motivated by the engineers lack of perception that this service is offered by their information systems (table 81).

There are often complaints by users that the library provision of information is slow. Yet in our survey, close to 40% of the respondents seldom or never obtained the information too late for use and 24% reported this problem as frequent. Although some delay is inevitable, it is very difficult to set limits to what is a reasonable delay, since this will vary with the type of material requested, the type of work for which it is requested and the degree of urgency of the request and the expectations of the requester. It seems that the expectations of the majority of BMEs are influenced by a lenient attitude developed towards problems related directly or indirectly to delay. This attitude can not be interpreted as lower expectations or satisfaction of users with the services offered. In a country like Brazil where information infrastructure is different from countries such as USA or England, this attitude only reflects the good-will of users and their way to survive with information systems that face many difficulties. A delay which might seem to be reasonable to BMEs would be probably considered a big delay by users of countries where information systems work more efficiently. Within this panorama it is very understandable that the majority of engineers persist in looking for the information while they continue to work and very few stop their work to wait for the information needed.

Amongst our sample the least overall frequent problems were "find language too technical" and "find information in a language that they were unable to read because of language difficulties". These are expected results in view of the qualifications, academic standards and competence in a foreign language (table 4 and 7) of the majority of members of our sample.

b) Problems and Actions Taken Related to Personal Variables

Six hypotheses were tested on the influence of the personal characteristics of the user on the frequency of encountering information problems and actions taken by engineers when the information needed was not immediately available.

With the exception of the problem "did not have access to unpublished information" whose frequency was significantly affected by degree, levels of frequency of encountering other problems did not vary significantly with degree, seniority and productivity. Engineers with a Ph. D. degree face this problem significantly more often than their colleagues with lower degrees. A higher need for unpublished information by the

Ph.D. group in relation to their colleagues with lower degrees is implicit in the above finding, reinforced by data in table 41 which show Ph. D. engineers as the only group that claims to use unpublished papers as a source of information. Moreover, the high percentage of engineers facing difficulty in having access to "unpublished information" may be an indication that the collaboration in the areas in which Ph. D. engineers are working is good enough to make them aware of existing unpublished information, but insufficient to give them accessibility to these data. Our research reveals BMEs as a group of users that seldom or never use external sources, and although it is noticeable that when respondents are divided by degree, Ph. D. engineers are the only ones to use colleagues from other institutions (table 53). There is evidence that scientists who do not have groups of collaborators in their research areas would have more difficulties in locating published and unpublished information (Crane, 1972). Our data also reveal that there is a tendency for the economic problems to increase as educational and seniority level increase (table 69 and 71). This seems to indicate that the capability of the libraries to attend the demands of their users decreases with the sophistication of the users.

The frequency with which engineers take the attitude "continue to work without information" was also influenced by degree. Engineers with a Ph. D. degree continue to work without information significantly more often than their colleagues with lower degrees. More confidence in their own knowledge and greater time pressures might be among the explanations for this. Furthermore, continue to work without information is not related to productivity level. This finding indicates that it is not the quantity of publications which influences the frequency with which engineers continue to work without information. Perhaps these variations are more attributable to the type of publication in which the engineer is working. Dead-lines established for publications such as articles in journals, presentations of projects and technical reports must be met on time. Data collected on BMEs productivity (table 10 and 11) indicate that these publications are the most common types of scientific and technical output of our respondents.

The frequency differences when the personal characteristics are taken into consideration, although not statistically significant, revealed some interesting tendencies. Thus for example, although low producers and junior engineers seem to have problems in getting information in time for use more frequently, these groups of engineers interrupt their work and wait for the information more frequently than the other groups of respondents. Junior and low producers are also less likely to continue to work without information. These findings suggest that both groups of engineers have a greater need and urgency for the fulfillment of their demands than do senior engineers or higher producers, maybe motivated by their lower confidence, lack of experience and knowledge.

c) Perception of Availability and Pertinence of Information Services

It is noticeable that the BMEs awareness of the information services offered by their information systems is lower than their awareness of the pertinence of these services. These results imply that the BMEs information systems were inefficient in letting users know about the library services offered. "Information on the-state-of-the-art" is among one of the services frequently perceived by engineers as relevant to their needs and although this service is offered by all institutional information systems it has been perceived as not available by the majority of the respondents (table 81). Furthermore, literature search on "the-state-of-the-art is is also the type of information service most used by engineers in their work (table 82). This result implies that engineers are in need of this service and willing to profit from searches made by the library staff. On this evidence a supportive information service on literature search which could develop into a high quality comprehensive and critical literature search, that would provide the requester with a summary sheet rather than references, present a good market for libraries. At present, comprehensive and critical literature searchers still belong to the self service area because it can be claimed that BMEs would gain substantially more by performing a search themselves than delegating these searches to individuals who are not skilled with subject knowledge.

Our data also suggest that at this point BME's have a better perception of the pertinence of "data banks" as a mean to acquire information than a few years ago when "accessibility to data banks" was offered on trial basis for a period of time in university libraries. The service was subsidized by the government but users had still to pay a small fee. After some time the accessibility to data banks was discontinued in some libraries because its use was low. Whether this was due to the inability of the library to sell and publicize this service, the attitude of the user that information must be free of charge, or to the personal preferences of the user is something that was not determined. However the engineers current experience in the use of computers may be responsible for this change in attitude. This may be the appropriate time for libraries to consider the re-instatement of this service.

Our results indicate that engineers are primarily dependent on written information for their work, and as a group they are self-sufficient users who know where to look for the information and how to search for it provided it is available. On the basis of these findings perhaps the library staff and resources would be better employed in organizing an optimum system for self help than attempting to organize reference desks and reader services. "Spoon feeding" of information to all BMEs would not be as helpful as, for example, a strong library collection, with freedom to achieve familiarity with the literature. However a selective feeding service on request, based on a continuous scanning of the literature on the engineers' subject area and the feeding of references, abstracts and the materials as they appear seem to be relevant. Personal services on request would be likely to offer a better pay-off in terms of investment of time and money.

The pertinence of the service of translation of technical documents was pointed out by close to 40% of the respondents. Since the weakness of our sample was found in languages such as German, French and Italian (table 7), a rational solution to the problem seems to be the provision of translation services of on request for documents published in these languages. A close cooperation between the library and the foreign language departments of the engineers' institution may solve the libraries immediate problem-shortage of qualified personal who could provide adequate technical translations.

d) Information Use During the Last Year of Work

When engineers were asked to select types of information they needed with higher frequency the previous year, the results show a pattern of frequency of use which can divide information types in three broad groups by frequency. The first group of frequently used types of information included information on "the state of the art", "information on equipment", "technological innovation" and "processing technology". The four types seem clearly related to the functions BMEs perform more frequently in their Brazilian institutions. which are to lecture, supervise theses, do research and consulting. The second group of types of information is used less frequently than the previous types by the BMEs. About one third of the sample states to use them frequently. Among them are: "economic/administrative", "market information", information on "raw materials", "standards and specifications, laws and regulations", "conservation of energy", "product development/industrial design", "quality control" and "production, planning and control". The third set of types of information has a rather low frequent use among the engineers of the sample. They basically refer to "industrial refuse", "packing and transport", "industrial and product safety" and "pollution control". This diversity of use is possibly a reflection of the diversity of the tasks and projects engineers are involved in. It probably also tells the reader what BMEs emphasize and in what engineers spend most of their reading time. The information type list presented to the Brazilian engineers is limited but it gives information experts an idea of where the information needs of this group of engineers lie.

9.6 Summary of Main Findings

What the analysis of the problems and attitudes reveals is that the BMEs difficulties in using and acquiring information are in the area of accessibility and availability of information. It also reveals that a high percentage of engineers continues to work without information, and that with the exception of the problem "did not have access to unpublished information" and the attitude "continue to work without information" which were significantly affected in their frequency by degree, all other problems and attitudes were not influenced in their frequency by degree, seniority or productivity. However differences in levels of frequency although not statistically significant showed some tendencies with which the problems experienced and attitudes taken did vary when the personal characteristics of the user are taken into consideration. This study also shows that some information services are perceived as offered by the majority of the sample, others are perceived as being offered by a moderate percentage of engineers, but as a rule, with the exception of the service "quick reference", the BMEs see services they regard as pertinent as not being provided.

In our sample, the most frequent problems encountered by the majority of the respondents were "Did not find information in Portuguese" and "Information was too expensive". Problems related to finding current information and lack of accessibility to unpublished information were reported as frequent problems by just under one half of the respondents. The problems of arrival of information on time for use, finding relevant information and lack of professional help to find information were considered frequent by between a quarter and a third of engineers. The overall least frequent problems were "find language too technical", "find information in a language that they were unable to read", "not know where to look for information" and "found information but it was classified". In the case of the problems of information use that we investigated "information was expensive" was reported by engineers as one of the main problems.

Results of this research also indicate that BMEs made relatively little use of external categories of people. Channels outside the organization are usually more expensive than internal channels because they imply more expensive means such as for example telephone, telexes, transportation to meetings, etc. These data suggest that there might be a relation between cost of channel use and frequency of use of external channels. Research could be conducted to investigate to what extent "cost of use of channels" influences the frequency of use of external people to the engineer's organization.

We feel that these results can provide some insights and broaden the perspective from which to view the frequency of encountering problems and actions taken by BMEs. Some of the main problems, identified can be useful in better planning of in-service programs where use of professional information services shall be the key objective.

CHAPTER 10

REVIEW OF THE OBJECTIVES, IMPLICATIONS, FUTURE RESEARCH AND CONCLUSIONS

It was noted in Chapter 1 that empirical data were required for the comprehension of Brazilian engineer's needs and use of information. This study collected data and presented findings on various aspects of information use by BMEs working in academic institutions in Brazil. This chapter reviews the objectives of the study, discusses the theoretical and practical implications of the findings, discusses the main points raised through the present research, suggests some issues for future research, and presents conclusions.

10.1 Review of the Objectives and Findings

The motivation for this study is to be found in the need for information studies in the area of mechanical engineering in Brazil. As already noted, before the late 1970s there was little investigation on the information needs and information seeking behaviour of Brazilian users. BMEs as teachers, scholars, researchers and practitioners are an identifiable user group presumably with information seeking habits, problems and attitudes of their own. But previous studies did not look into these aspects of information use in relation to BMEs working in academic institutions in Brazil. This is the first study to look into the information seeking behaviour, problems, attitudes and variables affecting the use of information of this population of users. This being the first study of its kind, one of the objectives was to draw a careful educational and work profile of this group of users.

The characteristics of these BMEs in terms of education, length of service in the present institution, foreign reading ability, productivity level and activities in which they are involved were discussed in chapter 6. In general BMEs are a highly qualified professional group, the majority holding a post-graduate degree (master's or Ph. D.), have received their post-graduate training in developed countries such as USA, UK, Canada, West Germany and France, read two or more foreign languages and are relatively good producers (over 50% are medium producers). Their production is mainly concentrated on publications such as articles in journals, technical reports and projects. In terms of position within the career structure most of the academics are either in the assistant professor or associated professorship status. The number of years of service in their present institution shows the majority of BMEs as not a especially mobile group, who within their responsibilities in teaching, research, and participation in committees are the main activities for the majority of BMEs.

Another objective was to outline a frequency picture of the use of information sources and channels by BMEs. Data collected in this study (discussed in chapters 7 and 8) reveal that the majority of BMEs use information sources and channels with various frequencies:

a) Use of Formal Written Information Sources

The pattern of use for these sources is **weekly** for textbooks and monographs and technical and scientific literature; **monthly** for tables, handbooks, indexes, bibliographies and abstracts, conference proceedings, and newspapers; **trimestral** for catalogues, bulletins published by the industry, laws and regulations, specifications and standards, technical reports (internal and external), theses and dissertations. Newspapers and patents are **seldom** or **never** used.

b) Use of Interpersonal Information Channels

b.1) Informal Written Channels

The pattern of use for informal written sources is **monthly** for letters and personal notebooks; **trimestral** for telexes. Unpublished papers and preprints are **seldom** or **never** used.

b.2) Informal Oral Channels

The pattern of use for informal oral channels is **daily for** telephone, **weekly** for talks in corridors and visits to offices of colleagues; **monthly** for meetings for projects from the engineer's institution; **trimestral** for visits to industry and visits to research and academic institutes.

b.3) Formal Oral Channels

The pattern of use for formal oral channels is **trimestral** for encounters at conferences, courses, seminars and industrial exhibitions and lectures and presentations at conferences, courses, seminars and industrial exhibitions.

c) Internal and External Channels

c.1) Categories of Locations Used as Internal and External Channels

The pattern of use for internal and external channels is weekly for personal files/records and collections; **monthly** for files/records and collections from the engineer's institution libraries and Nucleos and for files/records and collections from other libraries; **trimestral** for files/records and collections from institutional colleagues; departmental files records and collection. COMUT and bookstores, files/records and collections from professional organizations and files, records and collections from other institutions are **seldom** or **never** used.

c.2) Categories of People Used as Internal and External Channels

The pattern of use for different categories of people as means to get information is **weekly** for colleagues from the department; **monthly** for colleagues from the engineer's institution; **trimestral** for librarians from the institutional libraries and Nucleos and for the external category colleagues from other institutions. External categories of people such as: customers, vendors an manufacturers, consultants and librarians external to the engineers institution are **seldom** or **never** consulted.

The third objective was to identify the most frequent problems that surface during acquisition and information use. Our data indicate that the problems of BMEs are still mainly related to accessibility and availability of information.

The fourth objective was to outline a frequency picture of the attitudes taken by engineers when information needed was not available. It was found that although the majority of engineers continue to work without information they persist in trying to look for the information needed. Only a few engineers interrupt their work to wait for the needed information but almost two thirds of the sample continues to work without information. A discussion of problems and attitudes was given in section 9.5.

The final objective was to identify the variables influencing the frequency of use of sources and channels, and the problems and attitudes taken by engineers. It was found that educational level, seniority, productivity and accessibility influence the frequency of use of certain sources/channels. Educational degree also influences the frequency with which a problem was faced and action was taken by BMEs.

10.2 Theoretical Implications

This study sheds light on a number of aspects of librarianship related to the use of information by BMEs and highlights some of the differences and similarities in the use of information by Brazilian mechanical engineers and engineers from developed and developing countries. These differences are noticed in terms of use of formal written information sources, use of interpersonal information channels, problems encountered and actions taken.

10.2.1 Use of Formal Written Information Sources

The differences and similarities in the use of written information sources between BMEs and engineers from other countries were noticed in terms of hours spent reading, language in which literature is used and channels used to acquire formal written information.

a) Hours Spent Reading

Comparative data from other studies on the number of hours spent reading have revealed that engineers or scientists whose language is not English spend more hours reading than English native speakers. However our data reveal that BMEs spend about the same number of weekly hours reading as English-speaking engineers. The reason for the different result compared with the results of studies conducted among non-native English population can be probably found in the characteristics of the engineers under study. The majority of the BMEs have a high reading linguistic ability in the language (English) in which the majority of the literature they manipulate is published, have a post-graduate degree and a large percentage of them have received their degrees in developed countries.

b) Language in which Literature is Used

While native English speakers tend to rely almost completely on materials published in their native language, our results indicate that the majority of BMEs rely on information published in English as much or more than they rely on information published in Portuguese. However as the English speaking groups, BMEs seem to under use or not use at all materials published in languages different from English. This finding suggests that BMEs adopted English as their first language to get advances in their fields by "reading" books, articles, reviews, etc., and probably this predominance will be maintained or will decline according to the amount of information that will be published in other languages. It is also possible that BMEs are losing a significant amount of information and interaction because of dependence on English language materials.

c) Channels Used to Acquire Formal Written Information

As in other studies conducted in developed and developing countries BMEs personal files, records and collections are among the most frequent places consulted by engineers to acquire information for their work. Also in agreement with the literature, a major percentage of BMEs consult internal rather than external locations to acquire information for their work.

10.2.2 Use of Interpersonal Channels

The differences and similarities in the use of interpersonal information channels between BMEs and engineers from other countries were noticed in terms of hours spent communicating, and channels used to acquire oral information.

a) Hours Spent Communicating

Studies conducted in English-speaking developed countries found that engineers working in a non-academic environment spend more time communicating with colleagues than reading. Results from our study reveal that the majority of BMEs spend about the same time for both activities.

b) Channels used to Acquire Information

BMEs in academic institutions in Brazil communicate more with internal people than with people external to their organization. This pattern of use is similar to the pattern reported in studies conducted in developed and developing countries. However the majority of BMEs limit their communication to colleagues from the same institution because more than half per cent of our sample seldom or never communicate beyond the boundaries of their institution. A possible explanation was found in the differences that exist between engineers from developed and developing countries, in the perception of costs that have to be paid for the information received from a colleague. As it was pointed out in section 8.3 in developed countries (Allen, 1977) the personal cost paid for consulting colleagues in terms of technical performance or reputation for competence is less if external rather than internal colleagues are consulted. It seems that for engineers of our sample the opposite is true. Another difference between BMEs and users from developed countries was found in the use of preprints. While in developed countries most information-users get information for their work through informal media such as preprints and meetings (Garvey, 1979) two thirds from the sample of our study do not use preprints as a source of information for their work. This is a most unusual finding, since academic engineers would be expected to make as much use of the preprint system as do other academics

10.2.3 Problems and Attitudes

Studies conducted in developed English speaking countries as the USA and UK have shown that the main problems scientists and engineers face are identifying and disregarding irrelevant information from the massive amount that is available (University of Michigan, 1954; Shuchman, 1981). Linguistic ability in other languages than English was also a problem noted for English native speakers. The results of this study indicate that the information problems faced by BMEs are different from the problems faced by scientists or engineers from developed countries and more similar to studies conducted by Goldstein (1985) and Villarreal (1980) in Mexico, and Sabaratnam (1983) in Singapore, where the main problems of information are still related to accessibility and availability of information. The engineers' attitude in persisting in looking for information while continuing working is also a reflection of the information system. It is clear from the overall responses that the differences in problems and attitudes identified between BMEs and engineers from developed countries are mainly due to the differences between the Brazilian information system (e.g. deficient information infrastructure) and the information system from developed countries. However other differences seem to be due to the differences in characteristics of the population under study. (BMEs have a high reading linguistic ability, have post-graduate training and because of this they were exposed to instruction in literature searching and handling techniques, have international experience, are involved in various activities, etc).

10.3 Practical Implications

The main goal of this research was to achieve an understanding of information behaviour of BMEs. But some of the findings of the study can identify aspects of information that can be useful when seeking solutions or improvement of information use and information transfer among BMEs. Information transfer has ben described as a: "part of a larger system of knowledge transfer which includes a) education and training designed to create an awareness of and a capacity to select and utilize information; b) Research and Development that generates innovation and information; c) the data/information itself; and d) communication" (UNESCO 1981:5). Some of the practical implications of our findings and actions that might be taken will be discussed within this framework.

a) Education and Training

Data collected in this study reveal that although BMEs in general seem to have good training (sufficient knowledge and information to use sources), it is apparent that their education (awareness of services and systems) is poor. Thus, while training programs seem not to be a priority, education of BMEs in the information system, existing services, new services and resources available seem to be necessary. This will enhance the BMEs' awareness of the services offered by the Brazilian information system, so that engineers can fully understand the potent of these services and take better advantage of them. Educating engineers is not an easy task. It might be easier if the factors that influence selective provision of instruction given by Sullivan (1979) are considered. These factors are: provision of the instruction as a result of expressed general interest of the user, consideration of the status of the user (e.g. senior staff); provision of extra help to those who appear to need it; consideration of individuals activities (e.g. department, duties, areas of interest); amount of library use (e.g. are they frequent users, regular users); nature of library use (e.g. phone request, personal visit); nature of services required (e.g. do they require selective instruction in relation to library services?, particular services explained); time available, user competence, number of recruits, availability of new system to be demonstrated.

b) BMEs' Output

It is clear from our data that BMEs are good contributors to the Brazilian scientific and technical production system. Their contribution includes, books, articles (journals), technical reports, projects, technical regulations and patents. Apart from articles (journals), the BMEs greatest contribution comes from technical reports and projects. There is evidence in the literature that the rate of rejection of publication of works of authors from less developed countries is related to the low level of current awareness (Gordon 1979). Since "did not find current information" is a problem found by a large number of engineers it can be hypothesized that this might be one of the inhibiting factors of the quality and quantity of the engineers production (technical and scientific). However this has to be further investigated. Nevertheless, it is clear that the current awareness service ALERTA is not reaching all engineers who consider this service pertinent. An evaluation of the service to see if it is meeting its objectives is needed.

c) The Data/Information Itself

The analysis of the problems which are more likely to confront the engineers during the process of acquiring and using information indicates that there is a gap between the provision of information (by engineers information system) and the use of information (by engineers). Given the aim of bringing engineers into greater contact with the information needed, two main routes can be taken. The first one is directed toward the engineer himself. Its objective is to enhance his sophistication in information use. The second route is to make information more accessible. This is not an easy task but it is not an impossible one either. Information gathered during this research could be useful in making information more accessible. It was found for example that economic accessibility is one of the main problems faced by engineers when using information. This problem is related to the financial burden engineers have to undertake because libraries cannot provide the materials needed. If more money could be made available and independent budgets could be organized these problems could be minimized. But the perception of needs and the understanding of these needs by the decision makers and those who influence decision making of the value of libraries is also vital.

Improving the provision of materials needed by users calls for an evaluation of acquisition policies, and interlibrary loan services have to be carefully evaluated to see how they are affecting the availability of materials. The identification of information sources, what information is more frequently used by engineers and the tendencies of use of sources and channels, for example would help the library to review and redefine these policies. Since self-sufficiency as regards to total information availability is not possible even in the most advanced countries, developing information networks and resources sharing programs between institutions that have common goals and interests should be given high priority in the planning of library services. There appears to be among BMEs a need for publications in Portuguese. University libraries can play an important role in recording and making available the results of research conducted within their own and other institutions. This would make it easy to incorporate this information into national and international data.

The educational level of the users, good linguistic ability and lack of difficulties with technical language indicate that BMEs do not seem to have problems related to absorption and effective use of information. But just making information available is not sufficient to ensure its use. The manner in which people seek information is an important consideration in making sure the users obtain the information they need. This study found that FW information sources which offer quick information would be used more frequently by individuals who perceived them as being closer. There are also indications that the content of information might be an important determinant in the use of information, these findings indicate that making sources accessible and available is as important as maintaining their quality (content).

This study did not identify where reading is done. However the variety of activities in which BMEs spend their 40 contracted labour hours a week suggests that there is very little or no time for reading in working hours. If university administrators place any value upon the reading of scientific and technical literature and evaluation of the existing distribution of activities should be undertaken to determine if engineers have adequate time for reading during working hours. Provision of time for reading at work may increase the number of hours BMEs spend reading, to their advantage.

10.4 Communicating among Engineers

Results from this research indicate that interpersonal communicating among engineers as means to acquire information is mainly between engineers from the same institution and that persons closer organizationally are consulted most. Engineers would probably benefit from personal contact within their institutions if a central index of current research and development projects conducted within their institutions could be made available. The majority of engineers seldom or never consult people external to their institution. This situation might improve if guides to current research and projects conducted in institutions external to the engineers were locally available.

A general impression drawn from this work is that engineers find that libraries can offer services pertinent to their needs. However because of the poor awareness and availability of services offered by their information system, these services are not used to their full potential. The majority of engineers do not consult librarians (whether internal or external to the engineer's institution). Why do engineers take this attitude?. Is this an indication of the engineers' disatisfaction with the service they get when they ask for help to find information?, or are they a result of the engineers' tendency of self-sufficiency in the use of information?. Whatever the answer is to these questions it is probably time for librarians to look into the role they are playing when they assist users. Are librarians just assisting rather than leading to information?. This is a question that has to be answered immediately if librarians want to play a more effective role in helping users.

10.5 Further Research

This study shows a general tendency of BMEs to underuse oral information sources, especially people external to their organization. On the other hand, it shows that the majority of BMEs do use letters, encounters and lectures at conferences, courses, seminars, industrial exhibitions; visits to academic and research institutions even if it is on monthly and trimester basis. The use of these informal oral sources as a mean to get information seems to indicate the existence of personal networks of professional peers related through similar interests and institutional ties, who probably inform each other about on going research. Furthermore, the frequency (low) with which BMEs access published literature using secondary sources as indexes, bibliographies and abstracts also seems to corroborate indirectly the existence of these personal networks. However without further research it is impossible to state if such groups exist among BMEs. Research looking into the existence of "invisible colleges" would provide information that could help to understand how information is acquired by BMEs through interpersonal relations. It would also be important to build up a profiles of these groups of engineers so that they become useful sources of information.

Furthermore, according to Allen *"... several studies of industrial and government scientists and engineers revealed an inverse relation between extraorganizational communication and performance. This contrasted with a direct relation between intraorganizational communication and performance"* (1977:140). Engineers of our sample are very poor users of external sources, on the other hand they are reasonable high producers (table 10 and 11). It would be interesting to investigate the relationship between productivity and performance to find out wether the BMEs pattern of use of external sources is a tendency for "provincialism" or if it is a sign of competence.

Likewise our results indicate that BMEs' main information problems are related to accessibility of information. Furthermore, there is an indication that "high" producers faced problems such as "unable to get current information", "did not have access to non-published information" and "information was expensive" (table 74) with higher frequency than engineers with low and medium productivity. Further research could examine to what extent the problem of accessibility to scientific and technical information inhibits the quality and quantity of the BMEs scientific output. Another aspect which would be interesting to explore is the relationship between accessibility problems and rejection of papers presented for publication.

Although BMEs have a high reading ability in foreign languages (table 8), "could not find information in Portuguese" was reported by engineers as one of their main problems in information use. The preference of Brazilian scientists and engineers for materials published Portuguese in spite of their language ability in foreign languages was previously reported in the Rosenberg and Cunha study (1983). Could our results be taken as an indication of this preferences by BMEs? Or is this a reflection of the engineers' expectations for original data, and new findings that they can relate more closely to their work and cultural characteristics? Or does it reveal a preference related to costs? The study of these aspects would enhance the knowledge and understanding of the extent with which language ability and content of information influences BMEs' use of information.

Among the problems of information use "information was expensive" was reported by engineers as one of the main problems. Results of this research also indicate that BMEs made relatively little use of external categories of people. Sources outside the organization are frequently more expensive than internal sources because their use implies the use of more expensive channels such as for example telephone, telexes and meetings. These data suggest that there might be a relationship between cost of channel use and frequency of use of external sources. Research could be conducted to investigate to which extent "cost of channels" influences the frequency of use of people external to the engineer's organization.

10.6 Conclusions

Some of the personal characteristics of BMEs working in academic institutions are that they are highly qualified in terms of formal education the majority holding a post-graduate degree, they have high competence in foreign language reading ability, they are involved in a variety of activities and compared to international standards have a good output in article production for journals, in project writing and technical reports. Hence it could be assumed that the qualifications and activities BMEs are involved in generate information needs and ask for levels of national and international information services similar to the ones offered in developed countries.

The heavy reliance of BMEs on books, scientific literature and colleagues of the department to get information may be partially responsible for information losses and may create for them a tunnel vision on what is going on in the profession. To remedy this situation Brazilian information centers should build a good collection of books and scientific and technical journals to meet the expectations of the users, but should also provide accessibility to other variety of information sources

The fact that BMEs infrequently use unpublished papers, and external channels to obtain information may result in a significant loss of information necessary for the engineers' updating.

The engineers' Institutional libraries are still the most consulted channel for getting written information.

The low use of external information channels by BMEs seems to be due to poor bibliographic control, financial problems with cost and to the perception of the channels as not being indiscriminately available to the general public. It might also be due to the cultural characteristics of the population which prefers not to negotiate use when there are restrictions.

Educational level, seniority and foreign language reading ability do not strongly influence the use of information sources and channels by BMEs. This allows us to conclude that these variables, at least in the way they have been defined in our study, are not strong determiners in the frequency of use of information sources and channels and that engineers of our sample, in spite of the variation in their personal characteristics, have similar information needs and patterns of use of sources/channels. This may indicate that when users reach a certain degree of competence there is a levelling off in the needs and use of information sources/channels by a certain population.

BMEs rely in materials published in English more than do rely in publications in their mother tongue. The frequency of use of formal written (FW) information sources in languages other than Portuguese is positively related to the engineers reading ability in the language in which the written source has been used.

There is no conclusive literature on the influence of inter-institutional involvement in the use of information sources and channels, but our data suggest that there is a clear tendency for engineers with higher inter-institutional involvement to use external channels (people) more frequently than engineers with no inter-institutional involvement. But in relation to use of external channels (locations) there is no clear pattern of influence of inter-institutional involvement with use of information.

The findings of our study do not indicate a meaningful difference in the frequency of use of information between engineers involved in research and development projects, but the findings do seem to signal to a tendency for engineers involved in project development to use a broader variety of FW information sources and internal and external channels. In the use of Informal oral channels the data do not display such a pattern.

For BMEs working in academic settings perceived accessibility is an influencing factor on the frequency of use of FW information sources, but the same determining influence has not been found for the use of external and internal channels.

Institutional restrictions are a determinant factor in the frequency of use of the informal written (IW) channels telexes and letters. The frequency of use of informal oral (IO) sources is also related to institutional restrictions, however the use of local and long distance phone calls as a mean to get information is independent of these restrictions. It seems, therefore, that information libraries should make available resources in their budgets to minimize the effect of institutional restrictions on the use of information.

Engineers perceive services as being pertinent with higher frequency than they perceive them as being available. This leads us to conclude that education programmes in the information system, available for BMEs should be organized or intensified. Furthermore, new channels of communication between users and libraries should be opened and the existing ones should be evaluated.

According to the literature surveyed engineers usually rely heavily on a few types of information in their work. Our study is somehow in harmony with these findings because engineers use frequently only three types of information, but our findings also show that a significant percentage of engineers use a variety of types of information in their work, allowing us to conclude that, contrary to previous findings, BMEs use a great variety of information types in their work generating a variety of information needs and asking for the organization of adequate services of provision of information.

In developed countries the main problems scientists and engineers face are selection of information, finding time to use information and problems with foreign language reading ability. The problems more frequently found by BMEs, as surveyed in our study, are still in the area of availability and accessibility of information. This is a strong indicator that basic services of provision of information to BMEs within academic environment must be significantly improved.

There are indicators in our study that BMEs have a heavy financial burden because materials needed for their work have to be acquired and paid for from their own salaries.

The main problems reported by BMEs are to do with accessibility of information (table 65) so they need more help with access.

When personal characteristics are related to the frequency of information problems, degree only makes a significant difference in the frequency of one of the problems engineers face ("did not have access to unpublished information"). This seems to indicate that in the same way engineers' differences in frequency of use of sources levels off when personal characteristics are considered, the problems engineers face also seem to show a certain communality in relation to personal characteristics.

The most common attitude taken by BMEs when information is not found is "to continue to work without information and try again later". This might be an indicator of the willingness and persistence of the special effort BMEs make to obtain the information needed. Again, with the exception of educational degree which influences one of the actions taken "continue to work without information", personal characteristics are not an influential factor in the actions when BMEs do not find information available. However engineers working in product development are twice as likely to interrupt a projects until the information is found as those working in research projects.

BIBLIOGRAPHY

ALLEN, T. J. (1968)
"Organizational aspects of information flow in technology." ASLIB Proceedings 20 (11):433-454.

ALLEN, T. J. (1970)
"Roles in technical communication networks." In Communication among scientists and engineers, p. 191-208. Edited by C.E. Nelson and D.K. Pollock. Lexington, MA: Heath Lexington Books.

ALLEN, T. J. (1977)
"Managing the flow of technology: technology transfer and the dissemination of technological information within the R & D organization." Cambridge, MA: MIT Press.

ALLEN, T. J. et al (1971)
"Technology transfer to developing countries: the international technological gatekeeper." Technology Review 73 (March):36-43.

ALMEIDA, M. do C. and FALKENBACH, A. B. (1977)
"Estudo do perfil do usuario das empresas de energia eletrica: CBEE, CELF, ELECTROBRAS, ELECTROSUL e LIGHT." Revista da Escola de Biblioteconomia de Brasilia 5 (2):1057-1079.

ANDRADE, F. I. (1981)
"Estudo de usuarios na área de engenharia básica da Petrobras." Master Thesis. Universidade Federal do Rio de Janeiro: IBICT.

ANGELL, C. A. et al (1985)
"Information transfer in engineering and science." London: The Technical Change Centre.

ARAUJO, V. M. R HERMES de et al (1982)
"Estudo de usuarios de informação contida em patentes." Revista da Escola de Biblioteconomia de Brasilia 10 (2):159-162.

ARNDT, J. et al (1980)
"Information exchange among scientists: a two step sociometric study." Sociology 14 (August):441-448.

AUERBACH CORPORATION (1965)
"DOD user needs study Phase I." Final technical report-11J1-TR3, to the Advanced Research Projects Agency, Department of Defense. Philadelphia: Auerbach Corp., 1965.

BARRETO, A. de ALBUQUERQUE (1982)
"A estructura da comunicação científica a comunidade de química." Revista da Escola de Biblioteconomia de Brasilia 10 (1):73-82.

BAZZO, W. A. and PEREIRA do VALE, L. T. (1988)
"Introdução a engenharia." Florianópolis, SC: Editora da UFSC.

BERNAL, J. D. (1948)
"Preliminary analysis of a pilot questionnaire on the use of scientific literature." In The Royal Society Scientific Information Conference, 1948. Report, p. 589- 637. London: The Royal Society, 1948.

BERNAL, J. D. (1959)
"The transmission of scientific information: a user"s analysis." In Proceedings of the International Conference on Scientific Information, Washington, D.C. November 16-21 1958. p. 77-95. Washington, D.C.: National Academy of Science.

BEVERLY, J. E. (1986)
"Information and Technology transfer to developing countries." INSPEL 20 (3):127-138.

BITZ, A. S. and OWEN, B. S. (1981)
"An approach to the potential importance of information in engineering." Department of Mechanical Engineering. New Castle upon Tyne University. Report 5603, BLRDR.

BITZ, A. S. and OWEN, B. S. (1981)
"The communication and use of information in engineering projects. Methods of investigation. A pilot study in industry." (part 2 of Report 5603, BLRDR).

BLASS A. (1983)
"Pos-graduação em engenharia: a situação no Brasil." Apresentación al taller Latino Americano de post-grado en ciencias básicas y ingenierias. Promoción - UNESCO -CONICIT - Caracas, Venezuela, 21-25 de Noviembre, 1983.

BORGES, M. A. G. (1982)
"A demanda da informação técnica do extensionista rural." Revista da Escola de Biblioteconomia de Brasilia 10 (2):21-42.

BOTTLE, R. T. (1973)
"Scientists, information transfer and literature characteristics." Journal of Documentation 29 (3):281-294.

CRANE, D. (1970)
"The nature of scientific communication and influence." Internacional Social Science Journal 22 (1):28-41.

CRANE, D. (1972)
"Invisible colleges: diffusion of knowledge in scientific communities." Chicago: The University Chicago Press.

CULNAN, M. J. (1980)
"Organizational information flows and the industrial library: an empirical investigation." Ph. D. Dissertation, University of California, Los Angeles.

DAVID, A. et al (1979)
"Engineer's needs for scientifical and technical information." Committee on Engineering Information, Paris: World Federation on Engineering Organizations.

DERVIN, B. and NILAN, M. (1986)
"Information needs and uses." In Annual Review of Information Science and Technology. Vol. 21, 1986, p. 3-33. Edited by Martha E. Williams. White Plains, NY: Knowledge Industry Publications.

ELLEN, S. R. (1979)
"Survey of foreign language problems facing the research worker." Interlending Review 7 (2):31-41.

ERBER, F. S. (1981)
"Science and technology policy in Brazil: a review of the literature." Latin America Research Review 16 (January):3-56.

ERES, B. K. (1981)
"Transfer of information technology to less developed countries: a systems approach." Journal of the American Society for Information Science 32 (March):97-102.

ETTLIE, J. E. (1976)
"The timing and sources of information for the adoption and implementation of production innovations." IEEE Transactions on Engineering Management 23 (February):62-68.

FAIBISOFF, S. G. and ELY, D. P. (1976)
"Information and information needs." Information Reports and Bibliographies 5 (5): 1-16.

FEINMAN, S. et al (1976)
"A conceptual framework for information flow studies." In Information politics: Proceedings of the 38th Annual Meeting of the American Society for Information Science . Vol. 13 (1), 1976, p. 1-10. Edited by Susan Martin. San Francisco, California:ASIS.

FISHENDEN, R. M. (1959)
"Methods by which research workers find information." In International Conference on Scientific Information. Washington DC, November 16-21,1958; p. 163-179. Washington, D.C.:National Academy of Science.

FISHENDEN, R. M. (1965)
"Information use studies - part I - past results and future needs." Journal of Documentation 21 (3):163-168.

FLETCHER, L. S. and SHOUP, T. E. (1978)
"Introduction to engineering including fortram programming." Englewood Cliffs, N.J: Prentice Hall.

GARVEY, W D. (1979)
"Communication, the essence of science: faciliting information exchange among scientists, engineers and students." New York: Pergamon Press.

GARVEY. W. D. et al (1970)
"Some comparison of communication activities in the physical and social sciences." In Communication among scientists and engineers, p. 61-85. Edited by C.E. Nelson and D.K. Pollock. Lexington, MA: D.C.Heath Books.

GARVEY, W. D. and GRIFFITH, B. C. (1967)
"Scientific communication as a social system." Science 157 (September):1011-1016.

GARVEY, W. D. and GRIFFITH, B. C. (1968)
"Informal channels of communication in the behavioral sciences: their relevance in the structuring of formal or bibliographic communication." In Foundations of Access to Knowledge, p.129-146. Edited by Edward B. Montgomery. Syracusse, NY: Syracuse University, Division of Summer Sessions, 1968.

GERTSBERGER, P. G. and ALLEN. T. J. (1968)
"Criteria used by research and development engineers in the selection of an information source." Journal of Applied Psychology 52 (4): 272-279.

GERSTL, J. E. and HUTTON, S. P. (1966)
"Engineers.the anatomy of a profession a study of mechanical engineers in Britain." Tavistock Publications.

GIBBONS, M. and JOHNSTON, R. D. (1972)
"The interaction of science and technology." Final Report of a study carried out for the Economic Benefits Working Group of the Council for Scientific Policy. Manchester University: Department of Liberal Studies in Science.

GIFFIN, K. (1967)
"The contribution of studies of source credibility to a theory of interpersonal trust in the communication process." Psychological Bulletin 68:104-120.

GOLDSTEIN, E. S. (1985)
"The use of technical information by engineers of the electrical sector in Mexico." Ph. D. Dissertation. Los Angeles: The University of California.

GORDON, M. D. (1979)
"Deficiencies of scientific information access and output in less developed countries." JASIS 30 (November 1979):340-342.

GORDON, M. D. and SANTMAN, A. (1981)
"Language barriers, literature usage and the role of reviews: an international and interdisciplinary study." Journal of Information Science 3 (September):185-189.

GRALEWSKA-VICKERY, A. (1976)
"Communication and information needs of earth science engineers." Information Processing and Management 12 (4):251-282.

HALBERT, M. H. and ACKOFF, R. L. (1959)
"An operation research study of the dissemination of scientific information." In Proceedings of the International Conference on Scientific Information, Washington, D.C. November 16-21 1958. p.97-130. Washington, D.C.: National Academy of Science.

HALL, A. M. et al (1972)
"The effect of the use of an SDI service on the information gathering habits of scientists and technologists." Report 5146, OSTI.

HANSON, C. W. (1974)
"Review of research and experimentation on engineering information, particularly in mechanical engineering." Report 5202, OSTI.

HARDY, A. P. (1982)
"The selection of channels when seeking information: cost/benefit vs. least-effort." Information Processing and Management 18: 289-293 cited by GOLDSTEIN, E. S. (1985) "The use of technical information by engineers of the

electrical sector in Mexico." Ph.D. Dissertation. Los Angeles: The University of California.

HARRIS, I.W. (1966)
"The influence of accessibility on academic library use." Ph. D. Dissertation. New Brunswich, Rutgers University.

HERNER, S. (1954)
"Information gathering habits of workers in pure and applied science." Industrial and Engineering Chemistry 46 (January 1954):228-236.

HERNER, S. (1959)
"The information-gathering habits of American medical scientists." In Proceedings of the International Conference on Scientific Information. Washington, D.C. November 16-21 1958. p. 277-285. Washington, D.C.: National Academy of Science.

HERRON, N. L. (1986)
"Information-seeking behavior and the perceptions of information channels by journalists of two daily metropolitan newspapers." Ph. D. Dissertation. School of Library and Information Science, University of Pittsburgh.

HOGG, I. H. and SMITH, J. R. (1959)
"Methods by which research workers find information." In Proceedings of the International Conference on Scientific Information. Washington, D.C. November 16-21 1958. p. 131-162 Washington, D.C.: National Academy of Science.

HOGLUND, L. and PERSSON, O. (1975)
"A survey of studies on use and production of scientific and technical information." Research Report. No 23. University of UMEA, Sweden: Department of Sociology.

HOGLUND, L. and PERSSON, O. (1977)
"Information use within an applied technical field." In EURIM II: Conference on the application of research in RAI. Amsterdam, Netherlands, p. 188-195. London: ASLIB.

HOUGHTON, D. and PROSSNER, C. (1974)
"A survey of the opinion of British library lending division users in special libraries on the effects of non- immediate access to journals." ASLIB Proceedings 26 (September): 354-366.

HUTCHINS. W. J. et al. (1971)
"The language barrier: A study in depth of the place of foreign language materials in the research activity of an academic community." University of Sheffield: Postgraduate School of Librarianship and Information Science.

IKPAAHINDI, L. N. (1985)
"The relationship between the needs for achievement, affiliation and power and frequency of use of information sources and scientific productivity among Nigerian veterinary surgeon." Ph.D. Dissertation University of Pittsburgh.

INSTITUTO NACIONAL DE TECNOLOGIA (1986)
"Pesquisa do NIC revela perfil do técnico da área de corrosão." Corroção e proteção: Boletim Informativo 1(4):1-4.

JAHODA, G. et al (1966)
"Characteristics and use of personal indexes maintained by scientists and engineers in one university. " American Documentation 17 (April):71-75.

JENNY, H. K. (1978)
"Heavy readers are heavy hitters." IEEE Spectrum 15 (September):66-68.

JOHNSTON, R. D. and GIBBONS, M. (1975)
"Characteristics of information usage in technological innovation." IEEE trans. on Engineering Management EM 22 (February):27-34.

KASPERSON, C. J. (1978)
"An analysis of the relationship between information sources and creativity in scientists and engineers." Human Communication Research 4 (2): 113-119.

KAUFMAN, H. G. (1981)
"Information needs of practicing engineers." ASEE Annual Conference Proceedings.Scarce Resource Allocation Engineers in the 80's. p. 472-480. ASEE, 1981.

KENNEY, L. (1966)
"The implications of the needs of users for the design of a catalogue: a survey at the international labour office." Journal of Documentation 22 (3):195-202.

KING, D. and PALMOUR, V. E. (1980)
"How needs are generated; what we have found out about them." In The Nation wide Provision and use of Information (ASLIB/IIS/LA Joint Conference). Sheffield 15-19 September 1980. Sheffield. 1980: 68-79.

KREMER, J. M. (1980)
"Information flow among engineers in a design company." Ph. D. Dissertation. University of Illinois at Urbana-Champaign.

KREMER, J. M. (1980)
"Fluxo de informação entre engenheiros: uma revisão de literatura." Revista da Escola de Biblioteconomia UFMG 9 (1):7-41.

KREMER, J. M. (1981)
"Os gatekeepers na engenheria." Ciencia da Informação 10 (1):19-33.

KREMER, J. M. (1984)
"Estudo de usuarios das bibliotecas da Pontificia Universidade Católica do Rio de Janeiro." Rio de Janeiro, PUC.

LADD, E.C. and LIPSET, S. M. (1975)
"How professors spend their time. The Ladd-Lipset survey of U.S. faculty members." Chronicle of Higher Education 14 October: 2.

LARGE, J. A. (1983)
"The foreign-language barrier: problems in scientific communication." Thetford, Norfolk: The Thetford Press Limited.

LEGGET, R. G. (1976)
"Do engineers need or (buy) books?" Scholarly Publishing 7 (4):337-342.

LICEA DE ARENAS, J. (1981)
"Information use by faculty of agriculture and veterinary science: a case study." *Magister in Scientia Bibliotecaria* Thesis. University of Wales.

LINGWOOD, D. A. and McANANY, E. G. (1971)
"Scientific Information flow and national development. A study of brazilian chemists." Stanford, CA: Stanford University, Institute for Communication Research.

LOTKA, A. J. (1926)
"The frequency distribution of scientific productivity." Journal of Washington Academy of Sciences. 16 (12):317-323.

LUFKIN, J. M. and MILLER, E. H. (1966)
"The reading habits of engineers: a preliminary survey." IEEE Transactions on Education 9 (4):179-182.

MAIZELL, R. E. (1958)
"The most creative chemist reads more." Industrial and Engineering Chemestry 50 (10):64A-65A.

MAIZELL, R. E. (1960)
"Information gathering patterns and creativity. A study of research chemists in an industrial laboratory." American Documentation 11 (1):9-17.

MARTIN, M. W. and ACKOFF, R. L. (1963)
"The dissemination and use of recorded scientific information." Management Science 9 (January):322-326.

MARTYN, J. (1964)
"Report of an investigation on literature searching by research scientists." ASLIB Research Department, 1964.

MARTYN, J. (1974)
"Information needs and uses." In Annual Review of Information Science and Technology, Vol. 9, p. 3-23. Edited by Carlos A. Cuadra. Washington, D.C. American Society for Information Science.

MARTYN, J. (1987)
"Literature searching habits and attitudes of research scientists." (British Library Research Paper 14). British Library. Research and Development Department, 1987.

MARTYN, J. and VICKERY, B. C. (1970)
"The complexity of modeling information systems." Journal of Documentation 26 (September): 204-220.

McLAUGHLIN, C. P. et al (1965)
"Technology transfer and the flow of technical information in a large corporation." Cambridge, MA: Harward University.

McLEAN, D. D. (1983)
"Automation in the libraries of the city of São Paulo." Int. Lib.Rev. 15:147-153.

MEADOWS, A. J. (1974)
"Communication in Science." London: Butterworth.

MENZEL, H. (1958)
"The flow of information among scientists." Columbia University, Bureau of Applied Social Research, New York.

MICK, C. K. et al (1980)
"Towards usable user studies." JASIS 31 (Sept):347-356.

MISRA, U. N. (1986)
"Identification of users of engineering and technological information." Lucknow Librarian 18 (3):74-78.

MOOR, W.C. (1969)
"An Empirical study of the relationship between personality traits of research and development personnel and dimensions of information systems and sources." Ph. D. Dissertation, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

MOORES, P. (1981)
"Information users' changing expectations and needs." ASLIB Proceedings 33 (3):83-92.

MOREL, R. (1977)
"Um estudo sobre a produção científica Brasileira segundo os dados do instituto for Scientific Information (ISI)." Ciencia da Informação 6 (2):99-109.

NEGUS, A. E. (1982)
"Repackaging of engineering information for manufacturing industry." Report 5725, BLRDD.

O' BRIEN et al (1954)
cited by STUART, G. F. (1979). "Information for industry." New Zealand Libraries 42 (1):18-23.

OLAISEN, J. L. (1985)
"Toward a theory of information seeking behaviour among scientists and scholars." Ph.D. Dissertation. University of California.

ORR, R. H. (1970)
"The scientist as an information processor: a conceptual model illustrated with data on variables related to library utilization." In Communication among scientists and engineers, p. 143-189. Edited by C. E. Nelson and D. K. Pollock. Lexington, MA: D.C.Heath Books.

PAGANO, R.R. (1981)
"Understanding statistics in the behavioral sciences." St. Paul, Minnesota, West Publishing Co.

PAISLEY, W. (1974)
"Library and information needs of scientists and technologists." In Library and Information Service Needs of the Nation, p. 78-86. Proceedings of a Conference on the Needs of Occupational Ethnic and Other Groups in the United States. Washington, D.C. : U. S. Government Printing Office.

PAISLEY, W. (1980)
"Information at work." In Progress in Communication II, p.133-166. Edited by B. Dervin and M. Voigt. Norwood, NJ: Ablex Publishing Corporation, 1980.

PELZ, D. C. (1956)
"Social factors related to performance in a research organization." Administrative Science Quarterly 1:310-325.

PINHEIRO, L.V. R. (1982)
"Usuarios informação: o contexto da ciência e da tecnologia." Livros Tecnicos e Científicos. Editora S.A.: IBICT.

PLANO DE APOIO AO DESENVOLVIMENTO DE CIENCIA E TECNOLOGIA (PADCT) - Subprograma "Serviços de Tecnologia Industrial Básica." Novembro, 1983. Report.

RADWIN, E. (1975)
"Field survey of information needs of industry sci/tech library users." In Proceedings of 38th Annual Meeting, 1975. Boston, Mass. ASIS 1975, p.41-42.

RAITT, D. I. (1984)
"The communication and information-seeking and use habits of scientists and engineers in international organizations based in Europe and in European national aerospace research establishments." Ph. D. Thesis. Loughborough University of Technology. Department of Library and Information Studies.

RAVELLO, O. C. P. (1983)
"Usuario- um campo em busca de sua identidade?" Revista da Escola de Biblioteconomia da Univesidade Federal de Minas Gerais 12 (1):75-87.

ROADSTRUM, W. H. (1967)
"Excellence in engineering." New York.

ROGGE, A. E. (1976)
"A look at academic anthropology: through a graph darkly." American Anthropologist 78 (4) :829-843.

ROSENBERG, V. (1967)
"Factors affecting the preferences of industrial personnel for information gathering methods." Information Storage and Retrieval 3 (July):119-127.

ROSENBERG, V. and CUNHA, M. BASTOS DA. (1981)
"Use of scientific and technical information in Brazil." Ann Arbor, MI: University of Michigan, School of Library Science.

ROSENBERG, V. and CUNHA, M. BASTOS DA. (1983)
"Uso de informação técnica e científica no Brasil." Translated by Ricardo Lenzi Tombi. Brasilia: CNPq, Instituto Brasileiro de Informação Ciência e Tecnologia.

ROSENBLOOM, R. S. and WOLEK, F. W. (1970)
"Technology and information transfer: a survey of practice in industrial organizations." Harvard University, Boston: Graduate School of Business Administration, Division of Research.

SABARATNAM, S. (1983)
"Information Needs of Engineers in Singapore: An Exploratory Paper." A Master Dissertation. Loughborough University of Technology, Department of Library and Information Studies.

SANDOVAL, A. M. (1978)
"Centro de información científica y humanística: A university information center in the third world." UNESCO Bulletin for Libraries 32 (1):42-48.

SARACEVIC, T. (1980)
"Perception of the needs for scientific and technical information in less developed countries." Journal of Documentation 36 (September):214-267.

SCATES, D. E. and YEOMANS, A. V. (1950)
"Activities of employed scientists and engineers for keeping currently informed in their fields of work." American Council of Education, Washington, D. C.

SCHORR, A. E. (1975)
"Lotka's law and map of librarianship." Journal of ASIS 26 (3):189-190.

SCHROEDER, R. G. and BENBASAT, I. (1975)
"An experimental evaluation of the relationship of uncertainty in the environment to information used by decision makers." Decision Sciences (6):556-567.

SCOTT, C. (1959)
"The use of technological literature by industrial technologists." In Proceedings of the International Conference on Scientific Information. Washington, D.C. November 16-21 1958. p. 245-166. Washington, D.C.: National Academy of Science.

SCOTT, C. (1960)
"The use of technical literature by industrial technologists. A study of technical information in the electrical industry." - The Social Survey. Central Office of Information.

SHAW, R. R. (1956)
"Pilot study in the use of scientific literature by scientists." Washington, D. C.: National Science Foundation.

SHEPARD , M. O. (1976)
"User response to S.D.I. services developed at aeronautical research laboratories, Australia. In the Problem Organization of User benefit in Scientific and Technological Information Transfer AGARD, 1976, AGARD-CP-179, p. 10.1-10.9 cited by RAITT, D. I. (1984). "The Communication and Information-Seeking and Use Habits of Scientists and Engineers in International Organizations Based in European National Aerospace Research Establishments." Ph. D. Thesis. Loughborough University of Technology. Department of Library and Information Studies.

SHILLING, C.W. and JESSIE BERNARD (1964)
"Informal Communication among bioscientists." Biological sciences communication project. Washington, D. C. : George Washington University. Report No. 16-1964, Washington, 1964.

SHUCHMAN, H. L. (1981)
"Information transfer in engineering." Glastonbury, Connecticut, Washington, D.C. The Futures Group.

SLATER, M. and FISHER, P. (1969)
"Use Made of Technical Libraries." (Aslib Occasional Publication No 2.) London: Aslib.

SOUZA, F. R. S. et al (1977)
"O usuario e a caracterização de seus hábitos e interesses." In Congresso Brasileiro de Biblioteconomia e Documentação 7, Belem 1973. p. 173-199. Anais. Rio de Janeiro, IBICT, 1977.

SULLIVAN, C. (1979)
"Survey of in-house user education in special libraries." ASLIB Proceedings, 31 (2):322-333.

SUMMERS, E. et al (1983)
"The effect of personal, professional, and psychological attributes, and information seeking behavior on the use of information sources by educators." JASIS 34 (January):75-85.

STUART, G. (1979)
"User survey: information for industry." New Zealand Libraries 42 (1):18-23.

SWANSON, E. B. (1982)
"Information channel disposition and use." Information systems' working paper No 7-83. Los Angeles: University of California, Los Angeles, Graduate School of Management cited by GOLDSTEIN, E. S. (1985) "The use of technical information by engineers of the electrical sector in Mexico." Ph. D. Dissertation. Los Angeles: The University of California.

SWANSON, E. B. (1982)
"Toward a measure of information channel disposition" Information systems' working paper No 6-83. Los Angeles: University of California, Los Angeles, Graduate School of Management cited by GOLDSTEIN, E. S. (1985) "The use of technical information by engineers of the electrical sector in Mexico." Ph. D. Dissertation. Los Angeles: The University of California.

TORNUDD, E. (1959)
"Study on the use of scientific literature and reference services by Scandinavian scientists and engineers engaged in research and development." In Proceedings of the International Conference on Scientific Information, Washington, D.C. November 16-21 1958. p. 19-73. Washington, D.C.: National Academy of Science.

TUSHMAN, M. (1978)
"Technical communication in R&D laboratories: the impact of the project characteristics." Academy of Management Journal 21 (4):624-645.

UNESCO (1981)
"Transfer and utilization of information for development in the 1980's. Main problems and strategies for their solution." Issues discussed at a Consultation Meeting held in Toledo (Spain) 11-15 May, 1981.

UNIVERSITY OF MICHIGAN, INSTITUTE FOR SOCIAL RESEARCH, SURVEY RESEARCH CENTER (1954).
"The attitudes and activities of physiologists. A nationwide study." Ann Arbor, MI: University of Michigan.

VICKERY, B. C. (1961)
"The use of scientific literature." Library Association Review 63: 263-269.

VILLARREAL BUSTOS, G. et al. (1980)
"Diseño de un sistema de información técnica para el sector eléctrico." Bachelors thesis, Universidad Nacional de Mexico, Facultad de Ingenieria.

VOIGT, M. (1959)
"The researcher and his sources of sccientific information." Libri, 9 (3):177-193.

VON ZELST, R. H. and KERR, W. A. (1951)
"Some correlates of technical and scientific productivity." Journal of Abnormal and Social Psychology, 46 (October):470-475.

WERNER, J. D. (1969)
"A theoretical and empirical investigation of the relationships between some measures of information-related behavior and characteristics of the individual's task, person, organizational environment and professional environment." Ph. D. Dissertation. Northwestern University.

WHITE, M. D. (1971)
"Communications behavior of academic economists." Ph. D. Disseration. University of Illinois at Urbana-Champaign.

WHITEHALL, T.A. (1971)
"Information needs, task analysis and information inputs to tasks." Ciencia da Informação 8 (2): 113-118.

WHITEHALL, T. A. et al (1989)
"Information inputs to research and development project work." Journal of Information Science 15:135-148.

WILKIN, A. (1977)
"Personal roles and barriers in information transfer." In Advances in Librarianship, Vol. 7, p. 257-297. Edited by M. J. Voigt and M. D. Harris, New York: Academic Press.

WILKIN, A. (1981)
"The information needs, of practitioners: a review of the literature." University of London. Report 5611, BLR&D.

WILSON, T. D. (1981)
"On user studies and information needs." Journal of Documentation 37 (1):3-15.

WILSON, T. D. (1984)
"The cognitive approach to information seeking behaviour and information use." Social Science Information Studies 4:345-356.

WILSON, T. D. et al (1982)
"Models of the information user: progress and prospects in research." In Sweeney, G.P., Information and the Transformation of Society. North Holland Publishing Company, IIRS, p. 361-367.

WOLEK, F. W. (1969)
"The engineers: his works and needs for information." In Proceedings of the American Society for Information Science 6: 471-476.

WOLEK, F.W. (1970)
"The complexity of messages in science and engineering: an influence on patterns of communication." In Communication among scientists and engineers, p. 233-265. Edited by C. E. Nelson and D. K. Pollock. Lexington, MA: Heath Lexinton Books

WOOD, D. N. (1966)
"Chemical literature and the foreign language problem." Chemistry in Britain 2 (8):346-350.

WOOD, D. N. (1967)
"The foreign language problem facing scientists and technologists in the United Kingdom: Report of a recent study." Journal of Documentation 23 (June):117-130.

WOOD, D. N. (1974)
"Access to information in foreign languages: An experiment." BLL Review 2 (January):12-14.

WOOD, D. N. and HAMILTON, D .R. L. (1967)
"The information requirements of mechanical engineers: Report of a Recent Survey." London, Library Association.

APPENDICES

FEDERAL UNIVERSITY OF SANTA CATARINA
Post-Graduate Programme in Mechanical Engineering
Florianópolis, July 14th, 1988

Dear Professor:

The purpose of this letter is to introduce Prof. MARIA DEL CARMEN R. BOHN of the department of Information Studies of the Federal University of Santa Catarina. She is presently collecting data on the use and accessibility of information in the area of Mechanical Engineering and she is planning to submit her questionnaire to the members of your department.

The data to be collected have a twofold purpose: they will be used in her doctoral theses to be presented to Loughborough University of Technology and they will also be used in planning of a national information service in the technological area of Mechanical Engineering.

Prof. Maria del Carmen has been a brilliant Director of the Central Library systems of our Federal University and she has been co-responsible in the organization of the specialized library Nucleus of information on Metal-Mechanical with the support of PADCT.

I would like to ask you, therefore, that you would help Prof. Maria del Carmen to have access to the members of your Department.

Sincerely yours,

Florianópolis, July 1988

Dear Lecturer:

We are undertaking a research project on the use of information by Mechanical Engineers working in Brazilian Universities. The main objective of this study is to identify:

a) the use of scientific/technical information;
b) the influence of certain factors on the use of information;
c) the problems encountered in the use of information.

Several studies have been made on the use of information, but very few have concentrated on the use of information by Mechanical Engineers and no one has specifically surveyed the information needs of Mechanical Engineers working in Universities.

In an era of increasing sophistication in the control and dissemination of information, the information specialists must be aware of the needs of their customers in order to offer adequate services. The objective of the present research is to survey these needs through a questionnaire which will be sent to engineers working in four outstanding Mechanical Engineering Programmes in the Southern and Central Regions of Brazil.

The questionnaire presents questions on the use of information in the main academic activities of engineers (teaching, research and extension). **Section VI should only be completed if you have finished a project in the last three years.** In spite of its length, it will not take long to complete the questionnaire because most questions can be answered by circling figures or by ticking categories.

The data collected will be kept anonymous and will be used in the doctoral theses to be presented to the Department of Information Studies of Loughborough University of Technology, England, and they will also be used in the planning of information services for Mechanical Engineers in Brazil. The questionnaire will be collected personally by the researcher a week after distribution.

Please complete the questionnaire, helping us this way to better know and understand how you and the professionals of your area use information.

Thank you very much for your help.

Maria del Carmen R. Bohn
Department of Library Studies of the Federal University of Santa Catarina Department of Information Studies, Loughborough University of Technology, England.

I BACKGROUND INFORMATION

1) Please select the highest degree you have received and write in the appropriate box the institution, country and year the degree was obtained.

DEGREE	INSTITUTION	COUNTRY	YEAR OBTAINED
1 Ph. D. or Doctor's degree			
2 Master's			
3 Certificate/diploma			
4 Bachelors			
5 Other, specify			

2) Please indicate your present employment position by choosing your category and placing a check mark in the appropriate boxes (e.g. Associate Professor I, 40 hrs., FT (full time).

CATEGORY	LEVEL I II III IV V VI	NUMBER OF HOURS 12 20 24 40 DE
1 Lecturer		
2 Assistant		
3 Associate		
4 Professor		
5 Livre Docente		
6 Visiting Professor		

1

[1]Levels I to VI refer to the levels of career structure
Livre docente is a position of professor got by publications

3) How many years have you been working in the present institution?

YEARS [|]

4) Below is a list of activities related to your work. Select the activities in which you have participated within the last year. For each activity indicate, in terms of your time, your average number of hours of weekly participation. Please circle the appropriate number.

ACTIVITIES	DEGREE OF PARTICIPATION
1 Research (individual or group)	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
2 Supervision of theses	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
3 Lecturing in your institution and others	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
4 Supervision of practical work	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
5 Working in committees	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
6 Administration	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
7 Consulting	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
8 Visiting industries	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
9 Others, please specify	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

5) Within the last year, to what extent did your tasks at work and other professional duties (e.g. consulting, supervision of theses, research, etc.) involve you working with organizations other than your own? Please estimate the number of monthly hours by circling the appropriate number.

NUMBER OF HOURS PER MONTH	0 13	1 14	2 15	3 16	4 17	5 18	6 19	7 20	8 21	9 22	10 23	11 24 or more	12

6) Please estimate the number of hours you spend, per week, for each of the following activities: a) reading and b) communicating with colleagues, for keeping current and for problem solving.

a) **READING**

ACTIVITIES	NUMBER OF HOURS SPEND PER WEEK			
	LESS THAN 1 HR. PER WEEK	2-4 HRS. PER WEEK	5-7HRS. PER WEEK	MORE THAN 7 HRS. PER WEEK
1 Keeping current				
2 Problem solving				

b) **COMMUNICATING** (including writing letters and talking to colleagues)

ACTIVITIES	NUMBER OF HOURS SPEND PER WEEK			
	LESS THAN 1 HR. PER WEEK	2-4 HRS. PER WEEK	5-7HRS. PER WEEK	MORE THAN 7 HRS. PER WEEK
1 Keeping current				
2 Problem solving				

7) One of the usual barriers in the use of information is the language factor. Please tick the appropriate box to evaluate your reading ability in the following languages.

READING ABILITY					
LANGUAGES	DO NOT READ AT ALL	READ USING DICTIONARY (more than 10 times a page)	READ USING DICTIONARY (about 5 times a page)	READ USING DICTIONARY (about 5 times per chapter or article)	READ FLUENTLY
1 English					
2 French					
3 German					
4 Spanish					
5 Italian					
6 Other(s), specify					

8) Please indicate HOW OFTEN, **within the last year,** you used documents, (e.g. books, journals, newspapers, etc.) written in the following .languages? Please tick the appropriate box(es).

LANGUAGES	FREQUENCY OF USE				
	LESS THAN ONCE A DAY	AT LEAST ONCE A WEEK	AT LEAST ONCE A MONTH	AT LEAST ONCE A TRIMESTER	SELDOM OR NEVER
1 Portuguese					
2 English					
3 French					
4 German					
5 Spanish					
6 Italian					
7 Other(s), specify:					

9) A common activity in academic life is publishing and applying for patents. Please indicate:

a) HOW MANY of the following you have published, or had accepted for publication, within the **last five years?**

TYPE OF PUBLICATIONS	NUMBER OF PUBLICATIONS	
	ALONE	IN COLLABORATION
1 Books, as author		
2 Books, as editor		
3 Articles		

b) HOW MANY of the following internal works you have produced, within the **last year?**

TYPE OF PUBLICATIONS	NUMBER OF WORKS	
	ALONE	IN COLLABORATION
1 Technical reports		
2 Projects		
3 Standards and technical specifications		
4 Other(s), specify:		

c) HOW MANY patents have you applied for and got granted **during your career?**

PATENTS	NUMBER OF PATENTES APPLIED FOR AND GRANTED	
	ALONE	IN COLLABORATION
1 Patents applied for		
2 Patents granted		

II PROBLEMS IN THE USE OF INFORMATION

10) When obtaining and using information for your work, you may encounter several problems; below is a listing of some of these problems. Please, tick the appropriate box to indicate how frequently each of these problems surface during the last year.

PROBLEMS	FREQUENCY				
	SELDOM OR NEVER (0 -20% of the time)	OCCASIONALLY (21-40% of the time)	OFTEN (41-60% of the time)	FREQUENTLY (61-80% of the time)	MOST OF THE TIME (81-100% of the time)
1 Did not find current information					
2 Did not have access to unpublished information					
3 Did not find relevant information					
4 Did not have where to look					
5 Found language too technical					
6 Received information too late for use					
7 Did not find information in Portuguese					
8 Information was expensive					
9 Lacked professional help to find information					
10 Found information but it was classified					
11 Others (please specify)					

11) When you need information but it was not immediately available to you. How often did you take **during the last year,** the following actions? Please tick the appropriate box(es).

PROBLEMS	FREQUENCY				
	SELDOM OR NEVER (0 -20% of the time)	OCCASION ALLY (21-40% of the time)	OFTEN (41-60% of the time)	FREQUEN - TLY (61-80% of the time)	MOST OF THE TIME (81-100% of the time)
1 Continue to work without information					
2 Interrupt the work and wait for information					
3 Continue to work and try again later					
4 Other(s), please specify:					

12) Approximately how often, **during the las year** of your work, did you come across information relevant to your work that you would like to have read but were unable to use because of the language. Please tick the appropriate number.

Seldom or never	(1)
At least once a semester	(2)
At least once a month	(3)
At least once a week	(4)
At least once a day	(5)

III SOURCES OF INFORMATION

To find the information you used in your work you looked at a variety of WRITTEN AND ORAL sources of information. In the next questions we want to focus .your attention on the use and accessibility of these sources of information.

13) WRITTEN INFORMATION SOURCES

a) Indicate with a check mark how frequently you used each of the listed WRITTEN SOURCES/CHANNELS in obtaining information during the last year of your work.

SOURCES	FREQUENCY OF USE OF WRITTEN SOURCES				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
1 Technical literature and scientific journals					
2 Conference proceedings					
3 Books					
4 Handbooks					
5 Tables					
6 Technical reports (internal)					
7 Technical reports (external)					
8 Laws and regulations					
9 Specifications and standards					
10 Newspapers					
11 Indexes, abstracts and bibliographies					
12 Patents					
13 Catalogues (manufacturer's literature)					

SOURCES	FREQUENCY OF USE OF WRITTEN SOURCES				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
14 Bulletins published by industry					
15 Personal Notebooks					
16 Unpublished papers					
17 Theses and Dissertations					

b) When you needed WRITTEN information for your work **during the last year.** HOW OFTEN did you look for this information in each of the following places? Please, tick the appropriate box for each location used.

CHANNELS	FREQUENCY OF USE				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
1 Personal files, records and collections					
2 Files records and collections from institutional colleagues					
3 Departmental files, records and collections.					
4 Files records and collections from the engineer's institutional libraries and Nucleos					
5 COMUT (Interlibrary provision of photocopies of articles)					
6 Files records and collections from colleagues from other institutions					
7 Files records and collections from professional organizations					
8 Files records and collections from libraries other than institutional					
9 Bookstores					

c) Using the following definitions, indicate the degree of access that you have had to the following information sources/channels during the last year of your work. Please check only one answer for each source.

SIMPLE ACCESS (SA) Requires no displacement from the user's personal area (department), nor does it require the use of telephone;

EASY ACCESS (EA) Requires no displacement from the user's personal area (department), but does require the use of telephone;

ACCESSIBLE (A) Requires displacement from the user's personal area (department), but inside the building;

DIFFICULT ACCESS (DA) Requires displacement outside the building.

SOURCES/CHANNELS	DEGREE OF ACCESS			
	SA	EA	A	DA
1 Technical literature and scientific journals				
2 Conference proceedings				
3 Books				
4 Handbooks				
5 Tables				
6 Technical reports (internal)				
7 Technical reports (external)				
8 Laws and regulations				
9 Specifications and standards				
10 Newspapers				
11 Indexes, abstracts and bibliographies				
12 Patents				
13 Catalogues (manufacturer's literature)				
14 Bulletins published by the industry				
15 Personal Notebooks				
16 Unpublished papers				
17 Theses and Dissertations				

SIMPLE ACCESS	**(SA)**	Requires no displacement from the user's personal area (department), nor does it require the use of telephone;
EASY ACCESS	**(EA)**	Requires no displacement from the user's personal area (department), but does require the use of telephone;
ACCESSIBLE	**(A)**	Requires displacement from the user's personal area (department), but inside the building
DIFFICULT ACCESS	**(DA)**	Requires displacement outside the building

SOURCES/CHANNELS	DEGREE OF ACCESS			
	SA	EA	A	DA
18 Personal files, records and collections				
19 Files records and collections from institutional colleagues				
20 Departmental files, records/ collections				
21 Files, records/collections from the engineer's institutional libraries/nucleos				
22 Files records and collections from colleagues from other institutions				
23 Files records/collections from professional organizations				
24 Files records and collections from libraries other than institutional				
25 Bookstores				
26 Colleagues from the engineer's department				
27 Colleagues from the engineer's institution				
28 Colleagues from other institutions				
29 Customers				
30 Vendors or manufacturers				
31 Librarians from the engineer's institution and nucleos				
32 Other librarians				

14) ORAL INFORMATION SOURCES/CHANNELS

a) During the last year, HOW OFTEN have you consulted the following people to get the information for your work. Please tick the appropriate answer in each case.

CHANNELS	FREQUENCY OF USE OF CHANNELS				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
1 Colleagues from the engineer's department					
2 Colleagues from the engineer's institution					
3 Colleagues from other institutions					
4 Customers					
5 Vendors or manufacturers					
6 Consultants					
7 Librarians from the engineer's institution and nucleos					
8 Other librarians					

b) Please, indicate HOW FREQUENTLY you used during the last **year**, each of the following channels to contact people in order to get information for your work. Please tick the appropriate answer in each case.

CHANNELS	FREQUENCY OF USE OF CHANNELS				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
1 Telephone (conversations)					
2 Letters					
3 Telexes					
4 Encounters in courses, conferences, seminars and industrial exhibitions					
5 Lectures in courses, conferences,seminars and industrial exhibitions					
6 Talks in corridors					
7 Visits in offices					
8 Meetings for institutional projects					
9 Visits to industries					
10 Visits to research and academic institutions					

c) Please indicate by ticking in the appropriate box the degree of limitation or restriction that you, experienced during the last **year**, in the use of the following channels to contact people or use photocopy services, in order to obtain information for your work.

CHANNELS	DEGREE OF RESTRICTIONS OR LIMITATIONS IN USE				
	NONE	FEW up to 25% of the time	SOME 26-50% of the time	HIGH 51-76% of the time	VERY HIGH 76-100% of the time
1 Local phone calls					
2 Long distance phone calls					
3 Travel to other cities to attend encounters, courses, seminars, industrial exhibitions etc.					
4 Travel to other cities to present papers in encounters, conference, sources and seminars.					
5 Use of the mail					
6 Use of telex					
7 Use of duplication services					
8 Use of consultants					
9 Talks in corridors					
10 Visits to colleagues' offices					
11 Participation in meetings for institutional projects					

IV - USE OF INFORMATION

15) Please, indicate how frequently you used each of the listed types of information during the **last year** of your work. Please tick the appropriate answer in each case.

TYPES OF INFORMATION	FREQUENCY OF USE OF INFORMATION				
	SELDOM OR NEVER	AT LEAST ONCE A TRIMESTER	AT LEAST ONCE A MONTH	AT LEAST ONCE A WEEK	AT LEAST ONCE A DAY
1 Information on the "state of the art"					
2 Economic/administrative information					
3 Market information					
4 Information on equipment					
5 Information on raw materials					
6 Processing of industrial refuse					
7 Processing technology					
8 Production, planning and control					
9 Technological innovation					
10 Standards, specifications, laws and regulations					
11 Quality control					
12 Packing and transport					
13 Industrial and product safety					
14 Pollution control					
15 Conservation of energy					
16 Product development/ industrial design					
17 Others, please specify:					

V INFORMATION SERVICES

16) From the information services listed below, indicate in COLUM I the services offered by your institution **last year.** Please indicate in COLUM II the services that you consider more adequate for your present information needs. Mark as many options as necessary.

	I	II
a) Question and answer services	( )	( )
b) Preparation of bibliographies	( )	( )
c) Literature search on the "state of the art"	( )	( )
d) Translation of technical documents	( )	( )
e) Provision of photocopies of technical documents	( )	( )
f) ALERT (Bulletins including indexes of technical and scientific journals)	( )	( )
g) Reference to other sources of information (written and personal)	( )	( )
h) Loan of bibliographic materials (books, journals, patents, etc.)	( )	( )
i) Accessibility to data banks	( )	( )
j) Others, please specify:	( )	( )
	( )	( )
	( )	( )

VI **IF YOU HAVE NOT WORKED IN ANY PROJECT IN THE LAST THREE YEARS, PLEASE DO NOT ANSWER THE REMAINING QUESTIONS.** The following questions are concerned with the use of information in one of your recently completed projects. Please select ONE project completed during the **last three years** and answer the questions in relation to the selected project.

17) From the following statements select only ONE that describes best the objective of the project that you have selected. Tick the appropriate answer.

1) My project involved the formulation and testing of scientific theories, concepts, models of empirical investigation of physical phenomena. It involved the formulation and testing of hypotheses and the production of a technical report.

( )

2) My project involved the combination of existing and feasible concepts, perhaps integrating new knowledge, to provide distinctly new products or processes. It involved the application of known facts and theory to solve a particular problem through exploratory studies, design and testing of new components and systems.

( )

3) My project involved the combination and integration of generally available designs or components into desired products, processes and test procedures, or refinement of existing products,processes or test procedures. It involved the application of existing devices to a particular situation. It involved a design for an end-product.

( )

4) My project involved the combination of existing or new knowledge in order to discover the reason(s) for the mal-function of an existing system. It involved a hypothesis and a solution.

( )

5) The objective of my project was to use existing knowledge to improve the cost/performance for existing products, processes or systems; recombination, modification and testing of existing systems and opening new markets for existing products.

( )

SERVIÇO PÚBLICO FEDERAL
UNIVERSIDADE FEDERAL DE SANTA CATARINA
CAMPUS UNIVERSITÁRIO - TRINDADE - CAIXA POSTAL 476
CEP. 88049 - FLORIANÓPOLIS - SANTA CATARINA
TEL. (0482) - 33.1000 - TELEX: 0482 240
CURSO DE PÓS-GRADUAÇÃO EM ENGENHARIA MECÂNICA

Of. nº 147/CPGEM/88 Florianópolis, 14 de julho de 1988.

Senhor Professor:

Sirvo-me do presente para apresentar a Profa. MARIA DEL CARMEN RIVERA BOHN, do Departamento de Biblioteconomia e Documentação da Universidade Federal de Santa Catarina.

Realiza ela, presentemente, tomada de dados de um levantamento sobre o uso e o acesso a informações no âmbito da Engenharia Mecânica, e deseja, por isso, submeter um questionário a docentes do Departamento que V.Sa. chefia.

Além de constituirem subsídio para a Tese de Doutorado que a referida Professora realiza, junto à Universidade de Loughborough, na Inglaterra, servirão os dados em questão, também, para a propositura do planejamento de uma política nacional em informação tecnológica para a área de Engenharia Mecânica.

A par de ter atuado com brilho como Diretora da Biblioteca Universitária da UFSC, a Profa. Maria del Carmen é co-responsável pela implantação, nessa Biblioteca, do Núcleo Setorial de Informação em Metal-Mecânica, com apoio do PADCT.

Rogo pois, que V.Sa. facilite à Profa. Maria del Carmen o acesso aos Professores de seu Departamento.

Atenciosamente

Prof. Arno Blass
COORDENADOR

Florianópolis, julho de 1988

Prezado professor:

Estamos realizando uma pesquisa sobre o uso de informação pelos engenheiros mecânicos atuantes em Universidades Brasileiras. Neste estudo queremos identificar:

a) O uso da informação técnico/científica;
b) a influência de certos fatores no uso da informação;
c) os problemas que se apresentam no uso da informação.

Embora existam pesquisas realizadas sobre o uso de informação, são poucos os estudos dirigidos a identificar as necessidades de informação dos engenheiros mecânicos, e nenhum tem concentrado sua atenção especificamente no uso de informação pelos engenheiros mecânicos atuantes em Universidades.

Numa era de sofisticação crescente no controle e disseminação da informa ção, é importante que os especialistas da área tenham conhecimento em profundidade das necessidades de seus usuários para poder adequar seus serviços às necessidades reais. O presente estudo visa levantar estas necessidades através de um questionário que está sendo encaminhado a engenheiros atuantes em três cursos de excelência de Engenharia Mecânica do centro-sul do país.

O questionário consta de perguntas referentes ao uso de informação dentro das atividades acadêmicas (ensino, pesquisa e extensão), sendo que a **Seção VI** só deverá ser respondida, se você tiver completado um projeto nos últimos três anos. Apesar da extensão do questionário, você não levará muito tempo para completá-lo, uma vez que a maioria das perguntas deverá ser respondida marcando um X ou circulando os quadros correspondentes.

Os dados fornecidos permanecerão anônimos e servirão de base para a elaboração de nossa Tese de Doutorado na Universidade de Loughborough, Inglaterra e serão utilizados para elaborar uma proposta de planejamento, a nível nacional, dos serviços de informação na área de Engenharia Mecânica . O questionário será recolhido pessoalmente pela pesquisadora uma semana após a sua entrega.

Por favor complete este questionário, ajudando-nos, assim, a conhecer como você e os profissionais de sua área usam informação.

Muito obrigada por sua ajuda.

Professora María del Carmen R. Bohn
Departamento de Biblioteconomia da UFSC.
Department of Information Studies
University of Technology of Loughborough, Inglaterra

I INFORMAÇÃO PESSOAL E EXPERIENCIA PROFESSIONAL

1) Por favor, marque no quadro apropriado, o nível de estudo e tîtulo(s) que possui a nível de graduação e pós-graduação, indicando o país, a instituição e o ano de obtenção do(s) título(s).

NIVEL DE ESTUDO	PAIS	INSTITUIÇAO	ANO DE OBTENÇAO
1 Ph. D. ou Doutorado			
2 Mestrado			
3 Especialização			
4 Nível Universitário			
5 Outros, especifique:			

2) Indique, marcando no(s) quadro(s) apropriado(s), sua categoria funcional ou equivalente (ex. Professor Adjunto I, 40 hs, DE).

CATEGORIA	NIVEL						REGIME (EM HORAS)				
	I	II	III	IV	V	VI	12	20	24	40	DE
1 Auxiliar de Ensino											
2 Professor Assistente											
3 Professor Adjunto											
4 Professor Titular											
5 Livre Docente											
6 Professor Visitante											

3) Indique o número de anos que trabalha na presente Instituição

anos [|]

4) Entre as atividades listadas a seguir, selecione aquelas em que participou no último ano. Para cada atividade, indique, em termos de seu tempo, sua média de participação semanal. Circule o número correspondente.

ATIVITIDADES	GRAU DE PARTICIPAÇAO NUMERO DE HORAS APROXIMADO POR SEMANA
1 Pesquisa (individual ou de grupo)	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
2 Orientação de teses	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
3 Docencia (em sua institução e outras)	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
4 Estâgios de alunos	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
5 Participação em comissões	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
6 Administração	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
7 Consultoria	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
8 Visitas à industrias	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
9 Outras, especifique	0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40

5) Muitas vezes as responsabilidades professionais exigem que o engenheiro se envolva e mantenha contatos diversos com outras instituções (ex. institutos de pesquisa, outras universidades, industria, ect.). Se este for o seu caso, estime o número de horas mensais que dedicou, **no ultimo ano,** para realizar contatos com instituções diferentes da sua. Circule o número correspondente.

NUMBERO DE HORAS POR MES	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 ou mais

6) Estime o número de horas que dedica, **por semana,** às atividades de: a) leitura e b) comunicação com colegas, com a finalidade de atualizar-se e resolver problemas técnicos:

a) LEITURAS

ATIVIDADES	HORAS DE LEITURA POR SEMANA			
	MENOS DE 1HR. POR SEMANA	2-4 HRS. POR SEMANA	5-7HRS. POR SEMANA	MAIS DE 7 HRS POR SEMANA
1 Atualização				
2 Problemas técnicos				

b) Comunicação com colegas (falando e escrevendo cartas):

ATIVIDADES	HORAS DE COMUNICAÇAO POR SEMANA			
	MENOS DE 1HR. POR SEMANA	2-4 HRS. POR SEMANA	5-7HRS. POR SEMANA	MAIS DE 7 HRS POR SEMANA
1 Atualização				
2 Problemas técnicos				

7) Uma das barreiras no uso da informação é o fator lingüístico. Avalie seu nível de leitura em cada uma das diferentes línguas, listadas abaixo. Marque os quadros correspondentes.

LINGUAS	NIVEL DE LEITURA (Compreensão)				
	NAO LE	LE USANDO DICIONARIO (acima de10 vezes por pagina)	LE USANDO DICIONARIO (aprox. 5 vezes por página)	LE USANDO DICIONARIO (aprox. 5 vezes per artigo ou Capitulo	LE FLUENTE MENTE
1 Inglês					
2 Francês					
3 Alemão					
4 Espanhol					
5 Italiano					
6 Outras, especifique:					

8) Indique com que FREQUENCIA utilizou, **durante o último ano,** informações em publicações tais como: livros, periódicos, normas, tabelas, etc., publicadas em cada uma das línguas abaixo relacionadas. Marque os quadro(s) correspondente(s).

LINGUAS	FREQUENCIA DE USO				
	PELO MENOS UMA VEZ POR DIA	PELO MENOS UMA VEZ POR SEMANA	PELO MENOS UMA VEZ POR MES	PELO MENOS UMA VEZ POR TRIMESTRE	RARAMENTE OU NUNCA
1 Português					
2 Inglês					
3 Francês					
4 Alemão					
5 Espanhol					
6 Italianio					
7 Outras, especifique:					

9) A publicação de trabalhos, participação em congressos e a solicitação de registro de patentes podem ser consideras atividades rotineiras dentro da vida professional do engenheiro.

a) Entre as publicações abaixo relacionadas, indique o número de trabalhos publicados, apresentados em congressos ou aceitos para publicação, **nos últimos cinco anos.**

TIPO DE PUBLICAÇOES	NUMERO DE PUBLICACOES	
	INDIVIDUAIS	EM COLABORAÇAO
1 Livros, como autor		
2 Livros, como editor		
3 Artigos		

b) Entre os trabalhos internos, abaixo relacionados, indique o número de trabalhos que você produziu no **último ano.**

TIPO DE TRABALHOS	NUMERO DE TRABALHOS	
	INDIVIDUAIS	EM COLABORAÇAO
1 Relatórios técnicos		
2 Projetos		
3 Normas, especificações técnicas		
4. Outras, especifique:		

c) **Durante a sua vida professional,** quantas patentes requereu e quantas já lhe foram concedidas?

PATENTES	NUMERO DE PATENTES REQUERIDAS E CONCEDIDAS	
	INDIVIDUAIS	EM COLABORAÇAO
1 Patentes solicitadas		
2 Patentes concedidas		

II PROBLEMAS NO USO DE INFORMAÇAO

10) O Engenheiro, quando procura localizar informações para o seu trabalho, pode enfrentar alguns problemas. Indique, com que frequencia, **durante o ultimo ano**, se apresentaram em seu trabalho, cada um dos problemas abaixo relacionados. Marque o(s) quadro(s) correspondente(s).

PROBLEMAS	FREQUENCIA				
	RARAMENTE OU NUNCA (0 A20% das vezes)	OCASIO-NALMENTE (21 a 40% das vezes)	ALGUMAS VEZES (41 a 60% das vezes)	COM FREQUEN-CIA (61 a 80% das vezes)	QUASE SEMPRE OU SEMPRE (81 a100% das vezes)
1 Não encontrou informações atualizadas					
2 Não teve acesso a dados não publicados					
3 Não encontrou informações relevantes					
4 Não soube onde procurar					
5 Considerou a linguagem muito técnica					
6 Recebeu as informações tarde demais					
7 Não encontrou informações em Português					
8 As informações eram caras					
9 Faltou ajuda especializada para encontrar informações					
10 Encontrou informações mas eram sigilosas					
11 Outras, especifique:					

11) Quando há necessidade de informações e você não dispõe delas no momento, indique a frequência com que adotou **no último ano**, cada uma das ações abaixo relacionadas. Marque os quadros apropriados.

AÇOES	FREQUENCIA				
	RARAMENTE OU NUNCA (0 a 20% das vezes)	OCASIONALMENTE (21 a 40% das vezes)	ALGUMAS VEZES (41 a 60% das vezes)	COM FREQUENCIA (61 a 80% das vezes)	QUASE SEMPRE OU SEMPRE (81 a100% das vezes)
1 Continua o trabalho sem elas					
2 Interrompe o trabalho e espera pelas informações					
3 Continua o trabalho e tenta consegui-las novamente					
4 Outras, especifique:					

12) Indique, aproximadamente, com que freqüência, **no último ano**, encontrou informações relevantes para seu trabalho que tinha interesse em ler, mas não foi possível porque estavam em um idioma que não domina bem. Assinale o número correspondente.

Raras vezes ou nunca	(1)
Pelo menos uma vez por trimestre	(2)
Pelo menos uma vez por mes	(3)
Pelo menos uma vez por semana	(4)
Pelo menos uma vez ao dia	(5)

III FONTES DE INFORMAÇAO

Na procura de informações necessárias para o seu trabalho, você consultou uma variedade de fontes IMPRESSAS E ORAIS. Nas próximas perguntas, gostaríamos de focalizar a su atenção no uso e acesso a estas fontes.

13) FONTES DE INFORMAÇAO ESCRITAS

a) Com que freqüência utilizou em seu trabalho, **no último ano**, as fontes ESCRITAS, abaixo relacionadas? Indique cada uma das fontes utilizadas, marcando sua freqüência no quadro correspondente.

FONTES	FREQUENCIA DE USO DAS FONTES ESCRITAS				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS VEZ POR MES	PELO MENOS VEZ POR SEMANA	PELO MENOS UMA POR DIA
1 Periódicos científicos e técnicos					
2 Anais (trabalhos de congressos)					
3 Livros					
4 Manuais					
5 Tabelas					
6 Relatórios técnicos de seu Dpto. ou de sua instituçāo					
7 Relatórios técnicos externos					
8 Regulamentos e normas legais					
9 Normas e especificações técnicas					
10 Jornais					
11 Indices, bibliografias e resumos					
12 Patentes					

FONTES	FREQUENCIA DE USO DAS FONTES ESCRITAS				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS VEZ POR MES	PELO MENOS VEZ POR SEMANA	PELO MENOS UMA POR DIA
13 Catálogos de produtos industriais					
14 Boletins técnicos de indústria					
15 Notas pessoais					
16 Artigos não publicados					
17 Teses ou Dissertações					

b) Durante o último ano, quando precisou de informações ESCRITAS para seu trabalho, com que FREQUENCIA às procurou em cada um dos seguintes lugares? Marque os quadros correspondentes.

FONTES	FREQUENCIA DE USO				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS VEZ POR MES	PELO MENOS VEZ POR SEMANA	PELO MENOS UMA POR DIA
1 Arquivos/coleções pessoais					
2 Arquivos/anotações e coleções de colegas de sua instituição					
3 Arquivos/anotações e coleções do departamento					
4 Arquivos/coleções das bibliotecas e Núcleos de sua instituição					
5 COMUT (Serviço de Comutação Bibliográfica)					
6 Arquivos/anotações e coleções de colegas de outras instituições					
7 Arquivos/anotações e coleções de organizações profissionais					
8 Arquivos e coleções de outras bibliotecas					
9 Livrarias					

c) Categorize, dentro das definições abaixo, o grau de acesso que você teve, no último ano a cada uma das fontes de informação listadas. Para cada fonte, indique só um grau de acesso.

ACESSO SIMPLES	(AS)	Não requer movimento fora do Departamento nem uso do telefone;
ACESSO FACIL	(AF)	Não requer deslocamento do Departamento, mas requer uso do telefone;
ACESSIVEL	(AC)	Requer movimento dentro do prédio;
ACESSO DIFICIL	(AD)	Requer movimento fora do prédio.

FONTES	ACESSO			
	AS	AF	AC	AD
1 Periódicos científicos e técnicos				
2 Anais (trabalhos de congressos)				
3 Livros				
4 Manuais				
5 Tabelas				
6 Relatórios técnicos de seu Dpto. ou de sua instituição				
7 Relatórios técnicos (externos)				
8 Regulamentos e normas legais				
9 Normas e especificações técnicas				
10 Jornais				
11 Indices, resumos e bibliografias				
12 Patentes				
13 Catálogos de produtos industriais				
14 Boletins técnicos de indústria				
15 Notas pessoais				
16 Artigos não publicados				
17 Teses e Dissertações				
18 Arquivos/coleções pessoais				

ACESSO SIMPLES **(AS)** Não requer movimento fora do Departamento nem uso do telefone;

ACESSO FACIL **(AF)** Não requer deslocamento do Departamento, mas requer uso do telefone;

ACESSIVEL **(AC)** Requer movimento dentro do prédio;

ACESSO DIFICIL **(AD)** Requer movimento fora do prédio.

FONTES	ACESSO			
	AS	AF	AC	AD
19 Arquivos/anotações e coleções de colegas de sua instituição				
20 Arquivos/anotações e coleções do Dpto.				
21 Arquivos/coleções das bibliotecas e Núcleos de sua instituição				
22 Arquivos/anotações e coleções de colegas de outras instituições				
23 Arquivos/anotações e coleções de organizações profissionais				
24 Arquivos e coleções de outras bibliotecas				
25.Livrarias				
26 Colegas do departamento				
27 Colegas de sua instituição				
28 Colegas de outras instituições				
29 Clientes				
30 Vendedores e fornecedores				
31 Bibliotecários dos núcleos e bibliotecas de sua instituição				
32 Bibliotecários de outras instituições				

14) FONTES/CANAIS DE INFORMAÇAO ORAIS

a) Durante o **último** ano, com que FREQUENCIA consultou as seguintes pesssoas para obter informações para o seu trabalho? Marque a resposta apropriada para cada caso.

PESSOAS	FREQUENCIA DE CONSULTA				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS UMA VEZ POR MES	PELO MENOS UMA VEZ POR SEMANA	PELO MENOS UMA VEZ POR DIA
1 Colegas do departamento					
2 Colegas de sua instituição					
3 Colegas de outras instituições					
4 Clientes					
5 Vendedores e fornecedores					
6 Consultores					
7 Bibliotecários das bibliotecas de sua instituição					
8 Outros bibliotecários					

b) Durante **o último ano,** com que FREQUENCIA contatou pessoas usando os seguintes meios. Marque a resposta apropriada para cada caso.

MEIOS	FREQUENCIA DE USO				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS UMA VEZ POR MES	PELO MENOS UMA VEZ POR SEMANA	PELO MENOS UMA VEZ POR DIA
1 Telefone					
2 Cartas					
3 Telex					
4. Encontros em cursos, feiras, congressos, seminários, etc.					
5 Palestras em cursos, feiras, congressos, seminários, etc.					
6 Conversas informais					
7 Visitas à salas de colegas					
8 Reuniões de projetos de sua instituição					
9 Visitas à indústrias					
10 Visitas à instituições acadêmicas e de pesquisa					

c) Durante o último ano, quando precisou obter informações para seu trabalho, através de contatos pessoais ou através do uso de serviços de fotocópias, qual o grau de limitação ou restrição que sentiu no uso dos meios abaixo relacionados? Marque no respectivo quadro a resposta apropiada para cada meio usado.

MEIOS	GRAU DE LIMITAÇAO NO USO				
	NENHUMA	POUCA (0 a 25% das vezes)	ALGUMA (26 a 50% das vezes)	MUITA (51 a 75% das vezes)	BASTANTE (76 a 100% das vezes)
1 Chamadas telefônicas locais					
2 Chamadas telefônicas interurbanas					
3 Viagens a outras cidades para assistir, cursos, seminários, encontros, visitas a industrias, etc.					
4 Viagens a outras cidades para apresentar trabalhos em cursos seminários, encontros etc.					
5 Uso do correio					
6 Uso do telex					
7 Uso de serviços de duplicação (ex. fotocópias)					
8 Uso de consultores					
9 Conversas informais					
10 Visitas às salas de colegas					
11 Participação em reuniões sobre projetos de sua instituição					

I V USO DE INFORMAÇAO

15) Indique com que freqüência utilizou **no último** ano os tipos de informações abaixo discriminadas. Marque para cada informação sua freqüência de uso no quadro correspondente.

TIPOS DE INFORMAÇAO	FREQUENCIA DE USO				
	RARAMENTE OU NUNCA	PELO MENOS UMA VEZ POR TRIMESTRE	PELO MENOS UMA VEZ POR MES	PELO MENOS UMA VEZ POR SEMANA	PELO MENOS UMA VEZ POR DIA
1 Informações sobre o estado da arte					
2 Econômico/administrativas					
3 Mercadológicas					
4 Equipamentos					
5 Matérias primas					
6 Aproveitamento de resíduos de industrias					
7 Tecnologia de processos					
8 Planejamento e controle de produção					
9 Inovação tecnológica					
10 Normalização					
11 Controle de qualidade					
12 Embalagem e transporte					
13 Segurança industrial e do produto					
14 Controle de poluição					
15 Conservação de energia					
16 Desenvolvimento de produtos/desenho industrial					
17 Outros, especifique:					

V SERVIÇOS E INFORMAÇAO

16) Dentro dos serviços abaixo discriminados indique na **COLUNA I** os serviços de informação oferecidos pela sua instituição, no último ano. Na **COLUNA II** indique os serviços que considera como os mais adequados as suas necessidades atuais de informação. Marque tantas opções quantas forem necessárias.

	I	II
a) Atendimento a consultas (pergunta/resposta)	( )	( )
b) Levantamentos bibliográficos	( )	( )
c) Levantamento do "estado de arte"	( )	( )
d) Tradução de documentos técnicos	( )	( )
e) Fornecimento de cópias de documentos	( )	( )
f) Divulgação de sumários (Índices de revistas técnicas)	( )	( )
g) Referência a outras fontes de informação (impressas e pessoais)	( )	( )
h) Fornecimento de material bibliográfico (livros, revistas, patentes, etc)	( )	( )
i) Acesso a Banco de Dados	( )	( )
j) Outros, especifique	( )	( )
	( )	( )
	( )	( )

VI **RESPONDA AS PERGUNTAS RESTANTES DESTE QUESTIONARIO SO SE VOCE ESTEVE ENVOLVIDO NOS ULTIMOS TRES ANOS, EM PROJETOS DE PESQUISA, PROJETO (DESIGN), DESENVOLVIMENTO DE PRODUTO, SOLUÇAO DE PROBLEMA TECNICO OU PRESTAÇAO DE SERVIÇOS. CASO CONTRARIO, POR FAVOR NAO RESPONDA AS PERGUNTAS RESTANTES.** Estas perguntas se referem ao uso de informação durante a execução de um dos trabalhos acima relacionados. Selecione, UM DE SEUS TRABALHOS completados nos últimos três anos e responda as próximas perguntas em relação a este trabalho.

17) Entre as definições apresentadas a seguir selecione aquela que descreva melhor os objetivos do trabalho selecionado como base para responder as perguntas restantes

1) Meu trabalho envolve a formulação e teste de teorias científicas, conceitos, modelos ou investigações empíricas de fenômenos físicos. Podendo incluir a formulação e teste de hipóteses e a elaboração final de um relatório técnico, ou artigo.

( )

2) Meu trabalho envolve a combinação de conceitos já existentes e viáveis, talvez integrando novos conhecimentos com a finalidade de prover novos produtos ou processos. Envolve a aplicação de teorias e fatos já conhecidos com a finalidade de resolver problemas particulares através de estudos exploratórios, teste e projeto de novos componentes e sistemas.

( )

3) Meu trabalho envolve a combinação e integração de projetos e componentes, geralmente já disponíveis, em produtos desejados, processos e procedimentos de teste e/ou refinamento de produtos já existentes, processos ou procedimentos de teste. Envolve a aplicação de mecanismos já existentes a situações particulares. Envolve o projeto de um produto final.

( )

4) O objetivo de meu trabalho é descobrir os motivos do mau funcionamento de um sistema já existente. Envolve uma hipótese e uma solução.

( )

5) O objetivo de meu trabalho é o melhoramento do custo/desempenho de produtos, processos ou sistemas já existentes e/ou a recombinação e teste de sistemas usando conhecimentos já existentes ou a abertura de novos mercados para produtos já existentes.

( )

18) A execução de seu trabalho requereu seu envolvimento em diferentes atividades. Indique o seu grau de envolvimento em cada uma das atividades abaixo relacionadas. Marque os quadros apropriados.

TAREFAS	GRAU DE ENVOLVIMENTO			
	NENHUM (ate 25%)	POUCO (26-50%)	ALGUM (51-75%)	MUITO (76-100%)
1 Elaboração do projeto				
2 Formulação e definição do problema				
3 Formulação teórica				
4 Hipóteses e reformulação				
5 Coleta de dados				
6 Análise de dados				
7 Projeto do equipamento				
8 Teste e modificação do protótipo				
9 Construção do protótipo				
10 Apresentação de resultados				
11 Planejamento da embalagem e apresentação do produto				
12 Implementação/comercialização				