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.

BY

DAVID IAIN RAITT

A Doctoral Thesis

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

May 1984

LIST OF CONTENTS PAGE

PAGE

PAGE

PAGE

LIST OF FIGURES AND TABLES

Figures:

Tables:

PAGE

PAGE

For my love of May-time and the cheerful dawn.

ACKNOWLEDGEMENTS

I should like to thank the European Space Agency for permission to undertake this study and for subsequent support under its education and training programme.

I should also like to extend my gratitude to the librarians in the Deutsche Forschungs- und Versuchsanstalt für Luft und Raumfahrt, the Vienna International Centre, the Nationaal Lucht- en Ruimtevaartlaboratorium and the Centre National d'Etudes Spatiales for distributing, collecting and returning the questionnaires. I must express my thanks too, to the the staff in these organizations, as well as in the European Space Research and Technology Centre and UNESCO, who duly completed them.

I wish to record my appreciation to Max Hunt of the Computer Centre at Loughborough University for his assistance with SPSS.

Thanks are also due to Professor P. Havard-Williams and Stella Keenan of Loughborough University for their comments on the draft manuscript, and to Charlotte Sims for typing it.

DECLARATION

The work contained in this thesis is the responsibility of the author alone, is original and his own and has not been submitted elsewhere for a higher degree.

ABSTRACT

General communication concepts are first discussed together with models of the communication process, the functions of communication and barriers to interaction. The characteristics of organizations are then described and the role of communication in organizations is examined in relation to the main theories of organizational management. The flow of communication through networks within organizations is also noted. The members of these organizations and networks are often scientists and engineers and the characteristics of and differences between these two groups are considered. In addition, their information seeking habits and their use of information sources are discussed in general terms, together with their formal and informal communication patterns. An in-depth description is then given of the methodology used in a survey by questionnaire of scientists and engineers in six organizations of two particular types - international organizations and national aerospace research organizations. The detailed results of the analyses of responses are presented in terms of the information seeking and use habits and the communication habits of scientists and engineers within these organizations. Based on the results of the survey, suggestions for improving information transfer and communication flow within organizations are made.

LIST OF ABBREVIATIONS AND ACRONYMS

CEC	Commission of the European Communities
CERN	European Organization for Nuclear Research
CNES	Centre National d'Etude Spatiales
CONIE	Comision Nacional de Investigacion del Espacio
DFVLR	Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt
DOD	Department of Defence
ESA	European Space Agency
ESTEC	European Space Research and Technology Centre
FAO	Food and Agriculture Organization
FAX	Facsimile
IAEA	International Atomic Energy Agency
IGO	Inter-Governmental Organization
INSIS	Inter-institutional Integrated Services Information System
INTA	Instituto Nacional de Tecnica Aerospacial "Esteban Terradas"
ISDN	Integrated Services Data Network
LAN	Local Area Network
NASA	National Aeronautics and Space Administration
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium
OECD	Organisation for Economic Cooperation and Development
ONERA	Office National d'Etude et de Recherches Aerospatiales
RAE	Royal Aircraft Establishment
R&D	Research and Development
SDI	Selective Dissemination of Information
SPSS	Statistical Package for the Social Sciences
STI	Scientific and Technical Information
UN	United Nations
UNESCO	United Nations, Educational, Scientific and Cultural Organization
VIC	Vienna International Centre
WMO	World Meteorological Organization

INTRODUCTION

Reasons for Undertaking the Work

An organization has four essential characteristics - content, structure, communications and decision-making procedures (1). In so far as content is concerned this relates to the human beings - the individuals - employed in the organization. These individuals will, more often than not, be formed into groups which will then effect the necessary tasks and procedures of the organization. In perhaps a majority of organizations, many of these individuals will be scientists, engineers or technicians whose job it is to create, devise, develop, make, and test new products, services and systems. Some will be doing research aimed at increasing knowledge, some will be translating concepts and ideas into actual devices, some will be supervising others doing the work under contract. These people will interact at both a personal and organization level with other colleagues both inside and outside the organization to gain the necessary information for their tasks.

This state of affairs and the characteristics identified above give rise to a working environment that can be either simple or complex depending on the nature of the organization - its staff, functions, constitution, areas of responsibility, goals and so on. To be able to fulfill their role in the organization the individual scientists and engineers will have a greater or lesser need for information - either written or verbal - depending on their position, their perception of their task, their knowledge and their knowledge of information sources, their education and training and their personal inclinations.

"People find themselves in situations where they must make a decision, answer a question, locate a fact, solve a problem, understand something" (2). In attempting to meet these needs they use, both formally and informally, a variety of information providers or sources (e.g. libraries, individuals, computer databases), via a variety of methods (e.g. phone, letter, face-to-face contact) in a variety of languages.

Such use and methods and the problems arising therefrom relating to availability, convenience, language, personality, location inter alia, become readily apparent in an international organization like the European Space Agency (ESA) where staff representing some sixteen nationalities must communicate among themselves and with others outside the organization to ensure optimum continuity in Europe's space programmes.

It seems reasonable to assume that other international organizations would have problems similar to those of ESA because of different nationalities, cultures and relations with bodies in different member states; this would equally be probably true of national aerospace research establishments working on a technical and contractual level since they take part, like ESA, in multi-national aerospace projects.

This study, then, was undertaken to verify this belief by trying to discover the actual patterns of information seeking and usage between the scientists and engineers of these types of organizations and the methods and frequency of communication between them. Assuming that types of information users and their patterns of information-seeking behaviour could be identified, then recommendations could be made on how library and information services and methods of information flow in the participating organizations could be developed or adapted or improved to meet users' requirements.

Objectives

The overall objective of the work was to study the patterns of communication and information seeking and use of scientists and engineers working in an international organization oriented to space research and exploration (the European Space Agency) and to see how the results compared with a) other international organizations and b) other government-oriented aerospace organisations.
A number of secondary objectives were also established:

1. To ascertain whether and why certain groups of scientists/engineers need information more regularly, more frequently and in greater amounts than other groups.

2. To ascertain what kinds of information are needed by the various groups and how their requirements are satisfied.

3. To discover the channels whereby groups or individuals get their information and communicate with others; to examine the frequency with which they are used, the reasons for their use, and to find out which are the most fruitful and speedy.

4. To see whether and what barriers exist to information provision, procurement, reception and communication.

It was expected that the study would, in addition, shed light on the following aspects:

i. The reasons why some groups communicate more than others and the frequency with which information is communicated, together with the factors generating the information need and the motive for communicating.

ii. The differences in communication patterns between scientists on the one hand, and engineers on the other.

iii. The communication patterns for a given project and the cross-fertilization of ideas through functional support staff.

iv. The flow of communication, e.g. hierarchical, lateral, two-way, amount of reciprocity and factors affecting it, e.g. spatial conditioning, nationality, project isolation.

v. The extent to which information is passed to and received from outside bodies, e.g. contractors.

vi. The existence of gatekeepers, invisible colleges and isolates.

vii. The effect of environmental conditions (e.g. social, economic, political uncertainty and climate) on information usage and communications.

viii. The characteristics affecting information usage and communication such as age, seniority, research experience, project membership.

Formulation of Hypotheses

The European Space Agency (ESA) is an international organization which directly handles research and development projects, unlike certain other international organizations which have a more administrative, paper-pushing or mail-box role. Because of this, it was considered useful to see how the staff of some 600 scientists and engineers at ESA's main research and development establishment - ESTEC - in The Netherlands, compared with other organizations having similar roles in matters of communication and information use. The research concerned itself with finding and explaining the facts surrounding the formal and informal information-seeking behaviour of scientists and engineers in a multi-national government environment. Thus, it attempts to discover the communication channels most often used, the extent of communication with others, the nature of the communication and the use of the library or information centre in fulfilling information needs. A better understanding of the scientific and technical information flow in such bureaucratic organizations and the reactions of staff to it, could lead to greater economies and efficiency. A number of hypotheses which would serve as a basis for discussion and suggestions for improvements were formulated at the outset of the study. These are listed below:

1. The information needs and communication patterns of scientists and engineers in general are similar and cannot readily be distinguished.

2. However, scientists will be more aware of sources of information in their field than engineers and cover or utilize them better.

3. Scientists and engineers will tend to get most of the information they need from colleagues rather than from the library/ information centre.

4. There will be little inter-project but much intra-project communication in international and national organizations. Where functional support staff are assigned to several projects there should be good cross-fertilization of ideas.

5. Gatekeepers (i.e. high achieving individuals who span the organization's boundaries and who, because of their external contacts, bring fresh knowledge into the organization for dissemination to colleagues) will not exist among the staff of the national/international organizations.

6. a) There will be a tendency for staff to communicate more with peers than with either superiors or subordinates;

   b) the basis for such communication will, therefore, be similar interests/most knowledgeable person;

   c) while the purpose will be mainly for information exchange.

7. More time will be spent in an international organization on written rather than oral forms of communication than in a national aerospace establishment.

8. Despite this, both scientists and engineers will prefer to keep in touch with colleagues in a direct, conversational mode rather than a written mode.

9. Scientists and engineers with English as their mother tongue will tend not to communicate in other languages.

Regrettably some of the ideas implicit in these objectives and hypotheses had to be abandoned or modified after it became clear from the pilot surveys that staff insisted on remaining anonymous, were unhappy at naming their contacts and would not respond to the more personal questions relating to their reactions and attitudes and social information transfer activities. These factors meant that the construction of sociograms which would, hopefully, have pointed to the existence of gatekeepers and isolates and revealed cross-divisional flow and reciprocity of information could no longer be easily and readily done. The research still covers these aspects to a certain extent since the questionnaire elicited some of the details in a different way, but the results are rather diluted. In addition, refusal to answer personal questions meant that the effect of environmental conditions on information flow could not be properly ascertained, nor could many of the barriers to such flow be explored, nor even the adhesiveness of nationality/language groupings.

Choice of Organizations

Fourteen organizations were approached for inclusion in the study - seven international organizations and seven national aerospace establishments.

The organizations were: CERN - European Organization for Nuclear Research (Switzerland); ESA - European Space Agency (France); FAO - Food and Agricultural Organization (Italy); IAEA - International Atomic Energy Agency (Austria); OECD - Organisation for Economic Cooperation and Development (France); UNESCO - United Nations Educational, Scientific and Cultural Organization (France); WMO - World Meteorological Organization (Switzerland). The aerospace establishments were: CNES - Centre National d'Etude Spatiales (France); CONIE - Comision Nacional de Investigacion del Espacio (Spain); DFVLR - Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (FRG); INTA - Instituto Nacional de Tecnica Aerospacial "Esteban Terradas" (Spain); NLR - Nationaal Lucht- en Ruimtevaartlaboratorium (The Netherlands); ONERA - Office National d'Etudes et de Recherches Aerospatiales (France); RAE - Royal Aircraft Establishment (UK).

In selecting the organizations to take part in the survey, consideration was given to their size, the nature of their work, their employment of scientists and engineers and the countries in which they were located. Those initially selected would have yielded a rich variety of functions and employees and so enhanced the study. Had they all participated then the data would have been much more indicative of the true nature of communication and information use of the scientists and engineers within the types of organizations as a whole.

Out of the fourteen organizations invited to take part, six finally agreed to do so - three international organizations (ESA, UNESCO, IAEA) and three national aerospace establishments (NLR, DFVLR, CNES). A brief description of the organizations will be found in Appendix A.

The three international organizations are characterized by being financed and supported by the governments of many countries; European, in the case of ESA, but worldwide in the case of UNESCO and IAEA. Consequently the staff of these organizations are of many different nationalities, tongues and cultures and educational levels/backgrounds. While such organizations generally can attract well-qualified and linguistically-able staff due to their relatively generous salaries and conditions, one would expect there to be some problems in communicating.

The three national aerospace research establishments are each supported by the government of a single country and thus have primarily a national role, consequently the vast majority of their staff are of one nationality. Nevertheless, because of the expense of aeronautical and space projects, and the necessity for large test facilities, nations are forced to cooperate with other countries. Thus these three national organizations are somewhat similar to the international organizations in that they are government-run and have a large number of contacts on a technical and contractual level with organizations in other countries.

This implies that the staff of these national bodies should be able to communicate in other languages and that, here again, one can expect there to be similar communication channels amd problems.

Methodology and Analysis

There have been many studies on the subject of communications and information use in organizations and the relationship of this work to these other studies is discussed in Chapter 6. The extensive reading done for the present research also manifests itself for comparative purposes in the other chapters and their tables where appropriate.

In this study survey research was used to obtain feedback from the scientific and technical staff in a variety of international organizations and national aerospace research establishments located in Europe on their methods of communication and their information-seeking habits. The data was gathered by means of a questionnaire consisting of mainly closed menu-type questions to save time and effort of the respondents. A number of open questions were also included. Before being circulated the questionnaire underwent a number of pilot studies to try and achieve optimum comprehensibility and clarity. In two organizations (UNESCO and ESTEC) the questionnaires were sent directly to the individuals by the researcher, while in the other four participating organizations they were sent to a focal point (the librarian) for subsequent distribution within the organization. The number of questionnaires distributed to the six organizations was 1107 of which 287 (25.93%) were finally returned after follow-up letters and phone calls. The questionnaires were analyzed by computer using the SPSS program. The methodology is discussed at length in Chapter 6.

The results of the analysis fall into two parts - the information seeking and use habits of scientists/engineers in the two kinds of organization studied; and their communication habits. Obviously the two overlap to some extent since when seeking information a scientist or engineer might approach a colleague, thus getting an immediate verbal response to his problem.

The study results also point to the necessity for better marketing or promotion of library/information services and improved training of users. The ways in which communications and information flow within an organization can thus be made more efficient and productive, as a consequence of the analysis of replies, is the subject of Part 4.

Structure of the Work

The work is in four parts. Part 1, in three chapters, looks at various definitions of communication and models of the communication process, together with the functions of communications and factors which cause its breakdown. It also discusses, in Chapter 2, the general characteristics of organizations in relation to the main theories of organizational management. Chapter 3 examines the flow of information within the organization.

The two chapters in Part 2 examine the information seeking and use habits of scientists and engineers in general terms as well as their communication patterns. They set the scene for Part 3 which, in four chapters presents and discusses the research methodology and the results of the study.

Chapter 6 describes the study in detail, the choice of organizations and method of gathering data, the questionnaire design, and the distribution, collection and coding of it. Based on the results, Chapter 7 gives the background to the scientists and engineers in the study, while the next two chapters analyze in depth the communication habits of scientists and engineers and their information seeking and use habits.

The fourth and final Part gives, in two chapters, first, a review of the objectives, hypotheses and major findings and then discusses a number of points arising from the analysis, concluding with several recommendations for improving the availability and flow of communication and information within the organization.

A Note on the References

A great many books, articles and reports were read in depth or scanned for ideas and information. A fair number of these were subsequently discarded as being of no direct interest or relevance to the study in hand. Of the remainder, those references that are actually quoted from or referred to in the text are itemized alphabetically at the end of each chapter. They are also collated, for bibliographical completeness and convenience, alphabetically at the end of the work together with other references which were found useful or important for background but which are not cited. Material, which was consulted to assist with the study, on questionnaire design, survey techniques and statistical analysis of the data from the questionnaires is also included. A thematic breakdown of all these references is also provided.

REFERENCES

1) ACKOFF, R. L.
Systems, organizations and interdisciplinary research. In Emery, F.E., Systems thinking: Selected readings. Penguin, 1971, p. 330-347.

2) CHEN, CHING-CHIH and HERNON, P
Information seeking. Neal-Schuman Publishers, 1982.

PART 1

COMMUNICATION CONCEPTS

Part 1 looks at some definitions of communication and examines various models of the communication process. The functions of communication are noted and some of the barriers to interaction are described. Following this general introduction, the characteristics of organizations are discussed and the role of communication in organizations is examined in relation to the main theories of organizational management. Building on this, the flow of communication through networks within an organization is then considered. It is important to note that Part 1 is concerned only with introducing the concepts and features of human communication in very general terms. Part 2 will cover many of the aspects raised here in greater depth.

CHAPTER 1

THE COMMUNICATION PROCESS

1.1 INTRODUCTION

The Oxford English Dictionary defines communication as the 'act of imparting'. This would appear from definitions by writers in the field, to be only half the story. Johnston and Smith state that "communication is simply the process of creating understanding with ideas, facts and feelings, transmitted from senders to receivers" (8). Rogers and Agarwala-Rogers (19) go further - "communication is the process by which an idea is transferred from a source to a receiver with the intention of changing his or her behavior". "Communication basically means a process in which there is some predicable relation between the message transmitted and the message received" opine Katz and Kahn (9). Other definitions concentrate more on the medium: For example; Cherry (2) considers communication to be "the use of words, letters, symbols or similar means to achieve common or shared information about an object or occurence". Lin (12) believes communication is a scientific field in which the nature of human symbolic exchange is studied, while Robbins talking about scientific communication, defines it as "the public display, by an individual scientist or small group of scientists to other scientists, of the result of recent research accomplished by the individual or the group, by means of papers published in scientific journals, delivered at conferences, or informally distributed among members of so-called invisible colleges" (17).

These definitions give the flavour of the diversity of ideas (Koehler (10) believes that communication is too difficult to define) - some concentrate on cognitive aspects, others on behavioural aspects. For some the approach is informal, for others it is via formal publications. Redfield (16) notes that in fact much communication is unverbalized , i.e. conveyed by a nod, glance, a frown or a smile.

Whatever the definition it would appear that the process of communication involves a number of elements - sources, receivers, a medium of exchange and some degree of sharing or understanding between the source and the receiver. Communication also includes a number of activities - for example, information seeking, reading, writing, listening to talks, maintaining personal contacts inside and outside the organization, attending meetings, publishing papers and so on (4).

1.2 COMMUNICATION MODELS

One of the best known models of communication or information flow is that developed by Shannon and Weaver (15). In this five component model there was an information source (i) which used a transmitter (ii) to convert a message into a transmittable signal which was then sent through a channel (iii) to a receiver (iv) which reconstructed the message so that it could be read at its destination (v). Other theorists, including Shannon himself, have added to and refined this model by introducing the concepts of noise and feedback, thus viewing communication as really a two-way or interactive process. Rogers and Agarwala-Rogers (18) consider there are only four main components in the process - the source (originator of message); the message (the stimulus that the source transmits to the receiver); the channel (the medium by which the message is transmitted); and the receiver (the one who receives the message).

Each of the elements is given more functions than those implied above, which are adequately described by Koehler (10) in five steps. Step 1 includes the creation of the idea by the source providing the basis of a message. In step 2, the encoding of the idea/information into words or symbols suitable for transmission to the receiver takes place. These words or symbols constitute the message. In step 3 the actual transmission of the encoded information is done. It can be done in a variety of ways - orally, in writing, symbolically, by acting and using a certain channel, e.g. letter, telephone, stage. Step 4 is the decoding process where the message is interpreted and given meaning and substance.

In this step too is ideally implied reception and understanding of the message by the receiver. The fifth step - feedback - permits the source to know whether the message/idea has been received and understood and what effect it had.

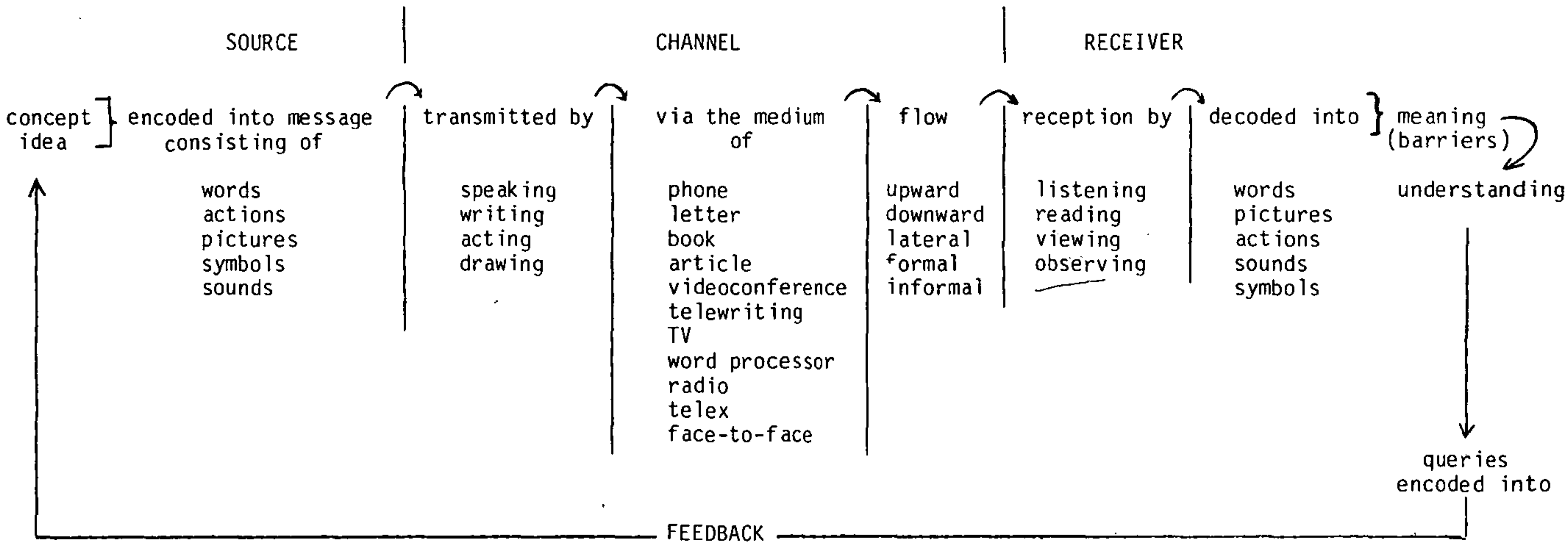
Davis, defining information as the process of passing information and understanding from one person to another, adds a sixth step - that of action on the part of the receiver in response to the communication (3). A fairly detailed model (adapted from Koehler (10), p.6) showing these steps and aspects is given in Figure 1.

1.3 FUNCTIONS OF COMMUNICATION

Before examining the functions of communication it is first necessary to consider the reasons for and purposes of communication. People communicate for many factors. Mitchell (14) lists a number of motives which include: the necessity to reduce uncertainty or to confirm beliefs; to solve problems; to have control of a situation; and to provide feedback. Thus, people communicate or fail to communicate in order to achieve some goal, to satisfy some personal need or to improve their immediate situation (7). Schachter believes communication to be the mechanism of induction, i.e. the means by which influence is exerted (20).

These motives lead to the purposes of communication, a primary one of which, within an organization, is to facilitate goal attainment (21). Another purpose, according to White (22), is to digest and classify all the information coming into an organization and to assist in the development of ideas and solutions to an organization's problems. For Davis (3) the purpose is to develop the information and understanding necessary for group efforts and to provide the attitudes necessary for motivation, cooperation and job satisfaction. Communication thus arises from the pressure towards uniformity which may exist in a group due to social reality and group locomotion (5).

FIGURE 1 - COMMUNICATION AND INFORMATION FLOW



Reading between the lines, it seems clear that a major function of communication is to inform: to keep staff informed of organizational developments and factors and events affecting their jobs and lives. A second function of communication is that of regulation where guidelines and instructions are issued for the purpose of control. The integrative function of communication gives an organization unity and cohesion through coordination; while the persuasive function relies on persuasion rather than commands by the manager to obtain better commitment of staff. Myers and Myers (15) note three broad functions of communication at the organization level:
1. Production and regulation (determining goals, assessing performance, commands/instructions); 2. Innovation (research and development, marketing, brainstorming sessions); 3. Socialization or maintenance (motivation, loyalty, inter-personal relations).

These are echoed by Farace (4) who names them environmental, motivational and instructional and who discusses the work of Jacob who analyzed the functional communication categories of 12 authors. Brown, on the other hand, prefers as types or functions of information: strategic (i.e. environmental issues), managerial and technical (1). Communication within an organization will tend to create a smoother work flow and foster better interaction among staff. Since, however, one party is the sender and another is the receiver, then personal relationships come into what is sent and received (22). These relationships are often a prime cause of breakdown in communications and thus may constitute a barrier to efficient communication.

1.4 BARRIERS AND BREAKDOWNS IN COMMUNICATION

Within the organization, communication problems can occur between management and staff, between staff amd users, within individual teams of workers, and between separate groups (22). Thus they can occur vertically and horizontally.

Communication is impeded by three broad types of barrier - physical, personal and semantic (3). Physical barriers are environmental factors which effect the sending or receiving of messages/information. They include the spatial location of the individuals or members of a group, i.e. the physical distance between them - they may be on another floor, in another part of the building, on a different site, in a different country. Time differences also play a role here. Political barriers which prohibit the flow of information to, from and within a particular country may also exist - these can lead to cultural alienation (13). Another physical impediment is distracting noise. Yet another, in the realm of formal scientific communication, is the delay in publication of a paper. Too many links in the reporting chain constitute a further physical barrier. In the more classical form of organization, breakdowns in formal communication were caused by individuals bypassing the hierarchy because the span of control was too large and consequently there were too many delays. In fact an initial barrier in many organizations is that substantial two-way informal and lateral communication is not expected since communication usually consists of management sending commands or instructions down through the hierarchy and receiving reports back (if they are lucky) (6). In matrix-type organizations communication breakdown is magnified because of the potential for conflicts over priorities, schedules, manpower and material resources. The assignment of staff to projects can create other communication problems since such personnel losses (to the functional department) or transfers from it leave gaps which replacement staff, not so au fait with the work, must fill.

Personal barriers arise from a whole host of judgements, views, prejudices, emotions, values of individuals. Their personalities, likes and dislikes, jealousy, competitive spirit, job function, may cause them to filter or distort or omit or delay messages. There may be a reaction to the person wielding the authority or the responsibility; there may be a threat to a person's status or ego. In international organizations there can be real conflicts relating to cultural factors. What is acceptable behaviour in one culture or race may be totally alien and unacceptable to another.

Some organizations too, operate on a "need to know" basis, which, if you are not in the know, can cause difficulties.

Semantic barriers refer to the linguistic abilities of those wishing to communicate and the limitations of the language or other medium used to exchange the message. Large (11) notes that the foreign language barrier probably poses the biggest current threat to scientific communication. In international organizations, where there are many nationalities, one or more common languages have to be adopted for official communications, but staff may not always speak or read them fluently. Consequently, there can be misunderstandings which may be overcome by using other forms of communication, for example, drawings or gestures.

One further breakdown in communication can occur with the amount, rate and complexity of information which an individual or group receives. If the quantity or complexity of information is too great it can lead to overload with which the system's information processing capacity cannot cope. Farace (4) has identified a number of factors affecting the information load. These include: the number of channels and their capacity for transmitting information; the organizational structure, i.e. the number of subordinates or peers a person might have; the degree of coordination or interdependence required with other groups or individuals; uncertainty in job demands caused by, e.g. changing deadlines, standards, more than one boss (in a project); the greater opportunities to interact (e.g. afforded by close spatial proximity, by the telephone, common language, etc.); the individual capacity for receiving, learning and understanding; and the individuals needs and desires to process communications. Results of information overload include a dropping off of output, frustration, stress and errors and a general lack of meaningful communication.

REFERENCES

1) BROWN, W.B.
Systems, boundaries and information flow. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p. 121-133.

2) CHERRY, C.
On human communication. 3rd ed. MIT, 1978.

3) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed. McGraw-Hill, 1981.

4) FARACE, R.V. et al
Communicating and organizing. Addison-Wesley, 1977.

5) FESTINGER, L.
Informal social communication.
Psychological Review, 57, 1950, p.271-282.

6) HOSLETT, D.S.
Barriers to communication. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p.147-154.

7) JACKSON, J.M.
The organization and its communication problem.
Advanced Management, 24, 2, Feb. 1959, p.17-20.

8) JOHNSTON, R.E. and SMITH, G.V.
Communication in today's engineering environment.
SAWE Journal, 39, 3, Spring 1980, p.33-41.

9) KATZ, D. and KAHN, R.L.
The social psychology of organizations. 2nd ed. Wiley, 1978.

10) KOEHLER, J.W. et al
Organizational communication: behavioral perspectives. 2nd ed. Holt, Rinehart and Winston, 1981.

11) LARGE, J.A.
The foreign-language barrier: problems in scientific communication. Andre Deutsch, 1980.

12) LIN, N.
The study of human communication. Bobbs-Merrill, 1973.

13) MICHEL, J.
Linguistic and political barriers in the international transfer of information in science and technology.
Journal of Information Science, 5, 4, Dec. 1982, p.131-135.

14) MITCHELL, T.R.
People in organizations: an introduction to organizational behavior. 2nd ed. McGraw-Hill, 1982.

15) MYERS, M.T. and MYERS, G.E.
Managing by communication: an organizational approach. McGraw-Hill, 1982.

16) REDFIELD, C.E.
Communication in management. University of Chicago Press, 1954.

17) ROBBINS, J.C.
Social functions of scientific communication.
IEEE Trans. on Professional Communication, PC-16, 3, Sept. 1973, p.131-135, 181.

18) ROGERS, E.M. and AGARWALA-ROGERS, R.
Communication in organizations. Free Press, 1976.

19) ROGERS, E.M. and AGARWALA-ROGERS, R.
Three schools of organizational behavior. In Ferguson, S. and Devereaux Ferguson, S., Intercom: readings in organizational communication. Hayden, 1980, p.2-31.

20) SCHACHTER, S.
Deviation, rejection and communication. In Cartwright, D. and Zander, A. Group dynamics: Research and theory. 3rd ed. Tavistock Pubs., 1968, p.165-181.

21) SCHULER, R.S. and BLANK, L.F.
Relationships among types of communication, organizational level and employee satisfaction and performance.
IEEE Trans. on Engineering Management, EM-23, 3, Aug. 1976, p.124-129.

22) WHITE, P.A.F.
Effective management of research and development. 2nd ed. MacMillan, 1980.

CHAPTER 2

COMMUNICATION IN ORGANIZATIONS

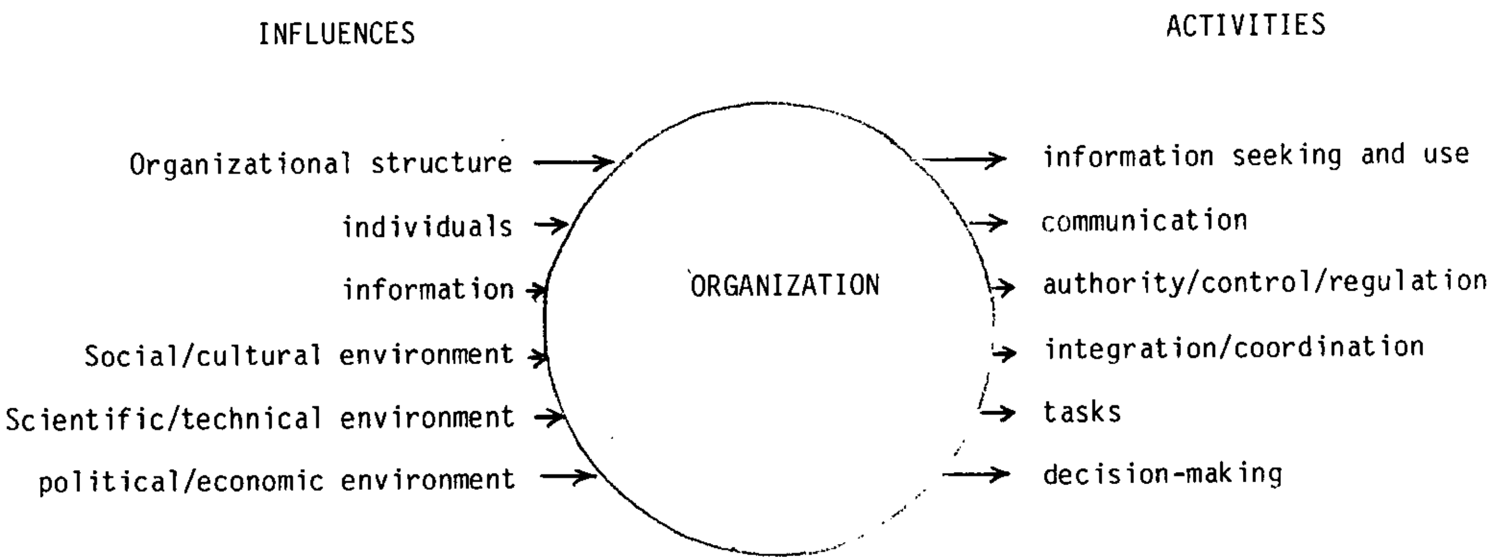
2.1 INTRODUCTION

In the previous chapter general concepts of communications were treated. It will have been noted that the communication processes were related to organizations. Organizations can be of several types, for example, societal, industrial, research, governmental. They may be local, national, international, private or public, for profit or not for profit. They may also be discipline or mission-oriented, or a mixture of both, or simply based on some common interest of members.

Downs (5) states that an organization is a system of consciously coordinated activities or forces of two or more persons explicitly created to achieve specific ends. This is endorsed by Barnard who writes that an organization comes into being when there are persons who are able to communicate with each other, and who are willng to contribute an action to accomplish a common purpose (2). An organization will have a certain number of activities going outside itself, such as producing goods, offering services, giving information and it will have a number of internal activities in addition, such as control and coordination of staff and profits, communicating with and informing staff and so on. Besides these activities an organization will also have a number of external and internal influences impinging on it. The structure of the organization and its personnel exert an internal impact, while its financing, flow of materials, location provide external influences. These influences and activities are summarized in Figure 2.

In this study two kind of organizations are examined - the international organization and the national aerospace research organization. As a basis for the discussion of organization structures and theories which follows later in this chapter, it is instructive to first look a little more closely at the types of organizations studied herein and the reasons for their selection.

FIGURE 2 - INFLUENCES ON ORGANIZATIONAL ACTIVITIES



2.2 INTERNATIONAL ORGANIZATIONS

Despite the myriad international organizations which abound, there seems to be no real United Nations definition as to what is an international organization (19). The (British) Library Association, for example, could be considered an international organization since it has members in a number of foreign countries. Such a definition, however, would embrace nearly all organizations!

Examples of international organizations include the European League for Economic Cooperation, the International Cooperative Alliance, the International Chamber of Commerce, the International Federation of Documentation, the International Council of Scientific Unions, the European Broadcasting Union. The point about these organizations, however, is that they are non-governmental, i.e. while nations may be represented on their boards, the representation is usually through private or public bodies in these countries, rather than governmental departments reflecting official government policy. Organizations in which governments participate directly are known as inter-governmental organizations (IGOs). In a very recent book (6) comparing international organizations it is stated that IGOs are set up by three or more states to fulfill common purposes or to attain common objectives. They have an international legal personality and the purposes and objectives they pursue are normally long-range in nature. Examples of IGOs include, besides the United Nations family, the Caribbean Community, the (British) Commonwealth, the European Community, Interpol, EFTA, NATO, OECD as well as the Organization of American States, World Council of Churches, the Arab League and the Colombo Plan. Thus IGOs may be categorized as being global or regional as well as classified by their functions and competence.

Such organizations may be purely political or political/economic or they may specialize in a particular field of technical activity (17). Some, e.g. the World Meteorological Organization, have a more functional or administrative role, though Gibson (8) believes that an international organization should not act as just a post office between contributing member states and industry.

Others, for example, ESA, may manage research and development projects and will quite probably have a matrix-type of structure.

International organizations (i.e. IGOs) are characterized by being established under multi-lateral international treaties and by being financed and supported by different countries. There may only be a dozen or so countries as in the case of ESA or a hundred or more in the case of the UN agencies. They also have a large, often administrative (albeit of a technical nature, e.g. overseeing study contracts), multi-national staff, which will usually be highly mobile due to the many contacts (for instructions, information, contracts, studies, etc.) needed with the member states. A degree of interdependence is implied which manifests itself partly by the flows of people and information across national boundaries in response to the needs of one state and in accordance with the capabilities of another.

Traditionally, international organizations have been based on confederal principles (18) where the rules or policy formulated by the organizations represent the unanimous consent of the, for the most part, equally participating member governments. The executive structure of the organization, which may be a simple, small secretariat or a large complex bureaucracy, is given little power of its own to formulate and implement rules and programmes; similarly the delegates representing their respective governments are told how to act and vote rather than acting as independent experts. These delegates will require more control and knowledge of what is happening to the money their governments have put into the budget (8), since their governments are in turn accountable for the spending of public as opposed to private money.

International organizations, by their very membership, are distinguished from other organizations in other ways too. There is, for instance, no uniformity of language or environment, despite there being one or more "official" languages. Because they are multi-national, international organizations are also multi-racial and this can lead to misunderstandings and tensions which inhibit the flow of communication and which in turn leads to less than efficient performance and working conditions.

It is probably more so in these kinds of organizations that the informal structure, i.e. informal communication networks, become prevalent as groups tend to form based on language or nationality, since staff and their families may be a long way from their native country and so seek out a familiar environment.

The international organizations considered for the present work were all inter-governmental specializing in a particular field of technical activity. Some were involved in research and development (R&D) while others had an administrative role. Financed by a substantial number of nations, their staff will reflect, to a greater or lesser extent, the budgetary contributions of each member state. Thus, in principle, each country participating in the funding and support of the organization will have nationals working in the establishment(s) of the organization. The organizations invited to participate in the present study were selected because of their scientific and technical or professional activities and their international nature (i.e. staff, cultures, nationalities, contacts) as well as for their size and proximity to the researcher. An overview of these organizations is given in Table 2 (Chapter 6) and Appendix A.

2.3 NATIONAL AEROSPACE RESEARCH ESTABLISHMENTS

The other type of organization in the study is that of a government-funded body which conducts research and development work in the aerospace field primarily in the national interest. Aerospace is a very broad term and, for the purposes of the study, it was narrowed down to cover space activities rather an aeronautics.

Although they are directed and financed by a single government and are situated (albeit with several establishments) in one country and, hence, have an essentially homogenous membership (i.e. the employees are of one nationality), these organizations are included for comparative purposes, because of the contacts they will have with other governments and research establishments outside the country.

They will develop such regional and global contacts in the spirit of cooperation due to the expense of developing, testing and carrying out long-term aerospace projects. This of course implies that the staff of such organizations will need to communicate with people of other tongues and cultures and thus there should be similar problems to those found in international organizations. It also implies, as in international organizations, a degree of interdependence and mobility of staff.

Since they are working on large-scale technical projects, the general structure of these organizations tends to be complex-project or matrix-management, which will give rise to problems of conflict. The organizations invited to participate in the present study were selected because of their research and development in space activities, because of their international contacts, and because of their size and proximity to the researcher. An overview of these organizations is given in Table 2 (Chapter 6) and Appendix A.

2.4 ORGANIZATIONAL STRUCTURES

Every organization shares certain characteristics or properties. These include its structure, size, complexity, age, membership, financing, contacts with other bodies, its products or activities as well as its management and goals. One of the purposes of the organization's structure is to provide stability, regularity and predictability (16). If the people in the organization are to work together to achieve common, specified goals and objectives via schedules and deadlines, then there have to be rules and regulations, ways of doing things, channels to be observed, lines of command, so that there is a sense of method and a non-chaotic state (14).

The people - the staff - will be doing different tasks in realization of the common goal. Thus there is a need for cooperation as well as coordination of manpower, material and financial resources.

These can be achieved by two main structures - the formal, hierarchical communication network and the informal, personal communication network (1,5). In the former, authority, officialdom, bureaucracy is implicit in the rules and regulations, the hierarchy of formal positions and the specialized division of tasks. The informal organization, on the other hand, is a network of personal and social relations not established nor required by formal authority (4). It is in fact the aggregate of the personal contacts and interactions and the associated groupings of people (2).

Embedded in the formal/informal structure of an organization is another structure - that relating to the organization of its activities, especially research and development. Badawy (1) has identified four main types of organization - functional, product, project and matrix - and gives the advantages and disadvantages for each. In the functional structure the organization is divided into a pyramid or hierarchy of units by functional speciality or scientific and technical discipline, e.g. manufacturing, engineering, marketing, finance, physics, chemistry, personnel. In the product organization there is a division for every product line so that each is autonomous. A project structure, consisting of self-contained units, is set up within an organization when there is a multitude of activities requiring the performance of certain tasks directed to the achievement of objectives within a given time-span and budget. Usually, the project structure will be dissolved once the tasks are finished, i.e. the objectives reached.

What sometimes happens in organizations is that the functional and project structures exist side by side, and staff in a functional role are asked to support projects. The matrix type of organization is a multi-dimensional structure that attempts to provide a balance between the short-term objectives of the project-type of organization and the longer-term technical expertise aims of the functional organization. It combines the standard vertical, hierarchical, functional structure, where more emphasis is placed on a member's own speciality rather than project needs, with a superimposed, lateral structure under a project manager (9).

Thus the matrix concept will be used when many projects or product lines must flow through a centralized functional complex of specialized departments (21). The purpose of such matrix structures is to increase the effectiveness of the work force by combining the advantages or orientation towards technical specialization on one side whilst retaining flexibility to re-deploy resources in accordance with overall priorities. This allows the maintenance of a high level of centralized technical expertise by the specialist units and, at the same time, a rapid and dynamic grouping of competent task forces to carry out the individual projects.

In view of the overlapping responsibilities between the project groups and the specialized technical services (functional support) which also have their own research responsibilities, the advantages of matrix management, i.e. the flexibility, the high level of expertise and the project effectiveness have to be bought at the price of an increased potential for conflicts between the various services. This risk must be minimized through a clear definition of responsibilities. These four types of structure can be found in all types of organization, though, of course, a given organization will select a structure in accordance with its aims and experience. Organizations, international or otherwise (e.g. the national aerospace organizations) which execute large, long-term projects will more than likely have a project or matrix organizational structure.

2.5 ORGANIZATIONAL THEORIES

An organization can be considered as a stable system of individuals who work together, within defined boundaries and according to defined rules and regulations, through hierarchies of power and division of labour, to achieve common goals (18). The views of organizations and their role have differed over the years. Early management writers advocated a rigid, top-down control of staff (the classical approach). Later, it was believed that there should be greater interpersonal contact, more upward communication or feedback, and more attention paid to the needs of staff (the human-relations approach).

Since neither of these approaches emphasized the relationships between the various groups of individuals in an organization the systems theory approach was developed. The current management thinkers have taken this approach further by the evolution of matrix organizations which grew out of the choice between functional and project-oriented forms (7). There have, then, been three basic management schools of thought relating to the way an organization should be run. These are the classical, human-relations and systems schools.

2.5.1 Classical Approach

Three names are usually associated with the classical approach to organization theory - though each had his own ideas. Max Weber is generally credited with evolving the first theory of an authority structure in organizations. His theoretical model was based on explicitness and authoritative administrative control with the principles of hierarchies, rules and well-defined, interchangeable jobs plus the authority to carry them out. This bureaucratic model would be efficient because it featured division of labour, precision, expertise, unambiguity, regulations and subordination. Communication was highly formalized and inflexible since the principle of subordination meant communication (i.e. rules and regulations) was initiated at the top.

In France, Henri Fayol, in his observations of organizations noted the functions of a manager (planning, organizing, commanding, coordinating and controlling) and formulated fourteen general principles of administrative management. Seven of these dealt with the chain of command and allocation of authority, but Fayol laid greater emphasis on communication than did Weber and was aware of the restrictions placed on communication by the pyramidal, hierarchical structure. In this structure a person wishing to communicate with a peer in a different division would have to go up through his hierarchy and down through his peer's hierarchy. Fayol suggested that there should be direct, horizontal communication between peers where circumstances permitted, for example, in crisis situations where speed was of the essence.

This by-passing mechanism became known as the Fayol bridge and is embodied in his principle of esprit de corps.

An alternative name for the classical school is the scientific management movement, whose founder, Frederick Taylor in the USA, developed a task-oriented approach which used scientific principles such as organization and method techniques to concentrate on the best way of doing a job. The idea was that jobs could be analyzed scientifically and thus standardized leading to greater control, reduction in time-wasting and inefficient operations and greater productivity, hence prosperity, for both employees and employers. The basis tenets of Taylor's work stress harmony rather than discord between workers and management since a fair day's work could be defined, thus there should be cooperation rather than individualism, although the individual rather than any group was rewarded. Emphasis was also placed on formal, hierarchical authority with the communication being mainly instructional and regulative downward from management to worker.

The classical ideas of organizations then - the contributions of Weber and Fayol and Taylor - include an emphasis on functionality, the purpose of which was to get the work done efficiently and with increased productivity through task specialization, standardization of roles, centralization of decision-making and delegation of authority. Communication was relatively unimportant - its purpose being to relay written work-related orders, instructions and information downwards to staff - and its role as a mechanism linking segments of systems was overlooked (3).

2.5.2 Human-Relations Approach

The introduction of mechanization to the work process in organizations led to the requirement that staff should be better trained. In addition the flow of work shifted in focus so that a worker became one of a team. Various studies were undertaken to look at the human aspect of working in organizations and thus the human-relations approach was born.

This approach has also been termed the theory of humanistic management, the behavioural approach and the human resources school. All are agreed though, that emphasis should be placed on social factors, informal communication and individual motivation rather than on the classical aspects of structure, order and formality. Barnard asserted that the formal chain of command and the formal structure did not guarantee compliance with orders communicated from above (2). This assertion paved the way for the recognition of social factors, since it stated, through the theory of acceptance, that subordinates decided whether an order was legitimate and whether to accept or reject it.

Studies made by Elton Mayo of the effect of environmental conditions on worker productivity led to the conclusion that an organization was a social entity with productivity being based on a group norm. These Hawthorne studies, as they are known, showed that people worked in groups rather than as individuals and that interpersonal relations were important to the well-being and hence effective functioning of a member of the group. It was realized that the root of workers' motivation and productivity was not the organization's structure but rather the informal communication which existed within a group. Other writers in the human-relations school stressed the concept of human motivation and needs. McGregor, with his theory of X and Y called for the integration of an individual's needs and goals with those of the organization, while Agyris claimed that the employee's struggle for real satisfaction often led to conflict between the goals of the organization and those of the individual. Organizing amounted to motivating and motivating depended on the leadership and communication skills of supervisors. Barnard (2) considered that one of the first essential functions of an executive was to provide the system of communication. Another theorist, Rensis Likert, also believed communication lay at the bottom of sound leadership and management.

His work showed that communication was the basis for teamwork, interaction and influence throughout an organization. It affected the decision-making process since decisions were made upon accurate communications and it was vital to the control process.

He evolved four systems of management based on his ideas but it was his System 4 which combined the group interaction process and the organization's structure to the greatest managerial effect (12,13).

The human-relations tenets challenged those of the classical movement which concentrated on economic man by shifting to social man and recognizing that horizontal communication channels between peers were needed on a regular basis not just when work-related crises arose. Far more attention was paid to the reactions of individuals and the necessity of upward communication to provide management with more insight into the lives, habits and attitudes of workers. Thus communication was relatively important, tended to be oral and had as its purpose the satisfaction of needs - both workers' and managements' - in order to get the job done.

2.5.3 Systems Theory Approach

The traditional, classical, scientific management and human-relations theories of organizations generally viewed the organization as a closed system from which external influences could be largely excluded or ignored. Over-concentration on principles of functioning and failure to understand and develop the process of feedback (10) were features of such organizations. In the newly-developed systems theory approach the organization was seen as a system of interrelated and interdependable components massed together for maximum performance and productivity (15). The systems theorists were concerned with understanding the complexity and interrelationships of such components without in any way trying to indicate a best method of organizing. The core of the theory is that the whole is more than the sum of its parts and to understand the whole it is first necessary to study the interrelations of the parts (14). Ludwig van Bertalanffy believed that it was communication which linked all parts of the system to facilitate their independence. This approach retains the hierarchical principles of other earlier theories, but adds a number of concepts of its own such as openness, boundaries, entropy and steady state. The open system, advocated by Katz and Kahn continuously exchanges information with its environment across the organization's boundary.

In the past the organization was treated as an isolated entity and not looked at beyond its bounds. The effectiveness of an organization (or a system) is thus contingent upon its environment. Contingency theorists Lawrence and Lorsch examined the degree to which organizations faced a turbulent (changing, unpredictable) or stable (static, predictable) environment and introduced the concepts of differentiation (many different people doing different jobs in departments with different projects) and integration (the manner in which the organization handles these differences) (11).

Just as the classical and human behaviour theories had sub-schools of thought, so too has the systems approach. The theory that the structure of an organization is occasioned by (or is contigent upon) its technology has been advanced by Perron and Woodward (20). The underlying idea here is that organizations in a mass-production, routine, industry like the car industry would be more rigidly controlled, after the classical manner, than say an organization with many different contracts and projects (e.g. in the aerospace industry) and thus requiring greater flexibility, less hierarchical control and greater independence and authority of the individual to be effective and successful. Woodward, developer of a classification scheme for technology which divided industrial organizations into three types, believed that the degree to which tasks could be broken down into component parts was an important determinant of organization structure and process.

The systems approach thus focussed on the interdependency of subsystem components each of wnich had certain goals which contributed to the organization's overall objectives. This interdependency depended on communication which was thus important to hold the organization together. The purpose of such communication was to control, coordinate and provide information and feedback to decision-makers.

REFERENCES

1) BADAWY, M.K.
Developing managerial skills in engineers and scientists. Van Nostrand Reinhold, 1982.

2) BARNARD, C.I.
The functions of the executive. Harvard UP, 1946.

3) DAVIS, K.
Communication within management. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p.155-162.

4) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed., McGraw-Hill, 1981.

5) DOWNS, A.
Inside bureaucracy. Little, Brown & Co., 1967.

6) FELD. W.J. et al
International organizations: a comparative approach. Praeger, 1983.

7) GALBRAITH, J.R.
Matrix organization designs.
Business Horizons, Feb. 1971, p.29-40.

8) GIBSON, R.
Project management information requirements in an international organization. In Project management and project control, 10th ESRO Summer School, Frascati, Italy, Sept. 1972, p.349-352, ESRO SP-90, 1973.

9) JOHNSTON, R.E. and SMITH, G.V.
Communication in today's engineering environment.
SAWE Journal, 39, 3, Spring 1980, p.33-41.

10) KATZ, D. and KAHN, R.L.
The social psychology of organizations. 2nd ed. Wiley, 1978.

11) LAWRENCE, P.R. and LORSCH, J.W.
Organization and environment: managing differentiation and integration. Harvard UP, 1967.

12) LIKERT, R.
New patterns of management. McGraw-Hill, 1961.

13) LIKERT, R.
The human organization: its management and value. McGraw-Hill, 1967.

14) MITCHELL, T.R.
People in organizations: an introduction to organizational behavior. 2nd ed. McGraw-Hill, 1982.

15) MYERS, M.T. and MYERS, G.E.
Managing by communication: an organizational approach. McGraw-Hill, 1982.

16) ROGERS, E.M. and AGARWALA-ROGERS, R.
Communication in organizations. Free Press, 1976.

17) STEINACKER, I.
Implementation problems for information systems within international organizations. In Wessel, A.E. The implementation of complex information systems. Wiley, 1979, p.110-133.

18) THARP, P.A.
Regional international organizations: structures and functions. Macmillan, 1971.

19) UNION OF INTERNATIONAL ASSOCIATIONS
Yearbook of International Organizations 1983/84, Vol. 1, Saur, 1983.

20) WOODWARD, J.
Industrial organization: theory and practice. OUP, 1965.

21) WRIGHT, N.H.
Matrix management: a primer for the administrative manager.
Engineering Management Review, 10, 3, Sept. 1982, p. 65-68.

CHAPTER 3

COMMUNICATION AND ITS FLOW

3.1 INTRODUCTION

In the previous chapters we have looked at communications in general and its role in organizations. In this chapter we turn to the types of communication and the channels through which it flows. In discussing the properties of communication channels, Ramstrom (23) identifies the following main types of channel: formal and informal, vertical and horizontal, internal and external, one-way and two-way, symmetrical and asymmetrical, in-channels (transmitting information to decision-makers) and out-channels (transmitting description of decisions made). Downs (11) distinguishes three types of communication: formal - official communications coinciding with formal, vertical authority; sub-formal - arising from informal, horizontal authority structure; and personal communication - when an individual reveals something of his own personal or private attitudes towards the organization. For other writers, for example, Fischer (13), formal channels consist of journal articles and texts. These are not conducive to interaction and are subject to long publication delays. For some, formal communication occurs when, say, a meeting is called for a given time and place to discuss a given topic. Redfield (24), on the other hand, considers the relationship between a superior and a subordinate as the central feature of formal organization structure. Formal communication may, thus, be public and oral or written.

Informal or personal communication may also be oral or written. A chance meeting in the corridor or a chat over lunch is considered informal as is a quick visit to a colleague's office. The grapevine by which rumours and generally accurate but incomplete news gets around an organization speedily is usually oral and informal. On the other hand, the sending of an internal memo is often considered informal whereas a letter being sent outside the organization is official and thus formal.

The essential difference between formal and informal comments is the greater stability and predictability of formal communication which is lent by the organizational structure (25).

In the pursuit of their work goals, people have forces acting upon them to communicate with those who will help them achieve their aims, and forces against communicating with those who will not assist, or may retard their accomplishment (19). Thus, to a large extent, communication - informal communication - will flow along friendship lines since trust implies freer information content. Such communication is therefore more personal between individuals and hence more interactive. Such communication is also more likely to take place horizontally or laterally between peers who have a greater awareness of interests and needs and attitudes and pressures.

Public as opposed to personal communication within an organization (for the publication of articles and papers is public communication to peers) consists of a downward flow of information from management to staff such as orders, instructions, policy, procedures, rules, general information; and an upward smaller, feedback flow from staff to management consisting of reports dealing with statistics, materials, man-hours, finance, suggestions, ideas, results (24). Both these channels are likely to be formal and written.

3.2 GROUPS AND COMMUNICATION NETWORKS

According to Jacobson and Seashore (20) the communication structure of an organization approximates a network of relationships of individuals in groups. A group is a collection of individuals who have relationships to one another that make them interdependent to some significant degree (8). There are various attributes to these relationships, for example, structural (vertical/lateral); organizational function (orders, information exchange, decision-making); spatial location; content; psychological concomitants (perception, motivation, expectation, satisfaction); frequency; continuity and medium.

The study of such groups has received considerable attention over the years (8, 9, 15, 16, 17, 19, 21). People in an organization can be formally structured into different groups according to their work or professional similarity and these groupings or systems of relationships between individuals are used by the organization for different purposes. Handy (17) lists a number of these purposes including: work distribution, i.e. the bringing together of a set of skills and talents for allocation to a particular task; management and control of work; problem-solving; and information processing.

The groups are often overlapping and interdependent and located near or far (19). Informal groups are also created, not by formal authority, but usually because of or in spite of it, to satisfy social and behavioural needs. Such informal groupings of staff do not effectively pursue organizational objectives (9) though they may contribute to them in an unofficial way. The corner-stone of any group, and hence, any organization since it is composed of groups, is the communication or interaction which must take place within and between the group and its members. This has also been studied extensively (4, 5, 7, 20, 26). It is communication which provides the means for making and executing decisions, obtaining feedback and correcting the organizational objectives and procedures.

If a collection of people engages in interaction frequently and over an extended period of time, it is likely that their interactions will become patterned (8). A number of studies have been made over the years on these patterns or networks and become part of the literature on group dynamics. Bavelas (7), for example, raises the idea of fixed communication patterns in an organization and shows how this affects the life and work of a group. Hurwitz shows that there is a marked tendency for people to communicate more frequently with those who communicate with them frequently than to those who communicate with them infrequently (18). Furthermore, people with power, (i.e. high up the hierarchy) communicate more frequently than people without, while individual group members occupying low status positions tend to communicate upwards in a hierarchy.

Allen's studies (1,2) have concentrated on finding out how the individuals in organizations or groups are linked by constructing sociograms which reveal who communicates with whom. Among the concepts he considers in particular is that of the gatekeeper who acts as a key person or focal point in the reception and distribution of peer information. More specifically, the gatekeeper links external, formal channels with internal, informal channels (14).

Other writers have conducted experiments to show the flow of communication and the degree of connection. Among the better known designs of communication network are circle, wheel and chain. Each of these gives different degrees of accuracy in information transfer, speed, flexibility, job satisfaction and leadership. Baskin and Aronoff (6) consider that a decentralized network such as the circle or the all-channel type is more effective in the solving of complex problems, is faster and is less prone to overload. As Rogers and Agarwala-Rogers point out, it is one of the functions of organization structure - the hierarchy - that helps to restrict the flow of communication and thus decrease the problem of information overload (unless there is a gatekeeper) compared with a centralized system such as the wheel (25).

A given communication link has a number of properties including symmetry, strength and reciprocity (12). Symmetry occurs when two people interact on equal terms, for example in a conversation where both take part equally. Asymmetry occurs when the exchange is unbalanced for instance by one giving and the other receiving information rather than a mutual interaction. The strength of the link relates to the degree of frequency and length of interaction; while that of reciprocity deals with the degree of agreement between the two parties. A fourth property is that of connectivity, i.e. the total number of possible channels that exist between a given number of nodes or people. Other link properties include the content of the exchange (e.g. facts, ideas, gossip) and the medium (letter, phone, face-to-face, etc.). Ramström (23) takes these properties further by characterizing information channels by their reliability (which affects the correctness and precision of the information received);

the speed (which influences the topical quality of the information content); and the capacity (which determines the completeness of the information sent through the various media (oral direct, oral indirect, written direct, written indirect)).

Regarding the roles of individuals in organization networks there would appear to be four distinct types; namely, the ordinary group member; the bridge (a member of a group with links to other groups); the liaison (someone with links to several groups but not being a member of any of them); and the isolate who is not a member of a group and who has no links to groups. The liaison role was first mooted by Jacobson and Seashore (20) and has appeared in different guises ever since (3, 16, 22). The gatekeeper, however, in Allen's usage, may be a member of a group unlike the liaison (3). The roles, of course, depend on the characteristics of the network which include the spatial dimensions of it; the mutual attraction of members; the status and rank differential of members; the nature of the task and the degree of satisfaction involved.

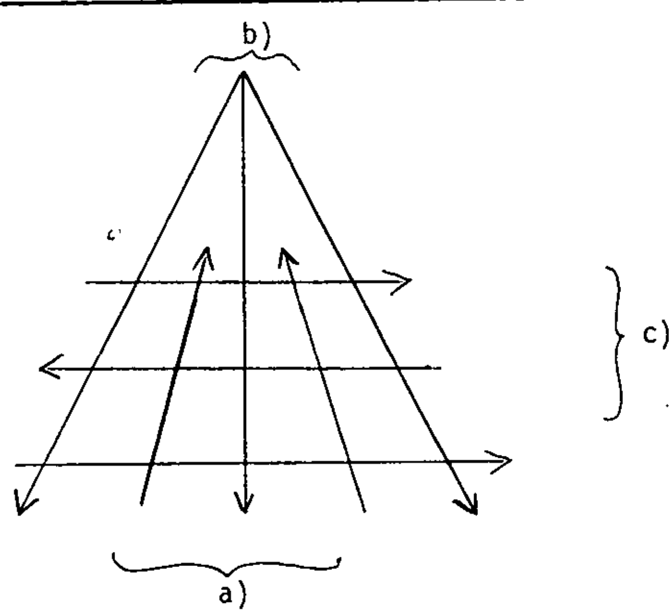
3.3 FACTORS IN COMMUNICATION FLOW

Information itself, communicated, can be favourable or unfavourable, it can be voluntary or involuntary, timely or untimely. There can be too little or too much - quality is more important than quantity. Dissemination does not necessarily mean reception and reception does not necessarily imply acceptance - it is often selective. Several factors can inhibit successful communication. There is no guarantee that a message will reach its target. To reach any person it is vital to use the right media - one that will make the biggest impact. The intelligence, interest, education, nationality, vocabulary, workload of the receiver may limit reception, acceptance and understanding of the message as may individual attitudes, the nature and tone of the message and its timing. Successful communication also depends on the source which must be credible and honest; the ideas or message which must relate to the problems, values, interests of the receiver; and the meaning, which must be clear with no room for doubt or misunderstanding.

Not to be overlooked are factors such as the degree of routiness and standardization of the communication, its actual route and the necessity for transformation en route. Also important is the size and complexity of an organization with different groups, doing different tasks on different projects at different sites which leads to problems in communications due to spatial separation, competition and reporting to different bosses. An example, of this is provided by Dennison (10) whose research shows that many of the aid-giving bodies do not provide much in the way of information and then only to a very few outlets. Often there is no system of press releases being made available and the intermediate bodies such as the project owner or government may act as gatekeepers and severely restrict the amount of information and the number of recipients to whom it may be passed (incidentally, this is not the usual function of gatekeepers!). Dennison also notes that there is often a time-lag between passing on all or part of the information and mailing list members can find that the supply of information received is at best erratic, and at worst non-existent. Ramström relates some of these factors to channel costs and quality (23).

The various components of organizational communication are tabulated in Table 1 and shown graphically in Figure 3.

FIGURE 3 - MODEL OF ORGANIZATIONAL COMMUNICATION FLOW



(NB. the appellations a), b), c) are those used in Table 1).

TABLE 1 - OVERVIEW OF ORGANIZATIONAL COMMUNICATION CHANNEL CHARACTERISTICS

	FLOW	CONTENT	FUNCTION	TYPE	MEDIUM
a)	downward, internal outward, one-way	procedures, rules, policy, instructions general information	informative, regulative, coordination	formal, written public	notices, bulletins, memos, committees
b)	upward, internal inward, one-way	ideas, opinions, suggestions, analysis, results	reporting, feedback	formal, written, public	reports, memos, brainstorming sessions
c)	lateral, internal, external a) two-way b) one-way	opinions, ideas, knowledge, general information	information seeking, social, cooperation	a) informal, oral, personal b) formal, written, public	a) face-to-face, notes, phone b) conf. meetings, publications

REFERENCES

1) ALLEN, T.J.
The differential performance of information channels in the transfer of technology. MIT Sloan School of Management, 1966, WP 196-66.

2) ALLEN, T.J.
Communication networks in R&D laboratories.
R&D Management, 1, 1, Oct. 1970, p. 14-21.

3) ALLEN, T.J. et al
The international technological gatekeeper.
Technology Review, 73, 5, March 1971, p. 36-43.

4) ANZIEU, D.
Les communications intra-groupe. In Geldard, F.A. ed. Conference on communication processes, Washington, 1963. Macmillan, 1965, p.109-188, discussion p. 189-218.

5) ARDOINO, J.
Information et communication dans l'entreprise et les groupes de travail. 2nd ed. Les editions d'organization, 1964.

6) BASKIN, O.W. and ARONOFF, C.E.
Interpersonal communication in organizations. Goodyear Pub. Co., 1980.

7) BAVELAS, A.
Communication patterns in task-oriented groups. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs. 1968, p.503-511.

8) CARTWRIGHT, D and ZANDER, A.
Group dynamics: research and theory. 2nd ed. Tavistock Pubs., 1968.

9) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed.
McGraw-Hill, 1981.

10) DENNISON, E. et al
International aid: channels of communication.
Management Decisions, 21, 4, 1983, p.36-44.

11) DOWNS, A.
Inside bureaucracy. Little, Brown and Co., 1967.

12) FARACE, R.V. et al
Communicating and organizing. Addison-Wesley, 1977.

13) FISCHER, W.A.
The acquisition of technical information by R&D managers for problem-solving in non-routine contingency situations.
IEEE Trans. on Engineering Management, EM-26, 1, Feb. 1979, p.8-14.

14) FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

15) FISHER, B.A.
Small group decision-making: communication and the group process.
2nd ed. McGraw-Hill, 1980.

16) GUETZKOW, H.
Differentiation of roles in task-oriented groups. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed.
Tavistock Pubs., 1968, p.512-526.

17) HANDY, C.B.
Understanding organizations. Penguin, 1979.

18) HURWITZ, J.I. et al
Some effects of power on the relations among group members. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs., 1968, p. 291-297.

19) JACKSON, J.M.
The organization and its communications problem. Advanced Management, 24, 2, Feb. 1959, p. 17-20.

20) JACOBSON, E. and SEASHORE, S.E.
Communication practices in complex organizations. Journal of Social Issues, 7, 1951, p. 28-40.

21) LEAVITT, H.J.
Some effects of certain communication patterns on group performance.
Journal of Abnormal and Social Psychology, 46, 1951, p. 38-50.

22) LIKERT, R.
The human organization: its management and value. McGraw-Hill, 1967.

23) RAMSTRÖM, D.
The efficiency of control strategies: communication and decision-making in organizations. Almqvist and Wiksell, 1967.

24) REDFIELD, C.E.
Communication in management. University of Chicago Press, 1954.

25) ROGERS E.M. and AGARWALA-ROGERS, R.
Communication in organizations. Free Press, 1976.

26) SCHEIN, E.H.
Interpersonal communication, group solidarity and social influence. In Bennis, W.G. et al. The planning of change. Holt, Rinehart and Winston, 1961, p.517-527.

PART 2

INFORMATION SEEKING AND COMMUNICATION HABITS OF SCIENTISTS AND ENGINEERS

This section attempts to build up a profile of the scientists and engineers in organizations and to note the differences between them. Following an overview of the characteristics of scientists and engineers, their information-seeking habits and the information sources, both oral and written, required and used by them are briefly discussed. Their communication patterns are then examined in general terms from the point of view of why they communicate, how they communicate and what problems they have in communicating. A more detailed study of the communication habits and the information-seeking and use habits of scientists and engineers will be presented in chapters 8 and 9.

CHAPTER 4

INFORMATION SOURCES AND USE

4.1 CHARACTERISTICS OF SCIENTISTS AND ENGINEERS

An organization is comprised of a number - large or small - of staff at least some of whom are professionals. Such staff, according to Davis (9), will be usually more intelligent, intellectually-oriented, achievement-motivated (especially towards problem-solving), analytical and self-disciplined. In addition, they require recognition, status, opportunities for growth, involvement, responsibility, autonomy and job-freedom. Professional staff may be roughly divided into scientists, engineers and "others". Included in the engineer group are technicians and technologists.

Engineers are responsible for formulating basic technical concepts, transforming them from ideas into physical entities, adapting resulting products to specific applications and evaluating their usefulness (29). They are thus more oriented towards applications rather than the generation of new concepts and theories leading to an increase in knowledge, which is the domain of the scientist. Science, state Gerstl and Hutton, is concerned with knowledge for its own sake and with the search for truth, whereas engineering is concerned with creating devices that will be useful. The engineer is thus the medium by which the public enjoys the fruits of scientific research (13).

Although Gerstl and Hutton note that engineering on a technical level is closely related to and interdependent on science, they and others point to distinct differences between science and engineering which must be appreciated. Allen (3) considers that engineers differ from scientists in their professional activities, their attitudes, their orientations and even their typical family backgrounds.

There is often a difference in education with the scientist going through a longer more academic educational process, and in addition there may be a difference in their information use and communication patterns. Ladendorf (18) believes that the striking contrasts in communication behaviour patterns between scientists and engineers can be traced to fundamental differences in group organization and motivation. The scientist sees himself as belonging to an amorphous group of fellows who share his research interests and attitudes regardless of their organizations and geographical locations. In contrast, the engineer/technologist works for organizations that are product/profit-oriented and which control the work (to create or improve products). Allen (2) goes further and suggests that mission-oriented organizations (as opposed to discipline-oriented) do not permit, for competitive reasons, free communication between members engaged on propriety research and people outside the organization. Because of the nature of his work, which is not contributing to theoretical advances and an increase in general knowledge, the engineer will tend more to publish his results in internal reports and memos rather than in journals read by the scientific and technical community at large. He is thus results-oriented rather than information-oriented (23). As a consequence of this, the engineer is not closely connected to the formal communications media (5) and thus has no real reason to read journals. Indeed "technical" journals are usually incomprehensible to him (18). Technologies do have their own journal systems, like science, but the literature does not cumulate and build on itself the way science does. It contains fewer references to other work and the work reported serves to document end-products rather than announce theories (20).

4.2 ORAL VERSUS WRITTEN SOURCES

Although Ladendorf (18) considers that engineers, because they are specialized in the tasks they work on, with an expertise based on knowledge and experience, have no need to read to keep themselves up-to-date, Marquis and Allen (20) are at pains to show that technologists publish less and devote less time to reading than scientists.

This is because technology, like science, develops cumulatively with each technical innovation building to a large degree upon its predecessors. Technologists have a communication requirement akin to that of scientists, namely to keep abreast of developments in their fields.

A number of factors influencing the information-seeking behaviour of scientists are put forward by Ritchie and Hindle (24). They include the scientific discipline and area of specialization, the nature and state of the R&D tasks, the organizational structure and the channels of information available. These apply equally well to engineers. However, regarding information channels and sources, Mick (21) found that scientists tend to be more print-oriented and maintain larger collections of books, whereas engineers were more oriented to interpersonal sources. Flowers, too, in his survey, found pure scientists were more dependent on literature than were industrial scientists and technologists (12). This observation is in fact common throughout the literature. Shuchman (27) discovered engineers got most of their technical information from talking to other engineers rather than by reading - 53% not reading or scanning any STI journals. Sutton (28), examining the information requirements of engineering designers in the light of several studies, found that engineers relied more on people, while chemists and physicists relied more on literature as sources of information. Gerstl and Hutton (13), in a study of mechanical engineers in the UK, discovered that 20% read no professional journal at all. Wood and Hamilton (30), in another study of mechanical engineers, noted that while they required a considerable amount of information outside the field of mechanical engineering, 37% read less than five journals regularly. Similarly, 54% of earth scientists regularly read six journals or less (14). Shotwell (26), too, in a survey of staff in an industrial biosciences research laboratory noted that the mean number of science journals read was 22.5, while the mean number of trade and technical journals read was six. Lufkin's informal discussions with senior staff revealed that many engineers kept up with advances through conversation with colleagues both inside and outside the organization (19).

The evidence seems, therefore, clear - despite the value to the technologist of maintaining a high level of activity in technical reading (25), regular reading is not the way that engineers obtain solutions to current problems. What distinguishes engineers from other professionals, observes Shuchman, is the high value they place on the information right around them (27). Most engineering problems require original solutions to be worked out on the bench rather than got from literature; and when they do require information they are far more likely to turn to colleagues. One reason for this is that reading requires a high degree of effort and concentration on the part of the user. Another reason is that engineers tend to use the most accessible source of information whether or not it supplies the needed quality (17) or whether or not it is the most accurate (31). This source is normally a colleague. The engineer, working on practical problems, often needs a solution right away to help with the immediate job in hand and cannot wait to ponder the ramifications and postulates as a scientist often can. Thus, he may not have the time, at that moment, to go and search the literature for references to previous work and so he is quite prepared to accept ideas from a colleague he considers an "expert" (1). In a study conducted by Engineering Index, Inc., it was recorded that engineers had a high willingness to accept data without first reviewing systematically the state-of-the-art findings upon which the data are found (10). Few scientists would do this. Their reputation is built up on the research and theories they have promulgated, to a worldwide, critical audience. It is also built upon their contribution to scientific understanding rather than some piece of equipment or device they have constructed and which is of limited value and interest.

The implication is, therefore, that the engineer requires information of a more factual nature (6), referring to specifications, codes of practice, design rules and failure criteria (15). Engineers, however, <u>do</u> read but for general interest, to keep up-to-date in their own fields and other fields, to discover new markets and to answer specific questions (25, 27). They largely ignore the valuable dynamic knowledge that is available to them through online databases (8).

Scientific and technical information (STI) sources external to an organization play a predominant role in supplying information in the idea-formulating phase, while internal sources play the more important role in the problem-solving phase (11). Thus, the pattern of acquisition and usage of STI, the information-seeking behaviour of scientists and engineers, is greatly affected by the organization's climate, work structure and processes and by the pattern of interpersonal interactions (22). What is noticeable, though, from the literature is that, despite their use of oral channels, in preference to written or published channels, engineers are notoriously poor communicators.

Allen (1) notes that although their personal contacts are better, average technologists do not communicate very well. Woelfle (29) and Fischer (11) agree, although, Gray (25) argues that engineers are not fundamentally bad at communicating compared to doctors, accountants, lawyers and other professionals. In fact, this sentiment is lent support from the Project on Scientific Information Exchange in Psychology which showed that psychologists in different groups or research areas had different communication patterns. Some, for instance, working in social perception published a lot but had little communication with each other (16). Allen (4) also noted that the behaviour of research-oriented staff was quite different from those doing product development. As further proof of this view one has only to look at the professional press - there is hardly an issue of a journal that does not contain some article or other on the importance of communicating and giving hints and tips on how to communicate effectively at meetings and elsewhere.

Being lax in his reading habits and not good at communicating, especially with non-specialists and outsiders, the engineer often turns to certain individuals to get access to the flow of information from outside the organization. Known as gatekeepers, such people have broader ranges of contacts with others outside the confines of the organization, read more journals and are generally better educated and higher performers. Breton (7) has noted that engineers normally use limited and dated resources - reference manuals, discussions with vendors and other engineers.

Clearly, if an engineer does not read much, then to rely on the knowledge of other engineers is a severe handicap since they will not be current and aware of latest developments either. Hence, the reliance, in technology at least, on gatekeepers who are. Scientists, on the other hand, as a group, because they wish to remain at the forefront of their field and be recognised for their endeavours and published work, keep themselves up-to-date and abreast of their fields by reading more, building on previous work and by being in contact with others in their field through invisible colleges.

REFERENCES

1) ALLEN, T.J.
The differential performance of information channels in the transfer of technology. MIT Sloan School of Management, 1966, WP 196-66.

2) ALLEN, T.J.
Roles in technical communication networks. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.191-208.

3) ALLEN, T.J.
Managing the flow of technology. MIT Press, 1977.

4) ALLEN, T.J. et al
R&D performance as a function of international communication, project management, and the nature of the work.
IEEE Trans. on Engineering Management, EM-27, 1, Feb. 1980, p.2-12.

5) ALLEN, T.J. and COHEN, S.I.
Information flow in research and development laboratories.
Administrative Science Quarterly, 14, 1969, p.12-19.

6) BERUL, L.H. et al
DOD user needs study, Phase, 1. Vols. 1 and 2. Auerbach Corp., 1965. Report No. 1151-TR-3. AD615501/2.

7) BRETON, E.J.
Reinventing the wheel: the failure to use existing technology. Mechanical Engineering, 103, 3, March 1981, p.54-57.

8) BRETON, E.J.
Why engineers don't use databases.
ASIS Bulletin, 7, 6, August, 1981, p.20-23.

9) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed.
McGraw-Hill, 1981.

10) ENGINEERING INDEX, INC.
Alternatives for accessing engineering numerical data. NTIS, 1978.
PB282609.

11) FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

12) FLOWERS, B.H.
Survey of information needs of physicists and chemists.
Journal of Documentation, 21, 2, June, 1965, p.83-112.

13) GERSTL, J.E. and HUTTON, J.P.
Engineers: the anatomy of a profession. Tavistock Publications, 1966.

14) GRALEWSKA-VICKERY, A. and ROSCOE, H.
Earth science engineers communication and information needs.
Final report and appendix. Imperial College, 1975. Research report No. 32.

15) GRAY, T.G.F.
Communication skills in engineering.
CME, 28, 4, April, 1981, p.23-27.

16) GRIFFITH, B. and MILLER, A.J.
Networks of informal communication among scientifically productive scientists. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.125-140.

17) HOLLAND, W.E. et al
Information channel/source selection as a correlate of technical uncertainty in a research and development organization.
IEEE Trans. on Engineering Management, EM-23, 4, Nov. 1976, p.163-167.

18) LADENDORF, J.M.
Information flow in science, technology and commerce: a review of the concepts of the sixties.
Special Libraries, 61, 5, May-June, 1970, p.215-222.

19) LUFKIN, J.M.
The reading habits of engineers - a preliminary survey.
IEEE Trans. on Education, E-9, 4, Dec. 1966. p.179-182.

20) MARQUIS, D.G. and ALLEN, T.J.
Communication patterns in applied technology.
American Psychologist, 21, Nov. 1966, p.1052-60.

21) MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980, p.347-356.

22) OLSON, E.E.
Organizational factors affecting the flow of scientific and technical information in industrial R&D divisions. NTIS, 1977. PB27761.

23) RICHARDSON, R.J.
End-user online searching in a high technology engineering environment.
Online, 5, 4, Oct. 1981, p.44-57.

24) RITCHIE E. and HINDLE, A.
Communication networks in R&D: a contribution to methodology and some results in a particular laboratory. University of Lancaster, Dept. of Operational Research, 1976. BLRDR 5291.

25) SCOTT, C.
The use of technical literature by industrial technologists.
IRE Trans. on Engineering Management, EM-9, 2, June 1962, p.76-86.

26) SHOTWELL, T.K.
Information flow in an industrial research laboratory - a case study.
IEEE Trans. on Engineering Management, EM-18, 1, Feb. 1971, p.26-33.

27) SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group, 1981.

28) SUTTON, J.R.
Information requirements of engineering designers. In AGARD TIP Specialist Meeting. The problem of optimization of user benefit in scientific and technological information transfer, Copenhagen, Denmark, 1975. AGARD, 1976. AGARD CP-179, p.12.1-12.8.

29) WOELFLE, R.M.
Role of the engineer in improving the communication of technical information.
IEEE Trans. on Professional Communication, PC-22, 1, March 1979, p.24-26.

30) WOOD, D.N. and HAMILTON, D.R.L.
The information requirements of mechanical engineers: report of a recent survey. Library Association, 1967.

31) YOUNG, J.F. and HARRIOTT, L.C.
The changing technical life of engineers.
Mechanical Engineering, 101, 1, Jan. 1979, p.20-24.

CHAPTER 5

COMMUNICATION HABITS OF SCIENTISTS AND ENGINEERS

5.1 INTRODUCTION

A significant amount of time is spent, it seems, by scientists and engineers in communicating. Burns (6) records that 80% of executives' time in an engineering factory was spent in conversation (including the telephone). Tushman (38) estimates that engineers and applied scientists spent 50-75% of their time communicating with others. Technical employees, in a Case Institute of Technology study, spent 61% of an 8-hour day communicating, while chemists spent some 40% (22). Farace (13) suggests that communication activities account for over 66% of the total time spent by members of an organization, while a Booz, Allen, Hamilton survey of 300 managers and professionals found that 67% of their time was spent reading, writing and in meetings (30). In a study of 560 scientists and engineers, Mick (27) showed that over 50% of a working week was occupied in communicating and reading. Why is so much time allocated to communication activities?

5.2 REASONS FOR COMMUNICATING

Communication as has been discussed earlier (Chapter 3) can be formal or informal. Generally, formal communication is considered to be communication via published channels (journal articles, conference papers, reports, books and the like). Garvey and a number of other writers refer to this as scientific communication. Informal communication, on the other hand, is usually thought of as interpersonal, oral communication.

Over the years there has been an increase in communication caused by a greater demand for information. This has been brought about by the emergence of new disciplines and specialities like space exploration, nuclear energy, telecommunications, oceanography; by the emergence of new technological countries, e.g. Japan, Taiwan;

by an increase in research activities; by the introduction and convergence of new techniques, technologies and equipment, e.g. computers, data networks, accelerators; and by the creation of work teams to handle large complex programmes and projects.

Menzel (25) notes that more scientists are demanding information faster, from a wider geographical coverage, and over greater cross-disciplines. He goes on to note that the purposes of information include keeping the scientist up-to-date (current awareness function), furnishing him with the most up-to-date answer or reference; furnishing him, on demand, with reports on given subjects over time (retrospective search function), brushing up knowledge of an area, and stimulating him to seek information outside his defined field.

Traditionally, scientists have made their research and work known via conferences and publications. Published scientific papers, says Robbins (32), contain a record of the culture of a discipline and are the means by which the accumulated heritage of the scientific discipline is transmitted among members and the means by which new knowledge is added to the discipline stock. This altruistic statement is indeed one reason why scientists communicate. Another is that the scientist needs to establish priority on his work; another is that he is bound by the system to publish, thus causing a superabundance of papers. In a series of studies of scientific communications in psychology, Garvey (16) found that scientists undertook a wide range of activities in trying to discover every available means of obtaining information on new, ongoing or recently completed work relevant to their own. Their way of adjusting to the information explosion was to place an increasing reliance on informal communication. Formal publication of work in journals and reviews very often takes far too long - it is necessary for a permanent record, but is deficient as a current awareness source for research activities. A review of the INSPEC SDI Service to 500 physicists and engineers revealed that 76% considered it important to keep up-to-date, though 40% had difficulty in doing so (20).

The growth in literature leads to a disinclination on the part of the scientist to depend on published sources - instead he tends to talk with those sharing his interests (5). Scientists and engineers communicate in order to keep abreast of developments in their fields, as well as to learn new facts and back up their existing knowledge.

Hagstrom (19) points out that informal contacts may induce solidarity in organizations conducting research since such informal communication between potential collaborators often takes the form of successively greater commitments to cooperate. He goes on to state that spatial propinquity is a factor leading to collaboration since it is likely to lead to informal communication. This idea is taken up by Howton (27) who argues that R&D organizations are peculiar in two respects: (a) the ties that bind the scientist or engineer to the organization through hierarchies are weak and (b) the ties that bind colleagues are usually strong in collectiveness rather than individuality. Whatever position a research worker (i.e. on a project) has in an R&D organization it is no more than a temporary one because he switches from one project/division to another. The scientist/engineer is itinerant within the organization, he suffers from organizational rootlessness, and can often be hard to locate within the organizational structure. Engineers at the researcher's establishment, for example, may be members of the functional structure but are required to support one or more projects. They are not formally part of these project teams and thus can feel left out of the close-knit relationships built up in such teams. Furthermore, since all their colleagues in their functional divisions are also supporting projects, they can rarely meet as a functional group to discuss common problems or division work. The feeling of being in the organization or a team, but not really part of it, plus the technical need to become knowledgeable and keep abreast of current information, provides an immediate motive and rationale for communicating by striking up contact and relations with others. Continuous project changes, then, do provide staff with the possibility of building wider networks of contacts.

Davis (10) suggests another reason. Noting that the primary activity of "specialists" in an organization is gathering data, issuing reports, coordinating activities and overseeing contracts and studies, then such specialists, (i.e. scientists and engineers) have a greater motivation to communicate since they lack line authority. Not having the power to command they have to "sell" themselves and their ideas - hence face-to-face, interpersonal communication is preferred since it permits the exertion of personal influence to persuade undecided people and to gauge responses and reactions.

5.3 CHANNELS OF COMMUNICATION

Three major forms of communication channels can be distinguished: i) published journal papers, reports and books, ii) attendance at conference and other formal meetings, iii) informal usually verbal, contacts. Hagstrom (19) includes three other channels, though these are but extensions of the third form above, e.g. contacts with former students, contacts with non-scientists, etc. For Garvey and Griffith (17) and Crane (7) the informal channels also include the publication of technical reports, manuscripts, correspondence, reports to invited audiences and exchange of preprints. Thus it is clear that the informal channels may be oral or written.

5.3.1 Characteristics of Formal and Informal Channels

Characteristics of formal channels, i.e. publications, have been noted in the previous section and are not of overly concern here. Such formal channels demand responsibility, says Hagstrom (19) - a finishing and polishing of the final article. But if this process and publication takes too long then there is a transfer of information from the formal to the informal domain, because the latter has certain attributes or characteristics which the former does not.

These include (after Emrich (12) and Garvey and Griffith (17):
(i) the timeliness - the possibilities of immediate feedback on relevancy, ambiguity and subsequent modification; (ii) direction of information to the user - allows him to select what he needs and/or route information to whom he wants; (iii) flexibility and open-endedness - increased possibility of including speculation, accounts of failure; (iv) redundancy - the same information can appear in different forms (oral, written) though not necessarily with duplication of content, and this helps reduce distortion and filtering; (v) the relatively small expenditure of time and effort; and (vi) the transient nature of the communication - not intended for permament archival storage.

Menzel (26) gives several other functions of interpersonal i.e. informal (non-published) communication among scientists, but they do not seem to the present writer to be particularly attributable to only non-published communication. For example, it is argued that the information received by interpersonal communication can be translated into action-based usable terms. Surely, upon reading an article, the information contained therein can also be utilized in the same way. On the other hand, interpersonal communication does permit quicker decision-making with knowledge of the acceptance of decisions.

Garvey and Griffith (17) go on to list a number of relationships between formal and informal communication in science. These are that informal channels were created to fulfil needs that formal channels cannot (e.g. timeliness). Conversely, formalization often grows out of informality - thus an informal publication, e.g. an internal report may become published as a formal journal paper. Once this happens then the more formal a channel becomes the fewer functions of informal communication it maintains. Finally, informal channels are unstable and temporary compared with formal, whereas the latter provides a permanent and public record. While much of this is directed at publication, it applies equally well to formal communication in the other sense discussed in earlier chapters, i.e. the formal authority which exists in an organization.

Staff may be informed formally in writing of some procedure or event and a record remains, whereas the same information related informally via the grapevine will soon be displaced by other topics.

Wolek (41) notes there is a greater reliance on interpersonal (verbal) communication in mission-oriented as opposed to discipline-oriented work with the interaction depending on the complexity of the message. Likewise, Tushman (38) believes that verbal communication is a more efficient information medium than is written for the purposes of problem solving in an R&D setting since it permits timely information exchange and rapid feedback and evaluation as well as real-time coding and synthesis. Similarly, Emrich reports two studies in which one in three scientists and engineers required oral rather than written information (12).

5.3.2 Communication Links

In the previous section communication was characterized by function. It can also be characterized by system level. Farace (13) identifies four levels of interaction or communication: i) invididual - communicating to and from a larger environment, ii) the dyad or two person unit e.g. superior-subordinate, peer-peer, iii) group - a set of individuals bound by a common work or friendship, iv) the organization as a whole. The effective transfer of information from one individual or one group to another depends, according to Rubenstein and co-workers (following their study of fifteen organizations) on the climate of relations between them, their task interdependence, the frequency of communication and their decision-making styles (33). In another study Ritchie and Hindle (31) found that the information flow between people tended to be upwards, across and then down, rather than by direct exchange. Tushman (38) argues that communication networks are an important process in R&D settings and that there is no one best communication pattern, since networks are contingent on the nature of the work involved.

There have been a number of studies on the communication patterns or networks of an organization.

Allen and his colleagues have sought to establish the contacts scientists and engineers have with each other, both inside and outside an organization. Such relations - normally informal - are developed via project teams, and intergroup transfers rather than the formal structure or hierarchy of the organization (2). Each of the individuals in the project team or group will hold a certain pos.tion vis-à-vis information transfer. Some - isolates - may be outside the web or network of contacts, neither being contacted by others nor contacting others themselves. Others will play a more important role by being a go-between or liaison between nodes of the network. This is particularly the case when these individuals are in contact with bodies outside the organization. Organizations in general and R&D organizations in particular, are dependent upon the timely and accurate information from a variety of external sources. The organization's boundaries can be effectively breached to allow such information in by individuals acting as bridges linking the organization's members to the outside. Such boundary-spanning individuals are termed gatekeepers.

5.3.2.1 gatekeepers

Gatekeepers are required, according to Tushman and Katz (39) because of the differences in language, cognitive coding, levels of understanding, "in-ness" (being in with the in-crowd) and to counteract communication impedance, distortion and bias. Studies have revealed that gatekeepers possess a number of attributes. They are able to gather and understand external information and translate it into terms that are meaningful and useful to colleagues. Allen (1) found that gatekeepers generally produced a large number of papers, were cited more, read more, tended to be first line supervisors, attended more conferences, had more outside contacts, were relatively high performers and had higher qualifications. Hagstrom (19) found a strong positive association between the productivity of scientists and their level of external contacts. While gatekeepers perform linking roles for projects carrying out locally-oriented tasks, there is some evidence (39) that they may also facilitate external communication by others in the group.

People tend to turn to gatekeepers for a variety of reasons: They may not know or have the necessary contacts to obtain the information they require, or they may not have the time nor the inclination to spend searching for the information they need. They may be deferring to the gatekeeper's position and knowledge.

The existence of gatekeepers has also been shown at an international level in studies at various Irish research institutes (3, 4, 21). By studying the amount of foreign technical correspondence and the frequency of foreign meetings attended it could be shown that international transfer of technology took place through certain intermediary agents. Such international gatekeepers tended to speak more foreign languages, read more foreign journals and had greater technical competence.

The flow of information from outside the organization is essentially a two-phase flow - from A to B (the gatekeeper) and from B to C. Persson (29) has criticized this two-step flow hypothesis and its application to gatekeepers on the grounds that while studies may prove the existence of individuals who are in contact with a large number of others, they do not reveal with whom the gatekeeper communicates outside nor what is discussed. He believes that gatekeepers contribute to an elitist pattern of information distribution rather than to a reduction of the information gap. However, Dennison mentions that gatekeepers actually restrict the distribution (11).

Gatekeepers, it would appear, though, are merely a complement to direct contact in research projects since there is usually no problem in communicating outside the organization. Peer contact goes on and so there is a low need for gatekeepers (39). The present researcher had hoped to demonstrate this in his study. He believed that gatekeepers would not exist to any great extent in international organizations and national R&D organizations simply because most scientific and engineering staff would have direct and continuous contacts with bodies and people outside the organization by virtue of their overseeing study contracts and development projects in the member states involved.

Clearly, some individuals would attend more meetings than their fellow project team-mates by virtue of their specialist role or knowledge and they would report back to colleagues and relay their (the latters') comments on - but this is not the true role of the gatekeepers in the accepted use of the term. In an international organization either everyone is a gatekeeper or no-one is.

5.3.2.2 invisible colleges

The gatekeepers by virtue of their reading and publishing habits will be at the forefront of their research field. The people they are in contact with outside the organization will also be at the forefront of the field. Thus they form an elitist communicating, highly productive group. Such a group may be termed an invisible college whose members as well as communicating with each other, set priorities for research and monitor the rapidly changing structure of knowledge in their fields (9). In addition, this unofficial group of everybody who is anybody in a segment of the research field, will send preprints to each other, collaborate and communicate at conferences (36). As Solla Price notes (35) scientific groups contain a set of interacting leaders (the gatekeepers). Invisible colleges effectively solve a communication crisis by reducing a large group to a small select one of the maximum size that can be handled by interpersonal relationships (c. 100 people). Thus the scientific community becomes an important channel for informal communications as a way of keeping current and aware and without the delays imposed by scientific and technical publications. Furthermore, these invisible colleges or groups of scientists in a research area are influential in the establishment of forms of international scientific cooperation (8).

5.4 Problems of Communication

In Chapter 1 some barriers to communication in general were examined. Here barriers, or problems in communication, specifically encountered by scientists and engineers in organizations are considered.

Undoubtedly one major problem is the sheer amount of literature published. Young and Harriott (42) believe the engineer cannot keep up with the volume of new information being generated and that, in any case, the useful life of published information is decreasing leading to an obsolescence of technical literature. Brookes (5) notes that the communication system of science is affected by an overwhelming spate of scientific papers, making it no longer possible for the scientist to continue laboratory work and search the literature. There is pressure on the scientist, especially in academic environments, to publish - for credit, prestige, to show competence, get promotion or new positions, to disseminate results, to lay claim to original work - and this tends to lead, according to Brookes (5), to the publication of trivia, to orthodox views only and to delays in publication. The time lag for many scholarly journals can be well over twelve months before articles are published owing to the number submitted as well as the peer refereeing procedure. In fact Garvey (15) quotes the following figures for the length of time elapsing between the earliest report and its subsequent publication as a journal paper - sixteen months for physics, twenty months for engineering and twenty-six months for social sciences. Such delays have driven scientists and engineers to communicate amongst themselves informally and establish invisible colleges.

Not only is the amount of literature, and the inevitable delays in publication, a problem but so is its diversity. Much significant work is often buried away in what is termed grey literature - reports, working papers, dissertations, specifications - material that is not considered open literature and thus publicly available. To get hold of it, indeed, even to hear about it, causes no few difficulties. The languages in which papers are written is also a contributory factor to poor communication and source use. Difficulties of communicating in a foreign language was considered one of the principal information transfer problems mentioned by British and French scientists (37). In his book, Large (24) contends that the foreign language barrier probably poses the biggest current obstacle to scientific communication, since it disrupts the information cycle and prevents potentially interesting data from reaching those who might use it.

While this is undoubtedly true to a certain extent, it is possible that the foreign language barrier may act as a welcome filter to stop scientists and engineers from getting even more swamped with material - possibly trivia, possibly duplicating other research, and almost certainly delayed.

To publish in another language or to translate articles can be costly. Many of the more learned journals with a small specialist circulation are also costly and complicated to produce. Thus, it is that a library's budget may not stand subscribing to more than a handful of such journals. In Swinburne's study (37) of British and French scientists the other major information transfer problem mentioned by the two groups was caused by lack of finance (e.g. for journal subscriptions). Nor is it only journal subscription - or formal communication - which suffers. Many organizations, notes Hinrichs (22), tend to reduce the overall information budget during periods of uncertainty since these coincide with economic constraints. The information budget includes also attendance at conferences and use of telephone and telex in addition to books and periodicals. When sources of needed information lie outside an organization then it is usually more expensive to tap these sources through "rich" channels (i.e. phone, face-to-face contacts) and thus if there is a reduction in the phone and travel budgets then communication inevitably suffers.

Regarding the channels of communication, there are a number of limitations to be considered. As information flows through the system (be it formal publication or informal personal communication) it encounters lags and filtering. This is evidenced by Dennison who reveals the restricted flow and delays in international aid information (11). Much of the scientist's communication behaviour, says Garvey (15) is an effort to compensate for these factors. Other limitations include, at the organizational level, internal postal delays; switchboard problems; difficulties contacting people because they are away, out of their office, in meetings; procedural delays (approval from director, confirmation in writing) and difficulties raised by differing priorities and conflicting objectives (40).

Further factors affecting scientific and technical communication in an organization mentioned by Fischer (14) relate to the organizational size and structure, managerial styles, the age of the R&D groups, and the layout of the organization itself. Regarding the latter point, it is a paradox in informal scientific communication according to Griffith and Miller (18), that individual scientists may be reluctant, at one extreme, to travel 75 feet to utilize another person's store of knowledge, but at the other extreme, would willingly travel hundreds or thousands of miles to communicate with other persons under other circumstances. In the researcher's own organization it is a fact that many staff are reluctant to walk a maximum of 250 metres (the average distance is probably in the order of 100 metres) to the library to borrow and return books, scan new journals etc. but willingly walk the same distance to visit the bank, travel office, canteen, commissary, record club, video club, music club and cultural library. It would seem that private purposes are more important than work matters!

As was noted in Chapter 1, there are also barriers or problems relating to the potential distortion of messages or information. This can be minimized by redundancy i.e. the sending of information by more than one channel. Clearly, though, this does not allow for the person who deliberately withholds from or distorts information given to colleagues.

One major problem which has received some attention (13, 28) is the information overload on the individual. Such an overload may arise because he is the manager of a large department; or a key person constantly in demand; because his work-load is too high or his travel schedule too hectic. Whatever the reason, there may come a point when a person cannot respond quickly and adequately to requests put to him for information. Consequently, he is unable to communicate effectively with the result that the efficiency of the organization is impaired. One solution to this problem is the availability of gatekeepers - though it is not clear why these high activity personnel do not also apparently suffer from the same phenomenon.

Schlesinger (34) suggests that risks in two-way communication include the inefficient use of time and the emotional expressions which may occur thus contributing to a breakdown in the conversation. Regarding time-wasting, the comment can be made that in any informal exchange between two scientists or engineers it is more than likely that for every technical topic discussed or fact requested there will be some social or non-technical views or information imparted which will vary inversely as the number of people involved in the interactive exchange grows. Thus in a formal technical discussion meeting there will be relatively little social or non-technical information exchanged. While this may indeed be an inefficient use of time, such non-technical exchanges do help cement relationships and foster a less stressful environment which can only be beneficial in the long run to the smooth running of a project.

REFERENCES

1) ALLEN, T.J.
Roles in technical communication networks. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington books, 1970, p.191-208.

2) ALLEN, T.J.
Communication networks in R&D laboratories.
R&D Management, 1, 1, Oct. 1970, p.14-21.

3) ALLEN, T.J.
The importance of direct personal communication in the transfer of technology. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976. AGARD-CP-179, p.2-1 - 2-10.

4) ALLEN, T.J. et al
The international technological gatekeeper.
Technology Review, 73, 5, March 1971, p.26-43.

5) BROOKES, B.C.
Communication between scientists.
Advancement of Science, 19, March, 1963, p.559-563.

6) BURNS, T.
The directions of activity and communication in a departmental executive group.
Human Relations, 7, 1954, p.73-97.

7) CRANE, D.
The nature of scientific communication and influence.
International Social Science Jnl., 22, 1, 1970, p.28-41.

8) CRANE, D.
Transnational networks in basic science.
International organization, 25, 3, 1971. p.585-601.

9) CRANE, D.
Invisible colleges: diffusion of knowledge in scientific communities. University of Chicago Press, 1975.

10) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed. McGraw-Hill, 1981.

11) DENNISON, E. et al
International channels of communication.
Management Decisions, 21, 4, 1983, p.36-44.

12) EMRICH, B.R.
Scientific and technical information explosion. NTIS, 1970.
AD 717 645, AFML-TR-70-182.

13) FARACE, R.V. et al
Communicating and organizing. Addison-Welsey, 1977.

14) FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

15) GARVEY, W.D. et al
Some comparisons of communication activities in the physical and social sciences. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.61-64.

16) GARVEY, W.D. et al
Research studies in patterns of scientific communication: I. General description of research program. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.165-183.

17) GARVEY, W.D. and GRIFFITH, B.C.
Informal channels of communication in the behavioral sciences: their relevance in the structure of formal or bibliographic communication. In Montgomery, E.B.,The foundation of access to knowledge. Syracuse UP, 1968, p.129-146.

18) GRIFFITH, B. and MILLER, A.J.
Networks of informal communication among scientifically productive scientists. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.125-140.

19) HAGSTROM, W.D.
The scientific community. Basic Books, Inc., 1965.

20) HALL, A.M.
Methodology and results of some user studies on secondary information services. In EURIM: European conference on research into the management of information services and libraries, Paris, France, 20-22 November 1973, p.31-37. ASLIB, 1973.

21) HERZOG, A.J.
The 'gatekeeper' hypothesis and the international transfer of scientific knowledge. In The problem of optimization of user benefit in scientific and technological information transfer, AGARD, 1976. AGARD-CP-179 p.15.1-15.9.

22) HINRICHS, J.R.
Communications activity of industrial personnel.
Personnel Psychology, 17, 1964, p.193-204.

23) HOWTON, F.W.
Work assignment and interpersonal relations in a research organization: some participant observations.
Administrative Science Quarterly, 7, 1962/63, p.502-520.

24) LARGE, J.A.
The foreign-language barrier: problems in scientific communication.
Andre Deutsch, 1983.

25) MENZEL, H.
The information needs of current scientific research.
Library Quarterly, 34, Jan. 1964, p.4-19.

26) MENZEL, H.
Informal communication in science: its advantages and its formal analogues. In Montgomery, E.B. The foundations of access to knowledge. Syracuse UP, 1968, p.153-163.

27) MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980. p.347-356.

28) MILLER, G.A.
The magical number seven, plus or minus two: some limits on our capacity for processing information.
Psychological Review, 63, 2, March 1956, p.81-97.

29) PERSSON, O.
Critical comments on the gatekeeper concept in science and technology. RIT, 1980, TRITA-LIB-6017.

30) POPPEL, H. L.
Managerial/professional productivity. Booz, Allen and Hamilton, 1980.

31) RITCHIE, E. and HINDLE, A.
Communication networks in R&D: a contribution to methodology and some results in a particular laboratory. University of Lancaster, Dept. of Operational Research, 1976. BLRDR 5291.

32) ROBBINS, J.C.
Social functions of scientific communication.
IEEE Trans. on Professional Communication, PC-16, 3, Sept. 1973, p.131-135, 181.

33) RUBENSTEIN, A.H. et al
Ways to improve communications between R&D groups.
Research Management, 14, 6, Nov. 1971, p.49-59.

34) SCHLESINGER, L.E.
Meeting the risks involved in two-way communications.
Personnel Administration, 25, 6, 1972, p.24-30.

35) SOLLA PRICE, D.J. de
Little Science, Big Science. Columbia UP, 1963.

36) SOLLA PRICE, D.J. de
The scientific foundations of science policy.
Nature, 206, 4481, 17 April 1965, p.233-238.

37) SWINBURNE, J.K.
Information use and transfer by British and French scientists: a study of two groups.
Journal of Information Science, 6, 2/3. April 1983, p.75-80.

38) TUSHMAN, M.L.
Managing communication networks in R&D laboratories.
IEEE Engineering Management Review, 9, 4, Dec. 1981, p.65-77.

39) TUSHMAN, M.L. and KATZ, R.
External communication and project performance: an investigation into the role of gatekeepers.
Management Science, 26, 11, Nov. 1980, p.1071-1085.

40) WILSON, T.D. et al
Information needs in local authority Social Services departments: a second report on Project INISS.
Journal of Documentation, 35, 2, June 1979, p.120-136.

41) WOLEK, F.W.
Preparation for interpersonal communication.
JASIS, 23, 1, Jan-Feb. 1972, p.3-10.

42) YOUNG, J.F. and HARRIOTT, L.C.
The changing technical life of engineers.
Mechanical Engineering, 101, 1, Jan. 1979, p.20-24.

PART 3

RESEARCH METHODOLOGY AND RESULTS OF STUDY

This section describes in detail the research methodology - the background to the study, the choice of organizations and survey technique, as well as the questionnaire design and formulation of questions. Following this, the results of the questionnaire analysis are presented in terms of the background, communication habits, and the information seeking and use habits of scientists and engineers.

CHAPTER 6

METHODOLOGY

6.1 INTRODUCTION

The objective of this research is to study the communication patterns and information use in a number of large international organizations and national aerospace research establishments. The topics studied are of interest since, unlike organizations looked at in other studies, the ones covered here are, on the one hand, multilingual and multicultural and thus create their own peculiarities and problems of communication and information transfer based on national and/or language groupings, customs, history, geography, beliefs, native country infrastructure and education, and, on the other hand, they are multidisciplinary, project-oriented organizations which, in turn, produces situations which may not necessarily maximize the efficiency of communication because it is based on conflict, competition and a diversity of interests.

The selection of the subject area for research seemed a natural one in view of the fact that the researcher worked in the library of the R&D establishment an international organization which was heavily project-oriented to space research. He had noticed that the library was not so heavily frequented and that certain groups of people or certain nationalities either never seemed to use the literature and facilities at all or else used them very often. He also observed that much communication seemed to take place informally and was often within certain language groupings. For example, people who spoke Spanish together were usually from different divisions and projects. Did they have common subject interests even though their actual work tasks differed or was their communication merely social?

For the purposes of comparison it was considered worthwhile to extend the study to include other international organizations based in Europe as well as European national R&D organizations involved in space activities, since these latter were similar work-wise to the researcher's establishment.

In order to get a feel for the subject and what kinds of organizations and aspects had been surveyed before (and thereby find new areas for study) an extensive literature search was carried out both manually and online. The results of this search threw up a vast number of references ranging from early discussions on group dynamics (e.g. 4, 9, 29) to the role of the journal in information transfer (e.g. 21, 31, 37). Since the researcher was more interested in trying to trace the informal communication patterns of scientists and engineers, articles dealing with scientific communication via formal channels (such as publications, conference meetings) were, in the main, discarded, though earlier documents on social interaction were read for background understanding.

The literature revealed that there have been many studies, over the years, on the subject of communication between and information use of various groups of individuals. Skelton (53) quotes a 1970 figure of between 400 and 800 science use studies. She found it difficult to compare some thirteen of them because the variables used - the units of measure, the localities, the staff - were not the same. Crawford (15) estimated there were over 1000, mainly in the information use area, and concluded that the scope of user studies had been extended to include users in a wide variety of disciplines, particularly in the social sciences and humanities (as opposed to the more traditional areas of science and technology). Other points she noticed were that the use studies were practically oriented although there was evidence of an increasing refinement in methodology and conceptualization. Also the environment in which information was being used was being considered more and there was a distinction made between the cognitive and social aspects of information.

There have also been a number of other reviews of such studies (2, 5, 14, 25, 33, 34, 36, 39, 40, 44, 45, 57). From these it can be seen that the studies can be grouped in any amount of different ways: for example, by the data collection techniques used (2, 25, 34, 45), by type of study (36, 40), by subject discipline (14, 15).

While the present study is not intended to be a real review of the literature in the sense of those cited above, it is noticeable that many of the articles and studies examined for this research fall into a number of clearly defined specialized categories (a breakdown is given in the Bibliography).

It would appear that research in this field suffers from three major problems:

a) the studies that have been carried out in the past do not really build on the research and work of previous surveys to any appreciable extent (25) since they address perhaps only one aspect with the result that it can be misleading to try and draw any valid conclusions which can be used to create norms;

b) partly because of this and because of the variances in the test conditions, locations, participants and methodology, there is not a high degree of consensus between researchers;

c) much of the work appears theoretical rather than having any practical applications. In other words, studies have been carried out to answer certain questions or to prove certain hypotheses rather than to be used to improve existing communication channels and information services in organizations. The research has usually produced no really useful or tangible results which could be employed to this end.

Previous studies have often tended to concentrate on one particular aspect or area. This study was designed to be much more broadly based than any other: it would examine more than one organization and answers were being sought to a wider range of issues. These issues especially relate to language and personality, and were not deeply covered in other studies. This project has benefitted from these other studies since they have provided valuable background and ideas. There are, however, a number of important distinctions or divergences between the present study and previous ones.

As seen from the thematic category breakdown in the Bibliography, several earlier studies were devoted to the work performance of personnel as a function of communication. The present study is not, nor does it concern itself as others do, with the actual information communicated. While communication channels are covered in the present work, it does not include the use of the grapevine, nor, save in passing, the flow of upward and downward communication. What it does concern itself with far more than the general books on human communications in organizations (e.g. 7, 10, 16, 31) is the transfer of scientific and technical information as opposed to instructional or informative information - the transfer being lateral rather than vertical and informal rather than formal, i.e. via face-to-face, telex, phone rather than via scholarly articles in journals. Other studies have tended to concentrate either on one particular organization (e.g. an industrial research laboratory (3, 27)) or one geographical area (11, 54, 58) or on one particular type of person or group (such as chemists (24, 39), psychologists (20), social scientists (53)) or on one particular aspect (e.g gatekeepers, networks (32)).

This study concentrates on six organizations of two types - three international organizations, and three national R&D establishments - in four countries (Austria, France, W. Germany, Netherlands) and on two basic categories of staff - scientists and engineers. In addition, it attempts to embrace both their information seeking and use habits as well as their communication habits. Few previous studies have tried to study both the interpersonal communication and information-seeking and use (the two are inextricably linked) of both scientists and engineers and even fewer have adopted the aerospace field as an area for serious study and then only in the services area (17, 26, 35, 38, 47, 49, 51). Furthermore, only two, so far as the researcher is aware, have concentrated to any extent on multinational environments, i.e. international organizations, and national R&D establishments working on multinational projects where communications will take place in several languages (13, 32).

6.2 CHOICE OF ORGANIZATIONS

Having decided what the objectives of the research would be (outlined in the Introduction), it was necessary to identify organizations based in Europe falling within the boundaries of the study; they had to be either international organizations proper with a fair number of scientific and/or engineering staff, or they had to be national aerospace establishments with international contacts.

Consideration was, then, given to the countries in which potential organizations were located, their size, the nature of their work and their employment of scientists and engineers. In all fourteen organizations (Table 2) were considered to be appropriate - seven international organizations and seven national aerospace bodies.

They were invited, by letter to the Director General or the Director of Administration at the end of January 1981, to participate in a research project on interpersonal communications. A draft copy of the questionnaire was enclosed. Of the fourteen organizations, twelve eventually replied and of these eight, after follow-ups, finally agreed to participate, though only six actually did (Table 3).

The two Spanish national aerospace establishments - Instituto Nacional de Tecnica Aerospacial (INTA) and Comision Nacional de Investigacion del Espacio (CONIE) - did not reply to either the original letter nor the follow-ups. This was probably because of the fact that the letter and draft questionnaire were in English and that the latter looked too long and complicated.

The European Organization for Nuclear Research (CERN) regretted that it was not possible to allow such a questionnaire to be distributed to professional staff within its laboratory, while the Office National d'Etudes et de Recherches Aerospatiales (ONERA), after initially saying that it could be interested in the project, finally decided that, since it was under the Ministry of Defence, it could not give any information on its activities to people outside France.

The Organisation for Economic Cooperation and Development (OECD) at first regarded itself in no position to contribute to the project because its aims, structure and requirements differed considerably from those of other international organizations where R&D constituted a major part of the activities. After this point was taken up by the researcher, OECD replied that its Energy Agency would let the staff of its Data Bank actively participate. Nominally this was fourteen people, but subsequent discussions revealed that not all were in post and that several of those that were, were new to the job. Consequently only five or six people were really available. In addition it was felt by the Director of the Data Bank that to save the time of his staff in completing a questionnaire it would be better to interview them. Had there been a substantial number of staff, then this might have been of interest so that data could have been obtained on the comparative usefulness of questionnaires versus interviews. As it was, interviewing was difficult for the researcher to arrange in view of the fact that the project was being carried out in his own time and at his own expense and not under the official direction of the European Space Agency (ESA). In view of the small number of highly specialized personnel it was decided to drop OECD from the list.

The Royal Aircraft Establishment (RAE) was another disappointment. Like the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (DFVLR) and the Centre National d'Etudes Spatiales (CNES), RAE had many diverse activities and covered many subject areas. Consequently, in order to make these three establishments approximate better to the European Space Research and Technology Centre (ESTEC) of ESA in terms of size and work activity, it was decided to approach only the Space Departments. Whilst the implications of the Strathcona Report were being conducted (which would lead to major alterations in the structure and responsibilities of the various RAE departments, among them the Space Department) RAE was unwilling to take part. Since the future policy of the Establishment was under discussion senior management were deliberately discouraging the transfer of information on RAE activities to outside bodies.

The World Meteorological Organization (WMO) also declined to take part on the grounds that the nature of its tasks and functions were administrative rather than research or scientifically oriented.

As noted earlier, the original letters were addressed to the Director General or Director of Administration. In certain cases, e.g. ONERA, DFVLR, RAE, CNES, NLR (Nationaal Lucht en Ruimtevaartlaboratorium), IAEA (International Atomic Energy Agency), the letter was passed to the librarian or equivalent for action. In the case of the Food and Agriculture Organization (FAO), it was passed to the Division Heads, one of whom replied offering full cooperation in the project since it was seen to be of benefit to FAO and might enable them to make improvements resulting in savings of time and thus making for higher efficiency. This was taking the study in precisely the spirit in which it was hoped it would be taken, but despite this positive reaction only five questionnaires were requested, none of which were returned! FAO was therefore also omitted from the study.

Of the six organizations which eventually returned questionnaires three (ESTEC, IAEA and UNESCO) were international organizations and three (NLR, DFVLR and CNES) were national aerospace establishments. A brief description of these organizations will be found in Appendix A.

It is interesting to note the difficulties in trying to get organizations to participate on an international level at even something so mundane as completing a questionnaire when one has no official backing. At least one of the organizations approached directly by the researcher came back at government level to query the project with the Director General of the researcher's organization (who knew nothing about it, the approval having been given by the Director of the researcher's duty station). In another instance, NLR refused to allow all its scientific and technical staff (250) to participate since this would mean the overall loss of some 250 man-hours of labour for which NLR would not be compensated.

TABLE 2 - SUMMARY OF ORGANIZATIONS INVITED TO PARTICIPATE IN THE STUDY

INTERNATIONAL ORGANIZATIONS

CERN - European Organization for Nuclear Research, Geneva, Swizerland. Founded 1954. Members: Governments of 13 countries. Staff: 3500. Languages: English, French. Aims: to provide for collaboration among European states in sub-nuclear research of a pure scientific and fundamental nature.

ESA - European Space Agency, Paris, France. Founded: 1975 (1962). Members: Governments of 11 countries. Staff: 1350. Languages: English, French. Aims: to provide for and promote, for peaceful purposes, cooperation among European states in space research and technology with a view to their use for scientific purposes and for operational space application systems. The largest establishment is the European Space Research and Technology centre (ESTEC) in The Netherlands.

FAO - Food and Agriculture Organization of the United Nations, Rome, Italy. Founded: 1945. Members: 152 nations. Staff: 4000 professional. Languages: English, French, Spanish, Chinese, Arabic. Aims: to raise the level of nutrition and standard of living of peoples in the Member States; secure improvements in the efficiency of production and distribution of all food and agricultural products.

IAEA - International Atomic Energy Agency, Vienna, Austria. Founded: 1956. Members: 110 Member States. Staff: 1163. Languages Languages: English, French, Spanish, Chinese, Russian. Aims: to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.

OECD - Organisation for Economic Cooperation and Development, Paris, France. Founded: 1961 (1948). Members: Governments of 24 countries. Languages: English, French. Aims: to promote economic and social welfare throughout the OECD area by assisting Member Governments in the formulation of policies designed to this end and coordinating these policies.

UNESCO - United Nations, Educational, Scientific and Cultural Organization, Paris, France. Founded: 1946. Members: 156 Member States. Staff: 3461. Languages: English, French, Spanish, Russian, Chinese, Arabic. Aims: to contribute to peace and security by promoting collaboration among the nations through education, science and culture; to maintain, increase and diffuse knowledge.

WMO - World Meteorological Organization, Geneva, Switzerland. Founded: 1947. Members: Governments of 157 countries. Staff: 297. Languages: English, French, Spanish, Russian, Chinese, Arabic. Aims: to facilitate worldwide cooperation in the establishment of a network of stations for making meteorological observations as well as hydrological and other geophysical observations related to meteorology; to coordinate the application of meteorology to aviation, shipping.

TABLE 2 (CONT'D)

NATIONAL AEROSPACE ORGANIZATIONS

CNES - Centre National d'Etudes Spatiales, Paris, France. Founded: 1961. Activities: prepares national programmes of space research with special emphasis on remote sensing, astronomy, satellites, launchers and communications.

CONIE - Comision Nacional de Investigacion del Espacio, Madrid, Spain. Activities: coordinates national programmes for meteorology, remote sensing, space sciences. Participates in scientific and application projects of ESA.

DFVLR - Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Cologne, FRG. Founded: 1969. Activities: conducts research in the aerospace field; participates in the planning and realization of aerospace projects; constructs and operates large-scale aerospace test facilities. Has various establishments.

INTA - Instituto Nacional de Tecnica Aerospacial "Esteban Terradas", Madrid, Spain. Activities: R&D in aircraft structures, propulsion, navigation, materials, electronics.

NLR - Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, The Netherlands. Founded: 1919. Activities: conducts theoretical and experimental research in civil and military aeronautics and space flight technology, remote sensing and wind tunnel testing; does sponsored work for various Dutch agencies, ESA and the aircraft industries.

ONERA - Office National d'Etudes et de Recherches Aerospatiales, Chantillon, France. Founded: 1946. Activities: research in airborne and space vehicles, propulsion, communication; develops, directs and coordinates scientific and technical research in the field of space and aeronautics; does sponsored work for public institutions and industrial firms.

RAE - Royal Aircraft Establishment, Farnborough, England. Founded: 1905. Activities: conducts R&D in all aeronautical, scientific and engineering disciplines except propulsion and radar; space activities include remote sensing and signal processing from satellites.

TABLE 3 - ORGANIZATION PARTICIPATION OVERVIEW

Organization		Reply Received	Agreed to take part	Did take part	Reason for not Participating
		INTERNATIONAL ORGANIZATIONS			
CERN	CH	Y	N	-	Stated no interest
ESA	NL	Y	Y	Y	-
FAO	I	Y	Y	N	Presumably no interest
IAEA	A	Y	Y	Y	-
OECD	F	Y	Y	N	Too few personnel
UNESCO	F	Y	Y	Y	-
WMO	CH	Y	N	-	Unsuitable organization
		NATIONAL AEROSPACE CENTRES			
CNES	F	Y	Y	Y	-
CONIE	E	N	-	-	Presumably no interest
DFVLR	D	Y	Y	Y	-
INTA	E	N	-	-	Presumably no interest
NLR	NL	Y	Y	Y	-
ONERA	E	Y	N	-	Government policy
RAE	GB	Y	N	-	Reorganization

6.3 METHODS OF GATHERING DATA

The purposes of surveys include the provision of information, the assessment of influence of various factors, the testing of hypotheses and the explanation of the relationship between variables' (42). To study the information needs and uses of scientists and engineers effectively means studying their behaviour and experiences in confrontation with information channels (40). Therefore, there is a need to borrow survey theory, techniques and methods from other disciplines where they have been developed and used to great effect. The data for surveys can be obtained by a variety of tools, the most common of which are mail questionnaires, interviews, diaries and logs, observation of participants and documentary sources. Combinations of these tools are also utilized. Each of these techniques has its own advantages and disadvantages and its use will be determined by these as well as the nature of the survey.

6.3.1 Mail Questionnaires

Mail questionnaires are used most effectively when the sample to be studied is geographically dispersed. To use direct observation or interview techniques could be prohibitively expensive and thus the questionnaire is a compromise (44). Use of the questionnaire permits the respondent to think about his replies and to complete it at his own pace and in his own time - a useful factor in situations where people travel a great deal or have a heavy work load. There are a number of disadvantages to mail questionnaires: experience with all types of questionnaires has proved that the response is likely to be on the low side; lack of interaction means that unclear questions cannot be explained; opportunities to probe or follow up incomplete questions are limited; the respondents frame of mind cannot be clearly ascertained; the people who return questionnaires are not necessarily representative of the groups to whom they were sent; questions may be misinterpreted; the distribution, completion and returning process can be lengthy; and a detailed explanation of how to complete the questionnaire is probably necessary. Some examples of mail questionnaire studies in the communication and information field are given by references 13, 17, 22, 46, 52 and 54.

6.3.2 Interviews

The personal interview (which is normally based on a structured questionnaire) overcomes many of the disadvantages of the mail questionnaire. Because the interviewer has a captive audience, s/he is able to make repeated call back visits if the person is not present. Thus the response rate tends to exceed that of a mail questionnaire. The interviewer can also gauge the mood of the respondent, clarify points and get fuller, more meaningful responses. Furthermore, much of the necessary coding of the answers can be done immediately. The interview technique may suffer since the interviewee is not often given sufficient time to gather his thoughts, thus many of his answers may be off-the-cuff rather than reasoned replies. There may also be personality differences between the interviewer and interviewee which may lead to a lack of cooperation on the part of the latter and there may be delays and difficulties in scheduling interviews with a diverse, highly mobile population. Some examples of interview studies in the information needs and use field are provided by references 11 (telephone), 13, 19, 24 and 56.

6.3.3 Diaries/Self-recording

In a further means of gathering data respondents are asked to keep diaries or records of their information seeking behaviour regularly over a period of time. The technique suffers, to a large extent from many of the same disadvantages as questionnaires, i.e. lack of interaction; lengthly process; frame of mind not ascertainable; lack of follow-up; need for detailed explanation. Moreover, it is not at all sure that busy, frequently absent respondents will really be able or willing to keep a running record of their information activities. Keeping a diary or log is virtually a full-time job! Since there is no structured framework for replies or entries as there is with mail questionnaires and interviews, it is also difficult to compare, code and analyze diary entries with any degree of meaning. Another problem is that of how typical is the respondent's behaviour during the particular period of time under study.

The diary does have its value when the type of behaviour being studied is continuing rather than past or "typical" behaviour (44). Examples of surveys using the diary method are relatively rare in the information and communication field although Burns (8) describes a study using self-recording techniques, as does Poppel (48) in his discussion of a Booz, Allen and Hamilton, Inc. study of managers and professionals. Paisley (44), Herner and Herner (25) and Christie (12) list several other surveys using the diary technique.

6.3.4 Observation of Participants

A fourth technique in the gathering of data is that of observing the participants and recording the amount of time spent on a given activity and the sources used. Since the observer is impartial, the results, like interviews, should be less biased than if the participant completes a diary or self-administered questionnaire. The method also permits the person under observation to go about his normal activities without himself losing time. However, the procedure is still fairly lengthy since it must be conducted over a period and the observer can collect data only when the person is around. It is usually impractical to follow the participant about everywhere and observe him in his office or the library or wherever else he happens to communicate. Unless observation is very discrete the person under observation may feel self-conscious and may even step up his normal information-seeking activities simply because he knows he is under observation (28). Halbert and Ackhoff (23) carried out some 25.000 observations of 1500 chemists and Wilson and Streatfield used structured observation partly because a questionnaire failed to take sufficient account of potentially explanatory variables (55).

6.3.5 Documentary Sources

One further method is the examination of literature and information requests to obtain statistics generated in the course of peoples' use of services and facilities. (These are what Herner and Herner (25) call indirect studies).

Such a method is normally indirect or passive in that it does not require any direct or active participation by a user. Consequently the amount of information gained is rather limited and probably best suited to the study of groups rather than individuals. The study by Ludewig (35) who examined reference questions to ascertain scientific information needs is an example of this type of method. Herner and Herner list three other studies which also employ this approach (25).

6.3.6 Combined Techniques

Within the communication field there are a number of studies which have been carried out using a combination of the major data gathering techniques as described above. The most common combination appears to be that of questionnaire followed by interview (1, 3, 22). Herner and Herner (25) also note a combination of interview and documentary sources, while diaries and interviews were used by Hogg and Smith (27) and Fischenden (18).

6.4 METHOD OF DATA COLLECTION CHOSEN FOR THIS SURVEY

Despite its disadvantages the method of data collection selected for the present study was the mail questionnaire. This technique was chosen for two main reasons:

a) it was hoped to study fourteen organizations in eight countries. It was out of the question to visit the establishments to conduct interviews or participant observations. Quite apart from the expense, the amount of time required off work to do this was unacceptable.

b) the target populations were highly active and mobile with frequent and often lengthy missions, consequently there would have been problems in scheduling sufficient interviews on one visit to get any meaningful response. The frequent absences and high work load also precluded the use of diaries. A mail questionnaire would, however, allow would-be responders to complete it at their leisure.

It was originally thought that within ESTEC, the researcher's own establishment, where there existed a captive audience, some of the other techniques could also be fruitfully employed and the efficiency of the various data collection techniques compared out of interest. Thus some staff could have been given diaries to complete, while others could have been interviewed (in fact follow-up interviews after the mail questionnaire were seriously considered) and yet others could have been observed. In the event none of these other techniques were used primarily because it was ascertained that staff did not have the time nor the inclination to keep diaries, nor did they wish to spend an hour during their working day in being interviewed. Since many did not visit the library regularly and since they worked in small, single, cubicle-type offices and travelled frequently, it was impractical as well as time-consuming to observe them. These points applied equally well to interviewing.

6.5 QUESTIONNAIRE DESIGN AND FORMULATION OF QUESTIONS

6.5.1 Basic Concepts

The reasons why a questionnaire was selected for the study have been outlined above. That was the easy part for, in the event, the questionnaire used in the study took some six months to develop and test and went through four versions. In designing a questionnaire, there are a number of points to be considered - for example, the appearance and layout, the content, the length and the covering letter and instructions for completion. Implicit here are several other aspects such as the purpose of the questionnaire, its language (i.e. vocabulary and syntax), its clarity, its frame of reference, information level, social acceptance, the form of questions and the ideas behind them, their sequence and the ease of subsequent coding. Clearly questionnaire construction and design is an art on which hinges the whole outcome of the survey and because of this a number of books were consulted by the researcher on the subject.

There are two main types of questionnaire - those with open-ended questions and those with closed questions. The former permit the respondent to give the reply in his own words and thus the surveyer may get much more precise and detailed information. On the other hand, the respondent might not be willing to write much at all by way of response. In either case, it can be rather difficult and time-consuming to collate all the different responses for coding and analysis.

The closed questionnaire comprises two types - menu and scalar. In the menu approach all the likely replies respondents might make are anticipated as far as possible and listed so that the respondent needs only to tick the appropriate response. Such a method is reasonably quick and saves the time of the person completing the questionnaire. A disadvantage is that pre-determined answers may condition the respondents thinking and/or may not be exactly how s/he would have chosen to reply. Another point is that the researcher has to try and think up all the alternative answers - though this can be usually covered by leaving a space for "other".

In the scalar type of closed questionnaire (which still has much the same advantages and disadvantages of the menu-type), the respondent is given a certain amount of latitude to reply to a given question within the limit of the scale chosen. Thus the scale might range from Very Good to Very Bad or from 1 to 7. Such a method does not force the respondent quite so much into a specific position or response.

Within the questionnaire itself, a special type of question may be asked relating to a critical incident, where the respondent is requested to describe some event, e.g. an information need and what action s/he took to find out the information and solve the problem. Such a question may be open all the way or once the event is described in the users own words, then it may be closed so that the action taken is identified in a menu of likely actions and responses. Examples of studies employing the critical incident approach include references 6, 11, 20, 24, 50.

In view of the fact that the staff at ESTEC had such a high work load and were very mobile (and there was no reason to suppose this was any different within the other organizations under study) it was believed they would never complete a fully open-ended questionnaire and so it was decided to make it closed in so far as possible and incorporating both menu and scalar-type questions. For similar reasons it was decided against having a critical incident even though this was catered for in the first version of the questionnaire.

Regarding the layout of the questions a balance had to be struck between having them in a logical progressive order and the advisability of having the most important questions early in the sequence, in case the interest of respondents flagged towards the end. It was also considered useful to add a brief explanation as to why each question was being asked, but this idea was finally discarded because it made the questionnaire too bulky.

6.5.2 The Initial Draft

The final questionnaire used in the present study went through four versions. The first consisted of some 120 questions which, among other topics, explored barriers to, and problems in, communicating as a result of working with people from different cultures, races, backgrounds and countries. It went into some detail on how the respondents felt about various issues, e.g. did they deliberately withhold information for diverse reasons or did they feel superior or annoyed when asked for information? It also contained a critical incident.

This initial draft was created by using four sources: first, other studies in the field and their results to get a feel for what had and had not been covered; second, other questionnaires in the same field (e.g. 17, 22, 43, 52) to see a) whether any of the questions might be profitably included in the researcher's draft, and b) whether they could serve as a check for what was included in the researcher's; third, a list of all the questions to which the researcher felt he would like to have responses within the framework of the study; and fourth, by discussion with a number of scientists and engineers in ESTEC to discover what they actually did.

This last method proved immensely valuable since, working in the library and therefore not involved in the day-to-day operations of the other divisions and sections, it was difficult to know exactly the nature of the work of the scientists and engineers, how often they went on mission and why they went, what meetings they attended and what they discussed and so on. Not being part of the every day life of the average scientist/engineer, the researcher had no real idea whether the responses he had given for each question were valid, appropriate or exhaustive. This was then another reason for discussing the draft questionnaire with the users. One further advantage was that the researcher was able to clarify some of the language so that it was comprehensible to those without English as their mother tongue.

It became very clear from these discussions with staff that the questionnaire as it stood was far too long and asked far too many questions which were considered to be of a personal nature. Because names were asked for, the staff polled were reluctant to answer in case their replies got back to Management. As a result of these preliminary discussions the initial draft was drastically reduced to some forty-six questions, many of which were in several parts.

The kinds of questions which were taken out asked, for example, did the scientists/engineers feel reluctance, annoyance, superiority or a sense of cooperation/involvement when asked to give information? Did they feel stupid or inferior or ashamed to show their ignorance when they asked for information? What did they do with the information once they had it - did they analyze it, verify it, use it as it was, follow it up? To what extent did they filter, update or distort information when passing it on to others? Did they do most of their background reading at home or in the office? What was the effect of being physically separated from other colleagues in a work team? All these kind of questions had not been asked before in other studies and were precisely the kinds of questions that needed to be asked to get a proper understanding of scientific communication. However, they were felt by the pre-pilot phase respondents to be an infringement of the privacy of staff and consequently most of them had to be dropped if the study was to go ahead.

In addition, the critical incident question and subsequent action was also dropped since staff considered it would require too much effort to think of a suitable recent event.

In the original version it was intended to provide six point scales ranging between "usually" and "rarely" for various questions. With an even number people would be forced to make a choice and could not mark everything straight down the middle as they could with an odd numbered scale. Respondents were expected to tick the appropriate place on the scale. Since some of the menus were rather lengthy it was decided for Version 2 of the questionnaire to make a neat matrix of boxes and to have greater clarity by not writing "usually/rarely" each time, but instead just to have them once only at the top of each row of boxes and by leaving out the intervening possibilities (often/not very often, etc.).

6.5.3 Version 2 - the Pilot Study

Consequently, Version 2 was the version that was sent out as the pilot study right at the beginning of March 1981. For this pilot study some twenty-eight staff (5% of the engineers/scientists in ESTEC) representing different backgrounds, sections, projects, nationalities, ages, sex and positions were approached and asked to complete the questionnaire once the general outline of the project had been explained to them. Of the twenty-eight, twenty-six agreed to help (of the two who refused one was too busy and one objected to questionnaires on principle) and twenty-three actually returned the questionnaire after some prompting. The pilot study was intended to reveal shortcomings of all procedures, instructions for completion and questions and thus a form was attached to the questionnaire asking for specific comments on the questionnaire itself, for instance, the format, order of questions, clarity, length, etc. Obviously at this stage, it was of greater interest to the researcher in getting the questionnaire right than it was in getting the relevant communication and information use data from these staff.

Rather disappointingly, some respondents, notably the English, made no real attempt to complete the questionnnaire and contented themselves with scrawling "much too complicated" across certain pages. The overall impression was that the questionnaire was reasonable, but in general the respondents felt that it was too long, too complicated and there was too much redundancy (this had been done deliberately to act as a cross-check on replies to certain questions).

Most people spent some 60-75 minutes filling it in. Happily there were few problems of understanding, although one or two people did suggest alternative wordings where they thought it was unclear.

Certain questions were re-worded on the basis of comments received to try and avoid literal interpretations. Thus, for example, some people commented that if they indicated they actually used information, then by definition it was useful. There was also, for some, no distinction drawn between being aware of information and actually obtaining it. If a person became aware of the existence of information from a colleague, then in so far as he was concerned he had obtained it. Whilst this may be true of facts it is of course not true for a journal article to which only the reference is given.

Another example of the care needed with wording and the difficulties of choosing the best expression is given by Question 18 in the final questionnaire which asked in which division a person worked. In the earlier versions of the questionnaire the expression "section/division/department" had been used to convey that what was required was the work unit of the staff member. However, staff in some of the establishments worked in X section which was a part of Y division which in turn was a part of Z department - thus they considered they worked in all three. Various alternatives were considered and in the end the word "division" was used as being reasonably representative and understandable.

6.5.4 The Third Attempt

As a result of the comments and subsequent discussions with a number of respondents the questionnaire was extensively revised and reduced to thirty-eight questions partly by amalgamating questions to get rid of the redundancy and partly by omitting some of the possible replies to a question. For example, "how often do you go on mission for reason A, B, C, D, E etc."? was just left as "how often do you go on mission"? In addition, the order of the questions was made more logical.

Comments had been made to the effect that the six point scale given for which they were expected to tick the appropriate box was too complicated to fill in and they would feel happier working with numbers, say percentages. This certainly was attractive since it meant the researcher could get some real figures (the original intention had been to convert the six point scale to percentages, each point representing 16.6%) without too much additional work. On following this idea through it was suggested that if respondents were expected to give percentages for, say, use of various kinds of literature, then they would have to think a little about it to make sure their quickly jotted numbers added up to 100%. How much better it would be, it was hinted, if they just put down numbers from 1 to 10 where 1 equalled 10% and 10 equalled 100%. This would mean they only had to check that the total was 10 instead of 100. This proposal was then incorporated, with rather clumsy wording, into Version 3 of the questionnaire which was then distributed to a further number of different staff for comments. The majority obviously misunderstood what was required for the general consensus was that they thought 1 was a low score (low utilization, rarely) and 10 was a high score (e.g. usually, very often). Consequently they felt that they could have, say, three 10s to show that they used those, for example, sources of information a great deal!

6.5.5 The Final Questionnaire

Version 4 of the questionnaire then came full circle and reverted to the original six point scale except that instead of ticking boxes, users had to put numbers between 1 (low) and 6 (high).

Another major change was that the questionnaire had to become anonymous due to respondent pressure (at least one establishment refused to participate unless it was made anonymous). One of the original ideas behind the project had been to study the flow of information through and across sections, projects and establishments and to try and identify gatekeepers and isolates by the construction of sociograms. Did, for instance, gatekeepers in the traditional sense exist in organizations which had many dealings with outside bodies or did their existence depend on whether the organization was mission-oriented like ESA or discipline- or service-oriented like FAO and UNESCO? For this purpose respondents were asked to identify themselves and to name up to five colleagues (peers, subordinates, superiors) with whom they were most in contact.

In every previous version of the questionnaire this detailed question was not well answered simply because names were requested. It was decided to leave it in to salvage what could be salvaged, but without names. This, then, meant that the questionnaire itself would also be anomymous. While this could have allowed some of the more personal questions regarding feelings, etc. to be reinserted, it was felt that this would have added considerably to the length of the questionnaire.

One other change in the final questionnaire was that questions relating to the project the person worked on or supported were omitted mainly because comments returned with earlier drafts from other participating organizations revealed that their organizational structures were somewhat different from ESTEC and that the concepts "project" and "support" staff did not apply since everyone worked for a project or considered every task worked on was a project. Thus it was decided to avoid confusion by omitting the question, and incidentally, thereby possibly foregoing obtaining information on the cross-fertilization of ideas through project and functional support staff.

Another similar modification made was the omission of questions relating to the kinds of information required by scientists and engineers, e.g. performance/experimental data, procedures/rules, general principles, etc.

For most staff, it seemed that such types of information were totally task-dependent and therefore they could not generalize and say what they needed when. Furthermore, it was often not possible for them to distinguish between some of the different categories. Consequently, because the types of information originally provided were not useful, it was decided to reduce them to the four general categories of ideas, facts, advice and opinions. The final version of the questionnaire consisted of thirty-six questions and is reproduced in Appendix B.

The language of the questionnaire was to be English since this was the mother tongue of the researcher and it was also an official language of the international organizations. The Dutch and German participants would, it was believed, have no problems either. It would prove an added bonus to see whether, in fact, non-English mother tongued respondents had problems in completing the questionnaire. CNES then said that a condition for its participation was that the questionnaire be in French. The researcher had no objections to this since the French version could also be used for ONERA, should it have decided to take part, and it could also be distributed to the sizeable French contingency in ESTEC which should hopefully have increased the likely response rate. Accordingly the researcher translated the entire questionnaire into French himself (it was subsequently checked by several scientists/engineers with French mother tongue!).

6.6 DISTRIBUTION OF QUESTIONNAIRES

The questionnaires were to be distributed to all the scientists and engineers in the various establishments agreeing to participate, thus no sampling procedure was deemed necessary.

As mentioned earlier the matter of handling the contact between the organization (except ESTEC and UNESCO) and the researcher was delegated to the Librarian. The latter agreed to be a focal point for the distribution and collection of questionnaires within his establishment.

Thus questionnaires were sent in bulk by mail to the Librarians at DFVLR, NLR, CNES and IAEA - the precise number required being indicated to the researcher by the Librarian.

In the case of NLR it was originally intended to circulate 250 questionnaires, but due to management intervention only fifty scientists and engineers were actually permitted to participate because of the loss of time which would result from completing the questionnaire during the working day. It was directed that there should be ten people from each of the five main divisions, and though the researcher tried to get all fifty people from one division, in the event an arbitrary selection was made of the fifty staff by NLR itself. UNESCO, unwilling to supply a focal point, was not averse to the researcher sending the ninety-five staff of the Science Sector the questionnaire directly. However, despite several requests the names of only thirty-nine professional staff were forthcoming. These were sent individual questionnaires and asked to return them to the researcher direct. For ESTEC, the researcher himself was the focal point for the return of the questionnaires which were distributed via the internal mail system.

The initial mailing of the questionnaires to the establishments was done towards the end of October/beginning of November 1981. They were distributed internally a few days later and staff were given three to four weeks to complete and return them to their focal point or the researcher direct in the case of ESTEC and UNESCO. The deadlines in each establishment were extended to take into account staff on mission and to try and obtain a higher rate of response. Reminders were sent round to staff both on the Librarians' own initiative and again, after Christmas 1981, on the urging of the researcher. During January and February 1982 what completed questionnaires there were were returned to the researcher. In view of the low number of responses the researcher once again asked the focal points to chase up those who had not replied (he did it himself for UNESCO and ESTEC). Despite numerous follow-ups and reminders on a personal basis few further completed questionnaires were forthcoming and the total average percentage returned was a disappointing 26%. A breakdown of the number of questionnaires distributed and returned is given in Table 4.

The results were especially poor (27%) from ESTEC, the researcher's own establishment. Here the researcher believed that, because there was a captive audience and because he was actually on the spot and saw the would-be respondents regularly, he could badger and persuade and entice them into replying. Sadly, this proved not to be the case!

It is, therefore, instructive to consider the possible reasons why, despite the steps taken to ensure an adequate return (establishment of a focal point, follow-ups and reminders, personal approaches), the response rate was still low. In so far as DFVLR was concerned, an internal action by Management (nothing to do with the study) was taken simultaneously with the distribution of the questionnaires and this had a negative impact on their completion as well as precluding the Librarian from chasing up non-respondents as much as he was obviously prepared to.

The Librarians acting as the focal points were really doing so because their Directors had requested them to and thus they had no real motivation nor would benefits accrue to them as a result of their labours. Thus, they felt that they could not spend too much time on chasing and reminding and in any case this may have put them in a disadvantageous position vis-à-vis staff in their establishments. Similarly, most staff could see no real value to themselves in completing a lengthy and complex questionnaire when they were hard pushed for time, in which they had no personal interest and which would not assist or benefit them. (Contrast, for example, a very recent survey on staff morale at ESTEC in which the response rate to the questionnaires was 55%. Here the questionnaire was much shorter and was concerned with matters of direct interest to staff such as working conditions, salaries, promotions. Even then 55% is not high. Even the 16-page, 700 item questionnaire of Mick (41) which took over three hours to complete, achieved a 50% response rate! On the other hand the European Commission's study (13) to ascertain how officials spent their working day achieved only a 22% response rate). For many of the staff the questionnaire was in a foreign language and the effort required to fill it in may have been too great.

Undoubtedly, some simply put it on one side and forgot about it while others would have been on lengthy missions.

A self-addressed envelope for returning the questionnaires may have helped in the case of UNESCO, as may have a focal point there. ESTEC staff were too busy with meetings and contract specifications or else were away and on their return were occupied with filing a mission report. Some kept promising to return the questionnaire but never did and although one can keep asking for it, there comes a point when one realizes that there never will be any reply.

TABLE 4 - DISTRIBUTION AND RETURN OF QUESTIONNAIRES

ORGANIZATION	NO. SENT	NO. RETURNED	% RETURNED
CNES	50	9	18
DFVLR	184	36	19.57
ESTEC	572	154	26.92
IAEA	211	49	23.22
NLR	50	24	48
UNESCO	39	15	38.46
TOTAL	1106	287	25.93

Why could T.J. Allen get a huge response rate from each surveyed establishment complete with names for the construction of sociograms? First, he studied very large organizations and thousands of staff.

Second, the research undertaken by the organization was government financed, therefore, they felt most likely that they had to comply with study requests. Next, the studies were not privately conducted, but had the official backing of both the researcher's and the researched organizations. Finally, the results of the studies were to be used in the same country. Here, the organizations from several countries were to be compared and given national pride, rivalry, conflict etc. perhaps there was a fear that the bodies of a particular country might be shown up in an adverse light.

6.7 CODING, DATA ENTRY AND ANALYSIS

For convenient content analysis of the questionnaires it was necessary to sort the data into categories and classifications for subsequent coding. It had been decided not to include precoding on the questionnaires themselves for two reasons. First, it was felt this would make the questionnaire less clear and second, because some questions were open-ended. Thus while a certain amount of coding could be done in advance, the bulk had to await the return of the completed questionnaires.

The researcher's own organization, ESTEC, agreed at the outset of the study, to permit the required analysis of data to be done on its main computer and to provide assistance in the data preparation. As the normal method of computer input was from 80-column punched cards, the coding form first constructed by the researcher was based on this format.

Since the number of questionnaires returned was hardly overwhelming, the coding frame was made by scanning all the questionnaires rather than just a sample. The 80-column punched card format posed no few problems owing to the fact that only a maximum of twelve positions could be catered for in any given column - this meant twelve responses and some questions had rather more than this. The replies to the open questions had been reduced into an appropriate number of common answers or categories and these and the longer closed questions had to be broadened to overcome the twelve category limitation.

Once completed the coding frame was shown to the programmer assigned to assist in writing the input and statistical programs.

It transpired that during the time the coding frame was being prepared a new method of input was available - that of entering the data in free-text form via a terminal - and this was preferred by the programmer. This meant that rather than entering strings of meaningless numbers, valid text and mnemonics could be entered instead thus affording instant recognition of the values at the output stage. It also meant that one was not bound to the limit of twelve categories as one was with punched cards. The coding frame had to be, therefore, re-written by the researcher to convert the 80-column variables into an alphanumeric free-text form.

Since the data entry was to be done via a terminal screen, it was necessary to design the layout of each screen so that it related to the coding frame. Once the researcher had done this the programmer wrote the necessary software to generate the screens on the terminal and capture the data. This was a lengthy business due to the fact that the programmer could not spend too much time on the researcher's task owing to his commitments elsewhere and the fact that the researcher's project was not an official Agency task and he was only helping out. Once the screens were ready the researcher discovered that the programmer had put them in an order different from that of the questionnaire which meant that the data entry would not be so convenient as he would have to skip back and forth between pages or screens. The programmer eventually correctd the screen order at the input level, but unfortunately did not modify the order at the output level. This meant that it was that much more difficult to identify errors since data input order did not match data output order.

While the terminal screens were being created, the researcher was busy coding each questionnaire with the new alphanumeric values. The actual input of the data took some eighty man-hours and was done by the researcher himself during the evenings, weekends and (1982) Christmas holidays.

With the data safely input (the original idea was to have validation of input but this proved too time-consuming for the programmer to write) the next step was the analysis by computer.

What the reseacher considered desirable were frequency distributions and cross-tabulations so that the effect of one variable on another could be seen. Since no statistical packages were available at ESTEC and none were permitted to be bought for this project, the programmer intended to write some simple statistical routines, but in the event found this would require too much effort. His superiors concurred and subsequently the researcher was informed that no further time could be spent on his "unofficial" project because of commitments to bona-fida ESTEC tasks.

After examining various alternatives (including doing the analysis by hand) the researcher turned to Loughborough University for assistance since they had access to the Statistical Package for the Social Sciences (SPSS). Provided the researcher supplied his data on magnetic tape in 80-column punched card format and did all the necessary coding for the computer, the University would run the data against the SPSS program.

The researcher then bought the relevant SPSS manuals and studied the program and system in order to be able to convert his data into the format required by SPSS, indicate what statistical routines and options were needed and then write the necessary computer instructions on punch card coding sheets. This was done over the Easter holidays (1983). The whole task proved rather daunting since the data, originally in 80-column format, was now in free-text format, and was required to be once again in 80-column format. In addition, SPSS handled numerics far better than alphanumerics and the data was mainly alphanumeric. Furthermore, SPSS could only accept four character alphanumerics whereas the free-text coded data used six character alphanumerics for greater mnemonic clarity. Another point was that blanks and zeros were treated equally under SPSS. In the free-text coded data zero was a valid, significant response, while a blank did not necessarily mean that the data was missing only that the response was not relevant.

Another major problem was that the SPSS program could only cater for 500 variables at one time, whereas the researcher had well in excess of 600!

All these difficulties had to be resolved by the researcher himself, remote from the University Computer Department, during a holiday period and just with a manual. The problem of replacing the six character alphanumerics by four characters was resolved by just using another shorter mnemonic. The blank and zero question was resolved by recoding. The reduction in the number of variables was achieved in two ways. First, by eliminating many unused reply possibilities (for example in Question 17 reasons for and against using certain means of communication were requested and up to six possible responses were allowed. Manual analysis of the returned questionnaires showed that the majority of people gave only one or two reasons, thus three was taken as a maximum with the saving of forty-eight variables) and by cutting down the number of people contacted in Question 18 from five to four for a saving of some sixty variables.

The SPSS coding format and instructions prepared by the researcher happily required only minor modifications before they were punched up by the Loughborough University Computer Department and run with the researcher's data. The sheer amount of variables and values and statistical options requested, however, severely overloaded the computer and the output facilities. It was thus necessary to: (i) reduce the amount of cross-tabulations originally required (not all of these were strictly necessary); (ii) condense the output format (this resulted in much compressed tables, loss of histograms and loss of value labels, thus making the actual analysis and interpretation more arduous); (iii) refine the statistical options requested; and (iv) cut down the number of variables for which frequencies and crosstabs had to be computed to much smaller manageable blocks.

Even once this was done, the output was still very slow in coming due to computer downtime, use of the system by other researchers and scheduling.

The variables were thus broken down into even smaller blocks by the researcher and all the basic statistics required were not finally in the researcher's hands until mid-September 1983.

6.8 POST ANALYSIS OF QUESTION FORMULATION

The results obtained from the questionnaire response are discussed in the following chapters. However, it was felt appropriate at this point, having already looked at the design of the questionnaire and the formulation of questions, to note the way in which the various questions were answered (without taking into account the content of the replies) since this reflects to some extent on the clarity of the questionnaire and its ability to be understood.

Many people were not too careful in reading the questionnaire and thus were careless in filling it in. This may have been due to the length of it and the time required to complete it (although it is interesting to note that the carelessness was not towards the end of the questionnaire). It may also have been due to language constraints (though the carelessness was not limited just to people with non-English mother tongue). Examples of not reading the questions properly are afforded by replies to Questions 18a and 18b. Question 18a asked for one tick per person in each group. A large number of people gave more than one tick in each group despite clear wording. In Question 18b instead of ticks respondents were asked to give numbers between 1 and 6. A substantial number, possibly conditioned by Question 18a gave ticks instead. In other questions too, e.g. Questions 15 and 26, where numbers between 1 and 6 were sought, respondents often gave ticks, or the number 0 to signify no use (the box was left blank if the response was inapplicable). The multi-part questions, e.g. Questions 27 and 33 were also not answered correctly in some instances. There was a tendency for some people to answer all the parts instead of just the relevant bits. For example, people said they were NOT familar with the work of their organization (Question 33), then went on to reply to the part of the question for people who were.

The various parts of these questions were clearly laid out and the relevant options were distinguished in some way, e.g. by being in capital letters or by being underlined. A way round this problem would have been to indicate to which question the respondent should skip next after having answered one part. This, however, can make for a somewhat more lengthy questionnaire and there is still no guarantee that the repondent will read the instructions more carefully.

There was a fair amount of inconsistency in replies between questions. In Questions 12 to 14 dealing with language ability, a respondent said, for instance, that he spoke French, English, German and Dutch (Dutch being the mother tongue). When asked which languages he could read he replied simply Spanish. Did this mean that he could NOT read those languages he spoke (including his mother tongue) or did it mean that, in addition to the others he could read Spanish but was unable to speak it? This was quite a common error if one can call it that. Other similar instances where a respondent replied he frequently communicated in Spanish, but he did not list this language as one he spoke nor as one he read! One thing not spelled out in the questionnaire was whether "communicate" referred to verbal or written communication or both. It was clear that some people took it only to mean verbal communication. (An early intention was to include a definition of communications at the start of the questionnaire but this was not done after comments were received during the pre-pilot phase). In Question 4 too, some people replying that they were not supervisors, nevertheless in Question 18 replied that some of their most frequent contacts were with subordinates. Inconsistencies were also rife in Question 33 where people said they wanted to be better informed about what their organization did but they did not want a newletter for this purpose and vice-versa, i.e. they did want a newsletter, but did not want to be better informed. As the question seemed rather clear it must have been that respondents were hurrying to finish off the questionnaire and therefore did not read the introductory text to the question properly.

While the researcher had endeavoured to list all possibilities for the menu-type questions, a few participants listed additional ones under the boxes named "other". For example, Question 21 asked where people obtained information from. A response not foreseen (since the researcher was really thinking in terms of sources available in-house), was "outside libraries".

Another relatively frequent response, not foreseen by the researcher and not thrown up in the pilot studies, was, in reply to Question 22 and/or Question 23 which asked about the frequency of using the library, "I never use the library".

Similarly, in Question 31 which asked about ways in which people kept up-to-date, among the possibilities listed was "scanning journals in the library". What was meant, of course, was scanning journals subscribed to by the library and thus available in the library even though they may have been circulated. Some respondents took this literally because they gave as an alternative response "scanning journals in my office" (i.e. as opposed to in the library). Literal replies were given to one or two other questions, by respondents whose mother tongue was not English, thus emphasizing the extreme care needed with wording although sometimes one cannot be much clearer. Consider the following question which asked simply "what information can you not get from the library"? One reply was "information stored in my own head" - which was not meant to be flippant. Again in Question 36 respondents were asked if they had any <u>general</u> comments. One reply was "no, only <u>specific</u> comments". These comments were then not given presumably because they had not been asked for!

In general, respondents seemed not to think too deeply about their answers and appeared to be conditioned by what they had put before. Thus, in those questions requiring a number between 1 and 6, there was a strong tendency for people to give the same number, e.g. 2, for every possible response. This was particularly noticeable in Questions 18b and 26. One other interesting fact was shown by Question 22 which asked whether people used the library now more, less or the same than they did twelve months ago.

Several reasons were suggested for the response. Those replying either "more" or "less" did give reasons, but those responding "about the same" felt there was no need to reply to the "why" part.

Regarding inadequate responses it was of course inevitable that there would be no replies at all for some questions or partial replies, irrelevant replies, inaccurate replies and replies that were poorly expressed (by virtue of a lack of vocabulary of non-English mother-tongued respondents). Some of these responses could still be used by either judicious interpretation on the part of the researcher or else by cross-checking with other replies. Thus, for example, if a person gave his nationality as Austrian and said he spoke German and English, but failed to indicate his mother tongue, then it was reasonably likely that of the two languages given, it was German.

With hindsight, one can see better where follow-up questions might have been asked. For example. in Question 30 which asked whether information sources were adequately covered, it would have been interesting to know which sources the respondent felt he did not cover. In Question 35, which asked whether the respondent would like an introductory session to the library, the options were Yes or No, but if the respondent said Yes, then since the questionnaires were ultimately anonymous, then the researcher was at a loss to know who needed this. A better approach might have been to exhort them to contact the library in this instance.

Finally, the importance of correct wording to get the reply sought is illustrated by two questions. Respondents were asked in Question 17 why they used or avoided certain ways of communicating. Two of these ways were via internal and external (i.e. published) reports/papers. What was meant was the generation of these documents. A large number of people took it in another sense - that of reading them. In Question 7 the question was asked "what was your previous work environment"? What was meant, of course, was the immediate previous one, not every job held throughout the respondent's life!

REFERENCES

1) ALLEN, T.J.
The differential performance of information channels in the transfer of technology. MIT Sloan School of Management, 1966, WP 196-66.

2) ALLEN, T.J.
Information needs and uses. In Cuadra, C.A. Annual Review of Information Science and Technology, Vol.4, ASIS, 1969, p.3-29.

3) ALLEN, T.J. and COHEN, S.I.
Information flow in an R&D laboratory. MIT Sloan School of Management, 1966, WP 217-66.

4) ANZIEU, D.
Les communications infra-groupe. In Geldard, F.A. Conference on Communication Processes, Washington, 1963. Macmillan, 1965, p.169-188 (discusson p.189-218).

5) BARNES, R.C.M.
Information use studies. Part 2 - Comparison of some recent surveys. Journal of Documentation, 21, 3, Sept. 1965, p.169-176.

6) BERUL, L.H. et al
DOD user needs study. Phase 1. Vols. 1 and 2. Auerbach Corp., 1965. Report No. 1151-TR-3 AD 615 501/2.

7) BORMANN, E.G. et al
Interpersonal communication in the modern organization. Prentice-Hall, 1969.

8) BURNS, T.
The direction of activity and communication in a departmental executive group.
Human Relations, 7, 1954, p.73-97.

9) CARTWRIGHT, D. and ZANDER, A.
Group dynamics: research and theory. 3rd ed. Tavistock Publications, 1968.

10) CHERRY, C.
On human communication. 3rd ed. MIT, 1978.

11) CHEN, CHING-CHIH and HERNON, P.
Information seeking. Neal-Schuman Publishers, Inc. 1982.

12) CHRISTIE, B.
Face to file communication: a psychological approach to information systems. Wiley, 1981.

13) COMMISSION OF THE EUROPEAN COMMUNITIES
File network needs and effectiveness study. CEC, 1980.

14) CRANE, D.
Information needs and uses. In Cuadra, C.A. Annual Review of Information Science and Technology, Vol. 6, ASIS, 1971, p.3-29.

15) CRAWFORD, S.
Information needs and uses. In Williams, M.E. Annual Review of Information Science and Technology, Vol. 13, ASIS, 1978, p.61-81.

16) DAVIS, K.
Human behavior at work: organizational behavior. 6th ed. McGraw-Hill, 1981.

17) DEWHIRST, H.D.
The role of the LRC technical library in fulfilling the information needs of professional employees. Langley Research Center, 1970.

18) FISHENDEN, R.M.
Methods by which research workers find information. In Proceedings of the International Scientific Conference on Information, Washington DC, 1958 Nov. 16-21, NAS, 1959. Vol. 1, p.163-179.

19) FJÄLLBRANT, N.
The development of a programme of user education at Chalmers University of Technology Library. PhD Thesis, University Microfilms, 1977.

20) GARVEY, W.D. et al
Research studies in patterns of scientific communication: I General description of a research program.
Information Storage and Retrieval, 8, 3, June, 1972, p.111-122.

21) GARVEY, W.D. et al
Research studies in patterns of scientific communication: III Information exchange processes associated with the production of journal articles. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.202-224.

22) GRALEWSKA-VICKERY, A. and ROSCOE, H.
Earth science engineers: communication and information needs. Final Report and Appendix. Imperial College, 1975. Research Report No. 32.

23) HALBERT, M.H. and ACKHOFF, R.L.
An operations research study of the dissemination of scientific information. In Proceedings of the International Scientific Conference on Information, Washington DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.97-130.

24) HERNER, S.
Information gathering habits of workers in pure and applied science.
Industrial and Engineering Chemistry, 46, 1, Jan. 1954, p.228-236.

25) HERNER, S. and HERNER, M.
Information needs and uses in science and technology. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 2, ASIS, 1967, p.1-34.

26) HERNER, S. et al
An evaluation of the Goddard Space Flight Center Library. Herner and Co. 1979. NASA-CR-159969.

27) HOGG, I.H. and SMITH, J.R.
Information and literature use in a research and development organization. In Proceedings of the International Conference on Scientific Information, Washington DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.131-162.

28) HOWTON, F.W.
Work assignment and interpersonal relations in a research organization: some participant observations.
Administrative Science Quarterly, 7, 1962/63, p.502-520.

29) KATZ, D. and KAHN, R.L.
The social psychology of organizations. 2nd ed. Wiley, 1978.

30) KING, D.W. and RODERER, N.K.
Communication in physics - the use of journals. 2nd ed. Holt, Rinehart and Winston, 1981.

31) KOEHLER, J.W. et al
Organizational communication: behavioral perspectives. 2nd ed. Holt, Rinehart and Winston, 1981.

32) KRAUSE, D.C.
Marine science networks involving the individual and UNESCO. Vol.1. The intergovernmental framework. Vol.2. Cooperation and coordination. UNESCO, 1978.

33) LIN, N. and GARVEY, W.D.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 7, ASIS, 1972. p.5-37.

34) LIPETZ, B-A.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 5, ASIS, 1970, p.3-32.

35) LUDEWIG, C.W.
Information needs of scientists in missile and rocket research as reflected by an analysis of reference questions. MLS Thesis submitted to University of North Carolina, 1965.

36) MARTYN, J.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 9, ASIS, 1974, p.3-23.

37) MEADOWS, A.J.
Communication in science. Butterworths, 1974.

38) MEADOWS, A.J. and O'CONNOR, J.G.
An investigation of information sources and information retrieval in astronomy and space science. 2 vols. OSTI, 1969. Report No. 5044.

39) MENZEL, H.
Review of studies in the flow of information among scientists. Columbia University, Bureau of Applied Social Research, 1960.

40) MENZEL, H.
Information needs and uses in science and technology. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 1, ASIS, 1966, p.41-69.

41) MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980, p.347-356.

42) MOSER, C.A. and KALTON, G.
Survey methods in social investigation. 2nd ed. Heinemann, 1977.

43) MURPHY, M.
Measuring library effectiveness: a prelude to change.
Special Libraries, 70, 1, Jan. 1979, p.18-25.

44) PAISLEY, W.J.
The flow of (behavioral) science information: a review of the research literature. Stanford University, Institute for Communication Research, 1965.

45) PAISLEY, W.J.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 3, ASIS 1968, p.1-30.

46) PELZ, D.C. and ANDREWS, F.M.
Scientists in organizations: productive climates for research and development. Wiley, 1966.

47) PINELLI, T.E. et al
A review and evaluation of the Langley Research Center's Scientific and Technical Information Program. Results of Phase I - knowledge and attitudes survey, LARC Research Personnel. NASA, 1980. NASA-TM-81893.

48) POPPEL, H.L.
Managerial/professional activity. Booz, Allen and Hamilton, 1980.

49) PRYOR, H.E.
An evaluation of the NASA Scientific and Technical Information System.
Special Libraries, 66, 11, Nov. 1975, p.515-519.

50) SCOTT, C.
The use of technical literature by individual technologists.
IRE Trans. on Engineering Management, EM-9, 2, June 1962, p.76-86.

51) SHEPPARD, M.O.
User response to the SDI service developed at Aeronautical Research Laboratories, Australia. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976, AGARD CP-179, p.10-1-10-9.

52) SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group, 1981.

53) SKELTON, B.
Scientists and social scientists as information users: a comparison of results of science user studies with the investigation into information requirements of the social sciences.
Journal of Librarianship, 5, 2, April 1973, p.138-156.

54) TÖRNUDD, E.
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 DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.19-75.

55) WILSON, T.D. and STREATFIELD, D.R.
Information needs in local authority Social Services departments: an interim report on Project INISS.
Journal of Documentation, 33, 4, Dec. 1977, p.277-293.

56) WOLEK, F.W.
Professional work: the context for evaluating the impact of user studies. In 15th Annual National Information Retrieval Colloquium, Philadelphia, PA. 3-4 May, 1973, p.34-35.

57) WOOD, D.N.
User studies: a review of the literature from 1966 to 1970.
Aslib Proceedings, 23, 1, Jan. 1971, p.11-23.

58) WOOD, D.N. and HAMILTON, D.R.L.
The information requirements of mechanical engineers: report of a recent survey. Library Association, 1967.

CHAPTER 7

THE BACKGROUND TO SCIENTISTS AND ENGINEERS

7.1 INTRODUCTION

Replies were received from 287 individuals in six organizations - three international organizations (218) and three national aerospace research establishments (69). It has been mentioned earlier that the European Space Agency, while an international organization, is, through its R&D establishment, ESTEC, also similar to an aerospace research entity. It is interesting, therefore, to note that, if the ESTEC replies are omitted from the international organization's responses then the replies for the latter (64) are nearly identical to those of the aerospace establishments (69).

Since the returns from the organizations were on the low side (26% response rate) the figures and percentages given throughout this discussion of results cannot be considered truly representative of the organizations as a whole.

It should be noted, too, that percentages have generally been rounded off in accordance with the usual rules. In some tables where the total is slightly more or less than 100% it is due to rounding up or down; where it is significantly more than 100% then it is because multiple answers were given. A blank left in the questionnaire could signify either that the question was not relevant or that no reply was provided even though the question may have been relevant. For convenience they have been grouped together in the tables under the heading N/A (not available). In addition, for ease of consultation and clarity, the precise number of respondents for each category has not been provided for some tables.

This chapter presents general information on the scientists and engineers who replied, relating to their sex and age, education and training, present field of activity, supervisory position, previous employment, familiarity with the organization in which they work and their nationality and linguistic abilities.

7.2 SEX AND AGE

The vast majority of respondents were males - only eight (2.8%) being female. None of these latter worked in the national aerospace establishments, possibly because aerospace is traditionally "technical" and thus a man's world - although the education and training as well as present subject field of these eight women were very definitely scientific and technically-oriented.

Respondents were asked (Question 2) to give their year of birth. As might be expected, there was a very wide range of years - from 1919 to 1956. Whilst the largest number of people (15%) were born in the years 1942/43, fully 77% were born before 1944 - thus it would appear that the organizations are composed of a middle-aged workforce. Indeed, in the European Space Agency as a whole, in 1971 the average age was thirty-five years, while in 1983 it was forty-four years.

TABLE 5 - AVERAGE YEAR OF BIRTH

ORGANIZATION		YEAR OF BIRTH
UNESCO	(N=15)	1929
IAEA	(N=49)	1936
DFVLR	(N=36)	1938
CNES	(N=9)	1939
ESTEC	(N=154)	1939
NLR	(N=24)	1943
ALL ORGANIZATIONS	(N=287)	1938

As can be seen from Table 5, the average year of birth was 1938, with UNESCO being the "oldest" organization and NLR being the "youngest". Again, it should not be thought that these average years necessarily reflect the true age of these organizations because it is not clear how representative the data is of all the people - or at least the scientists and engineers in the organizations.

In his study of 1315 engineers in eighty-nine firms, Shuchman (4) noted that the engineers were younger than the US Census sample of the profession. 5% were under twenty-five years old, 20% were between twenty-five and thirty-four years old and 10% were older than fifty-five years. Gerstl and Hutton (1) consider that older engineers maintain wider social networks with colleagues from work. Pelz and Andrews (3) found that performance among engineers and scientists peaked at mid-career (in the forties), then dropped, (though the drop was less among inner-motivated scientists and those in development laboratories) and then peaked again (lower) around the fifties. A measure of the published papers of these individuals also showed peaks at the same places. In general, government engineers reached their peaks before industrial engineers, but both declined rapidly and then recovered slowly. The recovery was slightly better in industrial engineers.

The present study did not attempt to measure performance and the comments above are included to show the effect of age in certain organizations. It had been thought to study the effect of age on information usage and communication, but because of the wide disparity in age and the low number of people with each age, no useful results were forthcoming.

7.3 SUPERVISORY POSITION

To Question 4 "Are you in a supervisory position?", 57% said that they were, while 43% replied they were not. It would appear from Table 6 that all the organizations, except NLR, are composed of chiefs rather than indians! Of course, NLR is a "younger" organization than the others and thus its junior staff will not yet have reached supervisory positions.

The very words "supervisory position" may have been misinterpreted. They were used as a euphemism for the concept of "person in charge". Being in a supervisory position, though, is not necessarily the same as being the person in charge of a department or head of section. Some respondents at ESTEC were not "bosses" in this sense, but yet were responsible for supervising one or two contractors. Others felt that the divisional secretary was strictly speaking a subordinate and therefore they considered themselves in a supervisory position.

TABLE 6 - SUPERVISORY POSITION

ESTABLISHMENT \ WHETHER SUPERVISOR		YES	NO
ALL	N = 287	57%	43%
INTERNAT. ORGS.	N = 218	60	40
AEROSPACE ESTABS.	N = 69	46	54
ESTEC	N = 154	60	40
IAEA	N = 49	53	47
DFVLR	N = 36	53	47
NLR	N = 24	25	75
UNESCO	N = 15	80	20
CNES	N = 9	78	22

It is clear that 80% of the UNESCO people cannot be supervisors proper. Given a Science Sector of some 90 people it is not credible that only people "in charge" replied to the questionnaire! It must be that the respondents felt themselves, rightly so, supervisors in the literal sense because they oversaw or supervised work being carried out in other countries under UNESCO grants and sponsorship.

Grouping the respondents into the three loose types of profession (i.e. Engineers, Scientists and Others), 56% of those in a supervisory position were Engineers, 31% were Scientists and 13% were classifed as Others. Of those not in a supervisory position, 52% were Engineers, 27% were Scientists and 21% were Others. Only 44% of all those classifed as Others were supervisors compared to 59% of Engineers and 60% for Scientists. It would seem that it is easier to get to the top in an organization if one is a scientist or engineer rather than a programmer, librarian, translator or publisher!

7.4 EDUCATIONAL BACKGROUND AND PRESENT FIELD OF ACTIVITY

Questions 5 and 6 asked "In which subject speciality were you educated or trained?" and "In what field are you now working"? As might be expected a wide variety of answers was given with no consistency among them. Eighty-nine distinct subject categories were distinguished and these were grouped into twelve broad subject areas. A detailed breakdown of these categories is given in Appendix C.

Table 7 shows what percentage of the respondents fell into the broad groupings. Because there was such diversity, even among 287 respondents, not many conclusions can be drawn from the data; however, there are one or two obervations that can be made. 4% of the respondents had education and qualifications in nuclear engineering/technology though only 2% are presently working in that field (in an international organization). The other 29% moved, with others, into safety engineering (i.e. nuclear safeguards). 8% of the total worked in this area (which included also product assurance and reliability) - but no-one had any formal education in this domaine. Of the 35% who studied engineering (including mechanical, electrical, electronics) only one third (12%) are now engaged in "pure" engineering - the others having moved into safety engineering (product assurance/reliability), space technology, management and telecommunications. Few appear to have been formally educated in these areas.

This would seem to support Shuchman's findings that 30% of engineers transferred industries (4). It would appear, then, that engineers change their area of activity or application/discipline more so than scientists. Their training obviously equips them to switch from one area to another where their tasks may be similar. Possibly this is due to the relatively ephemeral nature of engineering projects - whereas science offers more scope for long-term ongoing research.

It can also be seen from Table 7 that the international organizations and national aerospace establishments as a whole are rather similar in the present activities of their staff except for those in management and physics. Looked at in more detail, it would appear that somewhat fewer people are involved in management in CNES and IAEA. In the case of the former, though, since there were only nine replies the figure is virtually meaningless.

Another point worthy of mention is that the number of people involved in informatics in each of the six organizations is just about identical (7% or 8%). As might be expected IAEA is the only one of the six with workers in nuclear engineering and 31% of its staff are engaged in safety, particularly nuclear safeguards. The only other establishment with staff working in safety (actually in product reliability) was ESTEC. One would have thought the aerospace establishments, heavily involved in spacecraft, aircraft and equipment design, checkout and testing would have had some staff working in the safety/reliability field. (It must be emphasized, again, that these comments are based on the questionnaires returned - obviously each establishment may have a large reliability department with many staff, none of whom replied to the questionnaire.

An interesting example of the differences in activity of people with similar qualifications is afforded by those working in the earth science field. Three establishments - DFVLR, NLR and UNESCO - had earth scientists (3%, 4% and 40% respectively). The first two organizations' earth scientists would be using their specialist knowledge to develop techniques for remote sensing of earth resources, geological features and the like, whereas the UNESCO earth scientists would be concerned with helping Member States carry out ground surveys and develop and exploit their resources.

TABLE 7 - SUBJECT FIELD OF RESPONDENTS

SUBJECT	Broad field in which educated N=287	Present field of activity N=287	Present field of activity	
			Int. orgs. N=218	Aerospace Estabs. N=69
Chemistry/materials	4%	3%	3	4
Earth sciences	4	3	3	3
Engineer/electronics	35	12	11	13
Informatics/maths	6	8	7	9
Life sciences	3	3	2	7
Management/finance	5	19	21	14
Miscellaneous	8	9	10	6
Nuclear engineering	4	2	2	-
Physics/space sciences	25	10	8	14
Safety eng./reliab.	-	8	11	-
Space technology	3	16	15	19
Telecommunications	3	8	7	10
	100%	101%	100%	99%

% of respondents in each broad field

The majority of the more specialist subject categories had only a handful of members. Table 8 serves to show how people, who have a basic education and training in a given subject area, diversify and move into more specialist areas. For example, the physicists have moved into the realms of astrophysics, plasma physics, atomic physics, astronomy, etc.

TABLE 8 - EDUCATION VERSUS PRESENT ACTIVITY - CHANGES IN DIRECTION

SUBJECT FIELD	EDUCATED/TRAINED IN	PRESENT ACTIVITY
Physics	14%	1%
Electronics	9	3
Aeronautical eng.	9	2
Electrical eng.	7	1
Mathematics	4	1
Mechanical eng.	4	1
Space technology	2	5
Administration	1	9
Project management	-	5
Safety engineering	-	5

% of respondents

The staff of the organizations were, on the basis of their education and training (Question 5) and their present activity (Question 6) divided into three categories of profession, namely, scientists, engineers and others. ("Others" included those with qualifications and background in informatics, computer science, technical writing, translating, publishing, management, etc.). Table 9 gives the breakdown of the number of scientists, engineers and others responding from each organization.

TABLE 9 - SCIENTISTS AND ENGINEERS BY ORGANIZATION

ORGANIZATION		ENGINEERS (N=155)	SCIENTISTS (N=84)	OTHERS (N=48)
ALL ORGANIZAT.	(N=287)	54%	29%	17%
INTERNAT. ORGS.	(N=218)	55	28	17
AEROSPACE ESTAB.	(N=69)	51	35	14
ESTEC	(N=154)	60	24	16
IAEA	(N=49)	41	33	26
DFVLR	(N=36)	36	53	11
NLR	(N=24)	67	21	13
UNESCO	(N=15)	47	47	6
CNES	(N=9)	67	-	33

% of respondents

7.5 PREVIOUS EMPLOYMENT

On the surface it looks so easy to construct a questionnaire. Question 7 asked "What was your previous work environment?" What was meant was in what type of organization (e.g. academic, industrial, government, etc.) was the respondent employed before coming to work for his present organization, i.e. the immediately previous organization. Some respondents virtually summarized their entire career and ticked two or more of the boxes. On reflection, this could have been an added bonus since it showed the degree of mobility a respondent had in moving from one job to another. In the event only a small number ticked more than one box and no significant findings emerged. Shuchman (4) in a 1978 study to explore the pattern of information transfer and communication of bench engineers in industry (as opposed to R&D organizations) across certain variables, found that 30% of engineers had transferred from another industry.

In the present study, while it cannot be known what percentage of respondents changed their "industry" or direction of research (though see also the comments under Section 7.3), it can be shown, for example, that almost half of those working in national aerospace research establishments came from working in an academic environment. (Or is this another case of misunderstanding the question? Were these people merely students at university working for a degree in engineering which would equip them to go and work in a research establishment?). Similarly, nearly 50% of those working in international organizations came from industry. This is probably not surprising when one considers the scientific and technical nature of the international organizations, particularly ESTEC (and to a somewhat lesser extent, IAEA), and the many firms in the aerospace, telecommunications and electronics industries.

TABLE 10 - PREVIOUS WORK ENVIRONMENT

ENVIRONMENT		ALL (N=287)	INT. ORGS. (N=218)	AEROSPACE EST. (N=69)
Industrial	(N=117)	41%	47%	20%
Government	(N=71)	25	28	16
Academic	(N=71)	25	17	49
Nat. R&D lab.	(N=12)	4	3	7
Internat. org.	(N=7)	2	2	3
None	(N=5)	2	1	4
Other	(N=4)	1	2	1
% of respondents		100%	100%	100%

7.6 FAMILIARITY WITH ORGANIZATION

In general, slightly more people (52%) were more familiar than not (48%) with the work of sections or divisions other than their own in their organization (Question 33).

People working in aerospace establishments tended to be more familiar with their organizations - possibly because the aerospace establishments are smaller in terms of number of staff, have less diverse activities and fewer dealings with other nations. In international organizations exactly one half were familiar and one half were unfamiliar.

TABLE 11 - FAMILIARITY WITH ORGANIZATION

ALL ORGANIZATIONS (N = 287)		INTERNAL. ORGS. (N = 216)	AEROSPACE ESTABS. (N = 69)
Very familiar (N=16)	6%	6%	3%
Familiar (N=132)	46	44	54
Not very familiar (N=129)	45	45	43
Not at all familiar (N=10)	3	5	-
TOTAL = 287	100%	100%	100%

% of respondents

Those most familiar with their organization's activities tended to be life scientists and managers in international organizations and those involved in informatics, engineering and telecommunications in aerospace establishments. Chemists in both groups of organization were the most ignorant of their organization's activities, as were life scientists in aerospace establishments, and those working in the physics, engineering, informatics and safety engineering fields in international organizations. It is strange that the two sets of organization are virtually mirror images in familiarity for several different fields of activity (Table 12).

TABLE 12 - FAMILIARITY WITH ORGANIZATION BY FIELD OF ACTIVITY

FIELD	FAMILIAR		UNFAMILIAR	
	INT. ORG. (N=169)	AERO.ESTAB. (N=39)	INT. ORG. (N=109)	AERO.ESTAB. (N=30)
Chemistry/materials	17%	33%	83%	67%
Earth sciences	50	50	50	50
Engineering/electronics	40	67	60	33
Informatics/maths	31	67	69	33
Life sciences	75	40	25	60
Management/finance	66	60	34	40
Miscellaneous	55	50	45	50
Nuclear engineering	60	-	40	-
Physics/space sciences	28	60	72	40
Safety eng./reliability	43	-	57	-
Space technology	60	46	40	54
Telecommunications	47	71	53	29

% of respondents (N=287)

The most popular way of learning what was going on was from colleagues in other divisions, followed by colleagues in their own divisions. Of those replying they were not too familiar with the activities of their organization, 37% said they would like to become more familiar and 68% of these said they would find a monthly newletter giving what was happening elsewhere in their organization useful. The question is prompted, why cannot those people get the information from colleagues like those familiar do? Existing informal newsletters and official publications were not highly used sources of information (Table 13).

TABLE 13 - USE MADE OF VARIOUS SOURCES TO GAIN FAMILIARITY WITH ORGANIZATION

SOURCE	LOW USE	MEDIUM USE	HIGH USE	N/A
Informal newsletters	21%	12%	5%	62%
Official publications	16	18	10	56
Colleagues in own division	8	22	17	53
Colleagues in other divisions	5	23	22	50
Staff meetings	24	11	6	59
Other	1	1	2	96

N/A = no reply   Multiple answers were possible   N = 287

7.7 NATIONALITY AND LINGUISTIC ABILITY

7.7.1 Nationality

Six items were sought relating to the nationality and linguistic ability of the respondents. Staff were asked their nationality (Question 3), their mother tongue (Question 12), the languages they could speak (Question 12), the languages they could read sufficiently well to be able to understand a technical article/report (Question 13), whether they frequently communicated for work purposes in languages other than their own (Question 14), and if so in which languages (Question 14).

Between them the six organizations were represented by a total of twenty-eight nationalities - the largest group being the British (23%). Twenty-one of the nationalities had under 2% representation each in total. A complete list of nationalities is given in Appendix C. The national aerospace research establishments were virtually exclusively staffed with nationals from their own countries - the exception being DFVLR which has a sprinkling of Austrians (native German speakers) and Britons (who were liaising on space projects). A summary of the major nationalities is given in Table 14.

TABLE 14 - MAJOR NATIONALITIES REPRESENTED

NATIONALITY	ALL ORGS.	ESTEC(ESA)	UNESCO	IAEA	CNES	DFVLR	NLR
British (N=65)	23%	39% (24)	-	4%		6%	
German (N=59)	21	15 (17)	13	4		89	
Dutch (N=41)	14	10 (20)	7	-			100
French (N=35)	12	13 (18)	7	10	100		
American (N=30)	11	3	20	45			
Italian (N=13)	5	8 (9)	-	-			
Danish (N=7)	2	3 (1)	7	2			
Other (N=37)	12%	9% (11%)	46%	35%	-	5%	-
	(21 nats)	(7 nats)	(7 nats)	(13 nats)	-	(1 nat)	-

% of respondents (N=287)

The figures in parenthesis for ESTEC are for the situation of ESA as a whole and include all staff not just scientists and engineers. UNESCO had seven other nationalities with 7% representation (i.e. one person) and IAEA had three with 4% (two people - Polish, Canadian and Belgian). The reason, of course, that UNESCO and IAEA have a much higher proportion of American staff is that these international organizations are just that - international, whereas ESTEC is essentially European and hence the United States is not a Member Country.

7.7.2 Mother Tongue

Twenty mother tongues were represented, the most frequent being English (34%), followed by German (24%) (Table 15). Thirteen languages were each the mother tongue of less than 1% of the respondents. The reason English figures so high is that it of course includes Americans, Irish, Canadian and New Zealanders.

It is interesting to note that although IAEA claimed no staff with Dutch nationality, two respondents gave Dutch as their mother tongue, and at least one American gave German as his mother tongue. It is also interesting to note that in neither UNESCO nor IAEA were there any Italians (it is again stressed that these comments are made on the basis of the returned questionnaires and thus relate to the picture they present - it should not be assumed that this picture is necessarily a true reflection of the organization. Since, for example, Italy is a Member State of both UNESCO and IAEA it would indeed be surprising if there were no Italians employed. In fact, in so far as UNESCO was concerned the questionnaire was sent to one Italian within the Science Sector (it was also sent to nationals of the USSR, Hungary, Sudan, Egypt, Ghana - none of whom replied either). A complete list of mother tongues is given in Appendix C.

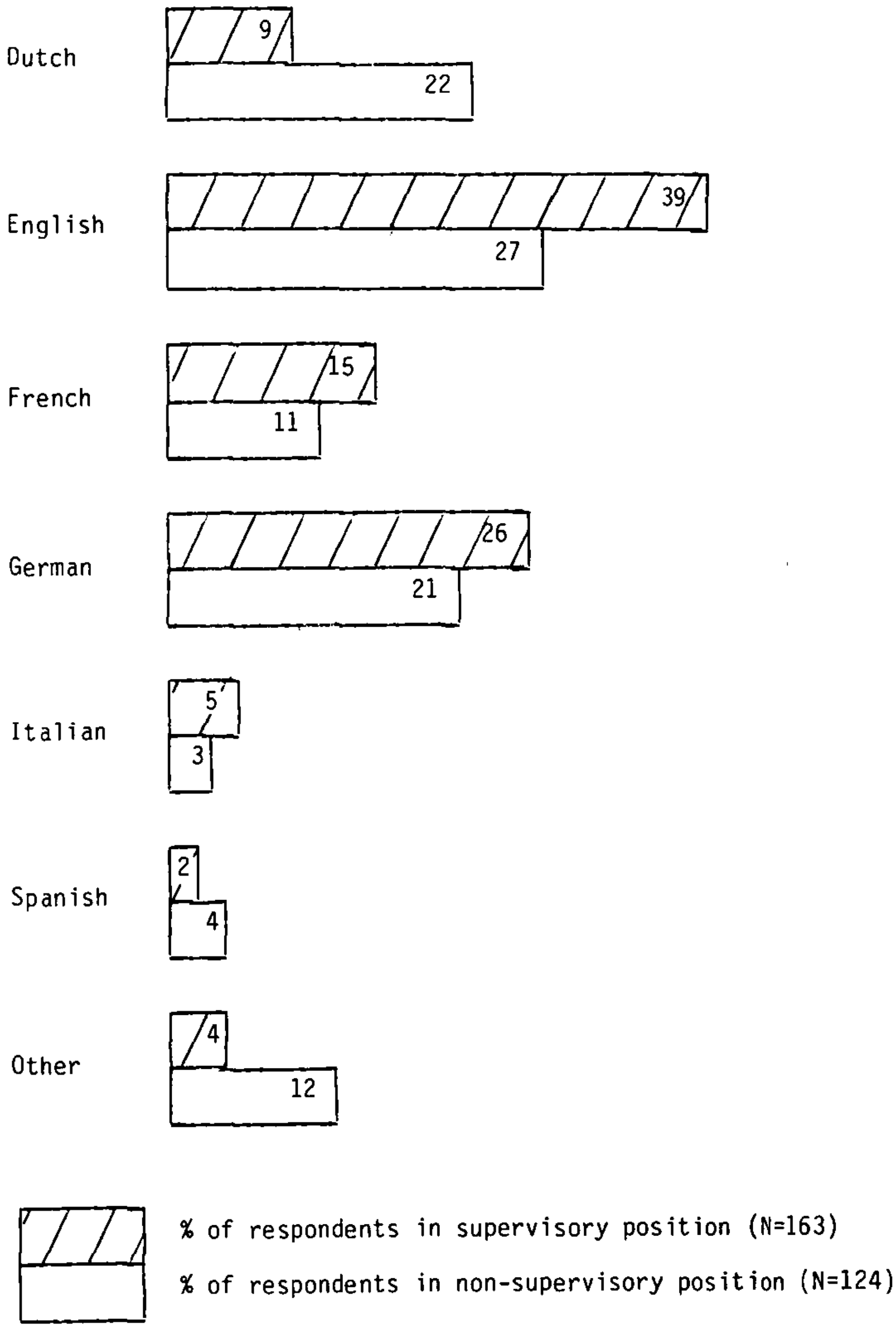
It would appear that those with English mother tongue were prominent in supervisory positions (39%) - although more than a quarter (27%) were not.

TABLE 15 - MOTHER TONGUE

MOTHER TONGUE	ALL ORGS.	ESTEC	UNESCO	IAEA	CNES	DFVLR	NLR
English (N=97)	34%	42%	33%	51%		6%	
German (N=68)	24	18	13	8		94	
Dutch (N=42)	15	10	7	2			100
French (N=37)	13	14	7	10	100		
Italian (N=12)	4	8	-	-			
Spanish (N=8)	3	2	7	8			
Danish (N=7)	2	3	7	2			
No. of other MT represented	13	3	4	7	-	-	-
N = 16	5%	3%	22%	19%	-	-	-

% of respondents

TABLE 16 - MOTHER TONGUE OF SUPERVISORS



Out of the "major" mother tongues only the Dutch were less representative as supervisors - this was no doubt due to the fact that many of the Dutch respondents from NLR were rather young. (Table 16).

Looked at in terms of the three professional groupings, over 50% of those with Dutch, English, French, German or Italian as their mother tongue were Engineers. 43% of those with German mother tongue were Scientists. In general, it appears that Italians and Germans do not go in for non-engineering or scientific jobs (Table 17).

TABLE 17 - MOTHER TONGUE AND PROFESSION

PROFESSION	DUTCH	ENGLISH	FRENCH	GERMAN	ITALIAN
Engineer (N=155)	62%	52%	54%	50%	67%
Scientist (N=84)	24	29	19	43	25
Other (N=48)	14	20	27	7	8

% of respondents

Some other points come out of this cross tabulation. For example: 32% of all the engineers who replied were of English mother tongue compared with 22% for German, 17% for Dutch, 13% for French and 5% for Italian. On the other hand, 33% of all scientists were of English mother tongue, 34% were of German, 12% were of Dutch, 8% of French and 4% of Italian. Equally, 40% of all those classed as "other" professional activity had English as their mother tongue, whilst 21% were of French mother tongue, 12% Dutch and 10% German.

From Table 18, which breaks the three professions down into the broad subject categories, it can be seen that native English speakers tend to be more involved in management (24%) - (this is consistent with Table 16 where 39% of those with English mother tongue were in a supervisory position).

The Germans on the other hand, tend to be more involved in space technology, the Dutch and Italians in physics and engineering and those with French as their native language equally in space technology, engineering and management. While only 3% of those with English as their mother tongue worked in the nuclear engineering and technology field directly, 60% of all those who did were English-speaking natives. A similar percentage (61%) worked in the broad safety field. 37% of all those working in space technology were of German mother tongue and 42% of those in the management area were of English mother tongue. 32% of all physicists were Dutch, while 25% were native German speakers. In telecommunications 32% had German as their native language and in informatics 41% were native English speakers.

TABLE 18 - MOTHER TONGUE AND FIELD OF ACTIVITY

FIELD	DUTCH	ENGLISH	FRENCH	GERMAN	ITALIAN
Chemistry/materials	2%	4%	3%	3%	-
Earth sciences	5	2	3	2	-
Engineering/electronics	19	6	19	12	33
Informatics/maths	7	9	5	6	8
Life sciences	2	2	-	7	-
Management/finance	10	24	19	19	8
Miscellaneous	7	11	14	3	-
Nuclear engineering	-	3	-	-	-
Physics/space sciences	21	6	8	10	25
Safety eng./reliability	2	14	3	3	-
Space technology	14	13	19	25	8
Telecommunications	10	5	8	10	17

% of respondents (N=287)

7.7.3 Languages Spoken and Read

7.7.3.1 major languages spoken and read

The foreign language barrier, according to Large (2), probably poses the biggest current obstacle to scientific communication. Mastery of a language includes four facets, he continues - comprehending speech, comprehending writing, producing speech and producing writing. This section looks at the speech facets, while the next will look at the writing facets.

Large (2) gives figures from various surveys to show that 85% or more of the respondents had a language proficiency in French, 50-66% in German, less than 10% in Russian and virtually none in Japanese. Regarding the latter language, figures from INSPEC (INSPEC Matters User Update No. 13, Sept. 1983), show that some 5% of the INSPEC database is made up of Japanese journals and 8.4% of INSPEC's coverage was written in Japanese (13.1% in Russian). This serves to emphasize what Large found, namely that the language distribution of published articles is in the reverse order to that above of language proficiency.

In the present study only one person could speak (but not read) Japanese and only a handful could speak and read Russian. A total of twenty-three languages were spoken and twenty-three were read - though they were not quite the same. Japanese and Yoruba were spoken but not read and Jugoslav and Czech were read but not spoken. Everybody spoke English - for 66% it was not their mother tongue, and almost everyone read it (98%). Table 19 gives an overview of the major languages spoken and read together with an indication of for how many a given language was not their mother tongue. As might be expected, slightly more people read a language than spoke it - English being the exception.

TABLE 19 - LANGUAGES SPOKEN AND READ

LANGUAGE	% who spoke	% for whom not mother tongue	% who read	% for whom not mother tongue
English	100	66	98	64
French	63	51	84	71
German	60	30	61	38
Dutch	37	23	37	23
Spanish	11	8	14	11
Italian	7	3	12	8
Russian	2	2	5	5

% of respondents (N=287)

One thing that stands out as rather remarkable is the number of people who have learned Dutch - not the world's most easy language to learn nor the most useful! Clearly, many of the non-Dutch staff at ESTEC, situated in the Netherlands, have made great efforts to learn the language of their adopted country. (Though as we shall see, regrettably, not many of them were British!).

The degree of proficiency in speaking or reading these languages is not known, although Question 13 did ask which languages the respondent read sufficiently well to understand a technical article/report, which implies a fair degree of competence. Furthermore, where a respondent said he spoke or read a language 'slightly' this was not counted by the researcher as one of the languages spoken/read.

7.7.3.2 number of languages spoken and read and by whom

An average of 2.9 languages were spoken and 2.3 read. The largest number spoken was eight (by one person) and the largest number read was nine (by the same person). Only 9% spoke only one language (i.e. their mother tongue) and only 6% read only one. 30% spoke four or more languages, while 43% read four or more (Table 20).

TABLE 20 - NUMBER OF LANGUAGES SPOKEN AND READ

NO. OF LANGUAGES	ALL ORGS.		INTER. ORGS.		AERO. ESTAB.	
	spoken N=287	read N=287	spoken N=218	read N=218	spoken N=69	read N=69
1	9%	6%	12%	7%	-	-
2	29	28	26	29	36	23
3	33	24	30	21	41	35
4	21	28	23	26	14	35
5	7	7	6	7	7	6
6+	2	8	2	9	1	1

It is interesting to see that in the national aerospace establishments everybody speaks at least two languages. Perhaps this is not surprising in the case of the Dutch whose own language is hardly universal and thus who learn other languages from an early age, (this is the reason for the higher number of people speaking and reading three or four languages in the aerospace establishments). The French, however, are, like the British and Americans, not known for their linguistic prowess and the fact that all the (admittedly only) 9 respondents from CNES spoke and read a second language possibly serves to indicate a certain degree of outside involvement.

As intimated above, the British and North Americans tend to speak and read fewer languages than other nationalities and nationals from the smaller countries, e.g. The Netherlands, Finland, Switzerland, Denmark, tend to speak rather more. In fact a total of eleven nationalities spoke more than five languages. (Törnudd (5) in her study of 188 Danish and Finnish scientists found 100% read five languages and 75% read six).

TABLE 21 - NUMBER OF LANGUAGES* SPOKEN AND READ BY DIFFERENT NATIONALITIES

No. OF LANGS. / NATIONALITY	1		2		3		4		5+	
	Spok.	Read	Spok.	Read	Spok.	Read	Spok.	Read	Spok.	Read
American (N=20)	27%	27%	40%	36%	27%	13%	7%	23%	-	-
Belgian (N=5)	-	-	-	40	80	20	20	20	-	20
British (N=65)	26	9	31	42	25	34	14	9	4	6
Danish (N=7)	-	-	13	-	13	14	29	14	42	72
Dutch (N=41)	-	-	5	7	36	7	46	71	12	14
French (N=35)	-	6	52	52	29	25	17	8	3	8
German (N=54)	-	-	35	20	37	28	20	32	7	12
Italian (N=13)	-	-	-	-	69	23	16	31	16	46
Spanish (N=4)	-	-	-	-	25	25	50	25	25	50

* including mother tongue   % of respondents

A surprising fact, to the researcher's mind, was that those with Spanish and Italian mother tongues all spoke and read three or more languages (including their own). As Table 21 shows, 27% of all Americans and 26% of all Britons spoke no foreign language, but whereas 27% of the Americans did not read a foreign language either, only 9% of the Britons could not read another language. (Törnudd (5) quotes Bernal as saying that 47% of the British in his study did not read any foreign language easily). In fact, these were the only two nationalities for which a substantial number could only speak and read their mother tongue - every other one of the twenty-eight nationalities replying could speak and read at least one language other than their own. While most people read more languages than they spoke, a few did speak more than they read.

7.7.3.3 languages and age and position

It was noted earlier that, because of the wide disparity in ages, not many useful results could be obtained with this parameter. With regard to languages, however, the fact emerges that the younger scientists and engineers of today do not speak or read as many languages as their elders. 30% of the respondents spoke four or more languages. Of these 47% were born before 1939. Of those born after 1944 only 11% spoke more than four. Put a different way, 14% of all respondents spoke more than four languages and were born before 1939 and 3% of all respondents spoke more than four and were born after 1944. Of those who could read four or more languages 46% were born before 1939 and 14% after 1944. Gerstl and Hutton (1) also noted that a knowledge of foreign languages was more likely in older engineers.

Gatekeepers, it might be remembered, tend to be high achievers, tend to read and publish more, have more contacts and are usually in a supervisory position. One might expect, therefore, that those speaking and reading several languages would be in some position of authority. It is therefore revealing that of the 9% who speak only one language, i.e. their own mother tongue, no fewer than 73% were in supervisory positions. However, the other side of the coin reveals that in fact only 12% of the non-supervisors spoke one language (though only 6% of the non-supervisors spoke only one).

9% of the respondents spoke five or more languages and of these 71% were in a supervisory position, though only 10% of all supervisors spoke five or more (compared to 6% for non-supervisors).

6% of those in supervisory positions read only their own language (though 56% of those reading only one language were in a supervisory position), while 16% read five or more (of all those reading five or more languages, 64% were in supervisory positions). These findings are echoed by the results from individual establishments, for example, at ESTEC 14% of those speaking only their own languages were in a supervisory position compared to 7% for those not. Similarly, at IAEA, 23% were in a supervisory position and 13% were not.

7.7.3.4 <u>languages and professional activity</u>

Differences were apparent in the number of languages spoken and read by scientists and engineers with the latter both speaking and reading more languages than the former despite the fact that a greater proportion were of English mother tongue. 34% of the engineers spoke at least three languages besides their mother tongue compared with 19% of the scientists. 33% of those classified as 'others' also spoke four or more languages. In the two groups - international organizations and national aerospace establishments - this difference was less marked and in fact was reversed in the case of the latter. 36% of the engineers spoke four or more languages in international organizations compared to 34% of the scientists and compared to 29% of the engineers in aerospace establishments and 30% of the scientists. Engineers are also ahead in reading languages - though not by such a marked degree - 46% reading four or more compared to 41% of the scientists. In the two organizational groupings, 44% of the engineers in international organizations read four or more languages compared to 35% of the scientists, and in the aerospace establishments the figures were 49% for engineers and 30% for scientists. In only one establishment, IAEA, did more engineers than scientists speak and read only one language (their own mother tongue) - a majority of these engineers were American.

If the broad subject categories are examined (Table 22) then those working in chemistry, nuclear engineering and technology and safety engineering were the poorest at languages. Reference back to Table 18 shows that a majority of the personnel working in these fields are of English mother tongue (i.e. predominantly American and British). Management was also another area which lacked members who were good at languages - not surprisingly, for one quarter of the management group was of English mother tongue.

In fact, 23% of all those speaking only one language (their own) were in management, as were 25% of those reading one language only. 19% and 38% respectively were in safety engineering and reliability. Earth scientists were the ones who spoke and read the most languages.

Since those in the nuclear engineering/technology and safety engineering fields worked exclusively in the international organizations, the figures above are reflected to a certain extent in an analysis of the two groups of organizations. However, no-one working in any of the fields in national aerospace establishments spoke or read only one language - everyone spoke/read at least one other besides their own - indeed, except for those working in management and informatics, staff spoke at least two others. Every relevant category also read at least two other languages. Table 23 shows the percentage of staff in international organizations and national aerospace establishments speaking and reading three or more languages. In the former group linguists were to be found most among the earth scientists, telecommunications engineers and engineers in general, while in the aerospace establishments the linguists tended to be earth scientists, physicists and space technologists.

In reading, the picture is somewhat different for international organizations. Earth scientists are still to the fore, along with telecommunication engineers and space technologists to a lesser degree. Those classed as miscellaneous also figured highly. In the aerospace establishments earth scientists and chemists were the best linguists, with physicists and managers the worst together with those in the miscellaneous category.

TABLE 22 - NUMBER OF LANGUAGES* SPOKEN AND READ BY SUBJECT SPECIALISTS

NO. OF LANGS. / SUBJECT	1		2		3		4		5+	
	Spok.	Read	Spok.	Read	Spok.	Read	Spok.	Read	Spok.	Read
Chemistry/materials (N=9)	45%	10%	45%	32%	-	23%	-	23%	10%	10%
Earth sciences (N=8)	-	-	-	-	50	37	25	25	25	38
Engineering/electronics (N=34)	8	3	20	32	38	20	24	36	8	8
Informatics/maths (N=22)	13	-	45	31	22	40	9	13	9	16
Life sciences (N=9)	-	-	32	33	55	45	32	10	-	10
Management/finance (N=55)	11	7	27	33	36	23	18	20	7	16
Miscellaneous (N=26)	3	-	26	19	23	19	38	34	7	28
Nuclear engineering (N=5)	41	20	-	20	18	20	41	20	-	20
Physics/space sciences (N=28)	7	-	21	36	46	14	21	43	3	7
Safety eng./reliability (N=23)	21	26	44	35	9	13	13	9	13	17
Space technology (N=46)	6	4	31	24	26	24	24	39	13	8
Telecommunications (N=22)	4	4	27	13	40	31	27	31	-	17

* including mother tongue

% replying in each category

TABLE 23 - PROPORTION OF THOSE SPEAKING AND READING 3+ LANGUAGES BY BROAD ORGANIZATION TYPE.

SUBJECT	Speaking		Reading	
	Internat. Orgs.	Aerospace Estabs.	Internat. Orgs.	Aerospace Estabs.
Chemistry/materials (N=9)	50%	67%	34%	100%
Earth sciences (N=8)	100	100	100	100
Engineering/electronics (N=34)	72	67	60	88
Informatics/maths (N=22)	37	50	61	84
Life sciences (N=9)	75	60	50	80
Management/finance (N=55)	65	50	58	70
Miscellaneous (N=26)	73	50	85	50
Nuclear engineering (N=5)	60	-	60	-
Physics/space sciences (N=28)	67	80	62	70
Safety eng./reliability (N=23)	35	-	40	-
Space technology (N=46)	61	69	69	78
Telecommunications (N=22)	73	57	80	86

7.7.4 Communicating in Other Languages

Question 14 asked "Do you frequently communicate for work purposes in languages other than your own"? 72% replied that they did and of these, 42% communicated in one language, 23% in two languages and 7% in three or more. 90% of those working in national aerospace establishments communicated frequently in another language compared to only 67% of those in international organizations. (However, of these 90%, 72% only communicated in one language, whereas only 33% communicated in only one language in international organizations). This was rather unexpected and two explanations spring to mind. For the aerospace establishments there is obviously a great deal of contact going on with people outside the organization - after all a German in DFVLR will hardly speak to another German colleague in DFVLR in Spanish! In the case of international organizations the amount of contact outside might be the same, but it may be with certain countries the language of which one does not know, e.g. USSR, Japan, African and Asian nations.

A common language between the personnel in the international organization and in the country in question could very well be English and since many of the staff of the international organizations are British or American then they would not be communicating in another language. These two nationalities are not known for speaking foreign languages - this is borne out by the fact that 56% of all Americans and 68% of all Britons did not communicate in any other language save English. And in ESTEC and IAEA, where there was a high proportion of native English speakers, 35% and 39% respectively said they did not communicate in another language at all. Of these 19% were Americans and 72% were British in ESTEC and 73% were Americans in IAEA. This bears out the researcher's final hypothesis that scientists and engineers with English as their mother tongue will tend not to communicate in other languages. Over one quarter of these staff did not read or speak another language either. The most frequently used "other" languages were English (by 59% of the respondents), French (27%), German (13%), Dutch (6%) and Spanish (4%).

No less than 33% of those who did not communicate in any other language, other than their own, were in a supervisory position. At IAEA 54% of supervisors and at ESTEC 37%, did not communicate in another language (compared with 22% of those in non-supervisory positions).

It was seen earlier that older staff could speak and read more languages than younger staff. The fact that they could speak more does not imply that they actually did. In fact, the analysis shows that while 15% of those born after 1944 do not communicate in another language, fully 46% of those born before 1939 do not either. Bearing in mind many of these will be of English mother tongue then since English is a fairly universal language there may be no need to communicate in another tongue. Or of course it could be due to a certain amount of reticence.

Scientists and engineers were evenly matched when it came to communicating in another language. 70% of scientists did compared to 71% of engineers. In general, engineers tended to communicate in more languages than scientists. In the two organizational groupings another pattern emerges. In aerospace establishments engineers were less likely to communicate in another language than scientists - 11% as opposed to 4%.

In international organizations 34% of the engineers only communicated in their own language, compared to 40% of the scientists (probably not surprising when one-third of each of these professions comprises staff with English mother tongue). In the broad subject fields, again it is those in safety and nuclear engineering who do not communicate in foreign languages, followed by those in informatics (although the latter group did read and speak other languages). Earth scientists and space technologists (plus those classed as miscellaneous) were the groups who regularly communicated in at least two languages other than their own. These patterns also hold good in the two organizational groupings - although in international organizations those involved in telecommunications join the ranks of the non-communicators in a foreign language.

REFERENCES

1) GERSTL, J.E. and HUTTON, S.P.
Engineers: the anatomy of a profession. Tavistock Publications, 1966.

2) LARGE, J.A.
The foreign-language barrier: problems in scientific communication. Andre Deutsch, 1983

3) PELZ, D.C. and ANDREWS, F.M.
Scientists in organizations: productive climates for research and development. Wiley, 1966.

4) SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group., 1981.

5) TÖRNUDD, E.
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, 1958, November 16-21. Washington D.C. National Academy of Sciences, 1959. Vol. 1, p.19-75.

CHAPTER 8

COMMUNICATION HABITS OF SCIENTISTS AND ENGINEERS

8.1 INTRODUCTION

In the introduction to Chapter 5 differing figures were quoted for the amount of time scientists and engineers spend communicating. On average it amounts to nearly two-thirds of their working time. This chapter will attempt to discover how much time was allocated to various communication activities by the scientists and engineers in the survey, who they communicated with, why and how, which methods of communication (i.e. channels - both oral and written) they preferred, and what barriers to communication were encountered. One factor impinging on the amount of time available for communication is the amount of time spent travelling for reasons of work and this, too, is explored. Naturally, much of this time spent away on mission will be for communication purposes, e.g. discussions with contractors, conference attendance and so on.

8.2 TIME SPENT COMMUNICATING

Question 15 requested the respondent to estimate how much of his working time during the 6 months prior to the date the questionnaire was completed was spent on any of a number of work-oriented communication or information transfer activities. He was asked to give a value of between 1 and 6 for each relevant activity, where 1 signified little time was spent and 6 signified that very much time was spent on it. For greater clarity the replies have been divided into three groups (with a high and a low value for each group) and these correspond to approximately under one-third of the respondent's time, half his time and over two-thirds of his time. From Table 24 it can be seen that the majority of scientists and engineers devoted less than one-third of their time to most of the communication activities.

TABLE 24 - TIME SPENT ON VARIOUS COMMUNICATION ACTIVITIES

ACTIVITY	LITTLE TIME	QUITE A LOT OF TIME	VERY MUCH TIME	N/A
Oral Formal Communication:				
staff meetings	58%	23%	8%	11%
contractor meetings	45	31	15	9
presentations	71	18	2	9
progress meetings	46	35	9	10
brainstorming sessions	60	15	7	18
committee meetings	57	14	4	25
AVERAGE ORAL FORMAL	56%	23%	7%	
Oral, Informal Communication:				
corridor talks	61	23	7	9
canteen talks	67	14	1	18
impromptu visits	37	39	19	5
sports/social	60	3	1	36
phone	32	42	22	4
videoconference	38	1	-	61
AVERAGE ORAL INFORMAL	49%	20%	8%	
Written Communication:				
letter	41	36	12	11
memo/telex	29	42	16	13
internal report	34	40	16	10
conference paper	55	15	3	27
external paper/article	56	9	4	31
giving documents	47	26	5	22
AVERAGE WRITTEN	44%	28%	9%	
TOTAL AVERAGE	50%	24%	8%	

N/A = no answer because activity was not relevant
N = 287 % of respondents multiple answers possible

The activities on which a majority of people spent a large amount of time were speaking on the telephone (22%) and visiting colleagues in their offices (19%) - both informal means of communicating. Personal observation by the researcher at ESTEC had led him to believe that a fair amount of informal work-oriented communication between staff was done in the corridors and in the canteen. 23% said they spent around 50% of their time in informal meetings in corridors, while 7% said they spent over two-thirds. Some 15% spent around half their time communicating for work purposes in the canteen. Among the formal communication activities, the one most people spent most time on was in meetings with contractors. Not much time was spent in formal presentations, staff meetings, committee meetings and brainstorming sessions.

It would appear, though, from Table 24 that people spent most of their time in written communication rather than oral. 16% spent at least two-thirds of their time in writing memos and telexes as well as in preparing internal reports. The amount of time spent on writing papers for external publication, i.e. at conferences or for journals is very much on the low side. Very little time was spent on videoconferencing, nearly two-thirds made no use of it at all. Staff in aerospace establishments were slightly higher users than staff in international organizations and interestingly enough, out of the infrequent users in ESTEC, those with French mother tongue were much more prone to use it than other nationalities.

It is not easy to compare these figures with those from other studies partly because different parameters and time scales have been used. Halbert and Ackoff (11), studying how 1000 chemists in fifty academic and industrial organizations spent their time in various scientific communication activities, found that, after observing them twice a day for nine days, communication took up on average 44% of their time - 33% on scientific communication and 11% on business communication. Specifically, they spent 10% of their time in general discussion, 9% in oral information transfer with no discussion, and 14% in written communication. More time was spent talking rather than listening.

Poppel, in a Booz, Allen and Hamilton study of 300 managers and professionals whose daily activities were recorded, reports that 8% of their time was spent reading, 13% was spent in creating documents, 8% was spent in analyzing information and 46% of their time was spent in meetings and on the phone (17). In their survey of seventy academic chemists and 262 industrial chemists and technologists, Bayer and Jahoda found that 60% of the latter and 49% of the former spent four or more hours per week in discussions with colleagues (3).

Hinrichs (12), describing a work sampling study of on-the-job time allocation of 232 chemists and chemical engineers in an R&D organization, found that technical employees spent almost five hours a day communicating (61% of an eight-hour day). 16% of this was spent writing reports and memos, 10% was spent reading reports and memos and 35% was spent in oral communication of which 6% on the phone, 10% in planned meetings and 19% in unplanned contacts. He also found that people underestimated the time spent in planned meetings and unplanned informal discussion and overestimated on time spent telephoning, reading and writing.

The present study was not geared to finding out precisely how a working day was spent. It is quite clear, though, that if all reading and writing activities are taken into account as well as oral communication, then for many scientists and engineers, particularly those on the management side, a large amount of their time will be spent in communication. Averaging out, it can be seen that over the six-month period in question 50% of the respondents spent less than one third of their time communicating, while 8% spent over two-thirds.

Comparing the two groups of organizations, i.e. international organizations and national aerospace establishments, it can be noted that, overall, staff in international organizations spent more of their time in formal oral communication, informal oral communication and written communication.

Regarding the first category, it can be seen from Table 25 that a higher proportion of those in international organizations spend a greater amount of their time in various planned (formal) meetings than do those in aerospace establishments with the exception of staff meetings - where twice as many scientists and engineers spent two-thirds of their time compared to people in international organizations. Concerning formal oral communication, scientists and engineers in aerospace establishments are less likely to spend their time chatting about work in corridors (97% of the respondents from DFVLR said they hardly ever did this) and the canteen. (Reasons for this could be that work colleagues may be spatially distant, thus making corridor talk difficult, or perhaps there is no works canteen and people go home for lunch).

In written communication, staff in international organizations spend more time writing letters and sending telexes than their counterparts in aerospace establishments, while the latter appear to spend more time on writing conference and journal papers. (This is consistent, as we shall see, with the fact that, in general, staff in aerospace establishments attend more conferences than staff in international organizations and with the fact that they also write a greater number of articles for external publication). It is not surprising that scientists and engineers in international organizations spend a lot of time communicating by letter and telex in view of the fact that they will contact people in far away places where telephone communication might be poor and in any case where a certain degree of formality will be required, not to mention a record of communication. In fact in UNESCO, 53% said they used letters very much, in IAEA the figure was 35% though in ESTEC it was only 3%. This can be explained by the fact that the European Space Agency - and thus ESTEC - because it is European, does not have so many intercontinental contacts in remote places and telephoning within Europe is probably somewhat more efficient than the post. It would appear that hypothesis 7 which reckoned that more time will be spent on written rather than oral forms of communication in an international organization than in national aerospace establishments is partially confirmed.

TABLE 25 - TIME SPENT ON COMMUNICATION ACTIVITIES BY ORGANIZATION TYPE

ACTIVITY	INTERNATIONAL ORGANIZATIONS (N=218)				AEROSPACE ESTABLISHMENTS (N=69)			
	LOW	AVERAGE	HIGH	N/A	LOW	AVERAGE	HIGH	N/A
Oral Formal Communication:								
staff meetings	59%	22%	7%	12%	57%	26%	13%	4%
contractor meetings	42	31	17	10	55	29	7	9
presentations	72	14	1	13	68	31	1	-
progress meetings	47	34	10	9	47	38	4	11
brainstorming sessions	59	15	7	19	65	17	7	11
committee meetings	53	15	5	27	68	15	2	15
AVERAGE ORAL FORMAL	55%	22%	8%		60%	26%	6%	
Oral, Informal Communication:								
corridor talks	59	23	6	12	68	19	7	6
canteen talks	66	14	1	19	73	14	1	12
impromptu visits	34	42	20	4	45	33	16	6
phone	32	42	22	4	33	42	21	4
AVERAGE ORAL INFORMAL	48%	30%	12%		55%	27%	11%	
Written Communication:								
letter	38	37	13	12	49	33	6	12
memo/telex	23	48	18	11	43	26	13	18
internal report	35	37	17	11	29	51	13	7
conference paper	53	12	3	32	61	25	6	8
external paper/article	55	6	4	35	58	19	6	17
AVERAGE WRITTEN	41%	28%	11%		48%	31%	5%	
TOTAL	48%	27%	10%		54%	28%	7%	

% of respondents spending time on various activities
multiple responses possible

On average, double the number of staff in international organizations spent a large amount of time in written communication compared to staff in aerospace establishments. While the percentage of staff in international organizations spending much time writing was higher than that of staff in both types of organization spending much time on oral, formal communication, it was equal to that of those spending a lot of time on informal communication.

8.2.1 Communication Activities of Scientists, Engineers and Others

The three types of professional - engineer, scientist and other - were cross-tabulated against the time spent on the various communication activities (Table 26). On the whole, in so far as formal oral communication, i.e. meetings, are concerned, the same percentage (7%) in each of the three categories spent an average of two-thirds of their time in these activities. Breaking it down, though, a much higher proportion of engineers spent more of their time in progress meetings than did scientists. Conversely, a slightly higher proportion of scientists spent more time in staff meetings than did engineers, though not as much as the "other" category. Twice as many members of this latter category spent more time in brainstorming sessions.

Regarding informal oral communication, again the two professions are similar thus bearing out hypothesis 1 which considered that the patterns of communication between scientists and engineers would not be dissimilar. As can be gleaned from Table 26, scientists made more use of the telephone than engineers, while the latter spent somewhat more time visiting colleagues and being visited. A high proportion of the non-scientists/engineers also spent a relatively high amount of time in visits to other offices and on the phone. Generally, scientists spent the least time in informal communication, the 'other' category spending most. The 'other' category also spent the most time on written communication. Engineers were amongst those writing the least. Scientists spent more time on written forms of communication than engineers - it was double in the case of writing papers for presentations at conferences.

TABLE 26 - TIME SPENT ON COMMUNICATION ACTIVITIES BY PROFESSION

ACTIVITY	Engineer (N=155)				Scientist (N=84)				Other N=48)			
	L	Q	V	N/A	L	Q	V	N/A	L	Q	V	N/A
Oral Formal Communication:												
staff meetings	59%	24%	6%	11%	60%	25%	9%	6%	52%	23%	15%	10%
contractor meetings	40	37	17	6	49	26	15	10	33	17	6	44
presentations	70	20	1	9	74	19	2	5	73	12	-	15
progress meetings	41	37	12	10	51	37	3	9	56	23	6	15
brainstorming sessions	65	17	6	12	61	12	6	21	44	14	12	30
committee meetings	57	14	3	26	57	16	6	21	58	10	6	26
AVERAGE ORAL FORMAL	55%	25%	7%		59%	22%	7%		53%	16%	7%	
Oral, Informal Communication:												
corridor talks	63	21	7	9	64	20	3	13	50	31	8	11
canteen talks	67	12	1	20	70	18	-	12	64	12	4	20
impromptu visits	36	37	23	4	38	46	13	3	37	37	19	7
sports/social	36	38	21	5	24	51	21	4	31	37	31	1
phone												
AVERAGE ORAL INFORMAL	50%	27%	13%		49%	34%	11%		45%	29%	15%	
Written Communication:												
letter	43	35	8	14	35	42	14	9	46	29	19	6
memo/telex	24	48	15	13	31	36	20	13	37	35	17	11
internal report	33	45	14	8	33	37	20	10	37	33	14	16
conference paper	58	14	3	25	59	18	7	16	37	14	2	47
external paper/article	60	9	4	27	55	13	5	27	46	4	4	46
giving documents	48	26	7	19	47	25	2	26	48	29	6	17
AVERAGE WRITTEN	44%	29%	8%		43%	28%	11%		42%	24%	10%	
TOTAL AVERAGE	50%	27%	9%		50%	28%	10%		47%	23%	11%	

L = little time; Q = quite a lot of time; V = very much time
N/A = no answer because activity not relevant or question not answered

They also spent more time than engineers on writing letters, telexes, internal reports and articles for publication - though the highest proportion of people who spent very much time on writing letters was in the 'other' category, whose members also wrote more letters than engineers.

In comparing the two types of organizations studied, 70% of the non-scientists/engineers (i.e. category 'other') in aerospace establishments spend over half their time in staff meetings compared to 46% for scientists and 26% for engineers in the same establishments and compared to 29% of non-scientists/engineers in international organizations.

It was considered that national aerospace research establishments would, because they were taking part in multi-national as well as national projects, have a fair degree of contact with contractors. It came as a surprise, therefore, to find that only 6% of the engineers in the aerospace establishments indicated they spent much time on contractor/consultant meetings. In international organizations the corresponding figure was 21%. For scientists the figures were much closer - 12% and 16% respectively. Similarly a higher proportion of engineers in international organizations (14%) spent a lot of their time (over two-thirds) in progress meetings compared to 6% of engineers in the aerospace establishments.

Regarding informal oral communication, both types of organization were similar to the time they spent talking on the phone, in corridors and in the canteen, although 7% of the engineers in international organizations and 4% of the scientists there spent two-thirds of their time discussing work while eating compared to 0% for the aerospace establishment staff. Whilst engineers were pretty much the same in both sets of organizations when it came to impromtu visits, scientists tended to do it far more in international organizations.

The letter-writers in both sets of organization were the scientists - 17% of scientists in aerospace establishments and 14% in international organizations saying they spent very much time on this activity.

10% of the engineers in international organizations wrote a lot of letters, while none wrote many in aerospace establishments. The time spent on sending telexes tells a similar story - scientists being the main users of this method and aerospace establishment scientists doing it more (25% to 19%) while aerospace establishment engineers do it less (9% to 18%). When it comes to writing internal reports, the staff at international organizations have to spend a greater proportion of their time on it than do those working in national aerospace organizations. Presumably this is because the staff of the former organization-type will be doing more studies, e.g. economic and environment conditions in a given country or region or reports on safety conditions at nuclear power stations, for example, in the case of IAEA. It would appear that scientists in national aerospace establishments spend more time writing conference papers and articles for publication than their counterparts in international organizations. This is possibly due to the fact that they have somewhat more time available to them.

Besides the broad groupings of scientists, engineers and others, cross tabulations were also performed on the time spent during a six month period on the various communication activities by the broad subject groupings representing the present field of activity. Chemists, it would appear from Table 27, unlike those in Halbert and Achoff's study (11), did not spend much time on any form of communication except for 10% in international organizations who spent over two-thirds of their time writing internal reports and letters. Generally speaking the staff of both types of organizations spent more time in written communication activities than oral. Life scientists in international organizations tend to spend a large amount of time in formal meetings (chiefly staff meetings and brainstorming sessions), while those in the miscellaneous group working in aerospace establishments spend very much time in informal verbal communication (primarily the telephone). Managers in international organizations spent quite a bit more time on informal communication than did managers in aerospace establishments, especially using the phone, impromptu visits (rarely done by managers in aerospace establishments), as well as chats in the

TABLE 27 - TIME SPENT ON BROAD COMMUNICATION AREAS BY SUBJECT SPECIALISTS

WORK AREA	ORAL FORMAL								ORAL INFORMAL								WRITTEN							
	INTERNAT.				AEROSPACE				INTERNAT.				AEROSPACE				INTERNAT.				AEROSPACE			
	L	Q	V	N/A	L	Q	V	N/A	L	Q	V	N/A	L	Q	V	N/A	L	Q	V	N/A	L	Q	V	N/A
Chemistry/materials (N=9)	78%	3%	-	19%	67%	16%	-	17%	62%	29%	-	9%	83%	17%	-	-	57%	27%	10%	6%	60%	20%	-	20%
Earth sciences (N=8)	58	28	6	8	42	50	8	-	50	33	12	5	50	37	13	-	20	37	27	16	20	80	-	-
Engineering/electronics (N=34)	50	23	10	17	64	26	4	6	57	29	10	4	46	38	16	-	46	32	5	17	64	13	9	14
Informatics/maths (N=22)	64	19	2	15	50	33	14	3	63	26	9	2	37	33	17	13	50	16	5	29	63	24	7	6
Life sciences (N=9)	37	21	25	17	60	30	7	3	25	25	6	44	25	75	-	-	40	10	25	25	48	40	-	12
Management/finance (N=55)	53	20	11	16	58	28	12	2	34	37	16	13	62	22	7	9	38	26	15	21	44	30	20	6
Miscellaneous (N=26)	45	20	4	31	79	17	4	-	43	27	11	19	38	31	31	-	36	14	16	34	45	45	10	-
Nuclear engineering (N=5)	73	27	-	-	-	-	-	-	50	45	5	-	-	-	-	-	32	40	28	-	-	-	-	-
Physics/space sciences (N=28)	55	19	4	22	67	27	2	4	54	25	13	8	77	7	12	4	38	34	10	18	54	26	12	8
Safety eng./reliability (N=23)	67	16	7	10	-	-	-	-	49	26	14	11	-	-	-	-	40	28	8	24	-	-	-	-
Space technology (N=46)	51	28	10	11	55	17	8	20	49	30	16	5	59	21	9	11	41	33	8	18	40	28	9	23
Telecommunications (N=22)	52	29	7	12	48	36	-	16	47	27	13	13	43	18	18	21	44	35	5	16	44	35	-	21

L = little time; Q = quite a lot of time; V = very much time
N/A = no answer

% of respondents in each category

corridor (11% said they spent very much time on this, compared to 0% of managers in aerospace establishments (90% of the latter, in fact, spent very little time communicating in corridors). On the other hand, managers in aerospace establishments spent more of their time in written forms of communication (mainly telexes and letters) than did managers in international organizations.

Those involved in telecommunications in international organizations did not waste time writing or sitting in meetings, preferring to spent their time communicating informally on the phone - though some 14% did it via visits, while 14% also did it in corridors. Interestingly enough, telecommunication engineers in international organizations followed a similar pattern, except that they hardly ever talked in corridors and 7% did spend a large proportion of their time in formal meetings and 5% did spend a lot of time sending telexes and writing internal reports. People working in the informatics field in international organizations spent less time on all categories of communication activities than their counterparts in aerospace establishments. Those in the various branches of engineering working in international organizations spent more of their time in formal meetings and in written communication in general than did equivalent personnel in aerospace establishments. The latter, however, spent a greater proportion of their time in informal communication, particularly in corridors.

8.3 THE MECHANICS OF COMMMUNICATION

Question 18 was a two-part question intended to discover the people respondents communicated with the most, where they were located, the reasons for communicating, what was transferred during the communication, the actual means of communication and the duration and frequency of contact. The respondents were asked to give replies for the five people with whom they had communicated most, for work purposes, over the previous six months. The second part of the question was not fully answered by everybody and in fact the whole question was rather difficult to analyze.

This was because, originally, as mentioned earlier, it had been intended that the respondents would actually name the people they communicated with, thus permitting sociograms to be constructed showing gatekeepers, isolates, cliques, etc. In the event, this proved impossible to do and the letters A to E were inserted for the names of the five colleagues. (For reasons given in Chapter 6, this number of five was eventually reduced to four in the analysis). The difficulty was that while person A for one respondent may have been a superior, person A for another respondent might have been a peer or a subordinate. Thus the results and comments and the figures which follow are averages of the responses based on a maximum of four persons with whom the 287 respondents communicated with the most. In view of the difficulties in analysis and the poor response to parts of the question, few cross tabulations were done.

From Table 28 it would seem that the primary basis for contact was hierarchical. This is misleading and is omitted from the present discussion because of the ambiguity in referring to both communication with superiors and subordinates. Furthermore, some respondents considered that communication with a peer was hierarchical if that peer was of a higher or lower career grade. It would appear then, from Table 28, that the average scientist or engineer communicates several times a day, for less than thirty minutes a time, with peers working in the same division on the same project and in the immediate vicinity. The basis for the contact is likely to be the qualifications and experience of the colleague and the contacting is done on a fifty-fifty basis. The usual nature of the contact is technical discussions for problem-solving with hard facts being the information mainly ransferred. The encounter will be face-to-face in the office or laboratory of either colleague. Hypothesis 6 was not fully confirmed. While staff did indeed communicate more with peers the primary basis for communication (omitting hierarchical) was the qualifications and experience of the colleague rather than the fact that he was the best informed person or had similar interests - though these were next in importance. Also the main purpose of the communication was much more likely to be technical discussions and problem-solving rather than exchanging of information.

TABLE 28 - THE MECHANICS OF COMMUNICATION

Status of people communicated with most:	
peer	36%
superior	32%
subordinate	30%
N/A	2%

Work assignment of people:	
same division and same project	53%
same division on different project	18%
different division on same project	17%
different division on different project	8%
N/A	4%

Physical work location of people:	
immediate vicinity	60%
different floor, same building	17%
different site/establishment	11%
different building on same site	8%
N/A	4%

Frequency of contact:	
several times a day	31%
once or twice a day	25%
once or twice a week	18%
several times a week	12%
several times a month	8%
less often	3%
N/A	3%

Basis for contact:	41%
hierarchical	17%
qualification/experience	13%
best informed person	9%
similar interests	7%
contractual	3%
personal friendship	2%
same language/nationality	8%
N/A	

Who initiates contact:	
fifty-fifty	56%
usually me	28%
usually him/her	10%
someone else suggests it	3%
N/A	3%

Usual nature of contact:	26%
technical discussions/	19%
problem solving	
information seeking/exchange	17%
progress reports	11%
briefings/debriefings	5%

Information transferred/communicated:	
facts	30%
ideas	17%
advice	12%
opinions	9%

Average duration of communication:	
less than ½ hour	58%
½-1 hour	21%
1-1½ hours	5%
1½-2 hours	3%
2-3 hours	1%

Usual form of contact:	
face to face	77%
telephone	13%
internal memo	2%
telex/fax	1%

Usual location of communication:	
his office/lab	36%
own office/lab	34%
meeting room in organization	5%
canteen	2%

NB: the percentages in this table relate to the number of respondents replying "usually" to each category.

N = 287   N/A = no answer

Apart from the slight variations in average percentages there is no real difference in the scenario outlined above between the scientists and engineers working in international organizations and those working in aerospace establishments. It would appear that those working in international organizations communicate a little more with superiors than staff in aerospace establishments, while the latter communicate more with peers. Regarding the work assignment of the colleagues communicated with, while staff in both types of organization talked most with colleagues working in the same division and on the same project, scientists and engineers in aerospace establishments were much more likely to talk to people in their own divisions but working on different projects.

Allen and colleagues (2) found that staff on development projects had slightly more internal communication within the projects. Technical staff communicated more with staff in the rest of the lab, while research staff communicated more with staff in other parts of the organization. Thus it is that hypothesis 4 is confirmed since the largest amount of communication took place within the same division and project, with relatively little communication going on with people working on different projects. The degree of cross-fertilization could not be ascertained. Though, in view of the fact that certain staff did support several projects and a fair amount of contact went on outside the establishments, then there is every reason to suppose that the hypothesis holds good.

What was surprising, was the fact that the staff in the aerospace establishments had twice as many contacts with people outside their own establishments than did the staff of international organizations. While this undoubtedly reflects the multi-national, cooperative nature of many aerospace projects, one would have thought that the staff in international organizations with a hundred or more Member States for the most part, would have had more outside contact. Possibly it is because the distance is so great between the headquarters of the organization and establishments and offices in far flung countries that this is not conducive to regular communication, unlike in Europe where mail and telephone services are more convenient and cheaper for the national aerospace establishments.

Another reason may be that the commercial nature of aerospace projects with their tight schedules and deadlines makes for much more urgency and frequency of contact. Table 29 shows the differences in type of organization, while Table 30 provides a brief overview of the usual form of contact for engineers, scientists and others (i.e. neither scientists nor engineers). The percentage of respondents using each form is given.

The figures in Table 30 point to confirmation of hypothesis 1 which argues that the communication habits of scientists and engineers are similar and cannot be readily distinguished. It is worth remarking that although scientists spent more time telephoning (Table 26), it was in fact more usual for the engineers to use it as a means of communicating. On the other hand, although engineers spent a greater proportion of their time in oral (face to face) situations, it was the scientists who used this form of communication more, though as Table 32 shows, engineers preferred this method more.

Talking to colleagues working nearby in the same division and on the same project was also found to be the norm in other studies. Halbert and Ackoff (11) noted that 21.4% of the chemists they studied communicated with other chemists. Shotwell (18), who studied the flow to and within an industrial biosciences research laboratory discovered that an average of 73% of the total time spent communicating was passed in one's own division, while Mick and his co-workers reckon that of the time devoted to discussion by scientists and engineers, 60% of it was held within the work group (15). On the other hand, Shuchman (19) reports that 60% of the engineers in his survey have contacts outside the work group (compared to 11% in the present study). Wilson et al, in their interviews of some 150 social workers, found 40% had daily contact with people outside their organization, 41% had weekly contact and 16% had monthly contact or less (22). In another study they analyzed 6000 records of communication events of twenty-two subjects and found over 70% of the information-transfer encounters occupied up to five minutes (21). In the present study, not strictly comparable, 58% of the respondents spent less than thirty minutes communicating.

TABLE 29 - THE MECHANICS OF COMMUNICATION BY BROAD ORGANIZATION TYPE

	INTERNATIONAL ORGANIZATIONS	AEROSPACE ESTABLISHMENTS
Status of people communicated with most:		
peer	34%	39%
subordinate	29%	32%
superior	32%	28%
N/A	5%	1%
Work assignment of people:		
same division/project	54%	52%
same division/different project	16%	25%
different division/same project	8%	6%
different division/project	17%	16%
N/A	5%	1%
Physical work location of people:		
immediate vicinity	62%	53%
different floor/same building	18%	15%
different building/same site	6%	12%
different site/establishment	9%	19%
N/A	5%	1%
Frequency of contact:		
once or twice a day	26%	24%
several times a day	31%	30%
once or twice a week	18%	17%
several times a week	12%	13%
several times a month	6%	11%
less often	2%	4%
N/A	5%	1%
	N = 218	N = 69

N/A = no answer

TABLE 30 - USUAL FORM OF COMMUNICATION FOR SCIENTISTS AND ENGINEERS

FORM OF COMMUNICATION	ENGINEERS (N=155)	SCIENTISTS (N=84)	OTHERS (N=48)
Face to face	75%	80%	76%
telephone	11%	10%	11%
letter	-	1%	3%
telex	1%	1%	-
internal memo	2%	1%	2%

% of respondents using given form

Hagstrom (10) showed there was a large positive correlation between productivity and extra-departmental communication. As seen from Table 28, face to face communication is the most usual form. This is confirmed by Shuchman (19) who states that the bulk of communication for engineers in industry takes place on a person-to-person basis. Frost and Whitley's finding that only 8.4% of information transactions were done by memo or phone and the vast majority were done face to face also provide confirmation (8). 61% of the communication transactions analyzed by Wilson and Streatfield (21) were oral - 45% of them face to face and 16% by phone. 5% were in writing.

Berkowitz and Bennis (4) deal with the interaction within and across organizational lines of ninety nurses working in British out-patient departments. Findings were that those with higher status normally initiated the contact, interpersonal contact was usual with peers and that the frequency of contact was inversely related to the other party's status. In the present study, contact initiation was mutual (56% saying it was initiated on a fifty-fifty basis).

Distance also plays a role in communicating. Allen and Cohen (1) observe that if two people are closely related organizationally, they will be more likely to discuss technical problems and provide each other with critical research information. This is consistent also with Shotwell (18) and Shuchman (19). Gullahorn, too, found that distance was the most important factor in determining the rate of interaction between any two employees (9). When distance did not serve alone as a basis for interaction, then friendship was the controlling influence. Allen and Cohen (1) also noted that there was a strong relationship in the selection of individuals for socialization and the selection of those for technical discussions. Festinger writes that the degree of friendship helps communication and that infrequent contact erects restraints against communication (6).

In the present study, cross-tabulations were not done on these aspects, though 60% of the respondents communicated with people in the immediate vicinity and 56% communicated with a colleague at least once a day and in many cases much more than that.

TABLE 31 - PREFERRED MEANS OF COMMUNICATING

MEANS OF COMMUNICATION	ALL (N=287)	INTERNAT. ORGS. (N= 216)	AEROSPACE ESTAB. (N= 69)
face to face/personal contact	44%	47%	37%
informal meeting	16	16	15
formal meeting	14	13	16
letter/memo	13	13	11
telephone	13	11	16
impromptu visits to offices/labs.	10	11	9
reports/publications	6	7	3
conference attendance	5	1	15
telex/facsimile	2	2	3
other	1	-	3

% of respondents preferring given means/multiple answers possible

Only 3% of the respondents gave personal friendship as a basis for the contact. 2% deliberately sought out contacts who spoke the same language. In general, people did have a lot of frequent, short contacts on a hierarchical basis - either with subordinates or superiors - with the main thrust of the meetings being of a supervisory or management nature. Fischer notes that communication, in terms of the frequency and time consumed, appeared to decline steadily with age (7). This finding was not verified by the present research.

8.4 COMMUNICATION CHANNEL PREFERENCE

It was learned in the previous section that 9% of the scientists and engineers spent two-thirds or more of their time in written communication, 8% in oral informal communication and 7% in oral formal communication. It was also learned that the usual form of contact for 77% of them was face to face. In this section the preferred ways of keeping in touch with colleagues and the reasons for use or avoidance of a given communication channel are explored. Table 31 gives various ways of keeping in touch and the percentage of the respondents who preferred that means. Multiple answers were given by some respondents. From this table it is immediately apparent that people prefer to discuss matters, exchange information in a face to face mode where they can gauge the other's facial features and movements for further clarification. It will be observed that some of the categories overlap, for example, informal and formal meetings could also be considered to involve face to face or personal contact, as could impromptu visits to colleagues (this could also be construed to be an informal meeting). It is also obvious that the two types of organization are reasonably similar with the major exception of conference attendance where no less than 15% of the scientists and engineers in aerospace establishments say that one of their preferred means of communicating is to go to conferences. This is consistent, as has been noted already, with the observation that individuals in aerospace establishments do attend more conferences than do the people in international organizations.

Further analysis reveals that 44% of all those in a supervisory position prefer having personal contact, 16% prefer formal meetings, 14% prefer informal meetings and the phone, 12% prefer letters as a way of keeping in touch and 11% like visiting staff. Slightly more people in non-supervisory positions preferred informal meetings, letters and visits than did those in supervisory positions. It is interesting to observe that one cannot necessarily equate being a supervisor with age, i.e. that supervisors are generally older than non-supervisors. This is demonstrated by the fact that 63% of those preferring formal meetings were older than forty-five years and only 49% of those preferring personal contacts were in this older group.

Younger staff, i.e. those under forty-five years old, preferred to keep in touch by conference attendance, reports, letters and personal contact.

Looking at preferences by job class, it appears that, as might be expected, both engineers and scientists, as well as those classed as others, preferred the personal, face to face contact way of keeping in touch over other methods. Scientists, as is shown in Table 32, were the least likely to keep in touch by letter (even though they spent more time writing letters than did engineers), but were the most likely to use the phone.

TABLE 32 - PREFERRED MEANS OF COMMUNICATING BY PROFESSION

METHOD	ENGINEERS (N=155)	SCIENTIST (N=84)	OTHERS (N=48)
face to face/personal contact	45%	41%	50%
informal meeting	16	16	14
formal meeting	14	16	16
impromptu visits	12	10	8
telephone	11	16	12
letter	11	8	25
reports	8	4	4
conferences	2	2	-

% of respondents preferring given method

Those in non-scientific and engineering jobs, e.g. information people, linguists, publishers, computer people, tended to keep in touch with colleagues far more by letter than did scientists or engineers. The figures tend to confirm hypothesis 8 that scientists and engineers will prefer to keep in touch with colleagues in a direct, conversational mode rather than by writing. In fact the figures are remarkably similar lending further support to hypothesis 1 which noted that the communication patterns of the two groups are similar and cannot be readily distinguished.

It was noted above that scientists, in general, prefer the telephone. From Table 33 it is apparent that it is really only those scientists in international organizations who prefer this method - although in aerospace establishments they did still prefer it over engineers. Also, scientists in international organizations were more likely to use letters than were engineers, although non-scientists/engineers used them the most in both types of organization. Scientists also preferred keeping in touch by conferences in both types of organization as well as by informal meetings in aerospace establishments.

In individual establishments, scientists were three times as likely to use the phone than engineers in ESTEC and DFVLR, while in UNESCO and IAEA use was equally divided. On the other hand, in UNESCO only scientists used letters, while in DFVLR only engineers preferred letters. Despite the fact that face to face communication was more or less equally preferred in general by all three classes, in DFVLR engineers were more than twice as likely to use this method than were scientists, while in NLR the situation was reversed. In IAEA, those in a supervisory position were more formal and preferred to keep in contact with colleagues by formal meetings and reports, though supervisors also liked to use the telephone. In NLR the phone was used exclusively by supervisors to keep in touch, with those in non-supervisory positions preferring the personal face to face method, informal meetings and conferences.

TABLE 33 - PREFERRED MEANS OF COMMUNICATING BY ORGANIZATION AND PROFESSION

METHOD	INTERNATIONAL ORGS.			AEROSPACE ESTABS.		
	ENGIN. (N=120)	SCIENT. (N=60)	OTHERS (N=38)	ENGIN. (N=35)	SCIENT. (N=28)	OTHERS (N=10)
face to face/personal contact	46%	43%	55%	43%	33%	30%
informal meeting	18	15	16	12	21	10
formal meeting	13	12	19	17	17	10
impromptu visits	12	12	8	11	4	10
reports	10	5	6	3	4	-
telephone	9	17	11	14	16	20
letters	9	11	26	18	-	29
telex	2	3	-	3	4	-
conferences	1	5	-	15	17	10
other	2	-	-	-	4	10

ENGIN = Engineers SCIENT. = Scientists
% of respondents preferring given means

Regarding nationality, in IAEA, where 45% of the respondents were American, it was surprising to note that given their apparent penchant for telephoning, only 9% of those Americans actually said the phone was their preferred means. Two reasons suggest themselves, first telephoning is more expensive in Europe than in the USA and second, the very nature of their work required formal records. Thus 18% preferred reports, 14% preferred formal meetings and 9% preferred letters. Further, it was noted that in NLR the phone was not used by those not in supervisory positions. It is interesting, therefore to note, that the Dutch in ESTEC did not make much use of the phone either, though the Germans and Italians did. The French in ESTEC did not write letters and only the British and Dutch really liked making impromptu visits to colleagues.

Looking at the situation from individual groups of scientists and engineers, one discovers that 41% of those working in the nuclear engineering field prefer to keep in touch by visits - probably visits to nuclear sites for safeguard checks. 25% of the earth scientists also liked to keep in touch by visits. Those who preferred formal meetings the most were those working in telecommunications (31%) in both types of organization. Letters were much preferred by those in the informatics field (31%) especially those informaticists working in international organizations (37%). After personal, face to face contact, which every group preferred, then life scientists (32%) preferred conferences; those in the safety/reliability field (21%) preferred formal meetings; those in engineering and electronics liked paying impromptu visits to colleagues (23%); managers (21%) also liked formal meetings; while physicists were equally divided between preferring the phone (20%) and informal meetings (21%); space technologists favoured also informal meetings; and chemists equally used conferences, reports and the telephone to keep in touch. In the two types of establishment, space technologists in aerospace establishments were nearly four times as likely to prefer the phone while managers in the same establishments were much more likely to prefer the means of formal and informal meetings and letters than their counterparts in international organizations.

TABLE 34 - PREFERRED MEANS OF COMMUNICATING BY PRESENT FIELD OF ACTIVITY

	CONFERENCE			FORMAL MEETING			INFORMAL MEETING			LETTER			PERSONAL CONTACT			TELEPHONE			REPORT			TELEX			VISIT		
FIELD OF ACTIVITY	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST	TOT	INT ORG	AERO EST.	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST	TOT	INT ORG	AER EST
Chemistry/maths.	10%	17%	-	-	-	-	-	-	-	-	-	-	55%	33%	100%	10%	-	33%	10%	34%	-	-	-	-	-	-	-
Earth sciences	10	-	50	-	-	-	10	17	-	-	-	-	36	50	-	-	-	-	11	17	-	-	-	-	25	33	-
Engin./electronics	6	-	22	3	4	-	14	20	-	6	-	22	41	40	44	5	8	-	6	4	11	3	4	-	23	24	22
Informatics/maths.	-	-	-	4	6	-	18	25	-	31	37	17	55	56	50	4	6	-	4	6	-	-	-	-	4	6	-
Life sciences	32	-	60	11	-	20	-	-	-	-	25	20	23	25	20	19	25	20	19	25	20	11	25	-	-	-	-
Management/finance	-	-	-	21	17	40	14	11	30	10	8	20	55	57	40	9	9	10	1	4	-	2	-	10	7	9	-
Miscellaneous	-	-	-	8	9	-	31	32	25	19	23	-	37	40	25	19	17	25	3	4	-	-	-	-	19	18	25
Nuclear engineering	-	-	-	-	-	-	-	-	-	40	20	-	35	20	-	-	-	-	35	40	-	-	-	-	41	40	-
Physics/ space sciences	11	6	20	17	12	30	21	22	20	7	6	10	32	39	20	20	28	10	3	6	-	7	6	10	7	6	10
Safety/reliability	4	4	-	22	22	-	-	4	-	9	9	-	48	48	-	9	9	-	13	13	-	4	4	-	4	4	-
Space technology	7	3	16	15	18	8	21	21	23	8	12	-	43	48	24	15	9	31	1	3	-	-	-	-	9	9	15
Telecommunications	-	-	-	31	34	29	14	13	14	18	20	14	45	40	57	22	20	28	4	7	-	-	-	-	7	7	-

TOT = Total (N=287)
INT ORG = International Organizations (N=218)
AER EST = Aerospace Establishments (N=69)

% of respondents preferring given means

Physicists in the latter organizations were nearly three times as likely to use the phone than physicists in aerospace establishments. Despite the fact that personal communication was preferred by most categories in both types of organization, space technologists, managers, physicists and those in the miscellaneous category in international organizations were much more likely to prefer it than their counterparts in aerospace establishments, though the reverse is true for chemists and telecommunication specialists. Table 34 refers.

Classing the figures in Table 31 into the three broad types of communication (i.e. written, oral formal, and oral informal), then we find that, overall, 21% prefer written channels, 19% prefer oral formal channels, while 83% prefer oral informal communication (multiple answers were given). Why should this be? Reasons why people prefer to keep in touch in a given manner are listed below in Table 35. Unfortunately, since many respondents provided more than one preferred way and more than one reason, it was not possible to relate, with certainty, which reason went with which method.

TABLE 35 - REASONS FOR PREFERRED MODE OF COMMUNICATION

REASONS	% giving answer
Best, easiest, most flexible	25
Saves time/rapid	14
More informative, spontaneous, up-to-date	12
Provides direct, two-way contact	12
No misunderstanding/accurate	11
Gives feedback/reactions	6
Record provided	5
Better relations/control	3
Geographical coverage better	1
Other	6
N/A	5

N=287 N/A = no answer % giving answer

However, some comments can be made. Where people wanted a record of the communication kept then they preferred to communicate by letter or telex. This method was also preferred by some because it accorded a better geographical coverage. Letters were chosen by others because they could be accurate with no misunderstanding. On the hand, face to face communication could also iron out misunderstandings on the spot since it provided direct, two-way contact with the possibility of instant feedback and reactions. While formal meetings were felt by many to be informative and up-to-date, the telephone was used to save time, though it was conducive to misunderstandings.

8.5 USE AND AVOIDANCE OF COMMUNICATION CHANNELS

Besides being requested to explain why they preferred a certain way of communicating, respondents were also asked, in Question 17, to say for each of a number of methods of communicating, why they might use or avoid them. These methods of communicating were: the telephone, letters, videoconferencing, telex/facsimile, formal meetings, informal meetings, internal reports and reports/papers published externally.

It is interesting to observe in the discussion and tables which follow, that what is one man's meat is another man's poison - this is illustrated by the complete opposites given in response to the various questions. For example, for some the phone was a cheap form of communication, while for others it was expensive. Letters were used by some because they provided a record, they were avoided by others for precisely the same reaso . Formal meetings were avoided by some because a certain amount of pre-preparation was required, while informal meetings were avoided by others because no pre-preparation was required. The replies given by the respondents were standardized into a number of categories.

8.5.1 Oral Channels

Most people (56%) used the telephone because it saved time, was fast and afforded a quick response.

24% used it because it enabled a direct, immediate reply, action or decision in real time, while 21% believed it an efficient, easy and convenient tool. Others liked it because it was informal, yet personal, could be used in-situ to cover a large geographical distance and because it was reasonably cheap. The main reason for avoiding using the telephone, given by 13%, was that it provided no record of the conversation, no record of agreements and decisions - though the discussion could be followed up in writing afterwards. Another reason for avoiding the phone (10%) was that it was impersonal and yielded no real reactions (other than by voice). It was also open to misunderstandings and misinterpretations, according to 11%, and it was much more difficult to correct these and get points across over the phone. 9% avoided the telephone because it could not permit the showing of documents and graphics and thus in effect placed limits on a technical discussion. Others felt the telephone was not an official means of communication since it was too informal. 4% found it expensive, and 4% also thought it an uncertain means of communication because the person called might not be there. If they did not know the person, then 5% would not use the phone.

Turning to other oral channels of communication it was found that their use is generally consistent with the low level of use afforded them in Question 15, particularly for formal oral channels. Thus formal meetings were not used by so many respondents. They were used by 18% because they were a traditional or a normal means of communication (whether useful or not) and as such were "official". 19% considered formal meetings to be the best method of information transfer, feedback and negotiating and 18% were happy that agreements could be reached and commitments and decisions made. On the other hand, 34% believed formal meetings to be nothing but time wasters (21%), with a low rate of information transfer (6%) and often irrelevant, non-technical discussion taking place (3%) with a tendency to compromise and produce no useful results (4%).

Formal meetings were employed because, besides being the done thing, it was the only way to get the right people to attend (they were thus unavoidable!) and they provided a record (minutes) of the structured session. 7% liked them because everybody had to come prepared. Conversely, 1% disliked this pre-preparation and 9% found them too bureaucratic, too difficult to set up and too many people were present. Because of the formality, 5% felt inhibited and avoided such meetings since people would not say what they really wanted to. 4% tried to avoid them because they would be expensive in terms of staff time and travel costs (if outside the organization) and because there was usually delays if urgent matters needed to be settled since people were bound by their official and formal nature.

Informal meetings on the other hand were much easier to arrange - with the right people being present - and could lead to a rapid exchange of views, ideas, background, without any commitment being made. 30% said they used informal meetings because of these points, 21% found it easier to communicate in the informal atmosphere because it was more open, personal and relaxed as participants were not bound by officialdom. Because they were not tied to a formal agenda, brainstorming sessions could throw up ideas and problems for formal discussion, though 15% found the informal meetings an excellent means of solving technical problems. 7% liked informal meetings because they cut through the formal rhetoric and careful political manoeuvring to get right to the heart of technical matters. Yet, the reverse is also true. 10% avoided informal meetings because, in their experience, no real results, discussions or decisions were forthcoming. 9% considered them a waste of time and time-consuming. 9% felt they went off at a tangent on unimportant topics because there was no control and a lack of meeting structure. 8% did not like the fact that there was no official record or binding commitments emanating from such meetings. Very few people indeed had any experience of videoconferencing and of those that did, while admitting that it saved travel, they tended to avoid it because it was expensive and required pre-preparation.

TABLE 36 - REASONS FOR USE AND AVOIDANCE OF ORAL METHODS OF COMMUNICATION

TELEPHONE		FORMAL MEETING		INFORMAL MEETING	
USE BECAUSE					
fast	56%	traditional	18%	ease of communication	21%
immediate reply	24%	best information transfer	17%	rapid exchange of views	20%
convenient	21%	agreements/decision reached	16%	enables problem solving	15%
long distance	8%	minuted, thus record	8%	easy to arrange	10%
informal	4%	attendance required	7%	technical matters	7%
personal	3%	pre-preparation required	7%	brainstorming	3%
remain in-situ	3%	structured agenda	4%	not limited to formal agenda	2%
cheap	2%	good feedback	2%	no pre-preparation needed	2%
other	3%	commitments made	2%		
AVOID BECAUSE					
no record provided	13%	time wasting	21%	no results/decisions	10%
open to misunderstanding	11%	too bureaucratic	9%	time wasting	9%
impersonal	10%	low information transfer	6%	no record/not official	8%
no graphics/docs.	9%	feel inhibited	5%	irrelevant topics	6%
person not known	5%	no results	4%	lack of formal structure	3%
uncertain means	4%	irrelevant/non-technical	3%	little pre-prep. needed	2%
expensive	4%	expensive	3%	other	1%
not official	3%	other	2%		
other	2%				

multiple reasons possible % of respondents using or avoiding method

Table 36 gives an overview of why these oral means of communication were used or avoided. Multiple answers were given and some people believed there was no reason to avoid them.

8.5.2 Written Channels

The written channels of communication were letters, telexes/faxes, internal reports and reports/papers published outside the organization. Letters were used by 45% of the respondents because they provided a record and a convenient references. 24% used them because they permitted clear, detailed descriptions, were precise and could be used to express abstract ideas as well as diagrams. They were favoured by 19% because they were formal and official - although 9% did not use them because they did consider them formal and because they provided a record! Letters allowed people to communicate worldwide cheaply and with a copy to anyone. No immediate reaction and the delay inherent in letters were the causes why 28% avoided them. Another 25% shunned them because they were time-consuming to prepare (for the secretary as well as the individual). 7% considered that letters created unnecessary formality and 2% believed them costly - mainly in terms of effort.

To combat the tardiness of postal deliveries, 71% preferred to use telexes or facsimile transmissions because they were speedy and permitted a rapid response. 34% pointed out they were also "in writing" and thus constituted a formal record and reference. Other reasons given for using telexes were that they could be short, yet detailed with the ability to convey technical data, and that they could be used for urgent communication. There was a guaranteed receipt with a virtually worldwide distribution and the ability to transmit copies. In short telexes and to a lesser extent faxes, were an efficient, convenient and economic form of communication for many. For others though, they were inconvenient (because one had to go to the telex room), prone to transmission errors and poor quality (faxes), impersonal, not private, open to misinterpretation (because of their brevity) and lacked the formality of a signed letter. 10% avoided them because they were expensive to send, while 13% did not use them because of their brevity which did not permit sufficient detail.

(Contrast this with the 8% who used them because, even though they were short, detailed, technical information could be transmitted).

Regarding use of internal reports, 10% wrote them because they were obliged to, though 32% saw them as a record and formalization of their work and results. 28% believed they informed others quickly, without a meeting, as well as enhancing their status - though 8% believed no-one read them, that they had no value and merely contributed to information pollution. 10% also saw internal reports as requiring a certain preparation and ordering of ideas and enabling a critique and discussion of these ideas while in the formative stage. On the negative side, 19% tried to avoid writing internal reports if they could because they were too time-consuming to prepare. 4% were disappointed that such reports had a controlled or limited distribution or were otherwise not suitable for outside distribution. For this, one needs to publish papers and reports externally. Of those that did, 24% did so to ensure a wide distribution of their work to and to maintain contact with the scientific community. 13% published articles because it gave them prestige, personal glory and recognition of their work - all useful factors and propaganda when it came to job hunting. 11% believed they were making a contribution to knowledge and ensuring that research work need not be duplicated. 9% used this communication method to provide a record or lay claim to their work position and results. Quite a large number (7%) considered that to write articles and reports for external publication made others aware of their organization's activities.

Like internal reports, 22% found that writing papers for external publication required too much effort and was too time-consuming. Others found the delays in publication were too great and that such articles constributed to information pollution, while a few were actively discouraged from publishing outside the organization.

Table 37 gives an overview of why the various written forms of communication were used or avoided. Multiple answers were given.

TABLE 37 - REASONS FOR USE AND AVOIDANCE OF WRITTEN METHODS OF COMMUNICATION

LETTER		TELEX/FAX		INTERNAL REPORT		EXTERNAL PUBLICATION	
USE BECAUSE							
provides record	45%	speedy, rapid response	71%	gives record of work	32%	wide distribution	24%
can be detailed, precise	24%	provides record	34%	informs others of work	28%	personal prestige	13%
more formal/official	19%	efficient/convenient	9%	required by organization	10%	contributes to knowledge	11%
communicate worldwide	6%	guaranteed receipt	6%	enables preparation and critique of ideas	10%	provides record/claim of work	9%
cheap	4%	short, but detailed	6%			advert for organization	7%
gives time to mull over	2%	urgent communication	6%				
other	5%	economic	3%				
		other	2%				
AVOID BECAUSE							
no immediate reaction	28%	not enough detail	13%	time consuming to prepare	19%	time consuming to prepare	22%
time consuming to write	25%	expensive	10%	little value/not read	8%	delay in publication	2%
too formal	7%	prone to transmission errors	6%	controlled distribution	4%	other	2%
provides record	2%	inconvenient to send	3%				
costly	2%	impersonal & informal	2%				
other	6%	open to misinterpret.	3%				
		other	1%				

multiple reasons possible

% of respondents using or avoiding method

8.5.2.1 papers published internally and externally

Despite being shunned by some, written channels of communication are among the most popular for scientists and engineers. During the two years prior to the investigation, the average number of papers published externally (i.e. journal articles, reports, books, conference papers) was one (Olson (16) found an average of 0.2 for three companies, and Törnudd (20) gives 3.6 for one hundred and eighty-eight Danish and Finnish scientists). The number of papers published internally (i.e. working papers, scientific and technical reports intended for distribution only within the organization) was 1.8. Fully 8% of the respondents produced over twenty internal reports, while 29% produced none. On the other hand, 43% did not publish any paper externally (Törnudd (20) found 65% did not publish at all, while Shuchman (19) found 75% did not).

TABLE 38 - NUMBER OF PAPERS PUBLISHED INTERNALLY AND EXTERNALLY

NUMBER	ALL (N=287)		INT. ORGS.(N=218)		AERO. ESTABS. (N=69)	
	INTERNAL	EXTERNAL	INTERNAL	EXTERNAL	INTERNAL	EXTERNAL
0	29%	43%	34%	48%	12%	26%
1-2	18	29	17	25	22	41
3-5	22	19	19	19	32	20
6-10	17	6	15	5	23	9
11-20	6	2	6	2	7	4
21+	8	1	9	1	4	-

% of respondents publishing papers

Staff in international organizations, particularly ESTEC, were more likely to write no papers and over twenty papers than staff in aerospace establishments both internally and externally (Table 38). In all cases those in supervisory positions published more than those in non-supervisory positions - consistent with the gatekeeper hypothesis. 64% of the supervisors published one or more papers externally compared to 49% of the non-supervisors. On the other hand, although 38% of those publishing more than six papers externally were aged over forty-five years, 57% of those publishing none were also forty-five years or older.

When it comes to nationality, 23% of those publishing one or two papers externally were German, 18% were Dutch, 16% were British, 11% were French and 9% were American. Of those publishing three to five external papers, 24% were German and 12% were Dutch and of those publishing six to ten papers, 38% were German and 25% were American. Overall, the British published the least number of papers externally and the Germans, closely followed by the Dutch, were the best at publishing. During the period in question, fully 62% of the British respondents did not publish any paper externally, compared with 46% for the French and Italians, 40% for the Americans, 32% for the Dutch and 29% for the Germans. It is interesting to speculate on just why the British are not keen on publishing. Possibly their work is of a nature which is not conducive to the preparation of position or claim papers and results studies. A large percentage of respondents said that such papers were too time-consuming to write, therefore they avoided them - perhaps these respondents were British. Maybe the British are not so eager for personal glory and fame. Perhaps it is because they have no time since they are continually on mission.

Although writing was not their preferred way of keeping in touch with colleagues, consisistent with the fact that scientists spent more time in writing reports and articles than engineers, the analysis shows that scientists wrote a greater number of documents - 8% publishing over ten papers externally, compared to 4% for the "other" category and only 1% for engineers. 70% of the scientists published at least one paper externally compared to 57% of the engineers and 38% of the non-scientists/engineers.

(Although these latter were heavy writers, their literary efforts were mainly confined to letters, telexes and internal reports). Within the two types of organization, engineers tended to write a greater number of internal reports in both international organizations and aerospace establishments than did scientists, though the opposite was true for papers published externally. In aerospace establishments twice as many scientists wrote no internal papers compared to engineers. Only 30% of the non-scientists and engineers in international organizations wrote at least one paper for external publication, whereas the figure was 70% for the same group in the national aerospace organizations.

Breaking the three broad professional categories down into the various fields of work activity, it would seem that the life scientists are the most keen to publish externally - 44% of them publishing over six papers in thr two years prior to the survey. 37% of the physicists also published over six, as did 20% of the nuclear engineers and 15% of those working in telecommunications. In fact, the life scientists and physicists were rather high publishers all round with 90% publishing at least one paper. The poorest authors were those in the management and informatics (including mathematicians) fields where only 40% and 36% respectively published at least one paper. Not so far behind were space technologists (50%) and safety/reliability engineers (52%). More people in the space technology field working in international organizations did not write any internal or external papers than did their colleagues in aerospace establishments, and in fact this pattern holds true for just about all the other relevant categories. On the other hand, the total number of reports written was greater in international organizations because certain groups wrote more, e.g. 9% of the space technologists wrote over twenty internal reports, while no space technologist did in the aerospace establishments. Similarly, 17% of the chemists, 13% of the safety/reliability engineers and 11% of the physicists all wrote twenty-one or more internal reports whereas none of their counterparts in aerospace organizations did.

8.6 CONFERENCE ATTENDANCE

Earlier it was seen that a small proportion of people prefer to keep in touch with colleagues via conferenes. A national or international conference affords a break from the office routine and the chance to renew acquaintances and meet new colleagues. During the two years prior to the present study, the average number of conferences attended by the respondents was 2.2. The average number attended by each organization was 1.5 for ESTEC, 2.3 for IAEA, 3.0 for CNES and DFVLR, 3.3 for NLR and 4.3 for UNESCO. 76% attended at least one conference, with this total dropping progressively with each conference up to and including five, then there was a dramatic upsurge with 12.5% managing to go to six or more conferences during the period in question, though 24% did not go to any. Generally speaking, the staff of aerospace establishments went to more conferences than staff in international organizations - 23% going to more than five (Table 39).

TABLE 39 - ATTENDANCE AT CONFERENCES

NUMBER ATTENDED	ALL (N=287)	INT. ORGS.(N=218)	AERO. ESTABS. (N=69)
0	24%	28%	10%
1	22	23	16
2	18	20	13
3	11	9	16
4	10	8	17
5	3	3	4
6+	12	9	23

% of respondents attending conferences

Holland (13) notes that of 143 researchers in three organizations, 66% went to at least one conference. Egan (5) gives a similar figure - 63% of the engineers he studied attended at least one conference in the year prior to his study.

Shuchman (19) found that of the engineers he studied, slightly less than 50% went to at least one conference during a two-year period - 6% going to one abroad. 28% went to more than one conference. Olson (16) states that in the R&D divisions of the three companies he studied during one year, the average number of conferences attended was two in one organization and 1.1 and 0.4 in the others. Such relatively hign attendance may not always be permitted, however, - it depends on costs (of travel, subsistence and so on). In 1984, for example, the European Parliament has reduced by some 30% its budget for Expert Meetings of the Commission of the European Communities - already severely curtailed in 1983.

Who goes to all these conferences? Nationality-wise it is the Dutch and Germans with 2.4% and 4.2% going to six or more respectively. Not surprisingly, perhaps those in a supervisory position go to more conferences than those in non-supervisory positions - nearly 29% went to more than five conferences compared to 11% for those in non-supervisory positions. Age-wise it is also the older staff who attend most conferences. Of those going to six or more conferences, 58% were forty-five years old or more - (14% of the over-forty-five age group). 55% of those going to three or more conferences were over forty-five years. Scientists are the ones who most frequent conferences - over 80% going to at least one, and almost 20% going to more than five, compared to 77% and 10% for engineers and 65% and 8% for non-scientists/engineers (Table 40).

The same pattern holds true for international organizations, though for aerospace establishments it is the engineers, rather than the "other" category who attend the fewest. Regarding the actual groups of scientists and engineers attending conferences, every one of those working in the nuclear engineering field went to at least three national or international conferences during the time in question. In international organizations the largest groups who did not go to any conferences were those in the informatics (50%) and management fields (44%) - these were also the largest groups in the aerospace establishments (17% and 20% respectively).

The ones attending the most conferences were in the nuclear engineering field, earth scientists (100% in aerospace organizations attended six or more) and those in the life sciences. Of all those not going to any conferences at all in international organizations, 32% were in management and in aerospace organizations the figure was 29% - it was also 29% for space technologists, though in international organizations this figure was 16%.

TABLE 40 - CONFERENCE ATTENDANCE BY PROFESSION

NUMBER ATTENDED	ENGINEERS (N=155)			SCIENTISTS (N=84)			OTHERS (N=48)		
	ALL	INT.ORG	AERO	ALL	INT.ORG	AERO	ALL	INT.ORG	AERO
0	23%	27%	11%	19%	23%	8%	35%	42%	10%
1	25	27	17	19	23	8	14	10	30
2	21	21	20	15	20	4	14	16	10
3	12	9	20	11	9	17	6	8	-
4	6	5	8	14	8	29	18	16	20
5	3	2	6	2	3	-	4	3	10
6+	10	8	17	19	13	33	8	5	20

% of respondents attending conferences

8.6.1 Papers Presented at Conferences

In some organizations, for instance, ESTEC, the chances of obtaining approval to attend a conference are improved if the would-be participant is presenting a paper.

This does not, however, seem to be a general rule, because no fewer than 51% of the respondents did not present any paper at a conference during the previous two years (attendance at a conference was assumed). 18% presented one paper, 14% presented two papers, 10% three papers, 3% four papers, 1% five papers and 4% more than five. The present study shows that 53% of engineers did not present papers at conferences, (Shuchman (19) found 69% of his engineers did not present conference/seminar papers), compared to 37% of scientists (though also compared with 69% of the "other" category). Only 16% of engineers presented more than two papers, whereas 25% of the scientists presented more than two (8% for the 'other' group, i.e. non-scientists/engineers).

Looking at the more detailed work areas of the three groups, those in management and space technology were the ones who tended not to give papers (67% and 61% respectively). Considering the vast amount of literature on chemistry it was a little surprising to find those working in this field in the organizations studied were not so bothered about writing and presenting conference papers, nor indeed papers for external publication. Physicists attended a lot of conferences and presented a lot of papers - 18% presenting more than five (21% attended more than five and 36% published more than five papers externally). Although a majority of those in the management field did not present papers at all, 15% did present three or four papers (compared to 18% for those in telecommunications, 25% for those in physics and 11% for those working in space technology).

8.7 TIME SPENT AWAY ON MISSION

Clearly a fair amount of time is spent attending conferences. It had been noted by the researcher that a significant proportion of the staff in his establishment spent a relatively large amount of their time out of the office on mission (official duty travel). In the original version of the questionnaire respondents were asked to estimate the time spent away on a variety of possibilities e.g. conferences, contractor meetings, expert meetings, and so on.

In the event since many missions were combined, the results were not usable, and the final questionnaire simply asked what percentage of work time was spent away from the office on official mission during the previous six months.

It is obvious from Table 41 that nearly everybody travels to some extent - the more so in aerospace establishments. 92% travelled at least once during the six-month period (Egan (5) found that 72% of the engineers in his study travelled at least once). 50% spent between 10% and 30% of their time away from the office, while 21% spent more than a quarter of their time on mission. Taking the six months, that is twenty-six weeks or one hundred and thirty working days and assuming an eight-hour working day equals 1040 hours. This means then that 21% of the respondents spent the equivalent of at least two hours per day out of the office every day for 6 months.

TABLE 41 - TIME SPENT ON MISSION

% OF TIME SPENT AWAY	ALL (N=287)	INT. ORGS. (N=218)	AERO. ESTABS. (N=69)
0	8%	11%	1%
1-3	8	6	12
4-6	15	13	19
7-9	3	2	6
10-14	14	11	25
15-19	10	12	4
20-24	19	19	19
25-29	7	6	9
30-39	8	10	4
40-49	2	3	-
50-100	4	5	1
N/A	2	2	-

% of respondents spending time on mission
N/A = no answer

Clearly, such a high mobility implies less time within the office for other tasks - small wonder that so many complained that it was too time-consuming to write papers and reports (and fill in questionnaires!). Also it is not surprising that the amount of background reading was on the low side - and the response shows quite clearly that little useful communication or reading took place on aircraft or public transport, or in airport lounges.

It is those in supervisory positions who spend the most time away - 47% spending over 20% of their time compared with 30% of the non-supervisors. Only 4% of the supervisors did not travel at all during the period as opposed to 14% of the non-supervisors. 33% of all those spending no time away were of English mother tongue, conversely 45% of all those spending over half their time away were also English. The Dutch travelled the most - 28% spending over one quarter of their time away, next came the Italians with 25%, then those with English as their mother tongue with 23%, followed by native German speakers with 20% and French with 13%.

Despite the fact that scientists attended a greater number of conferences than engineers, the latter, nevertheless, spent a very similar proportion of their time away on mission - 31% in each category spending less than 10% of their time away and 25% of the engineers and 23% of the scientists spending over one quarter of their time away. In the aerospace establishments over three times as many scientists spent more than 25% of their time away compared to engineers. In international organizations this situation was reversed though with not nearly such a large margin. Looking at specific work areas, 56% of those involved in safety engineering and nuclear safeguards spent more than 25% of their time away, as did 50% of the earth scientists in aerospace establishments. Also in the latter, 14% of the telecommunication people spent a quarter of their time away compared with 34% in international organizations. For those working in the space technology field, the percentages were 22% and 27%. 20% of those in management in international organizations spent no time away during the six months in question, whereas all those in management in aerospace establishments spent over 10% of their time away.

The question was also asked - was this percentage of work time spent away more or less than usual? 18% of respondents replied that it was more than usual, 19% replied it was less, and 63% estimated it was about the same.

8.8 BARRIERS TO COMMUNICATION

As outlined in Chapter 6, it had been hoped to gather data on the reactions of respondents when confronted with requests for information as well as potential barriers to information transfer. Due to reluctance on the part of the respondents in the pilot surveys to answer such questions, many of the aspects to be covered were dropped. What remained was one question (Question 19) asking whether any constraints to work-oriented communication were encountered when information was given and when it was received.

In general (Table 42), people did not admit to encountering constraints or barriers, particularly when the aspects reflected on their ability or character (e.g. languages, personality, competitiveness, culture). There were also no marked differences in barriers when giving or receiving information. Despite the fact that most British and Americans were poor at languages, relatively few people (5%) said that language was a big probllem in giving information - presumably because English is the lingua franca and everyone spoke it. One of the most aggravating constraints to communication for over 50% was when the person needed was not there at the moment s/he was wanted. Geographic location of the person communicated with was a barrier for almost 40% because it took longer to contact the person and it was costly to phone or visit. Despite the fact that people working in a different country was a barrier, the difference in time zones was not much of a problem - possibly implying that much of the communication, even for the international organizations, was done within Europe, but also indicating that contact may have been by letter. The spatial location of offices in the building was also a bit of an irritation and these two - the geographic and spatial separation - perhaps give the lie to Jackson who argues that people will communicate most frequently with those geographically closest to them (14).

While this has some truth (as indicated earlier) it is clear that people do want to communicate with those far away and the organizational structure might be such that individuals working on the same project are also scattered. Poorly written documentation was cited as a constraint by over 60% when they wanted to receive it (they were not nearly so bothered about it when they were giving it!). Complexity of the topic was sometimes a constraint, while the competence of the individual was more often a problem when receiving information than giving it.

TABLE 42 - CONSTRAINTS TO COMMUNICATION

CONSTRAINTS	WHEN GIVING INFORMATION				WHEN RECEIVING INFORMATION			
	rarely	sometimes	v.often	N/A	rarely	sometimes	v.often	N/A
language barrier	73%	8%	5%	14%	74%	10%	3%	13%
time differences	68	11	3	18	66	12	3	19
cultural factors	69	4	1	26	68	6	1	25
complexity of topic	53	25	4	18	50	26	3	21
political influences	59	13	2	26	58	11	4	27
economic factors	63	9	2	26	62	9	2	27
organizational structure	50	26	4	20	44	30	5	21
personality clashes	65	11	2	22	62	14	2	22
technical competence	66	11	2	21	58	20	1	21
insufficient work environment influences	61	13	1	25	60	13	1	26
geographic location	43	30	9	18	41	32	9	18
spatial location	61	10	4	25	59	11	4	26
person not there	41	41	11	7	37	40	11	12
competitiveness	63	11	-	26	58	13	2	27
poorly written document	60	13	4	23	42	31	8	19

multiple replies possible

% of respondents feeling constraint

N/A = no answer

REFERENCES

1) ALLEN, T.J. and COHEN, S.I.
Information flow in an R&D laboratory. MIT Alfred P. Sloan School of Management, 1966, WP217-66.

2) ALLEN, T.J. et al
R&D performance as a function of internal communication, project management, and the nature of the work.
IEEE Trans. on Engineering Management, EM-27, 1, Feb. 1980, p.2-12.

3) BAYER, A.E. and JAHODA, G.
Background characteristics of industrial and academic users and non-users of online bibliographic search services.
Online Review, 3, 1, March 1979, p.95-105.

4) BERKOWITZ, N.H. and BENNIS, W.G.
Interaction patterns in formal service-oriented organizations.
Administrative Science Quarterly, 6, 1961/62, p.25-50.

5) EGAN, F.T.
Today's engineer: a survey.
Electronic Products, 25, 9, 10 Dec. 1982, p.40-45.

6) FESTINGER, L.
Informal social communication.
Psychological Review, 57, 1950, p. 271-282.

7) FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

8) FROST, P.A. and WHITLEY, R.
Communication patterns in a research laboratory.
R&D Management, 1, 2, 1971, p.71-79.

9) GULLAHORN, J.T.
Distance and friendship as factors in the gross interaction matrix.
Sociometry, 15, 1952, p.123-134.

10) HAGSTROM, W.O.
The scientific community. Basic Books, Inc., 1965.

11) HALBERT, M.H. and ACKOFF, R.L.
An operations research study of the dissemination of scientific information. In Proceedings of the International Conference on Scientific Information, 1958 November 16-21, Washington DC.
National Academy of Sciences, 1959. Vol. 1, p.97-130.

12) HINRICHS, J.R.
Communications activity of industrial personnel.
Personnel Psychology, 17, 1964, p.193-204.

13) HOLLAND, W.E.
Characteristics of individuals with high information potential in government research and development organizations.
IEEE Trans. on Engineering Management, EM-19, 2, May 1972, p.38-44.

14) JACKSON, J.M.
The organization and its communications problems.
Advanced Management, 24, 2, Feb. 1959, p.17-20.

15) MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980, p.347-356.

16) OLSON, E.E.
Organizational factors affecting the flow of scientific and technical information in industrial R&D divisions. NTIS, 1977, PB27761.

17) POPPEL, H.L.
Managerial/professional productivity. Booz, Allen and Hamilton, 1980.

18) SHOTWELL, T.K.
Information flow in an industrial research laboratory - a case study.
IEEE Trans. on Engineering Management, EM-18, 1, Feb. 1971, p.26-33.

19) SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group, 1981.

20) TÖRNUDD, E.
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, 1958 Nov. 16-21, Washington DC. National Academy of Sciences, 1959, Vol. 1, p.19-75.

21) WILSON, T.D. and STREATFIELD, D.R.
Information needs in local authority social services departments: an interim report on Project INISS.
Journal of Documentation, 33, 4, December 1977, p.277-293.

22) WILSON, T.D. et al
Information needs in local authority social services departments: a second report on project INISS.
Journal of Documentation, 35, 2, June 1979, p.120-136.

CHAPTER 9

INFORMATION SEEKING AND USE HABITS OF SCIENTISTS AND ENGINEERS

9.1 INTRODUCTION

In the previous two chapters we have examined the general characteristics of scientists and engineers and factors impinging on their ability to communicate, in its widest sense, as well as the time they spend on various communication activities - both oral and written. Their preferred channels for communicating and the reasons for them were also noted. This chapter delves deeper into these channels of communication by looking at them as sources of information and how they are employed. Various factors generate an information need, for example, the type of work being undertaken, the discipline in which one is working, the knowledge of and availability of material. The manifestation of this information need is the identifying, finding and using of the information itself. Information seeking and use is a very personal thing - some people do it, others do not. Some people are by nature curious and anxious to learn all they can, while others have no desire at all.

9.2 TYPES OF INFORMATION REQUIRED

As noted in Chapter 6, it had been intended in the earliest version of the questionnaire to have a question requesting details on the precise information requirements of the respondents. A list of types of information was given but in the event these proved too imprecise, ambiguous or specific to those taking part in the pilot studies. Thus, in Question 26, they were reduced to four categories - facts, ideas, advice and opinions. The percentage of respondents requiring each type fairly or very often was 64% for facts, 23% for ideas, 10% for advice and 8% for opinions. Before giving the detailed results of the analysis it is worth seeing what other researchers found in this area relating to the types of information wanted.

Wood and Hamilton (33) in a 1966 study of 5000 mechanical engineers simply used the categories of competitive products, know-how and new ideas for the types of information required. In the DOD User Needs Study, Berul (4) found that 38% of the scientists and engineers polled needed facts and data. Similarly, Corridore (6), in a study to see the degree of user satisfaction with several Information Analysis Centres by nineteen R&D laboratories, found that of the 803 scientists and engineers studied, 38% also required facts and data, while 29% wanted theoretical/conceptual information. Menzel (23), in interviews with 161 polymer scientists in a large number of estalishments in 1964, elicited sources of information for specific types of query - these included procedures/techniques/materials; data/facts; and theory/ideas/concepts. Similar types crop up in the study conducted for Engineering Index (9), where Chief Engineers and Design Engineers needed daily ideas and theoretical information (22% and 23% respectively), experience (30%, 26%), and cost data (55%, 47%). They also needed data on specific materials and components as well as specifications and facts. Again, Rawdin (26), in an investigation of information needs and use parameters to explain library user behaviour, noted that of three hundred and sixty-three people in twenty-three libraries, 46% sought facts/data, 33% sought concepts and ideas and 11% sought facts and ideas. Finally, Shuchman (29) discovered that the main types of information needed by engineers was basic scientific and technical information (by 82%), in-house technical data (by 72%) and physical data (by 57%).

It must be obvious that all the types above are also somewhat general and ill-defined. All these categories were included in the list in the researcher's original questionnaire, and it is instructive to speculate on why they were not liked by the respondents to the pilot studies. There may have been a problem of language with some terms, e.g. conceptual, with the respondents not knowing how to define it or what was contained within it. Possibly several of the categories overlapped or could be seen to overlap - after all data on new materials or processes could be considered as facts. More likely, the respondents were daunted by the fact that they would have to think about the answer to the question. In any case, they would often have required many of the different types of data at one time. Thus the types were reduced to the four above.

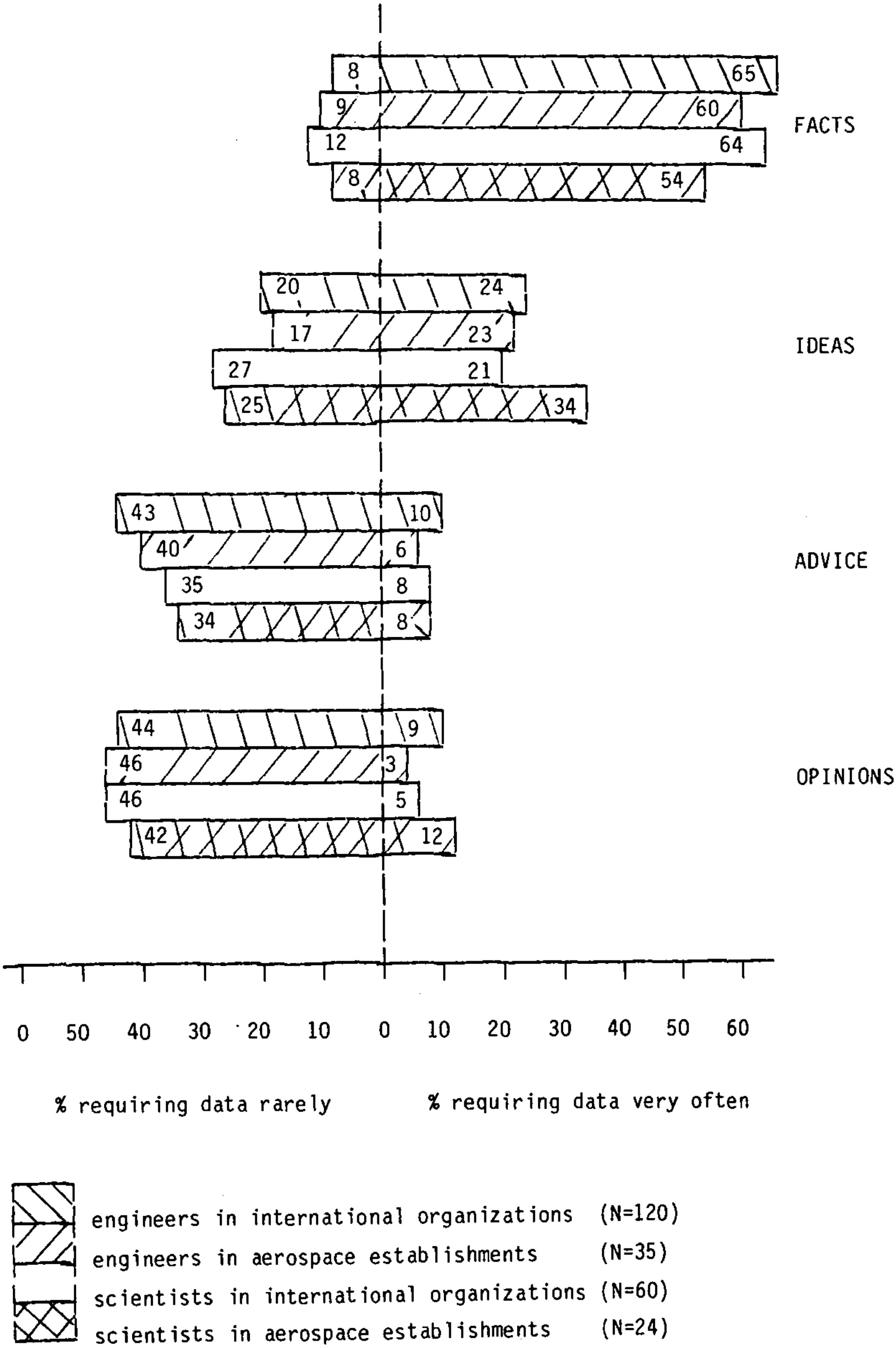
Respondents were also asked, not only how often they needed facts, ideas, advice and opinions, but also when they needed it or them by, how long they spent seeking the information and how old could it be. The frequency of requirement for the four types of information by scientists and engineers in both international organizations and aerospace establishments is shown graphically in Table 43.

It must be remarked how similar are the requirements of both engineers and scientists in the two types of organizations studied. This would appear to run counter to others, quoted elsewhere in this survey, who have noticed distinct differences between the two professional categories; however, the present finding does support the researcher's first hypothesis that the information needs of scientists and engineers are similar and cannot be readily distinguished.

9.2.1 Requirement for Facts

Facts were very often needed by 64% of the respondents and not very often or rarely by only 7%. Scientists needed facts only slightly less often than engineers, though in the national aerospace establishments, the number of scientists requiring facts very often was quite a bit lower than those in international organizations (54% to 64%). Looking at the specific fields of activity, it was discovered that 23% of those working in the space technology field in aerospace establishments rarely wanted facts (compared to 3% in international organizations). Others rarely wanting facts were 18% of those working in the information field in international organizations and 17% of those in the earth sciences. In addition, 16% of those in engineering and electronics in international organizations did not need facts, neither did 11% in the aerospace establishments. Among the highest users of facts were chemists (83% in international organizations and 67% in aerospace establishments), those in space technology (82% in international organizations and 61% in aerospace establishments) and those in management (72% in international organizations and 60% in aerospace establishments). All those in the nuclear field and 74% of those involved in safety also required facts very often.

TABLE 43 - INFORMATION REQUIREMENTS OF SCIENTISTS AND ENGINEERS



As for when the facts were needed by, a relatively low 57% said they wanted them with any degree of urgency, with scientists in both types of organization being less bothered about the time than engineers and with the "other" category in aerospace establishments being the least concerned about the urgency. These figures serve to confirm those of Anthony et al in their study of the use of physics literature, who found that time was a factor for 59% and that scientists were slightly less preoccupied with time than engineers (2).

Only people in three categories of work activity - engineering and electronics (8%) and management (13%) in international organizations and the miscellaneous group (50%) in aerospace establishments indicated there was no hurry for the facts they needed. No category stood out as requiring facts faster than others overall, though life scientists were significantly less likely to want facts quickly. Major differences were apparent between the two types of organization in telecommunications and information. In international organizations 50% of those in the latter class required facts urgently compared to a mere 17% in the aerospace establishments; whilst in telecommunications, whereas 54% in international organizations wanted facts quickly, 71% did in the aerospace establishments.

In total 43% spent as long as was necessary seeking the information they needed, and 22% did not spend long at all on the task. There were no real differences between scientists and engineers, nor between the two types of organization - though non-scientists/ engineers in international organizations, in fact, were willing to spend the most time. These results would seem to differ from Anthony and his colleagues who suggested that scientists generally spent 11.4 minutes seeking information, with chemists spending 12.8 minutes and physicists 11.8 minutes (2). In the present study those who did not spend very long searching were earth scientists (50%) and those in the nuclear (40%) and management (33%) fields in international organizations and physicists (40%) in aerospace establishments.

Some categories were common to both organizations - space technologists (21% in international organizations and 38% in aerospace) and those in engineering and electronics (32% and 22%). Among those spending the most time seeking facts were those in the information field (68% in international organizations and 33% in aerospace), chemists (50% and 33%) and life scientists (60%) in aerospace establishments.

Regarding the age of the information which respondents were willing to accept, 29% replied that there was no time limit, while 44% said the facts must be very recent.

(Anthony (2) found that 40% had no time limit, while another 40% were willing to accept literature up to ten years old). There were no differences between scientists and engineers in general, although many more engineers in aerospace establishments (40%) were prepared to accept a no time limit than either the scientists in their own establishments (29%) or both the engineers (29%) and scientists (32%) in international organizations. These engineers turned out to be mainly those working in the space technology field. Chemists and life scientists in aerospace establishments also had no time limits, neither did 73% of those in the telecommunications area in international organizations (57% in aerospace). Among those requiring only very recent data were those in the nuclear field, physicists (60%) in aerospace establishments, managers (60% each) in both organizations and space technologists in both organizations.

9.2.2 Requirement for Ideas

Ideas - conceptual information - were required both very often and not very often by only one quarter of the respondents. Scientists, particularly chemists and life scientists, in aerospace establishments wanted ideas the most; while out of the engineering group those in telecommunications in international organizations were the most eager for new ideas. Conversely, just over a quarter of the latter said that they did not need ideas so often as did one quarter of those in management.

Fewer than 20% of people said there was any degree of urgency for the acquisition of ideas - the life scientists and telecommunications specialists in international organizations being the ones normally needing the information quickest. Scientists, particularly chemists and life scientists, were prepared to spend longer seeking ideas than engineers in both types of organization, though nearly half those working in engineering and electronics in aerospace establishments and one-third of those in telecommunications in international organizations also spent a longer period of time in idea-seeking. When it came to saying how old an idea could be for acceptance, more people wanted newer ideas - that is to say that after a given period of time (unknown) then an idea was no longer of value because the need for it had passed.

This time span was longer for scientists working in international organizations than it was for scientists working in aerospace establishments - though it was not as long as that of engineers. For those working in telecommunications, an idea was always welcome for nearly 50% in international organizations and for one third in aerospace establishments. Those in the nuclear field were also always open to ideas. Conversely, for a very high proportion of life scientists in both organization types, an idea had to be used right away or else it was no good. For space technologists too, especially in international organizations, ideas were of no use if they were not produced relatively quickly.

9.2.3 Requirement for Advice and Opinions

Very, very few of the respondents wanted advice or opinions in their work - less than 10% - with, in fact, 40% specifically stating they did not require them at all. Engineers in international organizations were slightly more inclined to accept advice and opinions than scientists, although this position was reversed in aerospace establishments, heavily so in the case of opinions, where 12% of the scientists (predominantly life scientists) had a requirement for opinions compared to only 3% of engineers.

In international organizations, earth scientists often wanted opinions, but not so often advice. Those in the management field, in both organizations, were among those who rarely sought advice or opinions. Others in this group included space technologists, and those in telecommunications and engineering/electronics. For just about everybody there was no real urgency in getting advice or opinions, although chemists and those in telecommunications in aerospace establishments needed them most urgently. If the advice and opinions could not be had more or less straight away, then the majority of respondents did not waste time either seeking it or waiting for it - scientists waiting somewhat less time than the engineers in both types of organization, though even less so in aerospace establishments.

TABLE 44 - SPECIFIC INFORMATION REQUIRED AND NOT AVAILABLE FROM LIBRARY

TYPE OF INFORMATION REQUIRED	ALL (N=287)	INT. ORGS. (N=146)	AERO ESTABS. (N=41)
project related	25%	26%	22%
literature	10	9	14
technical/experimental	8	10	7
admin/finance	6	6	6
ongoing research	5	5	4
experience/advice/opinions	5	4	7
unpublished/restricted	4	4	1
miscellaneous	4	5	1
policy	2	2	3
real time data	2	2	3
peripheral/background	1	1	-
evaluated data	1	-	1

% of respondents requiring information
multiple answers possible

In general, it was the telecommunications people in aerospace establishments who spent the longest time seeking out advice, while it was those working in engineering and electronics in aerospace establishments who were always willing to accept an opinion no matter after how long.

9.2.4 Requirement for Other Types of Data

Nothwithstanding the above, the respondents were also asked to indicate what kinds of information they could not get from the library in their organization (Question 27a). The replies were reduced to twelve categories and serve to show also the types of data needed by the staff of the organizations. By far the highest type of information needed was day-to-day project-related information, next came literature, particularly from within the organization, then specific technical and experimental data. Table 44 shows the types of information required by the respondents (which they could not get via the library).

In general, engineers required project data more than scientists, while the latter required more literature and experience. In particular, the earth scientists in aerospace establishments needed experience far more than their counterparts in international organizations. Those in space technology in both organizations required a high degree of project information, as did those in management, particularly in aerospace establishments, where over double the number of those in international organizations needed it. Interestingly enough, while chemists and life scientists appeared quite heavily involved in projects, earth scientists and physicists were not. Data of a confidential nature was required mainly by those working in the nuclear safeguards fields at IAEA.

9.3 INFORMATION SOURCES

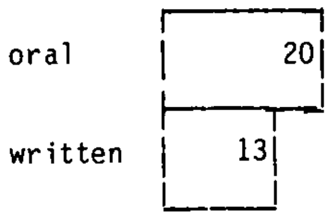
In the previous section, the types of information required by the scientists and engineers in the study were examined. Much of it, particularly those specific topics given in Table 44, is not available from the library . Where do they get this information from?

Sources of information were requested in three questions. Question 21 asked with what frequency needed information was obtained from a number of given sources (Table 46); Question 27b asked where information which could not be got from the library was obtained (Table 47); Question 31 asked in which ways one kept up-to-date with what went on in one's field (Table 48). The overwhelming conclusion from an analysis of the results is that the main source for information needed on a one-time basis, on a continuing basis or for keeping up-to-date, is colleagues and the main channel is oral - i.e. personal contact (Table 45). 45% of the respondents normally obtained needed information from colleagues in their own division. For information not available from the library, 58% turned to personal contacts, the originator, and contractors. To keep regularly up-to-date with what is going on in their field 39% preferred talking with colleagues at work. Thus the third hypothesis - that scientists and engineers will tend to get most of the information they need from colleagues rather than from the library/information centre - is confirmed.

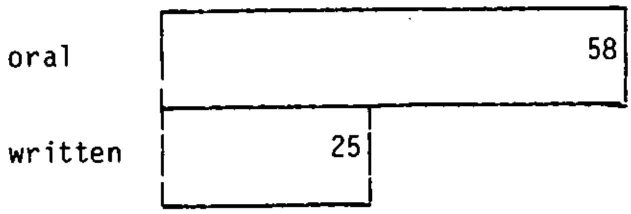
Table 46 indicates that oral sources sources were used very much virtually equally by engineers and scientists, at variance with Sutton (30) who noted that engineers relied more on people and chemists and physicists relied more on literature as sources of information. Mick (24), too, found that engineers rather than scientists were oriented towards interpersonal sources. However, he went on to suggest that scientists tended to be more print-oriented. From Table 46 it appears that except for meeting reports, abstract journals and computer files, engineers are rather more oriented to print sources. So much for the poor reading habits of engineers with references to which the literature abounds. It would seem that they are better than scientists! One other interesting anomaly is the following - if, as it is generally recognised, people get 20% of their information by ear and 80% by eye (normally in reference to papers presented at conferences), then in principle scientists and engineers should read much more than they speak! This is, of course, not borne out by any study.

TABLE 45 - ORAL AND WRITTEN SOURCES OF INFORMATION

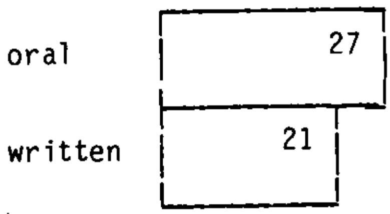
Needed information obtained very often



When information not available from library



For keeping up-to-date (usually)



Average of total oral and written sources

% of respondents using source

TABLE 46 - SOURCES OF NEEDED INFORMATION

SOURCE (N=287)	AMOUNT OF USE					
	NOT VERY OFTEN	FAIRLY OFTEN	VERY OFTEN	N/A	ENGINEERS (N=155)	SCIENTISTS (N=84)
ORAL						
colleagues in own division	12%	42%	45%	1%	43%	44%
colleagues on same project	26	43	23	8	24	24
other colleagues in org.	45	42	9	4	7	9
people outside organization	40	37	18	5	21	17
library staff	67	16	5	12	4	5
WRITTEN						
reference books	60	20	10	10	10	8
text books	46	22	14	18	13	12
conference papers	41	35	16	8	19	13
trade literature	58	19	5	18	6	1
journal articles	33	39	20	8	21	20
reports	16	47	30	7	35	28
standards	57	12	9	22	12	6
library lists	55	24	5	16	6	6
abstract journals	61	16	5	18	3	8
meeting reports	41	40	9	10	8	11
computer files	53	25	7	15	4	8
own work/sources/files	16	45	29	10	28	26
	% of respondents using source				% of respondents using source v. much	

N/A = source not considered relevant by respondent
Multiple answers possible

TABLE 47 - MAJOR SOURCES USED WHEN INFORMATION IS UNOBTAINABLE FROM LIBRARY

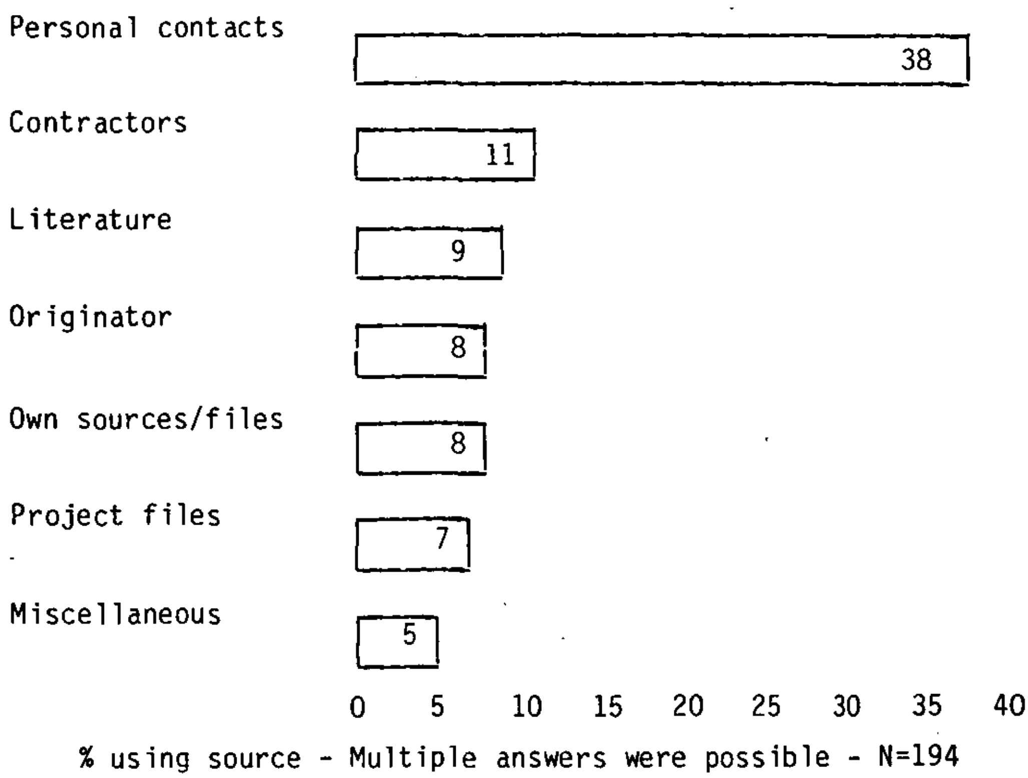


TABLE 48 - SOURCES USED FOR KEEPING UP-TO-DATE

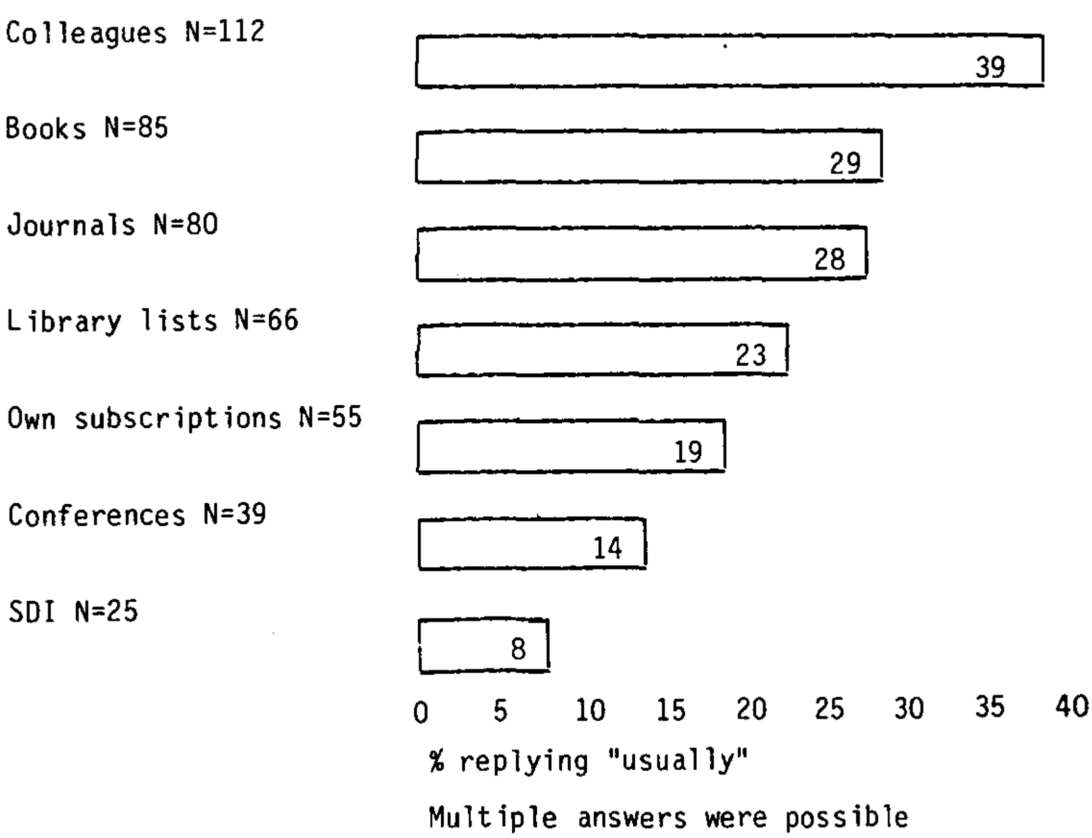


Table 45 gives an overview of the differences between those obtaining information from oral and written sources. One source listed was library staff and a total of 5% said they obtained needed information very often from such staff. If this low figure is omitted from the oral total, then that figure of 20% rises to 24%. It should be noted that on a large number of occasions staff turned to their own work or sources and files. In fact 29% used these very often for needed information. Since many did in fact have their own files, then this source has been included as a written source in Table 45. However, it is likely that some respondents actually got their information by carrying out tests or experiments. If this source is omitted from Table 45, the figure of 13% becomes 18%.

Tables 46 to 48 show the number of respondents, given as percentages, for a wide variety of information sources, both oral and written. Notwithstanding the use of colleagues as a source of needed information, literature was also important, particularly reports. The individual sources will be discussed further below.

9.3.1 Oral Sources

The colleague or personal contact as a source of information is again emphasized by noting the other oral channels employed - 23% obtained needed information very often from colleagues working on the same project, though not in the same division; 18% got information very often from people outside the organization; 9% got information very often from other colleagues within the organization, i.e. working on a different project and in a different division; while 14% kept up-to-date by attending conferences and hence meeting people there.

An interesting point is the following: from Table 29 it may be recalled that 19% of the respondents from aerospace establishments communicated most with people outside the establishment, whereas only 9% of those in international organizations did. However, as a source of information only 17% of those in aerospace establishments used contacts outside the organization very often, compared to 19% for staff in international organizations.

In general it was the engineers rather than the scientists who got information from people outside the establishment (21% of all engineers saying very often to 16% of all scientists) - though in aerospace establishments not only did scientists (predominantly earth and life scientists) get information more often from outside than scientists in international organizations, but they also got it more often than did engineers in aerospace organizations too. In fact, a similar pattern holds good for both information received from colleagues working in the same division as well as colleagues working on the same project but attached to a different division. It was those in the "other" category, however, who made most use of divisional colleagues. When it comes to getting information from other colleagues in the organization, then more scientists use this source more often than engineers, with scientists in international organizations using it more than scientists in aerospace establishments. Life scientists and earth scientists were leading contenders for those getting information from colleagues, whether they worked in their divisions or on their projects or not. Fully 90% of the managers in aerospace establishments relied on colleagues within their divisions for information, compared to 51% for management personnel in international organizations.

Those in the safety and space technology fields also made fairly high use of divisional colleagues, but not so much colleagues outside their divisions and projects. Among those using divisional colleagues the least as a source of information were those in the nuclear field, those in engineering and electronics and physicists. The latter, in fact, did not tend to use oral sources much at all - only 17% in international organizations saying they used divisional colleagues a lot (10% in aerospace establishments) and 20% and 30% respectively saying they used external contacts and librarians very often. Those in engineering and electronics also got quite a lot of information from outside, as did those in nuclear technology. Not getting information often from colleagues outside the organization were those in the information field (56% in international organizations, 33% in aerospace establishments) and those in safety (61%).

The latter figure is particularly interesting considering that 56% of those in safety spent over 25% of their time away from the office, presumably with colleagues at other sites.

People in aerospace establishments were three times as likely to turn to the librarian for information than were people in international organizations - possibly a reflection on the abilities and knowledge of the library staff, but more probably due to the location and proximity, existence even, of the library and its coverage. The bulk of these people were physicists in aerospace establishments (30%) and life scientists in international organizations (50%). Regarding the sources for information not available from the library, scientists were more likely than engineers to go to the originator, although the "other" category made most use of this source, particularly in aerospace establishments. Funnily enough, in international organizations it was the engineers and in aerospace establishments it was the scientists who used the contractor as a source of information - both by the same amount, 16%.

A score or more of the studies consulted in the course of this research give a global figure for the use made of oral sources of information, i.e. data gathered by personal contact. For example, Glass and Norwood (11) said 78% of scientists learned of work crucial to them from casual conversation. The percentages of scientists and engineers making use of oral channels range from 5% to 75% with an average of 39.4%. Several of the studies break these oral sources down into more specific ones. For example, Shuchman (24) notes that 87% of engineers rely on discussions with colleagues for information and 40% of this is exclusively within the work group. Table 49 gives a summary of selected studies for comparison. The disparity in some of these figures can be attributable to the different wordings and intentions of the questionnaires, as well as the kind of personnel surveyed. Thus, Gralewska-Vickery and Roscoe (13) looked at earth scientists - a relatively specific group, compared to the present study and others.

TABLE 49 - COMPARISON OF IMPORTANT ORAL SOURCES OF INFORMATION IN SEVERAL STUDIES

STUDY	colleagues in same div/proj.	other internal colleagues	people outside organization	suppliers/ vendors	confs./ mtgs.
The present study	34%	14%	18%	8%	1%
Corridore (6)	15			11	11
Disch-1 (7)	8		4	8	
Disch-2 (7)	24			14	
Goldhar (12)	41		8		12
Gralewska-Vickery & Roscoe (13)	80		49		58
Menzel (23)	6	15	13	6	1

% of respondents using source

There may also be a fair amount of overlap - for example, if conferences are a good source of information, then the people contacted there will, very likely, be people outside the respondent's organization.

9.3.2 Written Sources

Literature used the most by scientists and engineers as an information source comprises, according to a large number of writers, journals, books and handbooks. Few appear to make heavy use of reports. There are anomalies, however. Wood and Hamilton, surveying 5000 mechanical engineers, found they made heavy use of journals and books and relatively little use of patents and reports (except for aeronautical engineers) (33). Herner, found that 456 users of the Goddard Space Flight Center made heavy use also of journals, books and handbooks and low use of reports, specifications and standards (15). In a similar environment, however, Sheppard (28) found that scientists and engineers at an Australian aeronautical establishment used equally reports and books/journals. Hogg and Smith (17) report a similar finding. Shuchman (29) also notes that along with informal discussions with colleagues the most important source for engineers was internal technical reports. Allen, too, found evidence that engineers use informal literature, i.e. unpublished reports, more than the formal books and journals (1). Regarding scientists, the reverse seems to be true. Menzel (23), (for polymer scientists), Flowers (10) (for physicists and chemists), and Gralewska-Vickery and Roscoe (13) (for earth scientists - to a lesser extent) conclude that reports are barely used as a source of information. Mick and colleagues, on the other hand, show that 560 scientists and engineers place a reliance on the trade press (24). Table 50 gives an overview of the written sources of information used by scientists and engineers as detailed in relevant studies by other authors.

In the main, the present survey found that the source of literature used the most frequently was reports - some 30% saying they used reports very often compared to only 16% who replied they rarely used them.

TABLE 50 - COMPARISON OF IMPORTANT WRITTEN SOURCES OF INFORMATION IN SEVERAL STUDIES

STUDY \ SOURCE	Books	Journals	Conf. Procs.	Reports	Abstract Journals	Handbooks Ref.books	Specs. Standards Patents	Trade Lit.	Library Lists	Own Source
The present study	14%	20%	25% *	30%	5%	10%	9%	5%	5%	29%
Corridore (6)		15		30						10
Disch (7)	13	16.5								20
Flowers (10)	30.5	50.5	10.5							
Gralewska-Vickery & Roscoe (13)	78		95	5						
Herner (15)	12	11.5		10		10.5				
Herner (16)	68	62		7		23	5			27
Hogg & Smith (17)	5	46		5						
Meadows & O'Connor (22)	33	75	65							
Menzel (23)	11	25		5	1	7	5	3		
Sheppard (28)	53.5	49.5	25.5	50.5	16.5				46.5	40
Wood & Hamilton (33)	85	89	10	22.5	15		41			

* includes meeting reports   % of respondents using source very often

As might be expected from other survey results, overall it was the engineers who used reports more frequently than scientists - though the difference was not so marked. 35% of engineers used reports very often, compared with 28% of scientists, while 14% and 21% respectively did not use them so often. In fact, when the two types of organization are examined, it is seen that scientists in aerospace establishments use them almost twice as much as scientists in international organizations and slightly more than engineers in both organizations. These scientists are life scientists and physicists, though earth scientists and even chemists, in international organizations also make heavy use of reports. Among those using them the least are those in the management and information fields, telecommunications and nuclear engineering.

Table 51 shows the relative use of written sources of information by scientists and engineers in the two types of organization. It will be noted that certain of these findings contradict the findings of others. For instance, nearly half the respondents rarely use books and conference papers. One third use journals very infrequently. Consistently with others, though, standards and abstract journals are also not greatly used. In most cases the engineers use every source more frequently than the scientists in international organizations, except for abstract journals. In aerospace establishments, the scientists, beside abstract journals also make greater use of textbooks, journal articles and meeting reports. Needless to say, the scientists are mainly, once again, life scientists. Chemists also make heavy use of journal articles but not textbooks or meeting reports. Those in the management and space technology fields make the most infrequent use of journal literature. No fewer than 74% of telecommunication specialists rarely use textbooks in international organizations compared to 14% of the same group in aerospace establishments. Overall, though, it was the non-scientists and engineers who made most use of textbooks. Interestingly enough, 100% of those in nuclear technology and 48% of those in safety and reliability did not use standards! 80% of those in telecommunications also did not. Maybe that is one reason why there is so much bad design and workmanship nowadays - because engineers do not read much, particularly standards.

TABLE 51 - USE OF WRITTEN SOURCES OF INFORMATION

SOURCE	TOTAL (N=287)		INTERNATIONAL ORGS.				AEROSPACE ESTABS.			
			ENGINEERS (N=120)		SCIENTISTS (N=60)		ENGINEERS (N=35)		SCIENTISTS (N=24)	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
reports	16%	30%	15%	34%	10%	23%	12%	37%	4%	41%
own sources/files	16	29	17	32	12	23	25	17	17	33
journal articles	33	20	36	19	28	13	25	29	20	38
conf. papers	41	16	47	17	42	8	24	28	25	25
text books	46	14	51	14	48	7	34	12	22	25
reference books	60	10	61	10	66	6	62	12	34	12
standards	57	9	59	14	56	6	56	6	63	4
meeting reports	41	9	41	8	47	8	43	9	17	16
computer files	53	7	54	5	50	6	55	3	66	12
trade literature	58	5	59	6	55	2	51	9	59	-
abstract journals	61	5	65	3	56	7	60	3	62	12
library lists	55	5	61	3	50	5	48	15	42	8

% of respondents using each source
LOW = very infrequent use of source
HIGH = source used very often

The highest users of standards were life scientists - not the group which would have automatically sprung to the mind of the researcher.

Since computer output can be in the form of printout, it is valid to consider computer files as a written source of information. Respondents in the "other' category, which includes computer scientists, use computers most often. Not much use is made of computer files by scientists and engineers, although scientists in aerospace establishments tend to use the source the most. Breton comments that American engineers largely ignore the valuable dynamic knowledge base that is available to them through computerized databases and laments that they normally use limited and dated resources such as reference manuals (5).

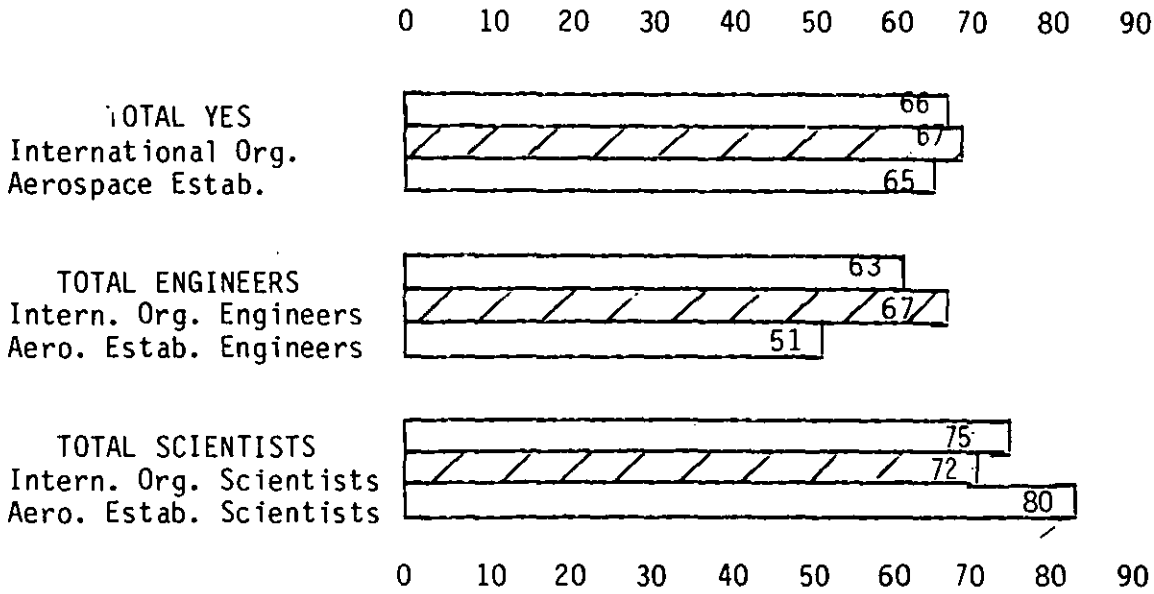
Also to be taken into account are one's own sources, sometimes meaning one's own work or experiments to find the answer, but more often taken to mean one's own (written) files of information. This is the second most frequently used written source of information. In general, the ones using their own sources most frequently were the "other" class, though more engineers than scientists in international organizations use their own sources, while virtually twice as many scientists than engineers in aerospace establishments tend to use their own sources or files. Earth scientists are the main users of their own files, followed by those in telecommunications and management. Those in engineering and electronics make little use of this source as do life scientists, particularly in aerospace establishments and space technologists in aerospace establishments. From Table 50 it is seen that from several studies (Corridore's being an exception), roughly one quarter use their own files as an information source regularly. Scott (27) also gives the figure of 40% for such use, while Bayer and Jahoda (3) reckon that 72% of industrial scientists and technologists and 69% of academic chemists routinely use their own collection of information. Shuchman finds evidence that 93% of engineers depend on their own store of information at some time or other (29).

9.3.3 Awareness and Coverage of Sources

Of course, using information sources is one thing - knowing about them is another. In general, while a majority (66%) of respondents felt they were sufficiently aware of sources of information in their field, a minority (41%) felt they adequately covered them. Staff in international organizations were slightly more aware of sources than their counterparts in aerospace establishments (largely because only one third of the respondents at CNES were sufficiently aware of them) though they covered them less, even though UNESCO was the only establishment in which more people considered they covered them adequately than not. Those in non-supervisory positions tended to be more aware of their sources than those in supervisory positions and also covered them better. Scientists tended to be more aware of information sources than engineers. 75% of all scientists (the figure rose to 83% for scientists in aerospace establishments) were aware of their sources, compared with 63% of all engineers - though engineers tended to cover them to the same extent - 42% saying they did cover them well enough, compared to 42% likewise for scientists. The latter figure was much more pronounced in aerospace establishments where 62% of scientists felt they covered them adequately compared to 33% of the scientists in international organizations (Tables 52 and 53). In individual occupations, a majority in all categories felt they were adequately aware of the sources in their fields - some, overwhelmingly, like those in nuclear technology and life sciences who were all 100% aware; and others, like the chemists where only 55.5% considered they were aware.

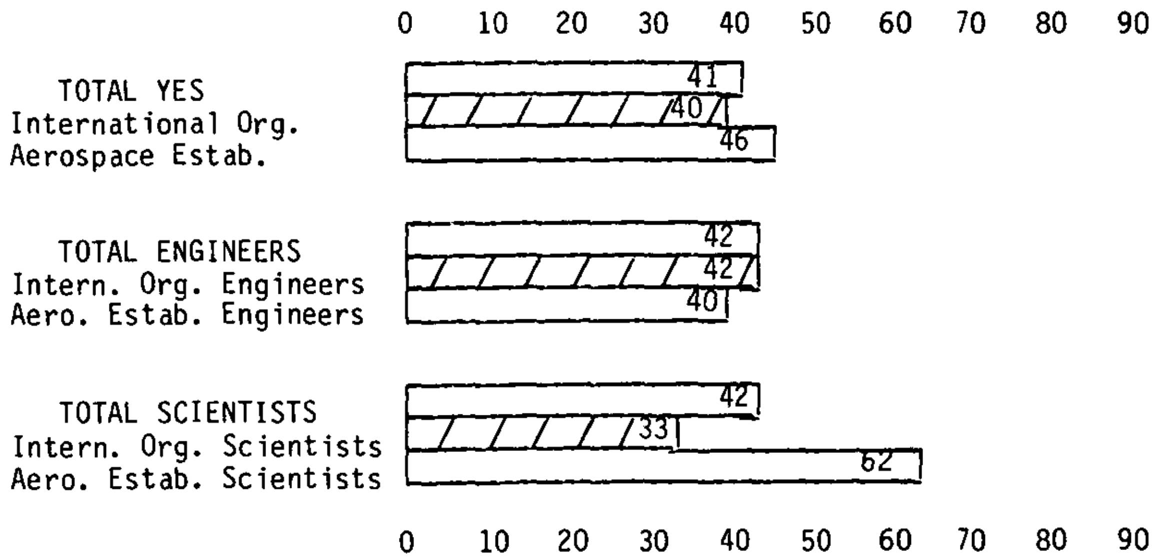
Differences were more pronounced when it came to covering the sources adequately. Only three groups - life scientists and those in the nuclear and telecommunications fields felt they covered the sources adequately. Those in space technology and earth sciences were split equally; while those in management, physics and chemistry did not cover the sources of which they were aware at all well. Regarding nationalities, the French were the least aware of sources - 43% replying they were, compared with 77% of Americans, 76% of Dutch and 73% of Germans.

TABLE 52 - AWARENESS OF INFORMATION SOURCES



N=287 % replying they were aware of sources of information in their field.

TABLE 53 - COVERAGE OF INFORMATION SOURCES



N=287 % replying they covered adequately sources of information in their field

The British were the second lowest - fully one third not being aware of sources of information in their fields. On the other hand, while a majority of Dutch and Germans replied they did adequately cover the sources, the Americans and British dropped to around a half of those being aware - 30% for Americans and 34% for British. Again, in general, it was the older staff who were both aware of sources and covered them. 51% of those adequately aware of sources were aged forty-five or over and 52% were over forty-five years who covered them satisfactorily. Overall, 39% of those saying they were aware of sources of information in their fields also covered them, and 27% said they were aware but did not cover them.

Other authors give somewhat similar figures, although the questions asked were not precisely the same. Hall (14), in a review of the INSPEC SDI service to 500 physicists and electrical engineers, found that 76% considered themselves well-informed (85% after the SDI service was introduced). Anthony (2) noted that 52% of scientists considered themselves well-informed, while from Bayer and Jahoda (3) it can be computed that 81% of chemists and technologists in industry agreed their present sources of information were adequte, compared to 77% of academic chemists. Hypothesis 2 stated that scientists would be more aware of sources in their field than engineers and would cover them better. This hypothesis was confirmed by the study results for the awareness of sources and only partly confirmed (in so far as scientists in aerospace establishments were concerned) for the coverage of sources - engineers covering them better than scientists in international organizations.

9.4 KEEPING UP-TO-DATE

While Hall (14) found that 76% of 500 physicists and electrical engineers considered it important to keep abreast of new developments, 40% had difficulty doing so. Törnudd (31) found that 48% of Danish and Finnish engineers and scientists had no problems keeping up-to-date. The implication in the present study is that scientists and engineers do not keep as current as they could because a) they do not spend sufficient time on information seeking and b) they do not adequately cover the sources of which they are aware.

Note the use of "could" as opposed to "would like to". If they spent a larger amount of their time in background reading then they would be better informed. The Engineering Index study concluded that keeping abreast of developments in the field of individual specialization appears to be a random event influenced by the literature that happens to cross an engineer's desk and by his circle of friends (9).

How did respondents keep up-to-date with what was going on in their field? In common with other studies, e.g. (21), scientists (especially in aerospace establishments) and engineers preferred to keep up-to-date by discussions and talks with colleagues at work. Also high on the list (Table 48) was reading new books and reports (since use of books as an information source was low and use of reports was high it can be assumed that respondents were more probably referring to reports as the literature source for keeping abreast rather than books). Journals were also a good means of keeping up-to-date - though, in fact, slightly more respondents said they used them relatively infrequently than usually. (The present study did not ask for the number of journals read, but other researchers agree that the number is around six or less. Gralewska-Vickery and Roscoe quote 54% as reading six or less (13). Wilson (32) noted that 80% of social workers read five or less and these were mainly journals on free circulation or obtained through professional membership. Mick gives five journals as the number reviewed regularly (24). Wood and Hamilton found 37% of mechanical engineers regularly read less than five (33). Egan (8) showed that most engineers read between four and six technical publications, while Holland (18) gives the number as four. Shuchman simply notes that 57% of engineers did not read or scan general STI journals (29). Use of conferences as a source of keeping up-to-date was fairly low, particularly among those in non-supervisory positions, consistent with the fact that not so many people go to many. Almost one quarter of the respondents kept abreast by scanning library lists, i.e. lists announcing new books and reports as well as important journal articles.

In international organizations a greater number of respondents (particularly scientists) kept abreast by their own journal subscriptions (i.e. received by membership of professional associations). Use of computerized SDI services was on the low side, especially in aerospace establishments, though scientists there used it more than scientists in international organizations, just as engineers there used it less. Since the services exist on all the major databases likely to be required by the scientists and engineers in the two types of organization, one might assume that libraries are not promoting this services to users - possibly for budgetary reasons. However, there is another possibility. For instance, the SDIs come round after the journals have been published, thus readers might already have found and read the articles they were interested in. On the other hand, SDIs may be a reason why some people do not visit the library often or much - they may wait for the SDI and get enough information from the abstracts to make a visit to the library to scan the relevant journals or conferences superfluous. This could account for, at least in ESTEC, the low rate of requests to the library for items announced in the SDI printouts. Of the 14% saying they used SDIs quite often, 6% read for three or more hours per week.

Those in both supervisory and non-supervisory positions tended to keep up-to-date mainly by talks with colleagues. Thereafter, while those in supervisory positions plumped for books, then journals, those in non-supervisory positions chose journals, books and library lists.

Looking at individual groups of scientists and engineers, it is apparent that chemists in international organizations prefer to keep up-to-date by talking with colleagues, reading books, and by SDIs, while chemists in aerospace establishments prefer scanning journals and library lists. Earth scientists scan journals (including their own subscriptions) read books and talk to colleagues. Those in space technology, like physicists and chemists do not subscribe to journals in their field or, if they do, then they are not used as a means for keeping abreast of developments.

In fact, space technologists in both organizations and physicists in aerospace establishments do not make much use of the journal literature at all, preferring instead to talk to colleagues, read new books and scan library lists.

9.5 TIME SPENT INFORMATION SEEKING

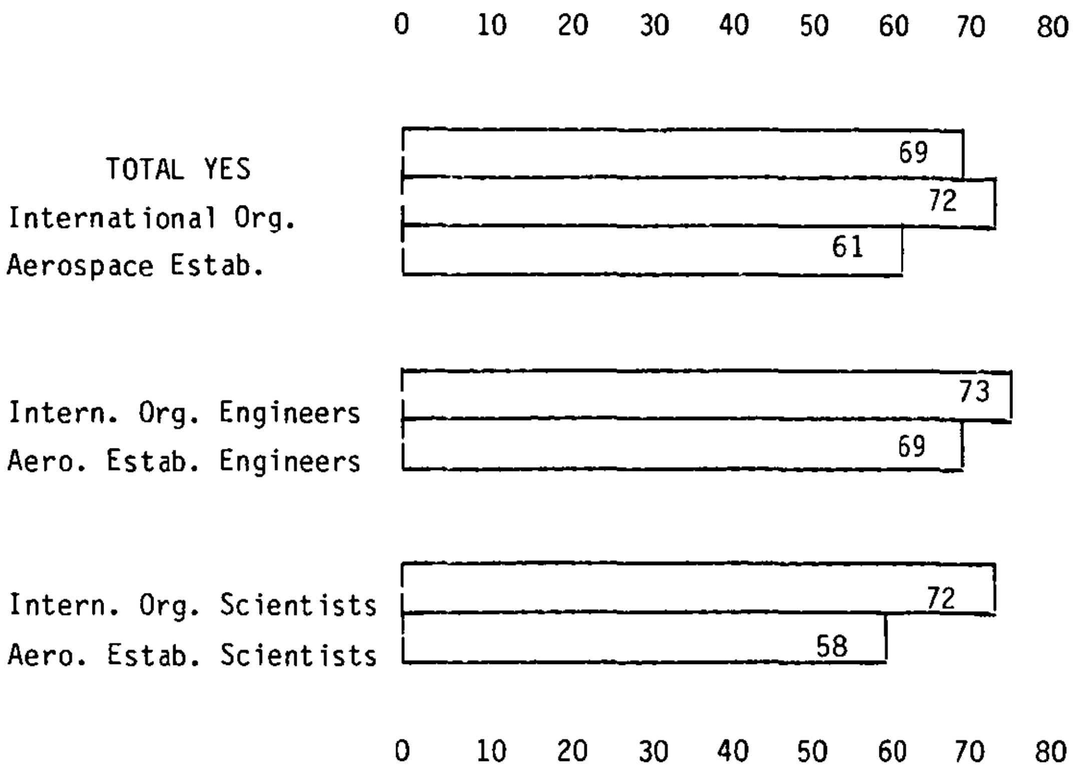
In general, an awful lot of people (32%) were not aware of the sources of information in their fields. This could be due to the education and training they received in the use of the library and sources while at university. Wood and Hamilton observed that 88% of mechanical engineers did not receive any training in how to search for scientific information (33). Törnudd (31) perceives a distinct correlation between educational record and the extent to which literature is resorted to. It could be due to the paucity of sources in their specific fields, though this is unlikely. It could be due to the vast multiplicity of sources, particularly in the English language. In view of the fact that probably a majority of literature sources will be in the English language and the fact that English is an official language in the international organizations, one would have expected the British and Americans to be much more aware of likely sources and cover them than they were and did.

The poor awareness and coverage could also be due to a disinclination to find out or simply due to lack of time. How much time was actually spent information seeking? Other writers give widely diverging times. Berul, of 1300 scientists and engineers in the US Defence community, says 24% of their time was spent locating, obtaining and using scientific and technical information (4). The Engineering Index study notes that only 5% of the respondents' time was spent searching for information (9). Mick and co-workers found that 2.8 hours/week was spent browsing in the library (24), while Anthony gives very precise figures: 11.4 minutes spent by scientists seeking information - 11.8 minutes by physicists and 12.8 minutes by chemists (2). From Bayer and Jahoda's figures it can be shown that four hours or less per week were spent by 56% of those in industry locating information and by 66% of those in academic environments (3).

The present research did not ask for amounts of time directly, but 69% did not spend as much time as they would like on information seeking. People in aerospace establishments were more satisfied with the time they spent than were those in international organizations (Table 54). Scientists, particularly in aerospace establishments, spent more time information seeking than engineers - though only one third of these scientists and one quarter of the engineers were satisfied they spent enough time. A majority of those in chemistry and life sciences spent as much time as they wanted on looking for information and among those that did not, physicists were the highest with 82% not spending sufficient time, compared with 77% for those in telecommunications, 76% for those in space technology and 74% for those in management. 24% of those in supervisory positions reckoned they did spend enough time, compared to 35% for those in non-supervisory positions. Older staff spent more time searching for relevant information - 54% of those replying they did spend as much time as they wanted were over forty-five years old. Nationality-wise, among those most satisfied with the time they spent information seeking were the Dutch (37%). One third of Americans also spent as much time as they wanted, though less than a quarter of the British did.

Generally speaking, 56% said they did not adequately cover the sources of information in their fields - but of these no fewer than 60% read for less than two hours per week on average. Conversely, of the 41% who did feel they covered information sources adequately, 52% spent more than 2 hours a week on average in background reading. Overall, 54% spent two hours or less a week in background reading - more respondents in international organizations spending up to two hours than in aerospace establishments (57% compared to 48%), (Table 55). Of the individual establishments the percentage of people reading for two hours or less ranged from 7% for UNESCO (all between one to two hours) to 67% for ESTEC (21% under one hour). In UNESCO, 60% read for between three and five hours a week. Of the 69% who said they did not spend enough time on information seeking, almost 60% read for a maximum of two hours a week.

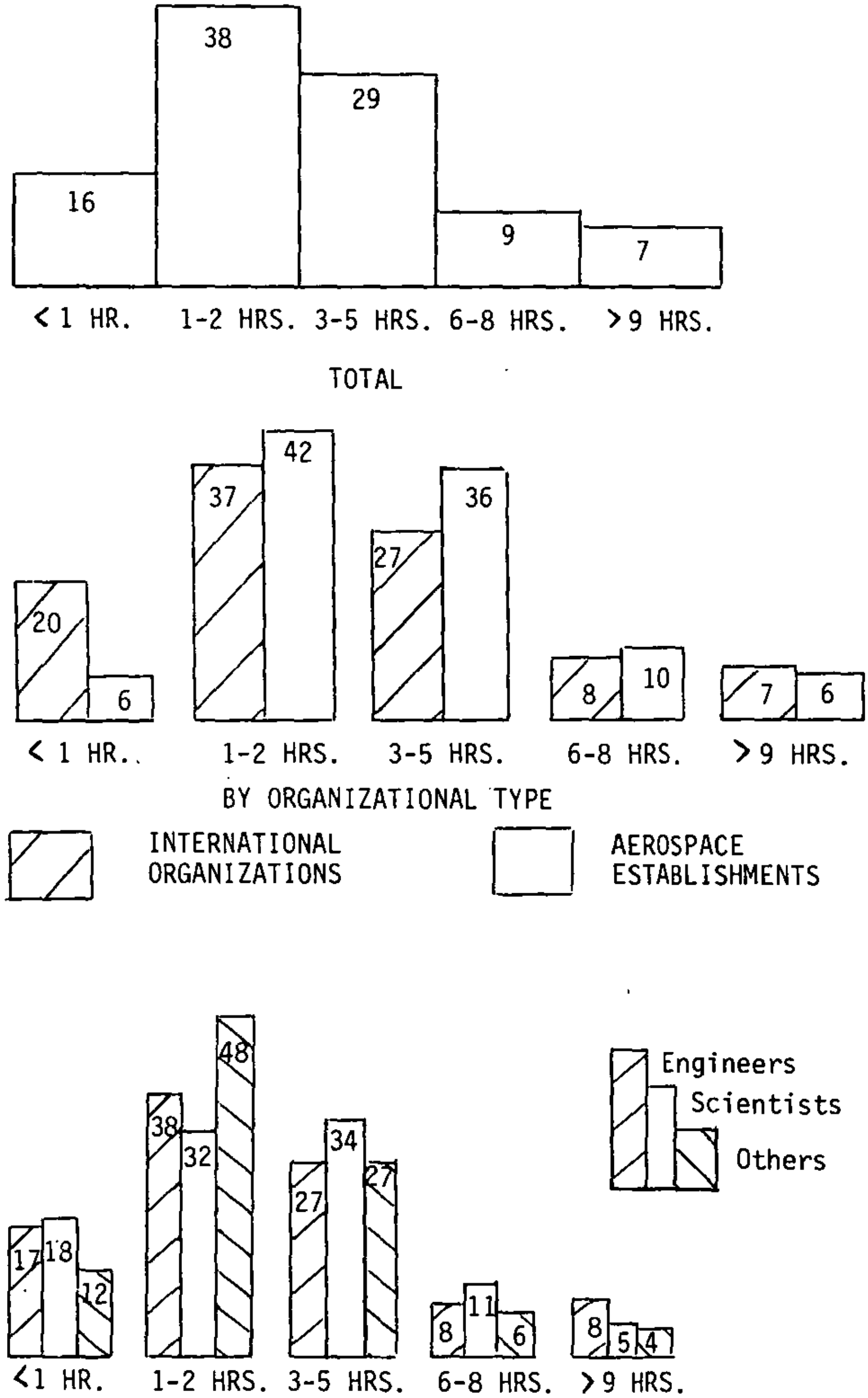
TABLE 54 - DISSATISFACTION WITH TIME SPENT INFORMATION SEEKING



N=287 % replying they did not spend as much time as they would like on information seeking

Previous evidence has suggested that gatekeepers read more than others and that gatekeepers are in supervisory positions. The present survey shows that those in supervisory positions tend to spend a little less time reading than those in non-supervisory positions - though in both groups more than 50% read for only two hours a week or less to keep themselves abreast of new developments. There was no difference between younger and older staff when it came to spending time on background reading - 50% of those spending no more than two hours a week were over forty-five years old and 50% were under forty-five years old. This result differs from that of Egan who found that older engineers read more (8). Herner too, found a slight increase in literature use by people over fifty (15).

TABLE 55 - TIME SPENT PER WEEK IN BACKGROUND READING



N=287 % of respondents spending time reading

Scientists tended to spend a little more time than engineers in background reading - 50% reading for three hours or more compared with 43% of engineers - though a slightly higher proportion of engineers (17%) spent more than six hours a week in background reading compared to scientists (15%) (Table 55). Whereas getting on for nearly half as many again of scientists in international organizations than engineers read for three to five hours a week, in aerospace establishments the picture was a virtual mirror image. Those spending less than one hour per week in background reading to keep abreast included virtually a quarter of all chemists, safety and reliability engineers, physicists and managers. 59% of those in the nuclear field spent six hours or more per week in background reading (100% spent more than three hours), as did 46% of the earth scientists. Other heavy readers included life scientists (26% spending more than six hours), physicists (25% spending more than six hours) and chemists (31% spending more than six hours).

From what has been said already, it will come as no surprise to learn that 77% of the British spend two hours a week or less in background reading and only 5% more than six hours. This is really very low - even the French are much higher, 60% of whom spend a maximum of two hours reading and 29% spending more than six hours - the highest percentage, in fact, the next being the Americans with 23% spending more than six hours reading.

Actually these figures for the time spent reading per week tie in quite well with other writers. In Hall's study (14), 50% spent less than two and a half hours/week reading. Anthony (2) gives figure of two hours a week spent by scientists in reading journals (compared to Japanese scientists who spent two hours a day!). Mick et al give 3.9 hours/week as the average reading time (24). In their survey of industrial and academic chemists and technologists, Bayer and Jahoda found that 47% of the industrial group spent less than four hours a week reading and 39% of the academic group did (3). Lufkin (21) worked out that, on average, engineers spent forty minutes a week reading contractor reports and professional society journals. Like Jenny, he found that high achievers read more as did those with a better education.

Jenny, in fact, who surveyed 3000 engineers in RCA in 1977 concerning the ways in which they utilize sources supplying the information they need, appears to be an exception to the relatively low figures given above for background reading. Jenny quotes figures a lot higher - 10.6 hours per week for low achievers and fourteen hours a week for high achievers (19).

Of those keeping up-to-date by reading new books, 42% read for two hours or less per week. Similarly, of those usually keeping abreast by scanning journals in the library, almost 50% read for a maximum of only two hours a week. On the other hand, 64% of those with personal journal subscriptions spent more than three hours per week reading - most likely at home. In an earlier draft version of the questionnaire respondents were asked where they did their background reading, e.g. at home, in the office, on public transport. Several people went to great lengths to explain that if they did read at all in the office then it was after office hours. Equally some considered it almost wrong to do reading for their work activities at home. Menzel, in a study at the Case Institute of Technology found that two thirds of chemists and physicists read journals at work (23).

Reasons for the small amount of time spent reading have been hinted at earlier. No motivation, low inclination, too little time because of meetings and study contracts, not necessary for the job being held down, low information requirements. Another reason put forward is the amount of time spent on mission - business away from the office. From Chapter 8, section 8 and Table 41 it may be recalled that 50% of the respondents spent between 10% and 30% of their time away from the office, while one fifth spent one quarter of their working life on mission. Background reading will not usually be done while on such business trips - one is too busy reading up about the meeting in hand.

Does, in fact, the time spent away from the office travelling have any bearing on the amount of time spent reading to keep abreast of developments? Not really.

Of those not doing any travelling at all during the period in question, 29% did less than one hour reading per week, while 50% did two hours or less. Of those spending over one quarter of their time on mission, 50% read for three hours or more a week and 14% read for more than nine hours/week. However, the biggest group of respondents (18.5%) spent 20-24% of their time away. Of these, 64% spent two hours or less in background reading, still leaving, though, a fairly hefty third who did spend three hours or more. Bearing in mind that 77% of the British read for two hours or less a week, one might conclude it was because they did spent a lot of time travelling. In fact 33% of all those not travelling at all were of English mother tongue, and 37% of the native English speakers spent less than 10% of their time away, while 73% spent less than 25% of their time on mission. It would have been interesting to learn where those that travelled a lot and found time for reading actually did it - on planes, trains or at home or in the office.

9.6 USE OF THE LIBRARY

9.6.1 Reasons for Visiting the Library

For many, the library is a prime source of formal or published information. Although a majority visit it only infrequently, few never visit it at all. What are the reasons why people visit the library? Of course, the reasons are obvious, but it is interesting, nevertheless, to look at the implications. The main reason given for visiting the library was to scan new journals - scientists in aerospace establishments doing this more frequently. The implications here are that either journals are not circulated within the establishments or if they are, then they take so long that it's better to read them in the library before they go out on circulation. The second most popular reason for visiting the library was to borrow documents (scientists and engineers in both organizational types were equal). In fact, while people were keen to borrow, they were not nearly so eager to return the books and reports - non-scientists/engineers being the best. This may point to a reason for not visiting the library so often - they could send the documents back by mail.

Scientists and engineers could just sit back in their offices and wait for journals to come to them on circulation. Murphy (25), examining nearly 800 cadets and faculty at the US Air Force Academy, found that the main reasons why faculty members visited the library were to return or borrow books, read class assignments and to carry out research for papers or projects. Cadets, on the other hand, visited the library to do research, to study and to return or borrow material. In the present study, visiting the library to do research was fairly low, although as Table 56 shows, a fifth of the scientists visited it very often to do their own literature searches. Only 6% visited the library very often to request a literature search - possibly a reflection on the competence of library staff. Although Bayer and Jahoda (3) found that almost 50% of both academic chemists and industrial chemists and technologists frequently used the library for browsing, in the present study only 8% did, although the figure was 16% in aerospace establishments. This may point to a lack of time - certainly a high proportion spent very little time in the library.

Engineers did not consult reference books nearly so much as scientists and the non-engineers/scientists. Those in aerospace establishments and in the category "other" also read newspapers in the library quite frequently.

On the other hand some people were at pains to point out that they never read newpapers in the library. The figures do not tally with those of Herner (15) in his study of pure and applied scientists and engineers. According to Herner the applied scientist wants searches done for him, does not frequent the library and makes relatively little use of written or published information. The lack of demand by non-scientific/technical staff (the "other" category) for literature searches is also interesting. Ludewig analyzed 575 enquiries from library users over a nineteen-month period and found that 33% came from engineers, 24% from scientists and 43% from others. 67% of queries were non-technical (20).

TABLE 56 - REASONS FOR VISITING THE LIBRARY

REASON FOR VISIT	TOTAL (N=287)	INT. ORGS. (N=218)	AERO. ESTAB. (N=69)	ENGINEERS (N=155)	SCIENTISTS (N=84)	OTHERS (N=48)
read journals	27%	24%	35%	21%	32%	31%
borrow documents	22	22	22	24	21	17
read new books	9	9	10	8	9	10
consult ref. books	9	10	5	6	12	14
browse	8	6	16	10	6	8
do own search	8	8	8	3	20	4
return documents	7	7	7	7	5	10
request lit. search	5	3	8	6	6	-
read newspapers	5	3	8	4	4	10

% replying they visited the library very often multiple answers possible

9.6.2 The Library as a Source of Information

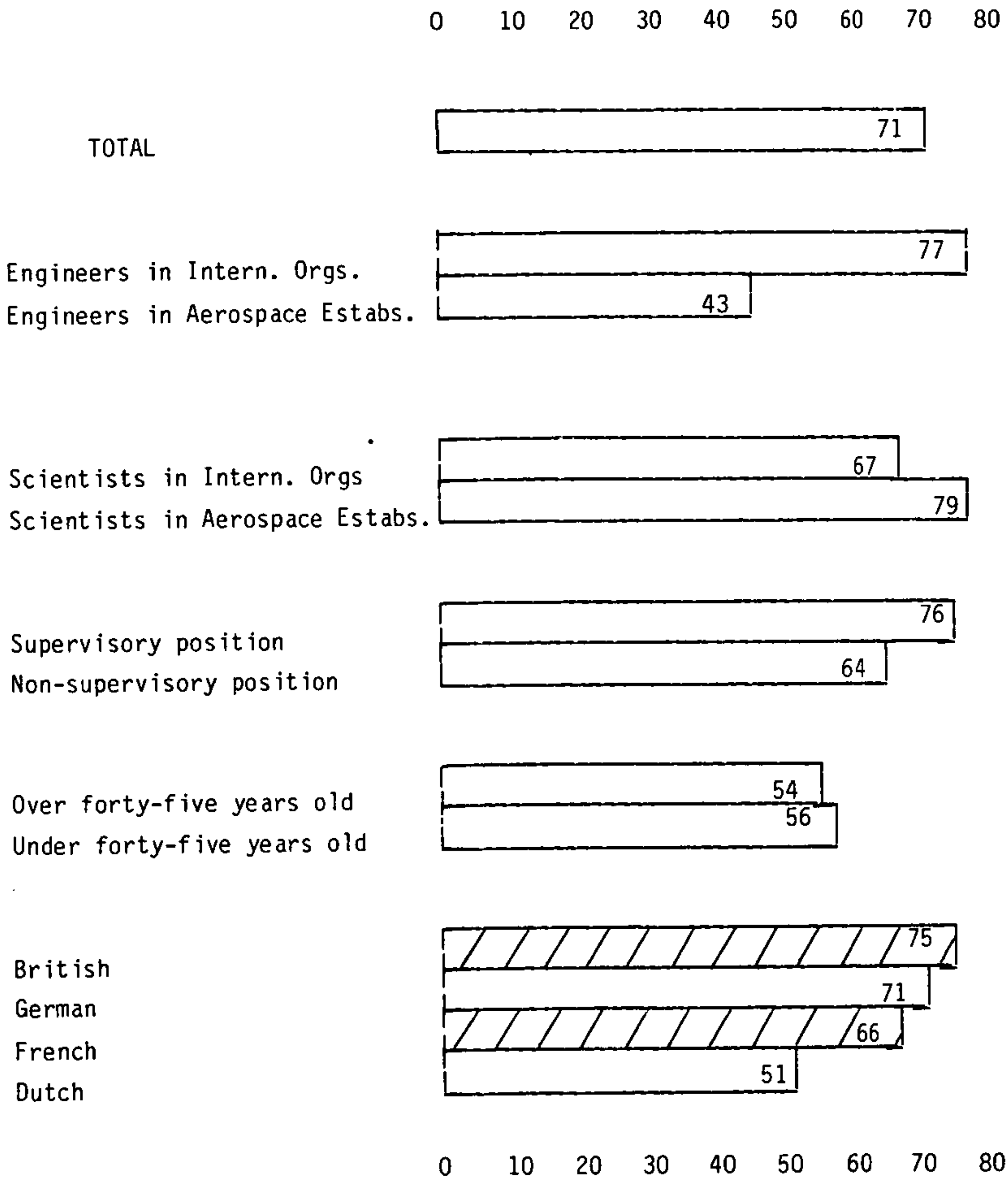
From the previous section it can perhaps be assumed that the average scientist or engineer uses the library more to see what new books and journal issues are available rather than as a real source of information. This is borne out by the replies to Question 27 which asked whether most of the information needed for work purposes was obtained from the library. A hefty 71% gave a resounding NO. (38% were engineers and 21% were scientists and the range for individual establishments was from 21% (NLR) to 100% (CNES). A smaller proportion in aerospace establishments said no than in international organizations and it turns out that it is the engineers in aerospace establishments (particularly NLR where 79% got what they wanted) who are the most satisfied with what they get from the library. Compare with Herner (15) who observed that the library is by far the most important source of published material for working scientists and with Herner (16) who notes that at the Goddard Space Flight Center, for 29% of staff the library was the main source of information. Corridore, too, found that 17% of the respondents in his study got the greatest amount of information from the library (6).

In general, those in non-supervisory positions got more of what they wanted from the library - self-evident, perhaps, in view of the schedule and planning details a manager might need.

Age-wise, 54% of those over forty-five years old did not get all they wanted from the library compared to 52% of those under forty-five years. The Dutch were the most satisfied with the information they could get from their libraries and the British were the least satisfied - 51% of Dutch, (94% in ESTEC), replying they could not get what they wanted compared to 75% for the British, 71% for the Germans and 66% for the French (Table 57).

The kinds of information which respondents required and which they could not get from the library were discussed in Section 9.2.4. Briefly, they were project-related, day-to-day details, literature, technical data, administrative data and experience.

TABLE 57 - PROPORTION NOT GETTING REQUIRED INFORMATION FROM LIBRARY



% replying they did not get most of the information they needed from the library.

The sources for these types of information were also covered - the main ones being personal contacts, contractors, originators' own sources and literature. Most of these sources - except the latter - it is obvious the library could not compete with - a fact recognized by the scientists and engineers. Of those that replied to the question "do you feel the library should be able to supply this kind of information?" (i.e. the information they said they could not get), 59% said no and only 10% responded yes. Reasons why respondents felt the library should not be in a position to supply the information were that it was too specific because it was project-oriented (16%), it was confidential (8%), that it was just not possible (8%) and that it was not its task (9%). Other reasons mentioned included the expense of trying to cover everything and the ephemeral nature of the information sought. Those who thought the library should cover everything gave as reasons that it was the library's function to cover everything (6%) and that it saved time.

9.6.3 Frequency with which the Library is visited

Above it was seen why the library was visited and it was shown that much of the information required could not be obtained from the library. Undoubtedly, this is a major reason why the library is not frequented so often. 60% of the respondents visiting it less than once a week - those in aerospace establishments being the less frequent visitors (Table 58).

Those in supervisory positions do not visit it so much - 63% saying they visit it less than once a week compared to 52% for those in non-supervisory positions. The older scientist and engineer also tends to frequent it less frequently. Scientists visit the library rather more than engineers - 15% visiting it more than three times a week compared to 13% for engineers (63% of engineers visit it less than once a week compared to 50% for scientists). Those visiting it least often were those in telecommunications, management and informatics in aerospace establishments and life scientists and safety/reliability engineers in international organizations.

TABLE 58 - FREQUENCY WITH WHICH LIBRARY VISITED

AMOUNT WEEKLY	TOTAL (N=287)	INT. ORGS. (N=218)	AERO. ESTAB. (N=69)	ENGIN. (N=155)	SCIENT. (N=84)	OTHERS (N=48)
<once	60%	57%	68%	63%	50%	67%
1-2 times	26	26	26	24	35	17
3-5 times	12	14	6	11	14	12
6-8 times	1	2	-	1	1	2
>9 times	1	1	-	1	-	2

% of respondents visiting the library

As for nationality, 83% of Americans visited the library less than once a week, compared with 61% of Germans, 60% of French, 54% of Dutch and 52% of British. 20% of the British visited it more than three times per week.

It would appear that those working in the R&D environment are less prone to use the library than those in an academic environment. Murphy found that 8% of faculty staff and 11% of Air Force cadets used the library daily, 38% and 28% used it once a week, 20% and 25% more than once a week, 25% and 24% once a month and 10% and 12% less than once a month (25). Of course, just because respondents in the present study did not visit the library much, does not mean to say that they do not use it - they could request documents and information by phone or mail, they could get journals on circulation and they could scan library announcement lists. It is noticeable, though, that at ESTEC the poorest library visitors and users are those working in project teams as opposed to those working in functional support.

This serves to emphasize the finding that the information needed by these members is not obtainable though the library. Asked if they used the library/information services in their organization more or less now than they did twelve months ago, 73% replied the same, 11% more and 14% less. Reasons for the given response were because of their current position (31%), their current task (31%), their experience (19%) and their reliance on other sources (15%).

If the library is active and dynamic in sending out material, doing literature searches, SDIs and reference enquiries, then there may very well be no need to visit the library often because staff get material anyway. Another reason for low visit frequency could be the distance the respondent was situated from the library.

Evidence proves that people will not travel 200 or so metres to the library if they can help it, though they will travel the same distance to the bank, travel office, canteen, video club, commissary, etc. Of the 60% visiting the library for less than once a week, 59% read for only two hours or less, while of those visiting the library more than three times a week, 61% read for more than three hours a week - further evidence that one is either a whole-hearted user of information or not. Jenny records that high achievers use the library more than once a week (19).

9.6.4 Time Spent in the Library

The study found that virtually half the respondents spent less than fifteen minutes in the library at any one time. This compares well with Rawdin (26) who found that 54% spent less than 17.5 minutes there. Mick (24) averaged the time out to thirty minutes a week spent in the library.

Just as those in supervisory positions visit the library less, so they also spend less time there - 53% spending less than 15 minutes there and 15% spending over thirty minutes, compared to 45% and 23% respectively of those in non-supervisory positions. In addition, 50% of those aged forty-five years and over also spend less than fifteen minutes there at any one time.

Staff in aerospace establishments spent quite a lot longer time there than staff in international organizations (Table 59) and while engineers spent less time in the library than scientists in general, engineers in aerospace establishments spent more time there than scientists in international organizations, though not as much as scientists in their own establishments (Table 60). 50% of engineers spent up to fifteen minutes in the library at a time, compared to 44% of scientists. Those spending the greatest amount of time in the library were life scientists in both types of organization and those in aerospace establishments working in engineering and electronics (89% staying there for longer than thirty minutes), earth scientists (100% staying there for thirty minutes or more), physicists (50% staying there for over thirty minutes) and telecommunications (43% for over thirty minutes). In the management area, 30% of such staff in aerospace establishments and 24% in international organizations spent less than five minutes there at a time - and these were among the most infrequent library users anyway. In international organizations, 50% of physicists and 60% of those in telecommunications only spent five to fifteen minutes in the library (compared to 20% and 43% for the same groups in aerospace establishments).

It has been suggested throughout that the British are poor information users. The study shows that 14% of the British spend less than five minutes in the library per visit, although 49% did spend between five and fifteen minutes there, compared to 32% of the Germans, and 15% of Germans who spent less than five minutes there. Only 2.5% of the French passed less than five minutes in the library at any one time and a surprising 43% spent fifteen to thirty minutes there, along with 31% of the Dutch. The Dutch (10%) also spent longer than one hour there. This is revealing in view of the fact that they were the ones who said they could get much of the information they needed from the library! Obviously the time spent there paid off! Also revealing is the fact that of the 49% spending fifteen minutes or less in the library at any one time, 64% read for less than two hours per week.

TABLE 59 - TIME SPENT IN LIBRARY PER VISIT

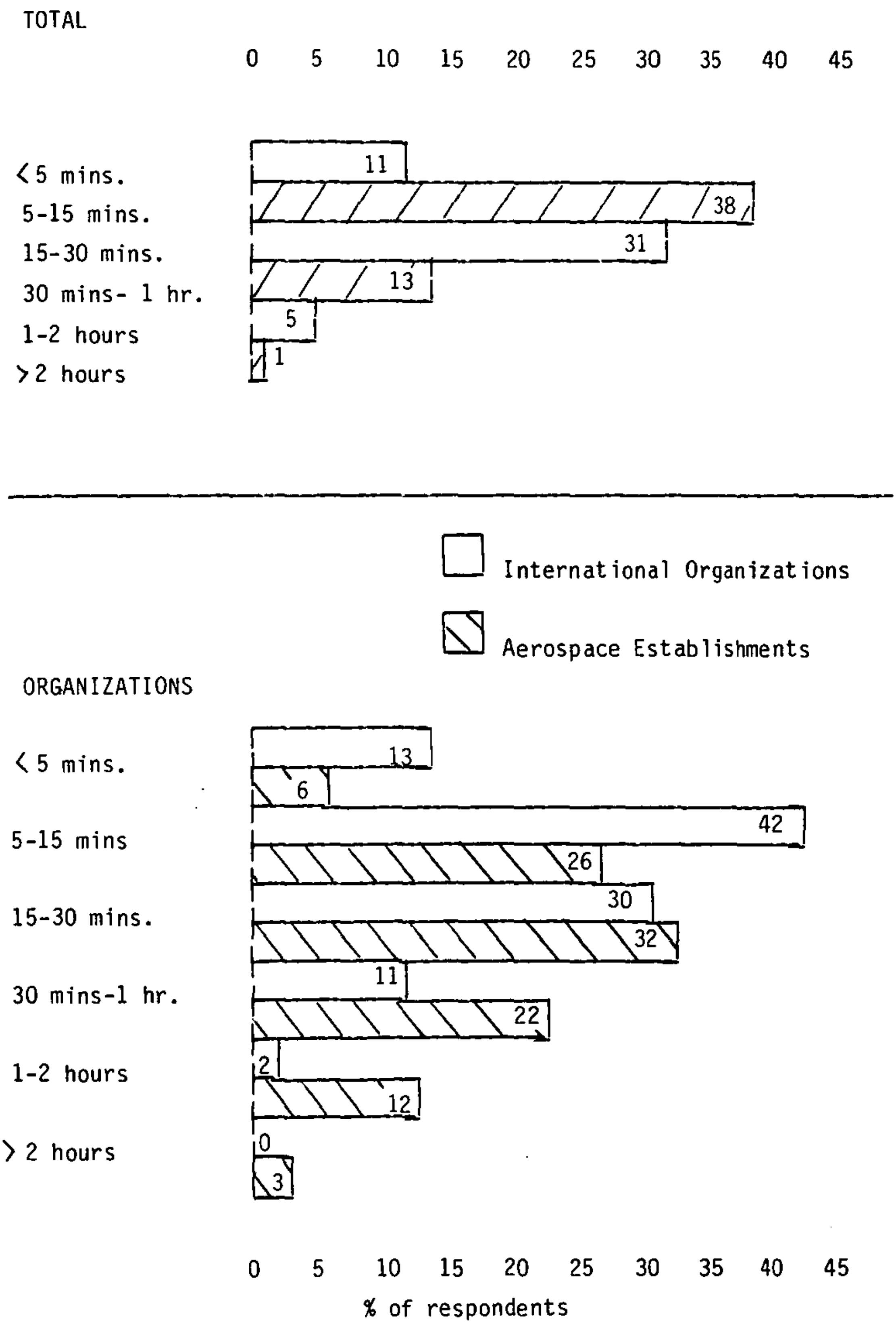


TABLE 60 - TIME SPENT IN LIBRARY BY PROFESSION AND ORGANIZATION

TIME	INTERNATIONAL ORGANIZATIONS			AEROSPACE ESTABLISHMENTS		
	ENGINEERS (N=120)	SCIENTISTS (N=60)	OTHERS (N=38)	ENGINEERS (N=35)	SCIENTISTS (N=24)	OTHERS (N=10)
<5 minutes	11%	12%	24%	3%	4%	20%
5-15 minutes	44	38	39	31	25	10
15-30 minutes	32	33	18	20	38	60
30-60 minutes	8	12	16	29	21	-
1-2 hours	2	3	-	14	8	10
>2 hours	-	-	-	3	4	-
N/A	3	2	3	-	-	-

% of respondents

N/A = no answer

Conversely, of those spending more than one hour in the library at any one time, 93% spent more than three hours per week in background reading. Heavy readers are thus heavy library users and vice-versa.

9.7 PROBLEMS WITH AVAILABILITY OF INFORMATION

Earlier it was noted that a large amount of information could not be obtained via the library, chiefly because it was of an informal, undocumented type that constantly changed. Such information is not generally provided by the traditional library. For the vast majority of respondents such non-availabililty from the library did not cause them any concern - they had their own sources and, as we have seen, these were chiefly personal contacts. In fact, given a number of potential problems in getting the information needed to solve problems or complete tasks, only a handful of people said any problems were present. The one causing the most problems was the delay in getting hold of it - 9% said this was very often a problem. It was also a difficulty encountered by Törnudd (31) in her study of scientists in Denmark and Sweden, where 6% said delay in publication was a problem. In the Engineering Index survey 63% of chief engineers and 56% of design engineers said that the delay in getting information could be twenty-four hours or more (9) - the implication being that this was an impediment to them.

Törnudd (31) noted other difficulties such as time limitations (71%) and lack of access to published literature (23%). In the present study, 69% considered they did not spend as much time as they would have liked on seeking information - in nice agreement with Törnudd. Jenny, in the survey of 3000 RCA engineers in 1977, found an obstacle to keeping abreast by reading was that they had no time either at home or work. 71% of high achievers had no time at work and 52% had no time at home, compared to 62% of low achievers having no time at work and 41% having no time at home (19).

According to Shuchman, the major difficulty engineers encounter in finding the information they need to do their job is identifying a specific piece of missing data and then learning who has it (29). Table 61 gives an overview of the problems encountered in getting needed information in the present survey.

No one admitted to the fact that language was a problem, signifying that there was sufficient in their own language (in fact too much information was the second biggest problem and the one with which the smallest number rarely had problems) or that they understood sufficient languages to be able to cope with material not in their native tongue.

Scientists and engineers did not mostly however want a course on how to use the library and sources of information - 60% replying NO they did not want a course organized and 35% replying they did. Staff were unsure whether the library already ran courses in information use - 46% saying no, 36% saying yes and 11% saying they did not know.

TABLE 61 - PROBLEMS GETTING INFORMATION

PROBLEM	OFTEN A PROBLEM	RARELY A PROBLEM
delay in getting it	9%	42%
too much available	7	51
not available in library	6	57
in microfiche form	4	57
no reference found	3	61
information is confidential	2	69
unhelpful library staff	2	72
unhelpful colleagues	-	68
in language not understood	-	75

% of respondents replying they often or rarely had a problem
N=287

REFERENCES

1) ALLEN, T.J.
Managing the flow of technology. MIT Press, 1977.

2) ANTHONY, L.J. et al
The growth of the literature of physics.
Reports on Progress in Physics, 32, 6, Dec, 1969, p.709-767.

3) BAYER, A.E. and JAHODA, G.
Background characteristics of industrial and academic users and non-users of online bibliographic search services.
Online Review, 3, 1, March 1979, p.95-105.

4) BERUL, L.H. et al
DOD user needs study. Phase 1. Vols 1 and 2. Auerbach Corp., 1965.
Report no. 1151-TR-3, AD 615501/2.

5) BRETON, E.J.
Why engineers don't use databases.
ASIS Bulletin, 7, 6, August 1981, p.20-23.

6) CORRIDORE, M.C.
Scientific and technical information needs of users or potential users of the DSA-administered, DOD Information Analysis Centers.
Defence Supply Agency, 1976. Final Report AD A024937.

7) DISCH, A.
The voice of the user: his information needs and requirements.
In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976. AGARD-CP-179, p.14.1-14.8.

8) EGAN, F.T.
Today's engineer: a survey.
Electronic Products, 25, 9, 10 Dec, 1982, p.40-45.

9) ENGINEERING INDEX, Inc.
Alternatives for accessing engineering numerical data. NTIS, 1978. PB282609.

10) FLOWERS, B.H.
Survey of information needs of physicists and chemists. Journal of Documentation, 21, 2, June 1965, p.83-112.

11) GLASS, B. and NORWOOD, S.H.
How scientists actually learn of work important to them. In Proceedings of the International Conference on Scientific Information, 1958 Nov. 16-21, Washington, DC. National Academy of Sciences, 1959, p.195-197.

12) GOLDHAR, J.D. et al
Information flows, management styles, and technological innovation. IEEE Trans. on Engineering Management. EM-23, 1, Feb. 1976, p.51-62.

13) GRALEWSKA-VICKERY, A. and ROSCOE, H.
Earth science engineers communication and information needs. Final Report and Appendix. Imperial College, 1975. Research report no. 32.

14) HALL, A.M.
Methodology and results of some user studies on secondary information services. In EURIM: European Conference on Research into the Management of Information Services and Libraries, 1973 Nov. 20-22, Paris, France. ASLIB, 1974, p.31-37.

15) HERNER, S.
Information gathering habits of workers in pure and applied science Industrial and Engineering Chemistry, 46, 1, Jan. 1954, p.228-236.

16) HERNER, S. et al
An evaluation of the Goddard Space Flight Center Library. Herner and Co. 1979, NASA-CR-159969.

17) HOGG, I.H. and SMITH, J.R.
Information and literature use in a research and development organization. In Proceedings of the International Conference on Scientific Information, 1958 Nov. 16-21, Washington, DC. National Academy of Sciences, 1959, p.131-162.

18) HOLLAND, W.E. et al
Information channel/source selection as a correlate of technical uncertainty in a research and development organization.
IEEE Trans. on Engineering Management, EM-23, 4, Nov. 1976, p.163-167.

19) JENNY, H.K.
Heavy readers are heavy hitters.
IEEE Spectrum, 15, 9, Sept. 1978, p.66-68.

20) LUDEWIG, C.W.
Information needs of scientists in missile and rocket research as reflected by an analysis of reference questions. MLS Thesis submitted to the University of North Carolina, 1965.

21) LUFKIN, J.M.
The reading habits of engineers - a preliminary survey.
IEEE Trans. on Education, E-9, 4, Dec. 1966, p.179-182.

22) MEADOWS, A.J. and O'CONNOR, J.G.
An investigation of information sources and information retrieval in astronomy and space science. OSTI, 1969. Report No. 5044.

23) MENZEL, H.
The information needs of current scientific research.
Library Quarterly, 34, Jan. 1964, p.4-19.

24) MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980, p.347-356.

25) MURPHY, M.
Measuring library effectiveness: a prelude to change.
Special Libraries, 70, 1, Jan. 1979, p.18-25.

26) RAWDIN, E.
Field survey of information needs of industry sci/tech library users. In Proceedings of 38th ASIS Annual Meeting, 1975, Boston, Mass. ASIS, 1975, p.41-42.

27) SCOTT, C.
The use of technical literature by industrial technologists.
IRE Trans. on Engineering Management, EM-9, 2, June, 1969, p.76-86.

28) SHEPPARD, M.O.
User response to the SDI service developed at Aeronautical Research Laboratories, Australia. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976, AGARD-CP-179, p.10.1-10.9.

29) SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group, 1981.

30) SUTTON, J.R.
Information requirements of engineering designers. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976, AGARD-CP-179, p.12.1-12.8.

31) TÖRNUDD, E.
Study of 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, 1958 Nov. 16-21, Washington, DC. National Academy of Sciences, 1959. Vol.1, p.19-75.

32) WILSON, T.D. et al
Information needs in local authority social services departments: a second report on Project INISS.
Journal of Documentation, 35, 2, June 1979, p.120-136.

33) WOOD, D.N. and HAMILTON, D.R.L.
The information requirements of mechanical engineers: report of a recent survey. Library Association, 1967.

PART 4

SUMMARY AND RECOMMENDATIONS

Chapter 10 Summary and Review of Results

Chapter 11 Conclusions and Recommendations for Improvements

In Chapter 10 the objectives of the study reported herein are recalled and their attainment briefly discussed. Next the hypotheses, formulated at the outset, are also repeated and examined to see whether, in the light of the study results, they can be accepted or rejected. Finally, the results of the survey are concisely reviewed to set the scene for Chapter 11, which aims to provide some discussion of points raised throughout the work with a view to giving recommendations on how improvements in various areas might be achieved.

CHAPTER 10

SUMMARY AND REVIEW OF RESULTS

10.1 INTRODUCTION

This study has surveyed the information seeking and use habits and communication patterns of scientists and engineers in two distinct types of organization. These two types of organization were international organizations and national aerospace research establishments, which it was believed would have similar information and communication patterns to the former by virtue of their taking part in multi-national projects.

Although the response rate was low, nevertheless, patterns were identifiable from various types of information users and these were found to be similar in many broad instances.

10.2 REVIEW OF OBJECTIVES

Following the primary objective to study and compare the patterns of communication and information seeking and use of scientists and engineers working in the two types of organization, several secondary objectives were established (see Introduction). These are discussed below.

It was to be ascertained whether certain groups of scientists/engineers needed information more regularly and frequently than others. This was treated in Section 9.2. In general, engineers required facts, data and advice or opinions slightly more often than did scientists. Furthermore, engineers were inclined to wait longer for these and spend longer seeking them than scientists, though they tended to need them faster. Scientists, on the other hand, required ideas more than engineers especially in aerospace establishments. They were also prepared to spend longer seeking ideas than engineers and were willing to accept a more flexible time limit on the age of them. Scientists also needed documentary information more than engineers.

Another secondary objective was to ascertain what kinds of information were needed by various groups and how their requirements were satisfied. The paragraph above gives an indication of the information needed. Requirements were satisfied by a variety of information sources - chief of these being informal communication with colleagues. Scientists tended to confer with colleagues in-house more so than engineers, while the latter got more information from outside contacts than did scientists. Regarding the use of literature to satisfy information needs, reports and journals figured strongly, with engineers favouring both (Section 9.3 refers).

The third objective was to discover the channels by which individuals or groups got their information and communicated with others. Also included here was an examination of their frequency of use and reasons for use. This objective was also attained in so far as the time spent communicating via a number of media was estimated (Section 8.2). In general, slightly more time was spent on written communication (particularly by scientists) despite the fact that oral sources were preferred to literature when it came to finding out about information and despite the fact that personal, face-to-face contact was the preferred, most fruitful communication channel. Section 8.5 discussed these aspects.

The final secondary objective had as its aim the identification of barriers to information provision and communication. While there are undoubtedly barriers for some individuals, few admitted to being in any difficulty because of them, so to all intents and purposes there were no real barriers. A discussion was given in Section 8.8.

10.3 REVIEW OF OTHER ASPECTS

It was anticipated that the study would also shed light on a number of other aspects including a) the factors generating an information need and the motives for communicating; b) the differences in communication patterns between scientists and engineers; c) the communication patterns for a given project and the degree of cross-fertilization of ideas; d) the general flow of communication and the factors affecting it; e) the extent of information flow to the organization from outside and vice-versa; f) the existence of gatekeepers and invisible colleges; g) the effect of environmental conditions on information usage and communications; and h) individual characteristics affecting information usage and communication.

As explained in the chapter on Methodology (Chapter 6), several of these aspects could not be covered, in particular, a), e), f) and g). While scientists and engineers were similar in certain aspects in their information and communication habits, there were differences between them, and even between different species of scientist and engineer. While the communication patterns for a given project could not be identified, there was some evidence of a cross-flow of ideas between staff on different projects, just as there was a fair amount of contact outside the organization with the person contacted being a useful source of information. The general flow of communication was found, in the main, to be lateral, i.e. among peers and the reasons for it were mainly to do with problem-solving and general technical discussions. The qualifications and experience of the person contacted was one of the prime reasons for initiating the communication. Various characteristics were found to affect information usage and communication habits such as personal preferences for a given mode of communication; and the current position held or task being undertaken. Whether the respondent was in a supervisory position or not was also a factor determining his use of various facilities. Nationality too, was seen to play a role.

10.4 REVIEW OF HYPOTHESES

To serve as a basis for discussion and suggestion for improvements to communication and information flow within the organizations, a number of hypotheses were formulated. Their confirmation or rejection was presented in the appropriate places in Chapters 7, 8 and 9, but it was felt useful to group them together here for ease of reference.

10.4.1 Hypothesis 1

The first hypothesis claimed that the information needs and communication patterns of scientists and engineers in general are similar and cannot be readily distinguished.

There is a way to distinguish between science and technology, i.e. scientists and engineers and that is by product. According to Moravcsik, science produces knowledge (intangible), while technology produces something more tangible in the form of say a gadget (1). Despite this dichotomy the relationship between science and technology can be demonstrated - science is a contributory and necessary condition for technology by providing knowledge on the basis of which new technology can evolve, but equally, technology is a contributory and necessary condition for the continuing development of science.

This being the case, one can argue that there may exist similarities in the way those involved in science and technology seek and communicate information. In fact, the study reveals that the information needs of scientists and engineers are remarkably similar in their requirements not only for facts and ideas, but also for advice and opinions. Regarding time spent communicating the same percentage of scientists and engineers spent a lot of time in formal, oral communication activities overall, although the amount of time spent in individual formal activities varied. A slightly higher percentage of engineers spent more time in informal oral communication than scientists and a slightly higher proportion of scientists spent more time in written communication than engineers, though the differences were not significantly greater. Scientists tended to write more papers for external publication than did engineers, although the latter wrote more papers internal to the organization. The usual forms of communication (face-to-face, telephone, written) chosen by the two groups were of a reasonable match and again, so were the preferred means of keeping in touch with colleagues very close. Although scientists went to more conferences than engineers (and presented more papers) overall both groups spent a similar proportion of their time away on mission.

On the basis of these results Hypothesis 1 is generally confirmed.

10.4.2 Hypothesis 2

This hypothesis stated that scientists would be more aware of sources of information in their field than engineers and would cover them better. The rationale here was that since scientists were generally considered by other writers to be more literature-oriented and -conscious than engineers and to form invisible colleges, then they should know and use sources better.

While a majority of respondents felt they were sufficiently aware of sources, a majority also considered they did not adequately cover (i.e. use, read) them. Scientists, the study found, were much more likely to be aware of sources of information in their field than engineers. However, an equal proportion of both groups considered they covered them adequately (though scientists covered them better than engineers in national aerospace research establishments and engineers covered them better than scientists in international organizations).

Hypothesis 2 is, then, only partially confirmed.

10.4.3 Hypothesis 3

Scientists and engineers will tend to get most of the information they need from colleagues rather than from the library/information centre was the thrust of the third hypothesis, which was formulated following the personal observation that many individuals did not use the researcher's rather excellent library.

The study revealed that not only was face-to-face or telephone communication the usual means, but it was also the preferred means, for the transfer of information, problem-solving, technical discussions, fact finding. Much of the information needed by respondents was not available from the organization library (nor did they expect it to be) and thus, they automatically turned to personal contacts. Colleagues in one's own division were by far the most frequently used source of information, both for on-demand information and for keeping up-to-date.

Oral sources were also the most popular way of familiarizing oneself with what was going on in the rest of the organization. A factor here is undoubtedly the ease and convenience with which colleagues can be tapped for information thus saving a time-consuming, possibly wasteful, trip to the library.

Hypothesis 3 is, therefore, confirmed.

10.4.4 Hypothesis 4

Hypothesis 4 states that there would be little inter-project but much intra-project communication and that where functional support staff were assigned to several projects there should be a good cross-fertilization of ideas.

The results from the study show that scientists and engineers tended to interact to a very large extent with colleagues working on the same project as themselves and to a much lesser extent with those people working on different projects. Colleagues working on the same project were also a prime source of information, though not as great as were colleagues working in the same division but not on the same project. To gain familiarity with what was going on in other parts of the organization, then there was a fair degree of interaction with colleagues from other divisions and projects.

The assignment of functional support staff to several projects could not be measured, neither could, therefore, the amount of cross-fertilization. However, the study shows that a reasonable amount of interaction took place between people in different divisions and projects and with colleagues outside the organization. Whilst part of this interaction was for familiarization purposes, part was also for technical discussions, problem solving, contractual studies and general information exchange. The assumption can thus be made that there would be reasonable, if not good, cross-fertilization of ideas.

Hypothesis 4 could be considered to be mostly confirmed.

10.4.5 Hypothesis 5

Gatekeepers, in T.J. Allen's or the accepted use of the word, are individuals who span the boundaries of an organization, digesting information from outside and passing it on to others inside. This hypothesis believed that such gatekeepers would not exist among the staff of national aerospace research establishments and international organizations.

It was considered that because so many individuals in the organizations studied, particularly the international organizations, would be in constant and continuous contact with other colleagues (peers, subordinates and superiors) outside their organizations for the purposes of contract supervision, control, trouble-shooting, project work, reporting etc. no clear-cut gatekeepers would emerge. If the property of boundary-spanning was a major characteristic of gatekeepers then clearly there would be many such gatekeepers in these organizations. The study showed that rather a high proportion of respondents had contact with people outside the organization for work purposes, particularly using them as sources of information. The greatest communication was between individuals in the same division or project. It would seem likely, then, that any information obtained via a boundary-spanning role, would be passed on to colleagues. Indeed, in the researcher's establishment where members (particularly functional support staff) of a project are experts in one particular area, then knowledge which they learn about is brought into the project (the cross-fertilization aspect). Clearly, not every expert on a given project or conversely, not every functional support staff member, can be considered a gatekeeper. Either everyone is a gatekeeper or no-one is on the basis of boundary-spanningness.

There are other characteristics of gatekeepers - they are more highly qualified, they read more, they are high achievers and in a supervisory position. Except for reading and supervisory position, these other qualities were not measured. However, in the researcher's own establishment those with the highest qualifications (generally the scientists) do not have more external contacts than engineers or those with lesser qualifications.

Again those in a supervisory position, in the researcher's organization, (supervisory position being equated with being the head of a section or division) do not have more contacts with the outside world. The amount of background reading per week was rather low, supervisors being lower than non-supervisors and engineers being lower than scientists.

On reflection, Hypothesis 5 probably cannot be said to be confirmed or rejected since all the necessary characteristics were not measured. However, evidence points to the fact that the usual definitions of a gatekeeper need further clarification in the context of international-type organizations.

10.4.6 Hypothesis 6

Hypothesis 6 was in three parts and suggested that there would be a tendency for staff to communicate more with peers than with either superiors or subordinates; that such communication would be based equally on similar interests and the knowledge of the person contacted; and that the purpose of the communication would be for general information exchange. This hypothesis was formulated on the basis of personal observation and discussion.

The study revealed that respondents did communicate somewhat more with peers than either of the other two categories. Subordinates were communicated with the least. The study also showed that the primary basis for contact was the qualifications and experience of the person contacted rather than the fact that the person was the best informed or had similar interests. (Hierarchy as a basis for contact was omitted from consideration as noted in Section 8.3). Again, the purpose of the communication - the usual nature of contact - was mainly for technical discussions and problem solving. Supervisory and management purposes ranked second, while information seeking and exchange as the purpose of the communication between peers came third.

Thus it is that while the first part of Hypothesis 6 was confirmed, the remaining two parts were not.

10.4.7 Hypothesis 7

The seventh hypothesis simply stated that more time would be spent on written rather than oral forms of communication in international organizations than in national aerospace research establishments. The reasoning behind this statement was two-fold; first staff in international organizations were probably more paper-pushers than staff in aerospace establishments - wrote more work statements, invitations to tender, internal reports and policy statements, for consumption by the various committees and governments to which they were beholden, and second, because of the expense of visiting or telephoning colleagues in distant lands (not to mention the possible non-existence or unreliability of this latter communication form in some areas of the world and the potential problems in understanding what was being said), they would probably adhere to writing letters and perhaps telexes where this was possible.

The study results show that more time was spent on all three major types of communication (oral, formal; oral, informal; written) by staff in international organizations than staff in aerospace establishments. In fact staff spent very slightly less time in written communication than oral informal in international organizations. However, they did spend, overall, twice as much time on written communication than did staff in aerospace establishments. Taking the individual forms of written communications, twice as much time was spent by the staff in international organizations on writing letters and significantly more time was spent both on writing memos and sending telexes as well as in writing internal reports. Conversely, staff in aerospace establishments spent more time on writing papers for conferences and journals.

Despite the fact that a relatively low percentage of respondents in international organizations spent time communicating with people outside the organization compared to staff in the national aerospace research establishments, one could accept this Hypothesis 7.

10.4.8 Hypothesis 8

This hypothesis was more or less a continuation of the previous one and argued that both scientists and engineers would prefer to keep in touch with colleagues in a direct, conversational mode rather than a written mode. In some respects this hypothesis is similar to number 3. If respondents tended to get most of their information from colleagues then presumably this was their preferred channel rather than just a more convenient, lazier method. In fact the survey demonstrates that an overwhelming number of scientists and engineers preferred to keep in touch with colleagues by means of face-to-face, personal contact as well as by informal meetings, formal meetings, visits and conference attendance. The major reason given for this preference was that such a method was simply the best, easiest and most flexible means of communicating, and one which provided instant feedback.

Hypothesis 8 was thus confirmed.

10.4.9 Hypothesis 9

The final hypothesis hypothesized that scientists and engineers with English as their mother tongue would tend not to communicate in other languages. It is common knowledge that the British and Americans (along with the French one might add) do not like speaking foreign languages.

Partly no doubt this is due to the fact that foreign languages are taught at a relatively late age in schools in these countries. It will also be partly due to the fact that English is considered a universal language and very often the first foreign language taught to those without English as their mother tongue. The survey bears this out by showing that of the two thirds who did not have English as their mother tongue, every single one spoke it. The study also noted that British and North Americans tended to speak and read fewer languages than other nationalities - over one quarter of both nationalities could speak only their own mother tongue - English - while over one quarter of Americans could only read English.

When it came to actually communicating in another language over half the Americans and over two thirds the Britons did not. Reasons for this are advanced in Section 7.7.4.

The results serve to substantiate and confirm Hypothesis 9.

10.5 REVIEW OF MAJOR FINDINGS

10.5.1 The Library/Information Centre and its Services

Nearly two thirds of the scientists and engineers visited the library less than once a week. Scientists visited it more regularly than engineers and those in supervisory positions visited it less often than those in non-supervisory positions. Staff in aerospace establishments also tended to visit the library less often than staff in international organizations although they stayed there for longer periods. Americans were among those who frequented the library least. Half the respondents spent less than 15 minutes in the library on any given visit. Scientists and non-supervisors tended to spend longer there. The main reason for visiting the library, especially in aerospace establishments and especially by scientists, was to read journals. Another reason was to borrow documents. Rarely was a visit made to the library to request a literature search or to conduct one's own search, although scientists did this more often than engineers.

One might be led to imagine that the resources of the libraries in the organizations were not too good. Almost three quarters of the respondents said they could not get the information they needed from the library - particularly engineers in international organizations and scientists in aerospace research establishments. But one has to understand the kind of information required by staff before judging the library. Two thirds of the respondents wanted facts most often rather than conceptual ideas and opinions and advice (the library is not usually in a position to supply the latter two).

The library does provide facts and sources for ideas. However, the type of facts or data which engineers, in particular, wanted was day-to-day information relating specifically to the large-scale projects they were working on and which the library could not possible make available unless it was itself actively involved in every project. Also required was real-time data, experimental data, plans, policy and projections and experience. The majority of respondents felt that the library should not supply this kind of information since it was too specific and ephemeral. For information that was unavailable from the library or information centre people tended to get it primarily from colleagues (in fact this was the case for any information whether available from the library or not). Where literature was used this tended to be reports, journal articles and conference papers. Journals and books were the literature sources mainly used for keeping up-to-date. Computerized databases and SDIs were rarely used either as a source of information or for keeping up-to-date.

One third of the people replying were unaware of the sources of information in their field - engineers in particular. Over half felt that they did not adequately cover the sources in their fields - engineers and scientists being the same. Those in supervisory positions tended to be less aware and hence did not cover them adequately.

The biggest problem reported by respondents (though only a small number) was the delay in getting information - though not necessarily from the library - and that there was often too much of it.

10.5.2 The Organization and its Communication Flow

The average scientist or engineer communicates several times a day, for less than 30 minutes a time, with peers working in the same division on the same project and in the immediate vicinity. The basis for the contact is likely to be the qualifications and experience of the colleagues and the initiation of the contact is done on a 50-50 basis.

The usual nature of the contact is technical discussions for problem solving with hard facts being the information mainly transferred in a face-to-face encounter in the office or laboratory of either colleague.

Although communication with close colleagues was the norm, staff in aerospace establishments had twice as many contacts with people outside their own establishments than did staff of international organizations - though overall the amount was fairly low. Previous studies have shown that a very high proportion of workers' time was spent on communication activities. The present study tried to ascertain whether the proportion spent was, in the respondents estimation, a little slice of their time or a large slice. It transpired that scientists and engineers did not spend large amounts of their time communicating a lot. The most time was spent, overall, in written communication rather than oral. Taking individual communication activities then those which were used very much by the largest proportion of respondents were telephoning, impromptu visits to colleagues and writing memos, telexes and internal reports. Not so much time was spent in formal meetings, except for meetings with contractors, neither was much time spent on informal communication in corridors and canteens. In general, staff in international organizations spent a greater proportion of their time in all the major forms of communication activity, while scientists spent a greater amount of time in written communication than did engineers.

The channel of communication most used and preferred was oral, namely, face-to-face, personal interaction of the informal type rather than formal meetings. The main reasons for this preference were the speed, ease and flexibility of it together with the fact that it provided instant feedback for clarification and understanding. The telephone was not a prime choice for preference despite its speed, convenience and time-saving capabilities mainly because it was not conducive to providing a record of the conversation nor to handling graphics and because it was also a time-waster.

Letters were preferred in some situations, namely, where a record was required and where telephonic communication links were not possible (e.g. in some developing countries), though it was generally agreed that this was a time-consuming method of communicating with inherent delays. Formal meetings were not generally preferred, even though they could provide a good overview of what was required or happening, because little attention was paid to the structure of the meeting, which was then permitted to become too bureaucratic, time-wasting and irrelevant. Reports and papers - both internal and for external publication - were not generally popular because they were time-consuming to prepare and were little read. Regarding conference attendance, over three quarters went to at least one conference in the two years prior to the study - the average was 2.2 - and 12.5% went to six or more. In aerospace establishments this proportion was almost doubled. Papers were not always presented by staff attending conferences.

Generally, very few scientists and engineers admitted to having problems or barriers to communicating. The problems most mentioned were to do with the location of the person one wanted to contact. It could be that he was not located in the immediate vicinity or was in fact located geographically very distant. Time differences were also a bit of a problem in this respect. A related problem was that the person was not present when he was wanted. Despite the fact that many Americans and Britons did not speak or read any language other than their mother tongue, language was not considered by many to be a barrier - possibly thus emphasizing the importance, or rather use, of English as the lingua franca. In fact every one of the respondents spoke English even though for two-thirds it was not their mother tongue. Virtually all read English as well. French was the second most common language, well over two thirds reading it and almost two thirds speaking it. Hardly anybody spoke or read the more exotic languages. Engineers tended to speak and read more foreign languages than scientists and those in non-supervisory positions tended to speak and read more languages than those in supervisory positions. Almost three quarters of the respondents communicated regularly for work purposes in a language that was not their own, though very few of these were of English mother tongue.

More staff in the national aerospace establishments communicated in other languages than did staff in international organizations.

10.5.3 General Background

Nearly half the respondents were unfamiliar with the general activities of the organization which employed them (particularly in international organizations) and with the work of other sections, divisions and projects within the organization. Those that were familiar gained their familiarity from colleagues in divisions other than their own as well as colleagues in their own division to a lesser degree. Over one third expressed an interest to become more familiar with the organization and considered that a monthly newletter might do the trick. Although a high proportion were unfamiliar with information sources in their field and did not use the library much on the whole, only one third of the respondents wished to have a course in the use of the library and sources organized for them. Just over one-third believed the library did already organize such a course. Perhaps the library was not used so much because over two thirds, particularly engineers, did not spend as much time as they would have liked on information seeking (aerospace establishment staff were somewhat better than their counterparts in international organizations).

On the other hand, respondents did not read much per week either - a majority reading for two hours or less per week. Those in supervisory positions spent less time reading than those in non-supervisory positions, engineers spent less time than scientists, staff in international organizations spent less time than staff in aerospace establishments and British personnel spent less time than other nationalities.

Nor was this a function of the time spent on mission, i.e. duty travel or trips for work purposes. Time spent out of the office travelling to and from and attending meetings will obviously play some role in the amount of time spent in background reading per week, in covering information sources, in seeking information, visiting the library, and in communicating.

Nearly one quarter of the respondents spent the equivalent of two hours per day out of the office on mission during the 6-month period prior to the investigation. Those in supervisory positions spent somewhat more time on mission as did scientists and fewer people in aerospace establishments did not travel during the period compared to international organizations. In fact, though, the time spent away from the office had an inverse effect on the time spent in background reading. Instead of heavy travellers being non-readers as one might expect - the reverse was just about true. Obviously these people had a different kind of motivation.

Respondents were also invited to give general comments on ways to improve communication and information flow in their organizations. Just over one third actually did so and the results are presented in Table 62. What respondents wanted most improved was the library service and facilities. This was followed by the suggestion that there should be a greater interaction with other divisions in the organization (it will be recalled that the amount of inter-divisional communication was on the low side) so that greater familiarity with the activities of the organization could be gained. It was believed progress reports would help in this respect. Also important was the need for an automated office to eliminate the paperwork; included here was the request for more secretaries to assist in the routine paperwork.
A fairly common complaint was that there was simply not enough time to spend on information seeking, background reading, real research work, because of the time taken for travelling and paper-pushing. There was also a plea for more training courses so that staff could be aware of the latest developments and techniques in their fields. To this end greater encouragement was sought to attend conferences and to write papers for external publication.

TABLE 62 - GENERAL COMMENTS

improved library facilities	11
closer interaction with other divisions	9
automated office	7
better management	5
more time to spend on information seeking	4
better training programmes	4
no changes necessary	3
miscellaneous suggestions	5

% of replies N=103 multiple answers possible

REFERENCES

1) MORAVCSIK, M.J.
The role of science in technology transfer.
Research Policy, 12, 5, Oct. 1983, p.287-296.

CHAPTER 11

CONCLUSIONS AND RECOMMENDATIONS FOR IMPROVEMENTS

11.1 INTRODUCTION

This chapter will provide, by way of conclusion, some discussion of points raised throughout the present work and, based on some of the findings in the analysis, will make comments or recommendations for the improvement of information flow, services and functions in certain areas as appropriate. Improvements, of course, have to be "sold" to both management and users. New services cannot just be introduced at the wave of a wand (though they frequently are) - they must relate to actual or potential requirements. To initiate the discourse in this chapter, then, we shall begin by remarking that within the concepts of marketing, there is a marketing plan which precedes any creation of products or services. Since this plan partly depends on an analysis of the organization's resources, the first section will cover an examination of the organization's structure and environment. Once the strengths and weaknesses, opportunities and threats of the organization are known, products or services designed to meet the organization's requirements can be designed. As an extension of this, the technology available for use within the organization's information environment will be described, together with the husbanding or management of the general information resources within the organization. These must then be promoted or marketed throughout the organization and users must be educated and trained in their use - the subject of the final section.

11.2 ORGANIZATIONAL STRUCTURE AND ENVIRONMENT

11.2.1 Ties and Uncertainty

It was noted in Chapter 2 that the structure and size of an organization, among other factors, played a role in its communication and information flow patterns.

A bureaucratic, hierarchical structure with an emphasis on formal, downward communication lends itself to the establishment of an informal, interpersonal network which bypasses the formal structure and shortens the time which messages need to move around a larger system. Otway and Peltu note that hierarchy and distance are key elements in bureaucracies which are poorly equipped to deal with the rapid technological change which a developing society imposes on the overall design of the organization. They go on to differentiate the organizations within the organization which exist - the formal organization, the technical organization, the informal organization and the de facto organization (where the unwritten rules apply) (29).

The technical or R&D organization, writes Howton (23), is peculiar in two respects - a) the ties that bind the scientist and engineer to the organization through hierarchy are weak and b) the ties binding them to colleagues are usually strong. This was observed from the present study. There are, of course, several reasons why this should be. Howton himself considers it is due to the fact that the individual is in a temporary position when he is working on a project or as a functional support staff member switching from project to project or division to division. He takes on a kind of organizational rootlessness. Besides this is the scientist's or engineer's perception of the organization and its objectives, aims, plan of work. If these are ambiguous or not clearly defined then the individual will tend to become disheartened to say the least, because he becomes uncertain of what is going to happen. Uncertainty in an organization can lead to a lack of motivation and consequent drop in performance. A recent example is the decision of the USA to pull out of UNESCO which causes uncertainty not only for the American staff employed there (over their careers and futures) but also for others (including nations) as the loss of 25% of the budget will cause programmes to be cut back. In the aerospace industry uncertainty is caused by escalating costs, airlines failing, lack of markets and rising fuel prices. In the atomic/nuclear energy areas uncertainty is caused by concern over nuclear missiles and radioactive leaks from reactors.

Uncertainty - political, social and economic - is probably greater in international organizations which have an allegiance to a wider community and where not only is the general state of the world affecting tasks, but so also are the many diverse national and political interests which are brought to bear. Besides the fact that they are subject to powerful and conflicting pressures, international organizations also suffer from a number of other weaknesses. For example, they are often too bureaucratic and centralized, inefficient and uneconomic with little incentive to improve. Furthermore, they often lack authority, being merely in an advisory or administrative capacity only.

As mentioned, a climate of uncertainty within the organization can lead to a lack of motivation, job satisfaction and career prospects, as well as conflict, non-cooperation and degradation of performance. Every individual has basic needs which when fulfilled allow him to increase his performance, efficiency and productivity. It is within the powers of the organization (and its governing body) to fulfill these needs by offering such basic tenets as a career policy, promotion scheme, reward scheme, incentives, in addition to strong decision-making and a direction in which to go. Conversely, some kind of hire and fire policy may well be required to get rid of unproductive workers who know they are secure in their jobs whether they perform well or not. Rice and Bair (37) believe organizational performance can occur and be measured at six levels including its mission, purpose, function, process, activity and actions. This performance - particularly technical and operational performance (which equates with success) - can be improved according to Bhalla (2), by forging a unified team approach within R&D groups to eliminate communication problems. Rubenstein, too, agrees that a climate of uncertainty as opposed to uncertainty within the organization leads to reduced communication problems and greater interaction between groups (40).

11.2.2 Group Interaction and Networks

The effective transfer of information from one group to another depends on the climate of relations between the groups, on the relative task interdependence and on the frequency of communication and decision-making style. Tushman (48) argues that communication networks are an important process in R&D settings and can be actively managed. Since networks are contingent upon the nature of the work within a project there is no best communication pattern. For a particular group to be successful and effective and to cope with uncertainty then the information processing capacity of the group must match its information processing requirements. Projects with different work characteristics require different communication networks including intra-project, extra-project as well as boundary spanning individuals (gatekeepers) - people who have contact with the scientific and technical community outside the confines of the organization. As Paolillo (30) notes, organizations faced with rapidly changing technologies need to develop R&D subsystems with the ability to gather and process technical information from the external environment. Gatekeepers, which link the organization to the outside are one way to do this (in this respect the librarian, via his library, is a gatekeeper). Paolillo goes on to give some apposite implications for management.

Briefly, they are as follows: i) given that gatekeepers maintain a large number of contacts outside the organization (as those especially working on research projects, projects facing a changing environment and projects with substantial task interdependence will) then it is advantageous to encourage the forming of such contacts (via travel, conferences, training, memberships, external publications); ii) the development of gatekeepers can be facilitated by in-house training, work assignments and transfers (Bhalla (2) and Fischer (15) too, also recommend rotating or interchanging certain departmental roles as a way to eliminate communication problems); and iii) gatekeepers should be located where they can best facilitate the flow of technical information within an organization (e.g. in project teams).

11.2.3 The Importance of Information to the Organization

The improvement of communications and the innovative process by the easy flow of information both in and out of the organization is also noted by Goldhar (18), who in fact echoes Paolillo and Fischer in calling for rewards to staff for seeking, sharing and utilizing new information. Fischer (15) also considers that communications will be improved by seeing that technical literature is available which thus increases the flow of external information into the laboratory.

Several writers argue that information is the organization's life's blood. Giuliano, for example, writing in a special advertizing section on information technology in Time during the latter part of 1983, considers that the organization is nothing but a structure for handling information regardless of its size, complexity and goals. The organization provides a means for gathering and coordinating information from a variety of sources to produce desired results. Hopwood, contributing a chapter for Otway and Peltu says that information is gathered and analyzed to make decisions at all levels and delineates organizational structures, responsibilities of units, the nature of authority and spheres of influence (29). The flow of information not only assists in cooperation and task interaction but also disseminates the organization's goals and mission. Information thus creates a perception of the organization's reality supporting its work activity and helping (or hindering) its ability to adapt to new challenges. According to Culnan and Bair, organizations are communication systems which process information and may be pictured as a network or matrix of nodes linking people internally as well as externally (9). These channels or links should be arranged to minimize the communication burden (26) and to share information. The greater the efficiency of communication within the organization, the greater the tolerance for interdependence.

Despite the emphasis on the importance of information and its flow within and without an organization, managers seem bent on hindering and obstructing it by exhibiting a singular lack of understanding of the role of communication which is so central to the R&D and administrative task.

Examples of the generally negative management attitude to information, as revealed by the present study, include a lack of encouragement to publish articles, to edit journals, join professional committees, attend conferences - all of which would surely enhance the prestige of the organization. Staff were considered to be wasting time if they visited the library too often or did their background reading during office hours (undoubtedly a reason why the amount of time spent reading was so low - "why should I do it at home in my own time when it's for the office?") or sat too long in the canteen even though work was being discussed, or spent too long on the phone or too much time away from their desk. Furthermore, long delays in getting replies to requests for information or approval for conference attendance because of the necessity for minor decisions to be taken right at the very top after passing through every other hierarchical level are hardly conducive to good employee relations.

Problem-solving times, for example, increase as communication channels become more impoverished, i.e. when one is forced to communicate by letters or phone rather than face-to-face. In periods of uncertainty, which may coincide with economic restraints, there is often a tendency to reduce the information budget (22) by restricting long distance phone calls, travel, library budget, etc. When sources of information lie outside the organization then it is frequently more expensive to tap these sources through rich channels (i.e. phone, face-to-face meetings, conferences). It has been intimated above how important such external sources are for improving performance, productivity and morale and thus managers should be careful not to preclude their use, particularly during times of uncertainty. Many staff, according to the present survey, were conscious of how expensive various means of communication were and what it cost the organization and thus they would not abuse richer channels. Daft and Lengel, in a paper introducing the concept of information richness, have as their premise that the accomplishment of the twin tasks of equivocality reduction and the processing of a sufficient amount of information and the ultimate success of the organization are related to the balance of information richness used in the organization (10).

11.3 SERVICES AND RESOURCES TO MEET REQUIREMENTS

11.3.1 Information in the Organization

The success of an organization rests on many factors: the size of its budget; the number and quality of its staff; the extent of the data processing and communication facilities; its place in the social and political community; its workload and schedules; its forward planning, and many more. All these factors have one predominant aspect in common: information. So, we are able to say that the success of an organization, whether large or small, is, to a very large extent, due to its recognition of the importance of information and its efficient use. Information, however, is difficult to define, it is not always tangible, and not always in demand, and it is difficult to assign a value to it. Often it is difficult to locate and obtain, it is not always free, it assumes many different forms - in short, it is a resource which must be husbanded and managed like any other resource in an organization.

Traditionally information has been thought of only in terms of libraries and information centres and the rather passive provision of services, whereby the information specialist, an acknowledged expert in his field, waits for the potential user to come to him when he needs information. The library is, however, only one source of information for the scientist, engineer or manager. More often than not such staff will turn to colleagues to get the required information. The extent of personal communications in an organization has been the subject of many recent studies, and it is clear that what is considered 'information' (facts, ideas, advice, opinions) by professional staff goes way beyond that which is contained in books and journals and which is thus considered information by the librarian/information specialist.

Any given organization will require many different types of information to satisfy the needs of its personnel. There will be financial and cost data, scientific and technical information, administrative, cultural, social, and political information.

There will also be a variety of ways by which this data is obtained and communicated - by word of mouth, by telephone, by telex, fax, from literature, reports, computer printouts, and experiments.

Different staff in an organization have different views of information. To the worker on the shop floor information is seen as the orders, instructions, rules, work schedules he receives from his superiors, and as the rumours on the grapevine. To the manager it includes the data and feedback he gets from subordinates as well as the computer printouts from the data processing room that enable him to plan ahead and make decisions. To the scientist it might be the latest issue of Nature, to the technical staff it might be data resulting from an experiment, and to the Public Relations office it could be a videotape from a recent exhibition and open-day.

To satisfy the information needs of its staff an organization has several separate sections. The finance office produces the state of the budget for the manager; the personnel office produces the rules and regulations which inform the staff of their rights and conditions of employment; the public relations office produces the glossy brochures describing the organization and its functions; the computer department churns out the data on production schedules, parts locations, inventories and so on; and the library provides the books, reports, and journals that the staff may need to help them in their work. The library or information department provides a number of services for the staff in an organization. In effect it acts as an acquisition, storage and retrieval centre of published information. To this end, having studied the stated goals of the organization and the perceived needs of its staff, the library will buy on a regular basis books, manuals, reports, conference proceedings, journals, standards etc. relating to those goals and perceived needs. The library will catalogue, index and store this literature and retrieve it on demand. The library may offer other services, too, such as compilation of references (bibliographies) on a given topic either on a retrospective basis or on a current awareness basis. More often than not these literature searches will be at the customer's request.

The library will also endeavour to obtain literature on behalf of staff when it does not have it in stock itself.

11.3.2 Use of the Library

The fact remains, however, that, generally speaking, the library or information centre has not been regarded as essential or even useful by many managers. Why is this? One reason is that because of the nature of the manager's current position and tasks he does not have the time to use the facilities offered, since more often than not, the information services are essentially passive, i.e. the services are not taken to the customer - they are not promoted or marketed in any way. Traditionally, the librarian's role has been to assist rather than to lead - assist the user in finding literature - not necessarily the best literature, or the most relevant or useful or accurate - that is up to the user to decide. The librarian takes no responsibility for incorrect interpretation or incorrect use. Another reason is because the information contained in the library is usually not the kind that managers want. They do not want to keep reading books on how to manage, or receive the latest list of references on how to conduct good interviews. What they require is hard data which will enable them to manage, to make the correct decisions, rapidly.

Thus the information section is tolerated as a means of assistance to the scientific and technical staff in the organization, the R&D people, those who need to solve technical problems. More often than not the library will not provide the precise information required by other non-scientific and technical departments, e.g. finance, marketing, and production data. Of course, it will take a few books and journals on the subject, but it will probably not have the detailed statistics and analyses and trends that those departments want, although it could access much of what is required online from computer hosts over various information networks. Even for the scientific and technical personnel the library may not have the kind of information needed - trade literature, properties of materials, test data which is obtained directly from experimentation or contractors.

Some personnel do not see that the information department should provide this kind of data as it is too restricted or too specialized; others, however, believe the library should be the place where they should be able to find anything they are ever likely to need.

The present study generally showed there was relatively little use made of the library and literature sources. A number of reasons were given earlier but others can be advanced for this state of affairs. Because of the climate in the organization (e.g. uncertainty) there may be a lack of inner stimulation or challenge to develop new areas, or move into new fields. Because of a tendency to over-specialize, an individual may well find himself in a too narrow field with little literature (and an invisible college) and no chance to diversify. The recruitment policy of the organization may play a role. Recruitment levels might be held steady or even cut back, and the retention of older staff who know the literature and sources of information and who may not do much research will lead to a lack of library use. It is noticeable in the researcher's library, that after a certain period of time use of the library drops off by newcomers to the organization. This is because they have then settled down in their job, understand its requirements and ramifications, and know what sources and information they need for their work.

Then again, some people just do not use the library - they see no need to. It is probably true to say that either one is a library user or one is not. Some individuals, particularly scientists, write papers to establish priority, to keep their name known, or because they are obliged to. Much depends, not on whether one is a scientist or engineer, but on whether one has the desire - an inner compulsion - to write, whether one has something to say (whether or not it may be trivial and whether or not it has been said before). This is why, very often, it is the same people giving papers every year at conferences. They are the active ones and probably library users. Possibly scientists feel it more in themselves to write more than other professions, e.g. engineers, as a result of their education and training and the system in which they find themselves.

Whether or not the library should expend its resources trying to reach habitual non-users is a matter of discussion. Clearly the information service cannot properly cater for all the diverse interests in a large R&D or international organization since it spreads resources too thinly. It is probably better, therefore, to offer a good service to those who are regular users who need and appreciate it. On the other hand, non-users should not be totally neglected. After all, because the organization is an open system it must import technical information from outside to thrive and survive. The librarian or information specialist interfaces between information and the external environment. The organization has to develop effective information acquisition and internal dissemination policies to reduce the cost of information access and to enable a free and easy flow of information, especially for those with little time. This involves ascertaining not only what information exists but also who wants it, i.e users' or potential users' requirements, and then creating services and resources to match the two. Carter discussed the difficulties of determining managers' information needs (5). What needs to be done is to stimulate a greater awareness of information and to find ways to provide it along with assistance on how it can best be used. This as we have implied above depends very much on the users' perception of the usefulness of information, especially literature sources. Obviously, the library or information centre will need to evaluate its present services in the light of user requirements and see what other services it could supply taking into account its resources (staff, funds, equipment, material). It comes back to the aims of the library and whether it should try to cover all or a selection. The study shows that while a minority did think the library should cover everything, the majority understood it could not. Richardson argues, in support, that no librarian can give across-the-board service any longer (38). The library should not feel that if it provides everything then it is not vulnerable to closure (see Matarazzo (27)!), though obviously it helps and does avoid duplication of effort and materials within the organization.

The present study points to information the library might provide - for example, literature in the form of computer manuals and data sheets.

Data and results were required - technical, experimental, financial. While project, cost and real-time data may not be practical for the library to cover, it could provide online access to the myriad of specialist online services which do cover such technical and financial data. However, attention should be given also to the bread and butter areas. The survey showed that reports, journals and conference papers were the most used literature sources of information. The library should perhaps build on these collections to the detriment of lesser sources such as trade literature and abstract journals (available mostly online). On the other hand, although computer files are relatively little used, those could be developed far more with the provision of searches on demand and SDIs. Breton (3) notes, though, that despite all the existing databases, a large segment of information that scientists and engineers consider vital to their work is not available in the form of a credible database. In such cases, then, the library or information centre could create and maintain specialist files, e.g. of costs/models or of policy decisions and statements and latest plans and projects. In a project-oriented organization much work, experiments, difficulties, solutions are duplicated between projects. Although there may be project archives the data is not often readily accessible and usable. It might be better to try and create online databases from it with optimum indexes so that it can be used by anyone for problem-solving and referral. Creation of expert systems within the organization, too, would enhance decision-making and information use.

The librarian or information specialist is a highly skilled individual, often with subject knowledge in addition to library/information qualifications. As such he or she is not only well placed to carry out literature searches, manually or online, via one of the many host computer's services available, but is also in a position to analyse the results of the search and give the requester a summary sheet with the necessary facts, rather than merely a list of references. There are some libraries and information centres where this is done.

In the late 1960s there was a trend in the USA towards information analysis centres where data was actually read and synthesized for the scientist or engineer or manager rather than presenting him with a list of references to the literature which he then had to find for himself and read. Such a service meant that the information specialist became fully cognizant with the work of the organization and its problems.

Perhaps longer opening hours might lead to greater use of the library and accommodate those users who either cannot get to the library during the working day for pressure of meetings or work or who feel they cannot slip in during office hours because of the management attitude.

11.3.3 Other Sources of Organizational Information

As has been seen the library or information department will be in a position to provide certain of the information needs of an organization, and because of his specialist knowledge the librarian or information officer will know of other sources to which he can turn to get additional information.

What other departments are there in an organization which also store and provide information? The computer department is an obvious one. The utilization of computers in organizations began in order to satisfy the enormous need of the financial department to keep track of its resources and to manage accounts receivable and accounts payable - including payment of staff salaries. Out of this development grew management information systems which collated and handled not only the budget, accounts and payroll, but also production schedules, records and marketing and engineering data, thus providing reports, tables, graphs and models on which managers could base their projections, so improving decision-making and planning. Larger computers led to greater amounts of and more varied types of data being stored and hence being made available for searching.

It was natural that, with his proven expertise for searching the literature, the information specialist would have access to these online files not only in the scientific and technical domain, but also to the many financial, economic, commodity, and time series databanks that are now available. Within the organization there may be a central registry which keeps records of all incoming and outgoing correspondence, telexes and faxes. Often this might be kept at a department or section level either instead of or in addition to the central one, and the organizations's computer might well be utilized to keep track of the flow.

In addition to information in published and machine-readable form, much information needed by the staff of an organization is communicated either verbally or by informal means such as memos, telexes, internal reports and the like. Studies have shown that the amount of time that scientific or technical and managerial staff spend in face-to-face communications (meetings, corridor discussions, telephone) is extremely high. What gets transferred during these exchanges is the up-to-date experience, knowledge, opinions, facts, ideas, or instructions that cannot be found in any book or report or computer printout.

Richardson (38) believes that few scientists and engineers in a contemporary high technology industrial environment operate in an information-impoverished mode - there are too many alternative channels. Indeed, the present study shows that the largest used source of information is colleagues - both internal and external, while another is the use of personal files or own research. Clearly, the library cannot compete here. It serves to emphasize, though, that the library/information centre is but one facet of the professional life of scientists and engineers and not necessarily the major one. Thus the library should not just look to itself for the causes and cures of ineffective information transfer within the organization.

What people appear to want are quick forms of communication, e.g. the telephone and telex. Something that can take less than five minutes to scan, say Wilson and Streatfield (53), stands a better chance of being read as it fits better into the work pattern. Hence, the emergence of electronic messaging systems. Despite this, people want face-to-face communication for the accuracy and understanding and feedback this form can provide. Videoconferencing would help in this respect and would have the added advantage of reducing travel costs.

The study also noted that greater interaction between divisions and project teams was needed so that staff could be aware of the activities of the organization as a whole. A regular bulletin of engineering, scientific and management information designed to enhance the flow of technical communication across the organizational, geographic and discipline boundaries would assist in this (43). The present study showed that a monthly bulletin would be welcome. ESTEC has since started two such newsletters - on space activities and computer software to keep staff informed of the latest news and events of interest to and affecting their work. Another new glossy bulletin aims at keeping staff up-to-date with developments in remote sensing and earth observation. Published quarterly in English and French, it is basically one department's attempting to keep other departments (as well as interested parties outside the European Space Agency) aware of what is happening in one particular area. Internal bulletins can promote and provide for an exchange of technical ideas and information; facilitate a dialogue between staff and management; and help the understanding of management goals and policies. What is required then, for the organization to function effectively is a regular supply of easily accessible information which is made available to staff on the basis of their requirements.

11.4 INFORMATION TECHNOLOGY AND RESOURCES MANAGEMENT

11.4.1 The Office Environment

According to Lee (25) the office workplace tends to be a varied setting where knowledge, information and perception are conceived, assimilated and communicated, decisions made and implemented and where documents and messages associated with these activities are created, processed and stored. Rostron (39) continues this theme by stating that the primary function of the office is to process information so that it is available to support timely decision-making. Methods which, therefore, provide information more reliably, more selectively and more quickly at less cost should form an important business objective.

Chapter 5 quoted various figures for the amount of time scientists and engineers spent communicating within the office or organization. Other studies have specifically related the time spent communicating in businesses and within management to improvements. Watanabe, for example, surveying fifty-two large corporations in Japan found that 17% of business communications involved remote meetings. In a nationwide survey of managers it rose to 40% of all business communications and was done by face-to-face contact or telephone. Increased efficiency was needed he concluded. Investigations and enquiries accounted for 20% of the executive's time, implying a requirement for increased speed (51).

In a recent study into information patterns within the European Community (6), professional staff spent 42% of their time reading, writing and dictating. In a more detailed analysis, 80% of officials' time was devoted to reading and evaluating, providing information, dealing directly with people, form-filling, clerical duties and using local sources of information. (Officials were eighty times more likely to use local sources of information). The European Commission like other bureaucratic international organizations, is heavily paper-oriented - some 35.000 pages/day being exchanged.

Dunning (12) reports an investigation of the information flow throughout the Commission, Council and European Parliament which found that as much as 80% of information communication is internal to each establishment or institution. Grant gives a lower figure - 60% of communication stays within the local office complex, while 25% is inter-office and 15% goes outside. He also notes that 91% of mail takes more than one day to be delivered intra-company (19). Within ESTEC, the figures are similar. In a typical area (division) 7% of the mail is internal to that division, 31% is addressed to other divisions within the same establishment, 31% goes to other ESA establishments and 15% goes outside. Mail also takes generally more than one day to move internally.

Since so much time and effort is expended on paper forms of communication, attention has been focused on the development of ways and means to speed up and make more efficient the formal and informal communication channels within the organization. Dordick (11) suggests there is a need for electronic communication and that the decreasing cost of electronics is intersecting with the increasing cost of administration and labour. He estimates that at present 13% of business mail is amenable to digitization, but by 1990 as much as 70% of inter-company messages will be transmitted electronically and up to 50% of inter-company messages by 1995. He also notes that 35% of the paper information in a company's files is never accessed and that 90% could be discarded after one year, but rarely is.

11.4.2 Information Technology within the Organization

What is needed, therefore, is not only methods of exchanging information and storing it, (for example microforms, digitally or on optical discs), but also methods of producing it. Hitherto, explains Lee, the word processor has not been a significant factor in the office workplace for a variety of reasons - an expensive word processor could hardly be justified as a simple replacement for a typewriter costing some ten to twenty times less (25).

However, the word processor could result in a 60% saving over conventional typing when costs of corrections and re-drafts were included. Sophisticated word processors now permit the formatting of text instantaneously on the screen in such a way that the operator has at any point in time, the actual layout and text available to him for direct correction. Tables, graphs and diagrams can be supported with also arithmetic and sorting operations. Word processors, though, while they speeded up production still produced paper.

The trend has now become towards a combination of basic office functions capable of access on a single work-station. Germane to this concept is the local area network (LAN) which maximizes use of existing equipment throughout the organization (e.g. word processors, terminals, mainframe computers, personal computers) by linking them to other related functions such as printers, telex and fax machines. Wilson (52) says that current office technology developments can perform the following functions: management of time through personal/group diaries, agendas, alerting files; progress reports of project management data; text and graphics preparation; electronic transfer of internal memos; information retrieval - both in-house and external; and distributed conferencing. The potential usage within an organization is at the level of the manager and knowledge worker who is required to produce and transmit written communication quickly and where fast retrieval of such communication is vital.

As mentioned above, the European Commission is looking at a system responding to the needs of civil servants in the approximately 100 institutions in thirty cities. It will need to be integrated for convenience to users and improved cost-effectiveness will be achieved by reducing the duplication of effort and lost time spent in telephoning (13% of officials' time), meetings (21%) and reading and writing (40%). The system is known as INSIS - inter-institutional integrated services information system - and by 1986 it is estimated there could be nearly 150.000 users (13).

Two of the main objectives of INSIS are:

- to bring about a general improvement in the effectiveness and working conditions of government officials throughout the Community and to ease communication problems

- to develop an advanced information and communication system for Community institutions and key government departments.

Gradually, INSIS will evolve, it is hoped, to an ISDN (Integrated Services Data Network). The services being talked about include phone, telex, audio conferencing, data transmission and fax at a first level with electronic mail, word processor exchange, video-conferencing, image and voice transmission and telemetry at a second. The network projects are intended to lead to the digitalization of existing networks, the introduction of satellite and optical fibre links, and the development of local area networks. These could then be interlinked into a single ISDN providing a complete range of services with high speed data transmission.

INSIS is a priority project of the Commission with a budget of 1 million EAU (around $1 million) for studies alone. One such study, recently completed, is in the area of user needs and it listed priorities for improvements. For all communications, improvements in written communication were required first, second in data processing, third in telephone and fourth in meetings. Just taking written communication, improvement priorities were access to information followed by the distribution of information and the production of information. A second study - a functional needs analysis - is just starting.

New information technology is also providing a wide range of opportunities for library and information centres. Possibilities include storing material, providing services and providing equipment such as videotex terminals and facsimile transceivers for document delivery.

In two recent papers the present writer has discussed these extensively together with reasons why new technology might be adopted by the library (35, 36). Some of these reasons are as follows:

- the library can enhance its own reputation, image and expertise
- the new services are but an extension of the old
- there is a growing realization that information is not just found in books
- libraries already have specialist knowledge in the processing of information and are therefore a logical place to start with the provision of new sources
- as one of the most frequented centres of a community the library is thus in an excellent position to provide new services and act as a test bed for new technology which individuals may not yet be able to afford themselves
- such new services would lead to an increase in library usage which would probably have a beneficial effect
- it would enable the library to provide a faster, more efficient and better service and get rid of some of its cumbersome, time-consuming manual routines
- the library could act as a service broker for online search services, videotex services, and cable television programme production.

Clearly, these reasons are not only relevant to the library, but also to the organization as a whole. However, care must be taken to ensure that, within the organization, there is not duplication of sources and services. All the necessary components of information and communication in an organization need to be managed.

11.4.3 Benefits and Drawbacks

Studies at NASA (National Aeronautics and Space Administration) reveal that of the approximately 30% of the average workday required for routine communication, a reduction to 15% could be achieved using office automation. Poppel (31) concurs in this estimate by remarking that the application of automated office support tools can save an average of 15% of knowledge worker's time by 1985.

Certainly the introduction and use of new information technology will reduce the cost of written message transfer services and increase the speed of message communication as well as alleviating the time-consuming drudgery of preparing texts. Lee (25) expresses concern lest these are the only reasons for installing such systems. Whilst it is also true that such systems and enhanced videoconferencing may obviate the need for some missions, Dordick (11) is at pains to point out that distributed conferencing systems should not be perceived as a major replacement for executive travel. There are too many other reasons why executives travel which have little to do with achieving business objectives. There are some situations where there is no adequate substitute for direct, face-to-face contact (for example, in protracted, polite negotiations with Middle East customers), especially post-meeting interaction in a relaxed social atmosphere (Giuliano (17) suggests that 50% of customer time in bars/restaurants involves business-related communication). Videoconferencing should thus be used for non-essential travel such as routine trips associated with regular meetings with fixed groups of participants.

Besides the obvious advantage of an efficient office communication system for saving staff members' time and thus freeing them to spend more time in other information activities like visiting the library or background reading, there are a number of other tangible and intangible benefits. Office automation could be useful in cases where the staff member is not present since messages can always be left in an electronic mail-box. There would be a reduction in typing work, with improved output and turnaround time, better presentation and the recording of information transactions - all required aspects thrown up by the present study.

Enhanced messaging and conferencing systems save on travel time and subsistence/accommodation costs, they save on phone calls and on the wear and tear of individuals, they enable people to work from home or elsewhere at more convenient, optimum times and a person need not be absent for several days and hence unavailable to others.

What office automation, in fact, leads to is a decreased need for manual tracking and control procedures, quicker decisions, more effective and timely communications and higher quality work. Notwithstanding these, there are potential barriers to be overcome: the fear of loss or threat to the functions of individuals; the fear of loss or threat to empires (e.g. loss of secretary); fear of machines and potential personal inadequacy; and dislike of keyboarding.

There seems to be a growing trend for managers themselves to use word processors to prepare their reports, formulate policy, and store records of meetings and decisions taken - and not only word processors, but personal computers too which permit executives to perform more complex analyses and retrieve information with greater flexibility and immediacy. There is a problem here, though, with the proliferation of small computers in organizations. There is not only the question of incompatibility between machines, but it is almost a case of too many cooks spoiling the broth. There is often no centralized control of what is input or output, which leads to duplication of work as well as inadequate or irrelevant data. The data gathered by individual managers is often not checked against corporate files and there is a danger that the amount of information stored and used for analysis and decision-making is too fragmented. The quality is therefore not necessarily the best, nor is it the most up-to-date, comprehensive, accurate or most closely matching or reflecting the needs of the company. There are the added dangers that managers might manipulate the data to give the results they want, and when they leave the organization take their information with them with the result that no one knows what is missing. Lee (25) draws attention to the need for re-organization of jobs and office procedures with the object of increasing worker satisfaction rather than creating a dehumanized automated production line. Office automation systems concentrate mainly on one type of information within organizations - the written (both formal and informal). If the scientist or engineer must spend time using the keyboard to send messages via electronic mail and local area networks (LANs) to elsewhere in the organization then this is probably no cheaper or quicker or more efficient to going to visit the colleagues and discussing matters face-to-face.

Happily, the automated office will not eliminate this entirely.

11.4.4 Information Resources Management

For better or worse - and it is in all likelihood for the better - the various information systems and components are now gradually being integrated. In library terms an integrated information system is one which integrates the various library routines such as acquisition, cataloguing, retrieval, circulation, accounts etc. In the broader organizational perspective the integrated information system will embrace the management information system, the word processors - all the information generating and processing systems, including the library.

The integration of these different organizational information systems has become known as information resources management. Information, as a vital resource of an organization, is being seen to require a manager who can be responsible for the various information activities within an organization. These include printing, photocopying, mail, archives, records, data processing, publishing, public relations, photographic/graphic, technical drawing and library services. The responsibilities of the information resources manager include coordinating relevant information activities; providing policy oversight and guidance; planning programmes and budgets; managing personnel; planning, developing and operating automated and non-automated information systems, and providing information technology support services (1).

An interesting fact is that most of the books and articles dealing with the topic of information resources management completely overlook the kind of information provided by the library/information centre and suggest that the information resources manager should come from the world of data processing or records management. Synnott and Gruber consider that information resources management includes the concepts of human resources management, hardware/software, telecommunications and the electronic office (45). They also list the skills such a manager might need - these include business management, marketing, and being a futurist.

Meltzer (28) lists fifteen principles of information management including encouraging access to information, anticipating information needs and recognizing the channels of information flow. He also considers that information technology permits managers to control a wider range of activities and staff. Raitt (34) makes a strong case for the information specialist as information resources manager.

11.5 MARKETING AND PROMOTION OF SERVICES AND RESOURCES WITHIN THE ORGANIZATION

11.5.1 Marketing Defined

It goes without saying that a great deal has been written about marketing. There is also a fair amount of literature on the marketing of libary and information services - good overviews and bibliographies being provided in references 7, 8, 32 and 42). Since the present study is concerned with information use and flow the remarks which follow will relate mainly to the role of the library/information centre in marketing and promoting information services within the organization. Marketing has been defined in many ways and from the various definitions it can be seen that the marketing funcion is divided into five distinct areas: find/define the customer and his needs; product creation; customer persuasion; product delivery; and after sales services and back-up. The essence of marketing is designing products or services for the requirements of identifiable groups. Its end objective is the acquisition of improved "sales" performance (such as use of online services) through greater customer satisfaction of his needs. Marketing is not just selling; it includes promotion, advertizing, distribution, service, pricing, product performance, quality, product design and capability, cost, delivery and back-up. Since information is often intangible, not always in demand and difficult to assign a value to, it is usually not the information per se that needs to be marketed, but the service behind it, the provision of it, the benefits of it. To market any of these aspects requires the construction of a marketing plan.

11.5.2 Marketing Planning and Research

Marketing planning is the process of organizing all of the considerations and tasks required to market a product or service most effectively so that they form an orderly and logical flow. It is through such planning that the information centre or library can set its own direction and course rather than leaving this to chance or misdirection by management or other groups competing for attention (such as the computer or public relations departments). The marketing plan is important and in fact unique because it is not until this plan is completed that other plans may be made (e.g. the production, advertizing, back-up service plans). There are five basic steps in the planning process:

a) setting objectives which must be measurable, achievable, credible, demanding and finite;

b) knowing present position - looking at the resources of the organization as well as the external environment to enable objectives to be attained;

c) examining alternative strategies or activities to get from where the organization or library is now to where it needs to go to fulfill its objectives;

d) selection of the appropriate strategy to fill the gap. The selection will be based on a knowledge of the market (competition and users); the product/service (e.g online system); the risks involved (will it be used); the investment necessary (e.g. for word processors, training); the resources available (manpower, space, materials); and the expected payback (increased utilization);

e) conversion to action plan, i.e. implementation of chosen strategy.

The marketing plan will include an indication of who the customers or users are and what their needs/requirements are.

This implies that before any type of product or service, be it SDIs or an office automation system, can be offered and made available, a fairly good idea of the categories and number of users in the organization must be obtained together with their patterns of information use. This intelligence can be gathered by the technique of market research. Market research is the process of finding and defining users with the aim of identifying trends in market size (potential), market demand (actual) and market profile (types of users), testing hypotheses as they affect the service and demand, and pointing to other activities or markets to be approached and product features to be emphasized. Market research attempts to answer the following questions:

- How many? This affords a complete picture at a given time. For example, number of searches done; length of time spent per search; number of requesters.

- What sort, who? Here one tries to see the type of (potential) user one has. Basic categories could be managers or researchers. There can be subgroups - physicists, chemists, engineers. Or one could divide or segment the market by education, or rank, or by location or age or motivation, e.g. reason for requesting an online search.

- How? By what media or methods can the market (potential users) be reached? Can posters be stuck where users will frequent, e.g entrance hall, canteen, recreation room? How will they be produced?

- Where? Geographic factors play a role in appeal. On a local level staff situated nearer the library probably use it more often than people located at the far end of the building.

- When? Various temporal factors effect the receptivity of potential users to advertisements or publicity. The time of day for instance - some people are late morning starters and so may be unreceptive to a new idea until after three cups of coffee! It's no good introducing a new service during the summer holidays or over Christmas.

- Why? The motivation behind users' needs and wants. Users wanting online searches, for example, could be motivated to help the firm prosper, to get a higher qualification, to get a raise, to write a paper, for private research, and so on.

It must be borne in mind that the market continuously changes - attitudes change, jobs change, research projects, working hours, locations change and these affect the pattern of library use. In the main there is a general ignorance with regard to the availability and procurement of information and thus the market must be measured in terms of potential rather than actual need.

11.5.3 The Service and its Promotion

The creation and development of a product/service is an innovative process which requires an understanding of what the market (users) needs and a specification which will include such things as performance, maintainability, reliability, appearance, cost, frequency of use, size and so on. A new product or service can always be "created" by changing an old or existing one. Even slight modifications or improvements make a difference. Difference, however, means nothing unless it is recognized as such by the customer and can affect him in some way, e.g. by being quicker, more up-to-date, easier to use or prepare. So before the virtues of a service or system can be extolled one must be aware of factors influencing the customer's decision to "buy" or use. These factors depend on his perception of the library and its reputation (e.g. reliability, accuracy, speed); the appearance, features and benefits of the service or product (it must be seen to fulfill his purpose); the packaging (if any) of the service or product; the availability, distribution and price; and the advertizing itself (which must be accurate, informative, honest).

Earlier, strategies to be used in getting the organization or library from where it is now to where it wants to go were mentioned. These strategies involve the mechanisms of advertizing, promotion, public relations and personal selling.

Advertizing is normally paid, non-personal presentation and promotion of ideas, a product or service, by an identified sponsor with intent to persuade. Promotion is used to inform, educate, persuade and reassure the customer. Sales promotion encourages use in the short term by an "offer". Public relations is a deliberate and planned effort to establish a positive environment in which an organization (including a library) can operate by the dissemination of news. Publicity is a non-personal stimulation of demand by the provision of news. Personal selling is personal persuasion.

These mechanisms enable the message, ideas and services to be communicated to the potential user. Clearly such communication mechanisms cover a wide variety of activities, techniques or tools ranging from brochures and posters to mail shots and demonstrations. All of this can be loosely termed publicity. It must be borne in mind that publicity can be favourable or unfavourable; it can be voluntary or involuntary; timely or untimely; there can be too little or too much; quality is more important than quantity; dissemination does not necessarily mean reception, and reception does not imply acceptance.

Several factors can inhibit successful communication; there is no guarantee that a message will reach its target - the education, nationality, vocabulary, location, workload of the audience may limit reception of the message. Similarly, individual attitudes may affect the reception, understanding and acceptance of the message or idea. The nature and tone of the message may itself inhibit successful communication, as may the timing. On the other hand, successful persuasion depends on the source which must be credible and honest; the idea which must relate to the hopes, problems, values of the target population; the meaning which must be clear with no room for doubt or misunderstanding; and the penetration - the message must be repeated often enough to get through.

11.6 EDUCATION AND TRAINING OF SCIENTISTS AND ENGINEERS

The information profession is realizing that education and training go hand in gove with marketing and promotion. Otway and Peltu (29) consider that in the office new skills are needed in three areas: communicating information, accessing information and holding group conferences. Gray (20) believes that engineers are not fundamentally bad at communicating compared to other professional groups, although he concedes that they are less than proficient in communicating ideas and arguements as opposed to bare numerical data. An improvement in teaching skills at undergraduate level would help, he says. Engineers, according to Woelfle (54), can improve technical communication by developing a greater awareness of its importance to their job and career, as well as by acquiring the basic skills to communicate effectively. These he says can be gained by courses, reading and writing more and by participating in professional activities which foster communication. It is not only a matter of just communicating effectively. It is also necessary that the scientist or engineer maintains himself within a communication network so that he is brought into contact with sources of information.

Problems of training present and potential users of scientific and technical information in better utilization of the information services and sources offered them is attracting increasing international attention. Interestingly enough, at a seminar in Rome on this subject in 1976 (49) there were representatives from four of the organizations asked to participate in this study (ESA, FAO, IAEA and UNESCO). Evans concludes that it is desirable that any instruction in information retrieval should improve the beneficial contribution of scientists and engineers to society (14).

11.6.1 Education Aspects

Since some writers, e.g. Brooke (4), differentiate between education and training, this dichotomy will be preserved here. Basically, education involves making users or potential users aware of services and systems, what they can and cannot do or provide, while training involves teaching them how to actually make use of them.

Schmidt (41) notes that there is very little information in the literature on why user education is necessary, instead it mainly relates to how it is done. Education gives the user an understanding of the system and what procedures he needs to follow, it allows him to find his way about the library or organization, it informs him about new resources. Such user education will, in the long run, save the time of both the librarian and the user as well as other members of personnel. Education of library users is a continuing process - but there are difficultes. Veenhoff-Lovering (50), discussing the dearth of literature in educating the special library user as opposed to the academic, argues that it is rather difficult to educate a middle-aged engineer, a recognized expert in his field, who knows it all already, or at least thinks he does. Sullivan, in a study of in-house user education in some 700 special libraries, found that 78% gave instruction to users either as a general practice or in certain circumstances (44). Factors influencing the provision of instruction include: the demand or interest of the user; the status of the user (e.g. he was a newcomer); the need perceived by the librarian; user activities (e.g. starting a special task or new project); the amount of library use; the nature of use (e.g. personal visit, phone request); the nature of the service required; and the time available. Sullivan also noted that libraries specializing in engineering were the least likely to give instruction.

Various methods of educating users or staff exist and these include printed guides and brochures, introductory lectures, a tour of the library, signs and so forth. The content will cover the layout of the library, its resources, other resources within the organization as well as outside, use of the catalogue, use of bibliographic tools and online terminal and introduction to general reference works. It must be emphasized though that such educational programmes do not only apply to the library. New staff members need induction courses not only to the library and its facilities but also to the remainder of the organization. This involves a guided tour of the establishment, introduction to colleagues and management, showing where facilities (printing, telex, public relations, canteen, travel office, etc.) are located and so on.

More often than not all the newcomer gets is a copy of the staff rules and annual report to make him feel at home.

11.6.2 Training Aspects

If education is one side of the coin, training is the other. Tocatlian (47) has observed that user training programmes are seldom designed around what is known of users' needs and information-seeking behaviour. Basic questions which need to be asked include:

- for whom is the training intended?
- why is the training required?
- what is the training programme intended to accomplish?
- where and when should it take place?
- what methods should be used?
- what equipment and materials are required?
- what should be the content?

The objective of a training programme is, of course, to provide participants with sufficient knowledge and information to equip them to use services and systems themselves. There is a vast amount of literature on training packages and programmes (see, for example, references 14, 16, 21 and 33). Keenan (24) looks at a representative sample of online user training packages in North America and Europe, and Tedd (46) also surveys similar packages. Hills (21) gives information about a variety of teaching and learning methods currently in use in a package which itself contains a book, audio tape, tape/slide programme, slides and an overhead transparency. Methods used for training users, particularly, though not especially, library users include audio and digital recording; computer-aided instruction; audio visuals; tape/slide packages; lectures; printed materials; videodiscs; distance learning via videotex systems and hands-on experience. Training courses need not necessarily cover every topic at once. There can be separate modules for say, use of online system - and naturally they may be given on an individual or group basis. Nor will they relate only to use of library facilities.

They will also cover use of office automation equipment as well as training in the subject field of the scientist and engineer to bring him up-to-date with new techniques and developments. There are, however, a number of problems in the smooth running of education and training programmes in the types of organization studied herein.

The average engineer or scientist spends a very significant proportion of his time in meetings and on mission. Thus it is very difficult to get a group together at any one time for any length of time. An individual's time is often committed weeks in advance. Coupled with this is the fact that because these people are so involved in such "conference" activities, they are loathe to spend what little time they do have on training. It also of course means that they have little time to visit the library and browse or even read the books they request to see. This is evidenced by the fact that in the researcher's establishment, when online searches are done for the scientist/engineer it is very noticeable that they only require typically half-a-dozen references or so that they can get hold of immediately. They do not want exhaustive searches across all databases - just a few useful titles which need not be the best nor indeed the most recent so long as they are available. Of course, while one of the reasons for wanting only a few references may be lack of time to obtain and read them (searches are often done because a difficulty has arisen and needs to be resolved as soon as possible), one of the reasons is undoubtedly that staff are working in the very forefront of technology, in highly specialized fields, studying problems for which no solution exists. Consequently, it is often not worthwhile them seeing what is available online (since it reflects information already out-of-date). They are the ones who will write the papers to be abstracted in the databases!
Much of the actual nuts and bolts work is done outside the organization under contract, thus many staff will be involved in project definition and placing and overseeing contracts. This means that the need for online searches is shifted to the contractor, although an overview of available literature is sometimes requested prior to a new project being designed. Another problem, certainly in so far as the library is concerned, may be that the establishment is scattered over a fairly large site, - though this is, in fact, hardly an unsurmountable problem.

11.7 RECOMMENDATIONS FOR IMPROVEMENTS

With so small a sample it is obvious that the present study cannot speak for all scientists and engineers in international organizations and national aerospace establishments. Nevertheless, the results can be considered indicative of their patterns of communications and information use. The suggestions or recommendations which follow are, therefore, not necessarily directed only to those organizations taking part in the study, but indeed to any other organization wishing to improve its communication and information flow and thus contributing to greater savings and efficiency. For each of the recommendations below the rationale behind it is given and, where appropriate, the method to carry it out.

Recommendation 1:

The library should stimulate a greater awareness of information within the organization.

Rationale: the library and sources of information are often little used because they are little known.

Method: Inform staff about availability of services and sources by using brochures, newsletters, special bibliographies, displays, and personal contact to promote them.

Recommendation 2:

The library should conduct a study to ascertain actual and potential users' real needs and requirements and information-seeking behaviour.

Rationale: The library then could create and ensure provision of services and sources sufficient to meet and capable of meeting these needs.

Method: An in-depth survey of both users and non-users by means of structured questionnaires and interviews.

Recommendation 3:

The library should aim to provide a superlative service to those who need and use its services the most.

Rationale: The library cannot and should not spread itself too thinly by thinking it can be all things to all men. Better a good service in several, important areas, than a poor service in many areas.

Method: Provide services and sources in needed areas. Assist in creation of databases where no external sources are available.

Recommendation 4:

Notwithstanding Recommendation 3 above, the library should aim to do more for managers.

Rationale: Managers are generally poor users and are often of a low opinion of the usefulness of the library and are unsympathetic to its goals.

Method: Provision of information managers specifically need, e.g. facts, costs, synthesized, evaluated data. Construction of a basic induction course for managers.

Recommendation 5:

The library should prepare, and subsequently evaluate, programmes of user education and training.

Rationale: It is not sufficient to just know about an information source. It must be used fully to get the maximum benefit from it. Such use will require prior training.

Method: Guided tours of the library explaining location, function and use of facilities and sources. Give theory and practical instruction in use of catalogue, online terminal, reference books, etc.

Recommendation 6:

A study aimed at finding out how and why staff spend their time in the office should be undertaken.

Rationale: This would reveal how much time was spent in communicating both internally and externally. Communication includes reading, telephoning, writing letters/telexes/memos, preparing contracts/reports/invitations to tender, being in meetings, etc. It would show where economies and improvements could be made.

Method: An in-depth survey of professional and managerial staff by means of structured questionnaires and interviews.

Recommendation 7:

The amount and flow of document preparation, copying and distribution should be measured.

Rationale: This would give an idea of the amount of paper being generated, handled and transferred both internally and externally and show what was strictly necessary and what was not with a view to eliminating much of it.

Recommendation 8:

The feasibility of installing an electronic storage and messaging system within the organization based on a local area network (LAN) should be studied.

Rationale: Such a system would eliminate much of the paper volume and flow, enable more accurate work to be done, better recording of messages and more efficient time management. It would give staff more time to spend in more useful and interesting pursuits such as research, information-seeking and background reading.

Recommendation 9:

Gatekeepers and boundary-spanning activities should be actively encouraged.

Rationale: Gatekeepers are individuals, known as experts in their fields to the world outside the organization, who through their interpersonal contacts bring in new information to the organization which helps it to develop and grow and survive. It would also enable such staff to keep up with their areas of expertise to the benefit of the organization.

Method: Management should encourage and support participation in conferences and professional activities, e.g. chairmanships and committee memberships, editorships, as well as the preparation of papers and articles for publication. Attendance at training courses would also help.

Recommendation 10:

The organization should encourage and actively try to achieve a greater interaction and exchange of information between its diverse divisions and groups.

Rationale: "Rootless" staff have a need to identify with the organization as a whole and all staff require a knowledge of what goes on throughout the entire organization rather than just their own division/project as well as what policies or changes might affect them.

Method: Greater dissemination of general, formal information about the organization (in addition to rules and regulations) downward and laterally; greater dissemination of policy to professional staff (as opposed to managers); greater interaction between non-interdependent groups by more frequent joint staff meetings; creation of a regular (e.g. monthly) newsletter with organizational, departmental and staff news; creation of a series of brochures describing the work and activities of each department.

Recommendation 11:

Management should strive to create better conditions for interpersonal communication and information use given their importance and effect in improving R&D innovation and performance.

Rationale: Better conditions not only increase productivity but also reassure staff thus leading to better motivation, increased job satisfaction and improved morale.

Method: Provision for job security, promotions, rewards, harmony within the organization. Installation of new information technology/automated office, e.g. word processors, LAN, videoconferencing to ease preparation of documents, facilitate transfer of messages and reduce need for routine meetings. Avoid reducing information budget and restricting use of the richer forms of information transfer during periods of uncertainty.

Recommendation 12:

The feasibility should be investigated of integrating under a single information resources manager the various departments dealing with information functions (such as the library; communications (mail/telex); reproduction/printing; publications; public relations; photographic/graphics; archives; computer department).

Rationale: This would bring together all the information resources and services scattered throughout the organization, thus enabling better control, greater economies, less duplication and easier creation of new services and sources matching organizational needs.

11.8 SUGGESTIONS FOR FURTHER WORK

Clearly, a study such as the present one which covers a lot of ground has possibilities for further work.

The recommendations above give an indication of some future work which could be profitably undertaken at an organizational level. In-depth surveys within international organizations could be carried out into users' - particularly managers' - precise information requirements and the factors generating an information need as well as into the information flow and use. Regarding flow it might be possible to clarify the roles of individuals in international organizations, in particular that of the gatekeepers. The usual concept of a gatekeeper as a highly motivated achiever, supervisor, and voracious reader with many external contacts would seem to need redefining within the context of an international organization since so many staff can be characterized by this definition.

It would be interesting, in addition, not only to build up a more complete profile of a gatekeeper, but also to study the characteristics and personality of individuals more. It is clear that some staff do have personality clashes and do withhold or distort certain information and this hampers communication. Research into these aspects, which would require the confidential cooperation of both staff and management, would prove helpful to understanding the structure of the organization, its communication flow, and how work gets done. Such research could also concentrate more on the grapevine - a most useful and fruitful source for all - than the present study did, as well as on the effect of environmental conditions on information usage and communication.

In parallel to an in-depth survey of users' information requirements, libraries would find it helpful to know how users actually used material and which documents and sources are actually used. Such a study would enable them to better utilize their budget and resources.

This in turn points to the need for the preparation of training programmes and materials to promote information and library use. The construction of good education and training programmes is a specialist task and presupposes an insight into the habits and characteristics of library users. In an international organization, before such training programmes were constructed, it would be useful to conduct a more in-depth study of the education, background and training in the use of libraries and information sources by the various nationalities. In the present study it was noticeable that certain nationalities never used the library - possibly because of their subject discipline, but also possibly because they were not taught to at university. Research into this area could throw some interesting light on library education in certain countries.

There is also scope for behavioural information scientists and librarians to study the motivation or reasons why an individual required this or that, read this journal or that one or communicated in another language. With regard to the latter, for example, did they do it because of the other person's language limitations, because it was a common language, to be polite, to ensure clarity or whatever?

One other aspect which could be profitably explored further is that of information richness and how it can explain the information processing behaviour of scientists, engineers and managers. For example, is there a positive relationship between information richness and the complexity of international and matrix organizational structures? The report by Daft and Lengel (10) lays the groundwork for such a study.

Research and studies such as these suggested above would greatly enhance the knowledge and understanding about the individuals making up an organization.

Their roles, bahaviour and attitudes could thus be stimulated and turned to the advantage of the organization as well as the benefit of the individual.

REFERENCES

1) BECKER, L.G.
Information resources management (IRM): a revolution in progress.
ASIS Bulletin, 6, 6, Aug. 1980, p.26-27.

2) BHALLA, S.K.
Make R&D cheaper, faster, better with teamwork.
Industrial Research and Development, 23, 9, Sept. 1981, p.159-161.

3) BRETON, E.V.
Why engineers don't use databases.
ASIS Bulletin, 7, 6, Aug. 1981, p.20-23.

4) BROOKE, A.
Some user education techniques appropriate to special libraries.
Australian Special Libraries News, 13, 1, March 1980, p.15-18.

5) CARTER, M.P.
Determining information needs.
Management Decisions, 21, 4, 1983, p.45-51.

6) COMMISSION OF THE EUROPEAN COMMUNITIES
File network needs and effectiveness study. CEC, 1980.

7) CONDOUS, C.
Non-profit marketing - libraries' future?
Aslib Proceedings, 35, 10, Oct. 1983, p.407-417.

8) CRONIN, B.
The marketing of library and information services. Aslib, 1981.

9) CULNAN, M.J. and BAIR, J.H.
Human communication needs and organizational productivity: the potential impact of office automation.
JASIS, 34, 3, May 1983, p.215-221.

10) DAFT, R.L. and LENGEL, R.H.
Information richness: a new approach to managerial behavior and organization design. Texas A&M University. College of Business Administration, 1983. AD-A128980 TR-ONR-DG-02.

11) DORDICK, H.S. et al
The emerging network marketplace. Ablex Publishing Corp., 1981

12) DUNNING, A.
INSIS: Inter-institutional integrated services information system. In Proceedings of 6th International Online Information Meeting, 1982 Dec. 7-9, London, England. Learned Information, 1982, p.161-176.

13) DUNNING, A.
The INSIS programme: information technology for the office worker. Paper presented at 7th International Online Information Meeting, 1983 Dec. 6-8. London, England.

14) EVANS, A.J. et al
Education and training of users of scientific and technical information: UNISIST guide for teachers. UNESCO, 1977.

15) FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

16) FJÄLLBRANT, N.
The development of a programme of user education at Chalmers University of Technology Library. University Microfilms, 1977.

17) GIULIANO, V.E.
Teleworking: a prospectus.
Telephony, 200, 2, 12 Jan. 1981, p.67, 70-72, 75.

18) GOLDHAR, J.D. et al
Information flows, management styles and technological innovation.
IEEE Trans. on Engineering Management, EM-23, 1, Feb. 1976, p.51-62.

19) GRANT, S.J.C.
Cornerstone of a multifunction workstation: electronic mail.
Telecommunications, 15, 7, July 1981, p.34F-34H, 71.

20) GRAY, T.G.F.
Communication skills in engineering.
CME, 28, 4, April 1981, p.23-27.

21) HILLS, P.J.
Information package on teaching and learning methods for librarians.
British Library, 1979. BLR&D report 5512.

22) HOLLAND, W.E. et al
Information channel/source selection as a correlate of technical
uncertainty in a research and development organization.
IEEE Trans. on Engineering Management, EM-23, 4, Nov. 1976,
p.163-167.

23) HOWTON, F.W.
Work assignment and interpersonal relations in a research
organization: some participant observations.
Administrative Science Quarterly, 7, 1962/63, p.502-520.

24) KEENAN, S.
Survey of packages for training users of online information
services. Final Report. CEC, 1978.

25) LEE, A.M.
Electronic message transfer and its implications. Lexington Books,
1983.

26) MARCH, J.G. and SIMON, H.A.
Organizations. Wiley, 1958.

27) MATARAZZO, J.M.
Closing the corporate library: case studies on the decision-making process. SLA, 1981.

28) MELTZER, M.F.
Information: the ultimate resource. Amacom, 1981.

29) OTWAY, H.J. and PELTU, M.
New office technology: human and organizational aspects. Francis Pinter, 1983.

30) PAOLILLO, J.G.P.
Technological gatekeepers: a managerial perspective.
IEEE Trans. on Engineering Management, EM-29, 4, Nov. 1982, p.169-171.

31) POPPEL, H.L.
Managerial/professional productivity. Booz, Allen and Hamilton, 1980.

32) RAITT, D.
Marketing and promotion of online services for intermediaries
In Proceedings of 4th International Online Information Meeting, 1980 Dec. 9-11, London, England. Learned Information, 1980, p.265-274.

33) RAITT, D.
Teaching the teachers: essentials of online educating for intermediaries. In Proceedings of 4th International Online Information Meeting, 1980 Dec. 9-11, London, England. Learned Information, 1980, p.427-434.

34) RAITT, D.
The information specialist: transition to information manager.
In B. Hubbard, State of the Art Report: Technology Management. Pergamon-Infotech, 1982, p.249-260.

35) RAITT, D.
Recent developments in telecommunications and their impact on information services.
Aslib Proceedings, 34, 1, Jan. 1982, p.54-76.

36) RAITT, D.
Information technology and the library.
The Electronic Library, 1, 2, April 1983, p.149-156.

37) RICE, R.E. and BAIR, J.
Conceptual role of new communication technology in organizational productivity. In Proceedings of 46th ASIS Annual Meeting, 1983 Oct. 2-6, Washington, DC. ASIS, 1983, Vol. 20, p.4-8.

38) RICHARDSON, R.J.
End-user online searching in a high technology engineering environment.
Online, 5, 4, Oct. 1981, p.44-57.

39) ROSTRON, S.
Tomorrow's office.
Reprographic Quarterly, 13, 4, 1979, p.135-138.

40) RUBENSTEIN, A.H. et al
Ways to improve communications between R&D groups.
Research Management, 14, 6, Nov. 1971, p.49-59.

41) SCHMIDT, J.
The nature and importance of user education and its relevance to the special library situation.
Australian Special Libraries News, 31, 1, March, 1980, p.9-13.

42) SMITH, B.B.
Marketing strategies for libraries.
Library Management, 4, 1, 1983, p.1-52.

43) SMITH, F.R.
Enhancing technical communications within a large corporation.
Technical Communication, Fourth Quarter, 1977, p.12-16.

44) SULLIVAN, C.
Survey of in-house user education in special libraries.
Aslib Proceedings, 31, 7, July 1979, p.322-333.

45) SYNNOTT, W.R. and GRUBER, W.H.
Information resource management: opportunities and strategies for the 1980s. Wiley, 1981.

46) TEDD, L.A.
Teaching aids developed and used for education and training for online searching.
Online Review, 5, 3, June 1981, p.205-216.

47) TOCATLIAN, J.
Training information users: programmes, problems, prospects.
UNESCO Bulletin for Libraries, XXXII, 6, Nov-Dec. 1978, p.355-362.

48) TUSHMAN, M.L.
Managing communication networks in R&D laboratories.
IEEE Engineering Management Review, 9, 4, Dec. 1981, p.65-77.

49) UNESCO
Final report of UNISIST seminar on the education and training of users of scientific and technological information (1976 Oct. 18-21, Rome, Italy). UNESCO, 1976, SC-77/WS/22.

50) VEENHOFF-LOVERING, A.
Educating the special library user: an annotated bibliography. 1960-1983. 1983. Unpublished.

51) WATANABE, T.
Visual communication technology: priorities for the 1980s.
Telecommunications Policy, 4, 4, Dec. 1980, p.287-294.

52) WILSON, T.D.
Office automation and information services. In Proceedings of 7th International Online Information Meeting, 1983
Dec. 6-8, London, England. Learned Information, 1983, p.199-206.

53) WILSON, T.D. and STREATFIELD, D.R.
Information needs in local authority social services departments: an interim report on Project INISS.
Journal of Documentation, 33, 4, Dec. 1977, p.277-293.

54) WOELFLE, R.M.
Role of the engineer in improving the communication of technical information.
IEEE Trans. on Professional Communication, PC-22, 1, March 1979, p.24-26.

BIBLIOGRAPHY

ACKOFF, R. L.
Systems, organizations and interdisciplinary research. In Emery, F.E., Systems thinking: Selected readings. Penguin, 1971, p.330-347.

ADAMS, E.B. and ROOD, S.A.
Critical issues in scientific and technical communication perspectives of users, providers and policymakers. Final Report 1976-1978. NTIS, 1978. PB 279 382 GWU/SCD-78/1.

ALLEN, T.J.
The differential performance of information channels in the transfer of technology. MIT Sloan School of Management WP 1966 196-66.

ALLEN, T.J.
Information needs and uses. In Cuadra, C.A. Annual Review of Information Science and Technology, Vol.4, ASIS, 1969, p.3-29.

ALLEN, T.J. (a)
Communication networks in R&D laboratories.
R&D Management, 1, 1, Oct. 1970, p.14-21.

ALLEN, T.J. (b)
Roles in technical communication networks. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.191-208.

ALLEN, T.J.
The importance of direct personal communication in the transfer of technology. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976. AGARD-CP-179, p.2-1 - 2-10.

ALLEN, T.J.
Managing the flow of technology. MIT Press, 1977.

ALLEN, T.J. et al
The international technological gatekeeper.
Technology Review, 73, 5, March 1971, p. 36-43.

ALLEN, T.J. et al
R&D performance as a function of international communication, project management, and the nature of the work.
IEEE Trans. on Engineering Management, EM-27, 1, Feb. 1980, p.2-12.

ALLEN, T.J. and COHEN, S.I.
Information flow in an R&D laboratory. MIT Sloan School of Management, 1966, WP 217-66.

ALLEN, T.J. and COHEN, S.I.
Information flow in research and development laboratories.
Administrative Science Quarterly, 14, 1969, p.12-19.

AMERICAN MANAGEMENT ASSOCIATION
Statistical concepts for managerial decision-making. AMA, 1970.

AMERICAN PSYCHOLOGICAL ASSOCIATION
Reports of the American Psychological Association's project on scientific information exchange in psychology. Vol. 1, 1963. CFSTI PB164496, Vol. 2, 1965. CFSTI PB169005. Supplement, 1968, APA.

ANTHONY, L.J. et al
The growth of the literature of physics.
Reports on Progress in Physics, 32, 6, Dec, 1969, p.709-767.

ANZIEU, D.
Les communications intra-groupe. In Geldard, F.A. ed. Conference on communication processes, Washington, 1963. Macmillan, 1965, p.109-188, discussion p. 189-218.

ARDOINO, J.
Information et communication dans l'entreprise et les groupes de travail. 2nd ed. Les editions d'organization, 1964.

ATHANASSIADES, J.C.
The distortion of upward communication in hierarchical organizations.
Academy of Management Journal, 16, 2, June 1973, p.207-226.

AUSTER, E.
Organizational behavior and information seeking - lessons for librarians.
Special Libraries, 73, 3, July 1982, p.173-182.

BADAWY, M.K.
Developing managerial skills in engineers and scientists. Van Nostrand Reinhold, 1982.

BAKER, D.B.
Communication or chaos.
Science, 169, 3947, 21 Aug. 1970, p.739-742.

✓BAKER, N.R. et al
Idea generation: a procrustean bed of variables, hypotheses, and implications. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.33-51.

BARNARD, C.I.
The functions of the executive. Harvard UP, 1946.

BARNES, R.C.M.
Information use studies. Part 2 - Comparison of some recent surveys.
Journal of Documentation, 21, 3, Sept. 1965, p.169-176.

BASKIN, O.W. and ARONOFF, C.E.
Interpersonal communication in organizations. Goodyear Pub. Co., 1980.

BAVELAS, A.
Communication patterns in task-oriented groups. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs., 1968, p.503-511.

BAYER, A.E. and JAHODA, G.
Background characteristics of industrial and academic users and non-users of online bibliographic search services.
Online Review, 3, 1, March 1979, p.95-105.

BAYER, A.E. and JAHODA, G.
Effects of online bibliographic searching on scientists' information style.
Online Review, 5, 4, Aug. 1981, p.323-333.

BECKER, L.G.
Information resources management (IRM): a revolution in progress.
ASIS Bulletin, 6, 6, Aug. 1980, p.26-27.

BELEW, W.W. et al
Passive solar energy information user study. Solar Energy Institute, 1980. SERI-TR-751746.

BENNIS, W.G.
Interpersonal communication. In Bennis, W.G. et al., The planning of change. Holt, Rinehart and Winston, 1961, p.408-411.

BENSAHEL, J.G.
Mixing the formal with the informal.
International Management, 36, 1, Jan. 1981, p.37-38.

BERGER, C.R. and ROLOFF, M.E.
Social cognition, self-awareness, and interpersonal communication. In Dervin, B. and Voigt, M.J., Progress in communication sciences. Vol. II. Ablex, 1980. p.1-49.

BERKOWITZ, N.H. and BENNIS, W.G.
Interaction patterns in formal service-oriented organizations.
Administrative Science Quarterly, 6, 1961/62, p.25-50.

BERUL, L.H. et al
DOD user needs study, Phase, 1. Vols. 1 and 2. Auerbach Corp., 1965.
Report No. 1151-TR-3. AD615501/2.

BHALLA, S.K.
Make R&D cheaper, faster, better with teamwork.
Industrial Research and Development, 23, 9, Sept. 1981, p.159-161.

BLAND, M.
Employee communications in the 1980s. Kogan Page, 1980.

BOOT, J.C.G. and COX, E.B.
Statistical analysis for managerial decisions. McGraw-Hill, 1970.

BORMANN, E.G. et al
Interpersonal communication in the modern organization.
Prentice-Hall, 1969.

BRASEY, E.
L'anglais ne suffit pas.
L'Expansion, No. 208, 21 Jan/3 Fev. 1983, p.21.

BRETON, E.J.
Reinventing the wheel: the failure to use existing technology.
Mechanical Engineering, 103, 3, March 1981, p.54-57.

BRETON, E.J.
Why engineers don't use databases.
ASIS Bulletin, 7, 6, August, 1981, p.20-23.

BROOKE, A.
Some user education techniques appropriate to special libraries.
Australian Special Libraries News, 13, 1, March 1980, p.15-18.

✓BROOKES, B.C.
Communication between scientists.
Advancement of Science, 19, March, 1963, p.559-563.

BROWN, W.B.
Systems, boundaries and information flow. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p. 121-133.

BURNS, T.
The directions of activity and communication in a departmental executive group.
Human Relations, 7, 1954, p.73-97.

CAMPBELL, D.T.
Systematic error on the part of human links in communication systems.
Information and Control, 1, 1958, p.334-369.

CARTER, M.P.
Determining information needs.
Management Decisions, 21, 4, 1983, p.45-51.

CARTER, R.M.
Communication in organizations: an annotated bibiography. Gale Research Co., 1972.

CARTWRIGHT, D and ZANDER, A.
Group dynamics: research and theory. 2nd ed. Tavistock Publications, 1968.

CASTELEYN, M.
Planning library training programmes. Andre Deutsch, 1981.

✓CHAKRABARTI, A.K. et al
Characteristics of sources, channels and contents for scientific and technical information systems in industrial R&D.
IEEE Trans. on Engineering Management, EM-30, 2, May, 1983, p.83-88.

CHAPANIS, A.
Interactive human communication.
Scientific American, 232, 3, March, 1975, p.36-42.

CHEN, CHING-CHIH and HERNON, P
Information seeking. Neal-Schuman Publishers, 1982.

CHERRY, C
On human communication. 3rd ed. MIT, 1978.

CHRISTIE, B.
Face to file communication: a psychological approach to information systems. Wiley, 1981.

CLARK, D.F. and ACKOFF, R.L.
A report on some organizational experiments.
Operations Research, 7, May-June 1959, p.279-293.

CLUTTERBUCK, D.
Breaking through the cultural barrier.
International Management, 35, 12, Dec. 1980, p.41-42.

COHEN, A.M.
Changing small-group communication networks.
Administrative Science Quarterly, 6, 1961/62, p.443-462.

COLEMAN, J.S.
Relational analysis: the study of social organizations with survey methods.
Human Organizations, 17, 1958, p.28-36.

COLEMAN, J.S. and MACRAE, D.
Electronic processing of sociometric data for groups up to 1000 in size.
American Sociological Review, 25, 5, 1960, p.722-727.

COMMISION OF THE EUROPEAN COMMUNITIES
Les cadres juridiques de la coopération internationale en matière scientifique et le problème européen. Actes de colloques d'Aix-en-Provence, 1967, Dec. 1-2, et Nice, France, 1968, Dec. 6-7. CEC, 1970.

COMMISSION OF THE EUROPEAN COMMUNITIES
File network needs and effectiveness study. CEC, 1980.

CONDOUS, C.
Non-profit marketing - libraries' future?
Aslib Proceedings, 35, 10, Oct. 1983, p.407-417.

CONSTANCE, J.D.
Creating a professional work climate.
Machine Design, 54, 19, 26 Aug. 1982, p.94-98.

CORRIDORE, M.C.
Scientific and technical information needs of users or potential users of the DSA-administered, DOD Information Analysis Centers.
Defence Supply Agency, 1976. Final Report AD A024937.

CRANE, D.
The gatekeepers of science: some factors affecting the selection of articles for scientific journals.
American Sociologist, 2, 4, Nov. 1967, p.195-201.

CRANE, D.
Social structure in a group of scientists: a test of the "invisible college" hypothesis.
American Sociological Review, 34, 3, June, 1969, p.335-352.

CRANE, D.
The nature of scientific communication and influence.
International Social Science Jnl., 22, 1, 1970, p.28-41.

✓CRANE, D. (a)
Information needs and uses. In Cuadra, C.A. Annual Review of Information Science and Technology, Vol. 6, ASIS, 1971, p.3-29.

CRANE, D. (b)
Transnational networks in basic science.
International organization, 25, 3, 1971. p.585-601.

CRANE, D.
Invisible colleges: diffusion of knowledge in scientific communities. University of Chicago Press, 1975.

✓ CRAWFORD, S.
Informal communication among scientists in sleep research.
JASIS, 22, 5, Sept-Oct. 1971, p.301-310.

CRAWFORD, S.
Information needs and uses. In Williams, M.E. Annual Review of Information Science and Technology, Vol. 13, ASIS, 1978, p.61-81.

CRONIN, B.
The marketing of library and information services. Aslib, 1981.

CULNAN, M.J. and BAIR, J.H.
Human communication needs and organizational productivity: the potential impact of office automation.
JASIS, 34, 3, May 1983, p.215-221.

DAFT, R.L. and LENGEL, R.H.
Information richness: a new approach to managerial behavior and organization design. Texas A&M University. College of Business Administration, 1983. AD-A128980 TR-ONR-DG-02.

DAVIES, A.H.
The practise of marketing research. Heinemann, 1976.

DAVIES, J.
Linguistics and political barriers in the international transfer of information in science and technology: a re-interpretation. Journal of Information Science, 6, 5, June 1983, p.179-181.

DAVIS, K. (a)
A method of studying communication patterns in organizations. Personal Psychology, 6, 1953, p.301-312.

DAVIS, K. (b)
Management communication and the grapevine. Harvard Business Review, 31, Sept/Oct. 1953, p.43-49.

DAVIS, K
Communication within management. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p.155-162.

DAVIS, K.
Human behavior at work: organizational behavior. 6th ed. McGraw-Hill, 1981.

DENNISON, E. et al
International aid: channels of communication. Management Decisions, 21, 4, 1983, p.36-44.

DERVIN, B.
Communication gaps and inequities: moving towards a re-conceptualization. In Dervin, B. and Voigt, M.J., Progress in communication sciences. Vol. II. Ablex, 1980, p.73-112.

DEUTSCH, M.
The effects of cooperation and competition upon group process. In Cartwright, D. and Zander, A., Group dynamics: research and theory. 3rd ed. Tavistock Pubs., 1968, p.461-482.

DEWHIRST, H.D.
The role of the LRC technical library in fulfilling the information needs of professional employees. Langley Research Center, 1970.

DEWHIRST, H.D. et al
Satisfaction and performance in research and development tasks as related to information accessibility.
IEEE Trans. on Engineering Management, EM-25, 3, Aug. 1978, p.58-63.

DISCH, A.
The voice of the user: his information needs and requirements.
In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976. AGARD-CP-179, p.14.1-14.8.

DOBROWOLSKI, M.
Information for engineers: a preference for informal channels.
Instrument Technology, 28, 6, June 1981, p.14-16.

DODD, S.C. and MCCURTAIN, M.
The linguistic diffusion of information through randomly overlapped cliques.
Operational Research Quarterly, 16, 1, 1965, p.51-63.

DORDICK, H.S. et al
The emerging network marketplace. Ablex Publishing Corp., 1981

DOWNS, A
Inside bureaucracy. Little, Brown & Co., 1967.

DUNN, O.J. and CLARK, V.A.
Applied statistics: analysis of variance and regression. Wiley, 1974.

Proc

DUNNING, A.
INSIS: Inter-institutional integrated services information system.
In Proceedings of 6th International Online Information Meeting, 1982 Dec. 7-9, London, England. Learned Information, 1982, p.161-176.

DUNNING, A.
The INSIS programme: information technology for the office worker.
Paper presented at 7th International Online Information Meeting, 1983 Dec. 6-8. London, England.

EGAN, F.T.
Today's engineer: a survey.
Electronic Products, 25, 9, 10 Dec. 1982, p.40-45.

EMERY, F.E.
Systems thinking: selected readings. Penguin, 1971.

EMRICH, B.R.
Scientific and technical information explosion. NTIS, 1970.
AD 717 645, AFML-TR-70-182.

ENGINEERING INDEX, INC.
Alternatives for accessing engineering numerical data. NTIS, 1978.
PB282609.

ENSLEIN, K. et al
Statistical methods for digital computers. Wiley, 1977.

EVANS, A.J. et al
Education and training of users of scientific and technical information: UNISIST guide for teachers. UNESCO, 1977.

UN ES00

EXON, A.
Getting to know the user better.
Aslib Proceedings, 30, 10/11. Oct/Nov. 1978, p.352-364.

FARACE, R.V. et al
Communicating and organizing. Addison-Wesley, 1977.

FARACE, R.V. and MABEE, T.
Communication network analysis methods. In Monge, P.R. and Cappella, J.N., Multivariate techniques in human communication research. Academic Press, 1980, p.365-391.

FEIBLEMAN, J. and FRIEND, J.W.
The structure and function of organization. In Emery, F.E., Systems thinking. Penguin, 1971, p.30-55.

FELD. W.J. et al
International organizations: a comparative approach. Praeger, 1983.

FENN, M. and HEAD, G.
Upward communication: the subordinate's viewpoint.
California Management Review, 7, 4, Summer 1965, p.75-80.

FERGUSON, S. and FERGUSON, S.D.
Intercom: readings in organizational communication. Hayden, 1980.

FESTINGER, L.
The analysis of sociograms using matrix algebra.
Human Relations, 2, 3, 1949, p.153-158.

FESTINGER, L.
Informal social communication.
Psychological Review, 57, 1950, p.271-282.

FESTIGER, L. and KATZ, D.
Research methods in the behavioral sciences. Dryden, 1953.

FISCHER, W.A.
The acquisition of technical information by R&D managers for problem-solving in non-routine contingency situations.
IEEE Trans. on Engineering Management, EM-26, 1, Feb. 1979, p.8-14.

FISCHER, W.A.
Scientific and technical information and the performance of R&D groups. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.67-89.

FISHENDEN, R.M.
Methods by which research workers find information. In Proceedings of the International Scientific Conference on Information, Washington DC, 1958 Nov. 16-21, NAS, 1959. Vol. 1, p.163-179.

FISHER, B.A.
Small group decision-making: communication and the group process. 2nd ed. McGraw-Hill, 1980.

FJALLBRANT, N.
The development of a programme of user education at Chalmers University of Technology Library. PhD Thesis, University Microfilms, 1977.

FLOOD, B.
Broadcasting vs. narrowcasting: the user as receiver and sender of information. In Information revolution. Proceedings of 38th ASIS annual meeting, Boston, Mass., 1975, p.45-46.

FLOWERS, B.H.
Survey of information needs of physicists and chemists. Journal of Documentation, 21, 2, June, 1965, p.83-112.

FRENCH, J.R.P.
A formal theory of social power. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs, 1968, p.557-568.

FROST, P.A. and WHITLEY, R.
Communication patterns in a research laboratory.
R&D Management, 1, 2, 1971, p.71-79.

GALBRAITH, J.R.
Matrix organization designs.
Business Horizons, Feb. 1971, p.29-40.

GARVEY, W.D. et al (a)
Some comparisons of communication activities in the physical and social sciences. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.61-64.

GARVEY, W.D. et al (b)
Communication in the physical and the social sciences.
Science, 170, 3963, 11 Dec. 1970, p.1166-1173.

GARVEY, W.D. et al
Research studies in patterns of scientific communication: I General description of a research program.
Information Scorage and Retrieval, 8, 3, June, 1972, p.111-122.

GARVEY, W.D. et al (a)
Research studies in patterns of scientific communication: I. General description of research program. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.165-183.

GARVEY, W.D. et al (b)
Research studies in patterns of scientific communication: II. The role of the national meeting in scientific and technical communication. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.184-201.

GARVEY, W.D. et al (c)
Research studies in patterns of scientific communication: III Information exchange processes associated with the production of journal articles. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.202-224.

GARVEY, W.D. et al (d)
The dynamic scientific-information user. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.256-279.

GARVEY, W.D. et al (e)
Communication in the physical and social sciences. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.280-299.

GARVEY, W.D. and GOTTFREDSON, S.D.
Changing the system: innovations in the interactive social system of scientific communication. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.300-321.

GARVEY, W.D. and GRIFFITH, B.C.
Informal channels of communication in the behavioral sciences: their relevance in the structure of formal or bibliographic communication. In Montgomery, E.B.,The foundation of access to knowledge. Syracuse UP, 1968, p.129-146.

GARVEY, W.D. and GRIFFITH, B.C. (a)
Communication and information processing within scientific disciplines: empirical findings for psychology. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.127-147.

GARVEY, W.D. and GRIFFITH, B.C. (b)
Scientific communication as a social system. In Garvey, W.D., Communication: the essence of science. Pergamon, 1979, p.148-164.

GERSTL, J.E. and HUTTON, J.P.
Engineers: the anatomy of a profession. Tavistock Publications, 1966.

GETZ, R.R.
A survey of New Jersey's agricultural weather service users. Bulletin of the American Meteorological Society, 59, 10, Oct. 1978, p.1297-1304.

GIBSON, R.
Project management information requirements in an international organization. In Project management and project control, 10th ESRO Summer School, Frascati, Italy, Sept. 1972, p.349-352, ESRO SP-90, 1973.

GIULIANO, V.E. (a)
Teleworking: a prospectus.
Telephony, 200, 2, 12 Jan. 1981, p.67, 70-72, 75.

GIULIANO, V.E. (b)
Teleworking: future shock?
Telephony, 200, 6, 9 Feb. 1981, p.56, 58, 60, 62.

GLASS, B. and NORWOOD, S.H.
How scientists actually learn of work important to them. In Proceedings of the International Conference on Scientific Information, 1958, Nov. 16-21, Washington, DC., NAS, 1959, p.195-197.

GOETZINGER C. and VALENTINE, M.
Problems in executive interpersonal communication.
Personnel Administration, 27, 2, 1964, p.24-29.

GOLDHAR, J.D. et al
Information flows, management styles, and technological innovation.
IEEE Trans. on Engineering Management. EM-23, 1, Feb. 1976, p.51-62.

GRALEWSKA-VICKERY, A.
Communication and information needs of earth science engineers.
Information Processing and Management, 12, 4, 1976, p.251-282.

GRALEWSKA-VICKERY, A. and ROSCOE, H.
Earth science engineers communication and information needs.
Final report and appendix. Imperial College, 1975. Research report No. 32.

GRANT, S.J.C.
Cornerstone of a multifunction workstation: electronic mail.
Telecommunications, 15, 7, July 1981, p.34F-34H, 71.

GRAY, T.G.F.
Communication skills in engineering.
CME, 28, 4, April, 1981, p.23-27.

GRAZIA, A. de
(Response to W.D.Garvey). In Montgomery, E.B., The foundations of access to knowledge. Syracuse UP, 1968, p.147-151.

GRIFFITH, B. and MILLER, A.J.
Networks of informal communication among scientifically productive scientists. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.125-140.

GROSSMAN, S.D. and LINDHE, R.
People react to more than the message.
Human Systems Management, 1, 3, Nov. 1980, p.261-267.

GRUNIG, J.E.
Communication of scientific information to non-scientists. In Dervin, B. and Voigt, M.J., Progress in communication science, Vol. II, Ablex, 1980, p.167-214.

GUETZKOW, H.
Differentiation of roles in task-oriented groups. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs., 1968, p.512-526.

GULLAHORN, J.T.
Distance and friendship as factors in the gross interaction matrix. Sociometry, 15, 1952, p.123-134.

HAGSTROM, W.D.
The scientific community. Basic Books, Inc., 1965.

HALBERT, M.H. and ACKHOFF, R.L.
An operations research study of the dissemination of scientific information. In Proceedings of the International Scientific Conference on Information, Washington DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.97-130.

HALL, A.M.
Methodology and results of some user studies on secondary information services. In EURIM: European conference on research into the management of information services and libraries, Paris, France, 20-22 November 1973, p.31-37. ASLIB, 1973.

HANDY, C.B.
Understanding organizations. Penguin, 1979.

HARKINS, C.
Mathematical considerations in seeking fundamental limits to professional communication processes and effects.
Proceedings of IEEE, 69, 2, Feb. 1981, p.167-170.

HAWKINS, H.S.
Training of agricultural scientists in scientific communication.
International Forum of Information and Documentation, 5, 3, 1980, p.30-35.

HERBERT, E.
Innovation in communication: shortening the feedback loops among humans. In Innovations in communication conference, 1970 April 9-10. CFSTI, 1970, p.170-183. PB192294-12. CFSTI-70-01.

HERNER, S.
Information gathering habits of workers in pure and applied science.
Industrial and Engineering Chemistry, 46, 1, Jan. 1954, p.228-236.

HERNER, S. et al
An evaluation of the Goddard Space Flight Center Library. Herner and Co. 1979. NASA-CR-159969.

HERNER, S. and HERNER, M.
Information needs and uses in science and technology. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 2, ASIS, 1967, p.1-34.

HERZOG, A.J.
The 'gatekeeper' hypothesis and the international transfer of scientific knowledge. In The problem of optimization of user benefit in scientific and technological information transfer, AGARD, 1976. AGARD-CP-179 p.15.1-15.9.

HERZOG, A.J.
Career patterns of scientists in peripheral communities.
Research Policy, 12, 6, Dec. 1983, p.341-349.

HILGARD, E.R. and BOWER, G.H.
Theories of learning. 4th ed. Prentice-Hall, 1975.

HILL, R. and WHITE, B.J.
Matrix organization and project management. University of Michigan Press, 1980.

HILLS, P.J.
Information package on teaching and learning methods for librarians. British Library, 1979. BLR&D report 5512.

HINRICHS, J.R.
Communications activity of industrial personnel.
Personnel Psychology, 17, 1964, p.193-204.

HOGG, I.H. and SMITH, J.R.
Information and literature use in a research and development organization. In Proceedings of the International Conference on Scientific Information, Washington DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.131-162.

HOLLAND, W.E.
Characteristics of individuals with high information potential in government research and development organizations.
IEEE Trans. on Engineering Management, EM-19, 2, May 1972, p.38-44.

HOLLAND, W.E. et al
Information channel/source selection as a correlate of technical uncertainty in a research and development organization.
IEEE Trans. on Engineering Management, EM-23, 4, Nov. 1976, p.163-167.

HOLSTI, O.R.
Context analysis. In Lindzey, G. and Aronson, E., The handbook of social psychology. 2nd ed. Vol. 2: Research methods. Addison-Wesley, 1968, p.596-692.

HOSLETT, D.S.
Barriers to communication. In Richards, M.D. and Nielander, W.A. Readings in management. 3rd ed. South-Western Pub. Co., 1969, p.147-154.

HOWTON, F.W.
Work assignment and interpersonal relations in a research organization: some participant observations. Administrative Science Quarterly, 7, 1962/63, p.502-520.

HUBER, K.C.
An overview of six widely distributed statistical packages. In Monge, P.R. and Cappella, J.N., Multivariate techniques in human communication research. Academic Press, 1980, p.529-540.

HULL, C.H. and NIE, N.H.
SPSS Update 7-9. McGraw-Hill, 1981.

HURWITZ, J.I. et al
Some effects of power on the relations among group members. In Cartwright, D. and Zander, A. Group dynamics: research and theory. 3rd ed. Tavistock Pubs., 1968, p. 291-297.

INDIK, B.P.
Superior-subordinate relationships and performance. Personnel Psychology, 14, 1961, p.357-374.

JACKSON, J.M.
The organization and its communications problem. Advanced Management, 24, 2, Feb. 1959, p.17-20.

JACOBSON, E. and SEASHORE, S.E.
Communication practices in complex organizations. Journal of Social Issues, 7, 1951, p. 28-40.

JAHODA, M. et al
Research methods in social relations with especial reference to prejudice. Part 2: selected techniques. Dryden, 1957.

JAMES, G.D.
Analysis and interpretation of data. In Rossmassler, S.A. and Watson, D.G., Data handling for science and technology. North-Holland, 1980, p.55-64.

JENNY, H.K.
Heavy readers are heavy hitters.
IEEE Spectrum, 15, 9, Sept. 1978, p.66-68.

JERKOVSKY, W.
Functional management in matrix organizations.
IEEE Trans. on Engineering Management, EM-30, 2, May 1983, p.89-97.

JOHNSON, N.L. and LEONE, F.C.
Statistics and experimental design in engineering and the physical sciences. 2 vols. Wiley, 1964.

√ JOHNSTON, R. and GIBBONS, M.
Characteristics of information usage in technological innovation.
IEEE Trans. on Engineering Management, EM-22, 1, Feb. 1975, p.27-34.

JOHNSTON, R.E. and SMITH, G.V.
Communication in today's engineering environment.
SAWE Journal, 39, 3, Spring 1980, p.33-41.

KAGAN, J. and HAVEMANN, E.
Psychology: an introduction. 4th ed. Harcourt, Brace, Jovanovich, Inc., 1980.

KAHN, R.L. and CONNELL, C.F.
The dynamics of interviewing: theory, techniques and cases. Wiley, 1967.

KATZ, D. and KAHN, R.L.
The social psychology of organizations. 2nd ed. Wiley, 1978.

KATZ, R.
As research teams grow older.
Research Management, XXVII, 1, Jan-Feb. 1984, p.23-28.

KEENAN, S.
Survey of packages for training users of online information services. Final Report. CEC, 1978.

KENDALL, M.G.
Rank correlation methods. 3rd ed. Griffin & Co., 1962.

KENNEDY, S.
Marketing of professional information services. MCB Publications, 1981.

KING, D.W. and RODERER, N.K.
Communication in physics - the use of journals. 2nd ed. Holt, Rinehart and Winston, 1981.

KOEHLER, J.W. et al
Organizational communication: behavioral perspectives. 2nd ed. Holt, Rinehart and Winston, 1981.

KOLODNY, H.F.
Matrix organization designs and new product success.
Research Management, Sept. 1980, p.29-33.

KORNFELD, W.A. and HEWITT, C.E.
The scientific community metaphor.
IEEE Trans. on Systems, Man and Cybernetics. SMC-11, 1, Jan. 1981, p.24-33.

KRAUSE, D.C.
Marine science networks involving the individual and UNESCO. Vol.1. The intergovernmental framework. Vol.2. Cooperation and coordination. UNESCO, 1978.

KRAWITZ, L. and NEWHOUSE, H.
A survey of external users of NWS information.
Bulletin of the American Meteorological Society, 59, 10, Oct. 1978, p.1288-1296.

LADENDORF, J.M.
Information flow in science, technology and commerce: a review of the concepts of the sixties.
Special Libraries, 61, 5, May-June, 1970, p.215-222.

LANCASTER, F.W.
Towards paperless information systems. Academic Press, 1978.

LANGROD, G.
The international civil service: its origins, its nature, its evolution. Sijthoff, 1963.

LARGE, J.A.
The foreign-language barrier: problems in scientific communication. Andre Deutsch, 1980.

LAWRENCE, P.R. and LORSCH, J.W.
Organization and environment: managing differentiation and integration. Harvard UP, 1967.

LEARY, T.
The theory and measurement methodology of interpersonal communication. In Bennis W.G. et al., The planning of change. Holt, Rinehart and Winston, 1961, p.307-321.

LEAVITT, H.J.
Some effects of certain communication patterns on group performance.
Journal of Abnormal and Social Psychology, 46, 1951, p. 38-50.

LEE, A.M.
Electronic message transfer and its implications. Lexington Books, 1983.

LEVIN, R.I. and RUBIN, D.S.
Applied elementary statistics. Prentice-Hall, 1980.

LIKERT, R.
New patterns of management. McGraw-Hill, 1961.

LIKERT, R.
The human organization: its management and value. McGraw-Hill, 1967.

LIN, N.
The study of human communication. Bobbs-Merrill, 1973.

LIN, N. et al
A study of the communication structure of science. In Nelson, C.E. and Pollock, D.K. Communication among scientists and engineers. Heath Lexington Books, 1970, p.23-60.

LIN, N. and GARVEY, W.D.
Stratification of the formal communication system in science. In American Sociological Association annual meeting, 1971, Aug/Sept., Denver, Colorado. AMA, 1971. Abstract, p.137.

LIN, N. and GARVEY, W.D.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 7, ASIS, 1972. p.5-37.

LINDZEY, G. and ARONSON, E.
The handbook of social psychology. 2nd ed. Vol. 2. Research methods. Addison-Wesley, 1968.

LINDZEY, G. and BYRNE, D.
Measurement of social choice and interpersonal attractiveness. In Lindzey, G. and Aronson, E., The handbook of social psychology. 2nd ed. Vol. 2. Research methods. Addison-Wesley, 1968.

LIPETZ, B-A.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 5, ASIS, 1970, p.3-32.

LITWIN, G.H. and STRINGER, R.A.
Motivation and organizational climate. Harvard University Graduate School of Business Administration, 1968.

LUCE, R.D. and PERRY, A.D.
A method of matrix analysis of group structure. Psychometrika, 14, 1, March, 1949, p.95-116.

LUDEWIG, C.W.
Information needs of scientists in missile and rocket research as reflected by an analysis of reference questions. MLS Thesis submitted to University of North Carolina, 1965.

LUFKIN, J.M.
The reading habits of engineers - a preliminary survey. IEEE Trans. on Education, E-9, 4, Dec. 1966. p.179-182.

MARCH, J.G. and SIMON, H.A.
Organizations. Wiley, 1958.

MARQUIS, D.G. and ALLEN, T.J.
Communication patterns in applied technology. American Psychologist, 21, Nov. 1966, p.1052-60.

MARTIN, M.P. and FUERST, W.
Communications framework for systems design. Journal of Systems Management, 35, 3, March 1984, p.18-25.

MARTYN, J.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 9, ASIS, 1974, p.3-23.

MATARAZZO, J.M.
Closing the corporate library: case studies on the decision-making process. SLA, 1981.

MAXWELL, A.E.
Analysing qualitative data. Methuen, 1961.

MCALPINE, A. et al
The flow and use of scientific information in university research. Manchester Business School R&D Unit, 1972. OSTI Report 5138.

MEADOWS, A.J.
Communication in science. Butterworths, 1974.

MEADOWS, A.J.
New technology and developments in the communication of research during the 1980s. Primary Communications Research Centre, 1980.

MEADOWS, A.J. and O'CONNOR, J.G.
An investigation of information sources and information retrieval in astronomy and space science. 2 vols. OSTI, 1969. Report No. 5044.

MELTZER, M.F.
Information: the ultimate resource. Amacom, 1981.

MENZEL, H.
Review of studies in the flow of information among scientists. Columbia University, Bureau of Applied Social Research, 1960.

MENZEL, H.
The information needs of current scientific research. Library Quarterly, 34, Jan. 1964, p.4-19.

MENZEL, H. (a)
Information needs and uses in science and technology. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 1, ASIS, 1966, p.41-69.

MENZEL, H. (b)
Formal and informal satisfaction of the information requirements of chemists. Interim Report. Columbia University. Bureau of Applied Social Research. CFSTI, 1966, PB 173261.

MENZEL, H.
Informal communication in science: its advantages and its formal analogues. In Montgomery, E.B. The foundations of access to knowledge. Syracuse UP, 1968, p.153-163.

MENZEL, H.
Formal and informal satisfaction of the information requirements of chemists. Final Report. Columbia University. Bureau of Applied Social Research. CFSTI, 1970. PB 193556.

MICHEL, J.
Linguistic and political barriers in the international transfer of information in science and technology.
Journal of Information Science, 5, 4, Dec. 1982, p.131-135.

MICK, C.K. et al
Towards usable user studies.
JASIS, 31, 5, Sept. 1980, p.347-356.

MILLER, G.A.
The magical number seven, plus or minus two: some limits on our capacity for processing information.
Psychological Review, 63, 2, March 1956, p.81-97.

MITCHELL, T.R.
People in organizations: an introduction to organizational behavior. 2nd ed. McGraw-Hill, 1982.

MONGE, P.R. and CAPPELLA, J.N.
Multivariate techniques in human communications research. Academic Press, 1980.

MONTGOMERY, E.B.
Four "new" sciences: an approach to complexity. In AGARD storage and retrieval of information - a user-supplier dialogue conference, 1968 June 18-20, Munich, West Germany. AGARD, 1968, p.41-48. AD 481245 AGARD-CP-39.

MORAVCSIK, M.J.
The role of science in technology transfer.
Research Policy, 12, 5, Oct. 1983, p.287-296.

MORONEY, M.J.
Facts from figures. Penguin, 1979.

MOSER, C.A. and KALTON, G.
Survey methods in social investigation. 2nd ed. Heinemann, 1977.

MOSTELLER, F. and TUKEY, J.W.
Data analysis including statistics. In Lindzey, G. and Aronson, E., The handbook of social psychology. 2nd ed. Vol. 2. Research methods. Addison-Wesley, 1968, p.80-203.

MUCCHIELLI, R.
Le questionnaire dans l'enquete psycho-sociale. 6th ed. Entreprise moderne d'editions, 1979.

MUCHINSKY, P.M.
An assessment of the Litwin and Stringer organization climate questionnaire: an empirical and theoretical extension of the Sims and Lafollette study.
Personnel Psychology, 29, 1976, p.371-392.

MURPHY, M.
Measuring library effectiveness: a prelude to change.
Special Libraries, 70, 1, Jan. 1979, p.18-25.

MYERS, M.T. and MYERS, G.E.
Managing by communication: an organizational approach. McGraw-Hill, 1982.

NASH, S.H.
Selecting and implementing a word processor in the library.
The Electronic Library, 1, 4, Oct. 1983, p.265-273.

NELSON, C.E. and POLLOCK, D.K.
Communication among scientists and engineers. Heath Lexington Books, 1970.

NELSON, R.C.
Transcultural communication. In Vardaman, G.T. and Halterman, C.C., Managerial control through communication. Wiley, 1968, p.172-183.

NEWCOMB, T.M.
An approach to the study of communicative acts.
Psychological Review, 60, 6, 1953, p.393-404.

NIE, N.H. et al
SPSS - Statistical package for the social sciences. McGraw-Hill, 1970.

NIE, N.H. et al
SPSS - Statistical package for the social sciences. 2nd ed.
McGraw-Hill, 1975.

NOSOK, B.D. and GORLOV, A.A.
Ob izuchenii potrebnostej vrachei tsentral'nykh bol'nits v nauchnoi meditsinskoi informatsii (Scientific medical information needs of district hospital staff: a user study).
Nauchno. Tekh. Inf., 1, 2, 1974, p.11.

OLSON, E.E. (a)
Organizational factors affecting information flow in industry. Aslib Proceedings, 29, 1, Jan. 1977, p.2-11.

OLSON, E.E. (b)
Organizational factors affecting the flow of scientific and technical information in industrial R&D divisions. NTIS, 1977. PB27761.

OPPENHEIM, A.N.
Questionnaire design and attitude measurement. Heinemann, 1968.

ORR, J.M.
Libraries as communication systems. Greenwood Press., 1977.

ORR, R.H.
(Response to H. Menzel). In Montgomery, E.B., The foundations of access to knowledge. Syracuse UP, 1968, p.164-167.

ORR, R.H.
The scientist as an information processor: a conceptual model illustrated with data on variables related to library utilization. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.143-189.

OTWAY, H.J. and PELTU, M.
New office technology: human and organizational aspects. Francis Pinter, 1983.

PAISLEY, W.J.
The flow of (behavioral) science information: a review of the research literature. Stanford University, Institute for Communication Research, 1965.

PAISLEY, W.J.
Information needs and uses. In Cuadra, C.A., Annual Review of Information Science and Technology, Vol. 3, ASIS 1968, p.1-30.

PAISLEY, W.
Information and work. In Dervin, B. and Voigt, M.J., Progress and communication sciences. Vol. II. Ablex, 1980, p.113-165.

PAOLILLO, J.G.P.
Technological gatekeepers: a managerial perspective.
IEEE Trans. on Engineering Management, EM-29, 4, Nov. 1982, p.169-171.

PARTEN, M.
Surveys, polls and samples: practical procedures. Harper and Row and John Weatherhill, 1950.

PATTERSON, M.
Spatial factors in social interactions.
Human Relations, 21, 4, Nov. 1968, p.351-361.

PAYNE, S.L.
The art of asking questions. Princeton UP, 1973.

PELZ, D.C. and ANDREWS, F.M.
Scientists in organizations: productive climates for research and development. Wiley, 1966.

PERSSON, O.
Critical comments on the gatekeeper concept in science and technology. RIT, 1980, TRITA-LIB-6017.

PINELLI, T.E. et al
A review and evaluation of the Langley Research Center's Scientific and Technical Information Program. Results of Phase I - knowledge and attitudes survey, LARC Research Personnel. NASA, 1980. NASA-TM-81893.

POPPEL, H. L.
Managerial/professional productivity. Booz, Allen and Hamilton, 1980.

PRYOR, H.E.
An evaluation of the NASA Scientific and Technical Information System.
Special Libraries, 66, 11, Nov. 1975, p.515-519.

PRYOR, H.E.
Listening to the user: a case study. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976. AGARD-CP-179. p.11.1-11.7.

RAITT, D. (a)
Marketing and promotion of online services for intermediaries. In Proceedings of 4th International Online Information Meeting, 1980 Dec. 9-11, London, England. Learned Information, 1980, p.265-274.

RAITT, D. (b)
Teaching the teachers: essentials of online educating for intermediaries. In Proceedings of 4th International Online Information Meeting, 1980 Dec. 9-11, London, England. Learned Information, 1980, p.427-434.

RAITT, D. (a)
Recent developments in telecommunications and their impact on information services.
Aslib Proceedings, 34, 1, Jan. 1982, p.54-76.

RAITT, D. (b)
The information specialist: transition to information manager
<u>In</u> Hubbard, B., State of the Art Report: Technology Management.
Pergamon-Infotech, 1982, p.249-260.

RAITT, D.
Information technology and the library.
The Electronic Library, <u>1</u>, 2, April 1983, p.149-156.

RAMSTRÖM, D.
The efficiency of control strategies: communication and
decision-making in organizations. Almqvist and Wiksell, 1967.

RAWDIN, E.
Field survey of information needs of industry sci/tech library
users. <u>In</u> Proceedings of 38th ASIS Annual Meeting, 1975, Boston,
Mass. ASIS, 1975, p.41-42.

READ, W.H.
Upward communication in industrial hierarchies.
Human Relations, <u>15</u>, 1962, p.3-15.

REDFIELD, C.E.
Communication in management. University of Chicago Press, 1954.

RICE, R.E. and BAIR, J.
Conceptual role of new communication technology in organizational
productivity. <u>In</u> Proceedings of 46th ASIS Annual Meeting, 1983 Oct.
2-6, Washington, DC. ASIS, 1983, Vol. 20, p.4-8.

RICHARDS, J.W.
Interpretation of technical data. Van Nostrand, 1967.

RICHARDSON, R.J.
End-user online searching in a high technology engineering
environment.
Online, <u>5</u>, 4, Oct. 1981, p.44-57.

RITCHIE E. and HINDLE, A.
Communication networks in R&D: a contribution to methodology and some results in a particular laboratory. University of Lancaster, Dept. of Operational Research, 1976. BLRDR 5291.

ROBBINS, J.C.
Social functions of scientific communication.
IEEE Trans. on Professional Communication, PC-16, 3, Sept. 1973, p.131-135, 181.

ROBERTS, A.H.
The system of communication in the language sciences: present and future. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.293-306.

ROBERTSON, A.
Information flow and industrial innovation.
Aslib Proceedings, 25, 4, April, 1973, p.130-139.

ROBERTSON, I.T. and COOPER, C.L.
Human behaviour in organizations. Macdonald and Evans, 1983.

ROGERS, E.M. and AGARWALA-ROGERS, R.
Communication in organizations. Free Press, 1976.

ROGERS, E.M. and AGARWALA-ROGERS, R.
Three schools of organizational behavior. In Ferguson, S. and Devereaux Ferguson, S., Intercom: readings in organizational communication. Hayden, 1980, p.2-31.

ROGERS, E.M. and SHOEMAKER, F.F.
Communication of innovations. 2nd ed. Free Press, 1971.

ROSTRON, S.
Tomorrow's office.
Reprographic Quarterly, 13, 4, 1979, p.135-138.

ROTHWELL, R. and ROBERTSON, A.B.
The role of communications in technological innovation.
Research Policy, 2, 1973, p.204-225.

ROTHWELL, R. and ROBERTSON, A.B.
The contribution of poor communication to innovative failure.
Aslib Proceedings, 27, 10, Oct. 1975, p.393-400.

RUBENSTEIN, A. et al
Explorations on the information-seeking style of researchers. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.209-231.

RUBENSTEIN, A.H. et al
Ways to improve communications between R&D groups.
Research Management, 14, 6, Nov. 1971, p.49-59.

SAHA, J.
User studies for evaluation of information systems and library resources. In Proceedings of 35th FID conference and international congress of documentation, 1970 Sept. 14-24. Buenos Aires, Argentina. FID, 1970, 7p.

SAMPSON, A.
The new Europeans. Hodder and Stoughton, 1968.

SCHACHTER, S.
Deviation, rejection and communication. In Cartwright, D. and Zander, A., Group dynamics: Research and theory. 3rd ed. Tavistock Pubs., 1968, p.165-181.

SCHEIN, E.H.
Interpersonal communication, group solidarity and social influence. In Bennis, W.G. et al. The planning of change. Holt, Rinehart and Winston, 1961, p.517-527.

SCHLESINGER, L.E.
Meeting the risks involved in two-way communications.
Personnel Administration, 25, 6, 1972, p.24-30.

SCHMIDT, J.
The nature and importance of user education and its relevance to the special library situation.
Australian Special Libraries News, 31, 1, March, 1980, p.9-13.

SCHULER, R.S. and BLANK, L.F.
Relationships among types of communication, organizational level and employee satisfaction and performance.
IEEE Trans. on Engineering Management, EM-23, 3, Aug. 1976, p.124-129.

SCOTT, C.
The use of technical literature by industrial technologists. In Proceedings of the international conference on scientific information, 1958 Nov. 16-21, Washington, D.C., NAS, 1959, p.245-266.

SCOTT, C.
The use of technical literature by industrial technologists.
IRE Trans. on Engineering Management, EM-9, 2, June 1962, p.76-86.

SCOTT, W.G.
Organization theory: an overview and an appraisal. In Richards, M.D. and Nielander, W.A., Readings in management. 3rd ed. South-Western Pub. Co. 1969, p.664-688.

SELZNICK, P.
Foundations of the theory of organizations. In Emery, F.E., Systems thinking: selected readings. Penguin, 1971, p.261-280.

SENDERS, J.W.
Some thoughts on scientific communication or who does what and with which and to whom? In Innovations in communication conference, 1970 April 9-10. CFSTI, 1970, p.184-188, PB 192294-13, CFSTI-70-01.

SHEPPARD, M.O.
User response to the SDI service developed at Aeronautical Research Laboratories, Australia. In The problem of optimization of user benefit in scientific and technological information transfer. AGARD, 1976, AGARD CP-179, p.10-1-10-9.

SHOTWELL, T.K.
Information flow in an industrial research laboratory - a case study.
IEEE Trans. on Engineering Management, EM-18, 1, Feb. 1971, p.26-33.

SHUCHMAN, H.L.
Information transfer in engineering. The Futures Group, 1981.

SIMS, H.P. and LAFOLLETTE, W.
An assessment of the Litwin and Stringer organization climate questionnaire.
Personnel Psychology, 28, 1975, p.19-38.

SKELTON, B.
Scientists and social scientists as information users: a comparison of results of science user studies with the investigation into information requirements of the social sciences.
Journal of Librarianship, 5, 2, April 1973, p.138-156.

SLATER, M.
The neglected resource: non-usage of library-information services in industry and commerce. Aslib, 1981. BLR&D Report 5628.

SMITH, B.B.
Marketing strategies for libraries.
Library Management, 4, 1, 1983, p.1-52.

SMITH, F.R.
Enhancing technical communications within a large corporation.
Technical Communication, Fourth Quarter, 1977, p.12-16.

SOLLA PRICE, D.J. de
Little Science, Big Science. Columbia UP, 1963.

SOLLA PRICE, D.J. de
The scientific foundations of science policy.
Nature, 206, 4481, 17 April 1965, p.233-238.

SOUDER, W.B. and CHAKRABARTI, A.K.
Managing the coordination of marketing and R&D in the innovation process. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.135-150.

SPERO, J.E.
Barriers to international information flow.
Telecommunications, 17, 11, Nov. 1983, p.67-69.

SRINIVASAN, S.
Impact of user study in the improvement of documentation services in developing countries. In Proceedings of 35th FID conference and international congress of documentation, 1970 Sept. 14-24, Buenos Aires, Argentina. FID, 1970, 14p.

STEINACKER, I.
Implementation problems for information systems within international organizations. In Wessel, A.E. The implementation of complex information systems. Wiley, 1979, p.110-133.

STREATFIELD, D. and WILSON, T.
We have ways of making you......read?
Library Association Record, 80, 2, Feb. 1978, p.62-63, 65.

STREATFIELD, D. et al
Training social service staff to make better use of information: two practitioner-training courses and their implications.
Aslib Proceedings, 32, 3, March, 1980, p.134-144.

SULLIVAN, C.
Survey of in-house user education in special libraries.
Aslib Proceedings, 31, 7, July 1979, p.322-333.

SURATT, S.T.
Computer communications and information at CBS.
EBU Review, XXXIII, March 1982, p.22-27.

SUTTON, J.R.
Information requirements of engineering designers. In AGARD TIP Specialist Meeting. The problem of optimization of user benefit in scientific and technological information transfer, Copenhagen, Demark, 1975. AGARD, 1976, AGARD CP-179, p.12.1-12.8.

SUTTON, H. and PORTER, L.W.
A study of the grapevine in a governmental organization.
Personnel Psychology, 21, 1968, p.223-230.

✓SWINBURNE, J.K.
Information use and transfer by British and French scientists: a study of two groups.
Journal of Information Science, 6, 2/3. April 1983, p.75-80.

SYNNOTT, W.R. and GRUBER, W.H.
Information resource management: opportunities and strategies for the 1980s. Wiley, 1981.

TARNOPOL, L.
Lack of communication savvy often costly to engineers.
Personnel Journal, 28, 1959/60, p.126-129.

TAYLOR, J.A. and EAGLE, L.J.
Communication networks and organization structure. In Ferguson, S. and Ferguson, S.D., Intercom: readings in organizational communication. Hayden, 1980, p.34-49.

TEDD, L.A.
Teaching aids developed and used for education and training for online searching.
Online Review, 5, 3, June 1981, p.205-216.

THARP, P.A.
Regional international organizations: structures and functions.
Macmillan, 1971.

TOCATLIAN, J.
Training information users: programmes, problems, prospects.
UNESCO Bulletin for Libraries, XXXII, 6, Nov-Dec. 1978, p.355-362.

TORGERSON, W.S.
Theory and methods of scaling. Wiley, 1958.

√ TÖRNUDD, E.
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 DC, 1958 Nov. 16-21, NAS, 1959, Vol.1, p.19-75.

TRIANDIS, H.C.
Cognitive similarity and interpersonal communication in industry.
Journal of Applied Psychology, 43, 5, 1959, p.321-326.

TRIANDIS, H.C.
Some determinants of interpersonal communication.
Human Relations, 13, 1960, p.279-287.

TUSHMAN, M.L.
Communication in research and development organizations: an information processing approach. PhD thesis. MIT 1976.

TUSHMAN, M.L.
Managing communication networks in R&D laboratories.
IEEE Engineering Management Review, 9, 4, Dec. 1981, p.65-77.

TUSHMAN, M.L. and KATZ, R.
External communication and project performance: an investigation into the role of gatekeepers.
Management Science, 26, 11, Nov. 1980, p.1071-1085.

TUSHMAN, M.L. and NADLER, D.A.
Communication and technical roles in R&D laboratories: an information processing approach. In Dean, B.V. and Goldhar, J.L., Management of research and innovation. North-Holland, 1980, p.9-112.

UNESCO
Final report of UNISIST seminar on the education and training of users of scientific and technological information (1976 Oct. 18-21, Rome, Italy). UNESCO, 1976, SC-77/WS/22.

UNESCO
Guidelines on studies of information users (pilot verson). UNESCO, 1981, PG1/81/WS/2.

UNION OF INTERNATIONAL ASSOCIATIONS
Yearbook of International Organizations 1983/84, Vol. 1, Saur, 1983.

VEENHOFF-LOVERING, A.
Educating the special library user: an annotated bibliography 1960-1983. 1983. Unpublished.

VOOS, H.
Organizational communication: a bibliography. Rutgers UP, 1967.

WALTON, E.
Motivation to communicate.
Personnel Adminstrative, 25, 2, 1962, p.17-19, 39.

WATANABE, T.
Visual communication technology: priorities for the 1980s.
Telecommunications Policy, 4, 4, Dec. 1980, p.287-294.

WEIL, B.H.
The role of the information service group in internal communications. In Singer, T.E.R., Information and communication practice in industry. Reinhold, 1958, p.54-64.

WEISS, R.S. and JACOBSON, E.
A method for the analysis of the structure of complex organizations.
American Sociological Review, 20, 1955, p.661-668.

WERSIG, G.
Zur Systematik der Benutzerforschung.
Nachr. Dok., 24, 1, Feb. 1973, p.10-14.

WHITE, P.A.F.
Effective management of research and development. 2nd ed. MacMillan, 1980.

WILSON, T.D. (a)
On user studies and information needs.
Journal of Documentation, 37, 1, March 1981, p.3-15.

WILSON, T.D. (b)
Guidelines for developing and implementing a national plan for training and education in information use. UNESCO, 1981, PG1/80/WS/28.

WILSON, T.D.
Office automation and information services. In Proceedings of 7th International Online Information Meeting, 1983 Dec. 6-8, London, England. Learned Information, 1983, p.199-206.

WILSON, T.D. et al
Information needs in local authority Social Services departments: a second report on Project INISS.
Journal of Documentation, 35, 2, June 1979, p.120-136.

WILSON, T.D. and STREATFIELD, D.R.
Information needs in local authority Social Services departments: an interim report on Project INISS.
Journal of Documentation, 33, 4, Dec. 1977, p.277-293.

WOELFLE, R.M.
Role of the engineer in improving the communication of technical information.
IEEE Trans. on Professional Communication, PC-22, 1, March 1979, p.24-26.

WOLEK, F.W.
The complexity of messages in science and engineering: an influence on patterns of communication. In Nelson, C.E. and Pollock, D.K., Communication among scientists and engineers. Heath Lexington Books, 1970, p.233-265.

WOLEK, F.W.
Preparation for interpersonal communication.
JASIS, 23, 1, Jan-Feb. 1972, p.3-10.

WOLEK, F.W.
Professional work: the context for evaluating the impact of user studies. In 15th Annual National Information Retrieval Colloquium, Philadelphia, PA. 3-4 May, 1973, p.34-35.

√ WOOD, D.N.
User studies: a review of the literature from 1966 to 1970.
Aslib Proceedings, 23, 1, Jan. 1971, p.11-23.

√ WOOD, D.N. and HAMILTON, D.R.L.
The information requirements of mechanical engineers: report of a recent survey. Library Association, 1967.

WOODWARD, J.
Industrial organization: theory and practice. OUP, 1965.

WRIGHT, N.H.
Matrix management: a primer for the administrative manager. Engineering Management Review, 10, 3, Sept. 1982, p. 65-68.

YATES, F.
Sampling methods for censuses and surveys. 3rd ed. Griffin, 1965.

YOUNG, J.F. and HARRIOTT, L.C.
The changing technical life of engineers.
Mechanical Engineering, 101, 1, Jan. 1979, p.20-24.

ZAND, D.E.
Information, organization, and power: effective management in the knowledge society. McGraw-Hill, 1981.

THEMATIC BREAKDOWN OF REFERENCES

What follows is a rough-and-ready breakdown of the vast majority of the references in the bibliography into various themes. Many of the general books and articles on organizations and communication in organizations do, of course, address many of these themes, but they are subsumed under a general heading only. As a rule only where an article concentrates mainly on one or two of the topics is it included under an appropriate theme. Some of the categories do overlap to a certain extent. One or two miscellaneous documents have been excluded from the listing. The list of headings is as follows:

1. ORGANIZATIONAL ASPECTS

1a organizations in general
1b international organizations
1c aerospace organizations
1d management aspects
1e productivity
1f performance
1g innovation and change
1h technology transfer
1i improvements
1j organizational climate
1k marketing
1l information resources management
1m office automation/information technology
1n information services

2. GENERAL COMMUNICATION ISSUES

2a formal/scientific communication
2b invisible colleges
2c information content
2d overload/information processing
2e barriers to communicating

3. COMMUNICATION IN ORGANIZATIONS

3a organizational communication in general
3b informal/grapevine
3c vertical
3d interpersonal communication/interaction
3e channels
3f information flow/communication patterns
3g networks
3h groups
3i gatekeepers

4. PERSONAL CHARACTERISTICS

4a general characteristics
4b behaviour/motivation
4c roles of individuals
4d education and training

5. INFORMATION NEEDS/USE/SEEKING STUDIES

5a general
5b science in general
5c physical/earth sciences
5d life/social sciences
5e chemistry
5f science and technology/R&D
5g engineering

6. METHODOLOGY AND TECHNIQUES

6a statistical analysis
6b data analysis
6c questionnaire design
6d survey methods

1. ORGANIZATIONAL ASPECTS

1a Organizations in General:

Downs
Feibleman and Friend
Galbraith
Handy
Hill and White
Jerkovsky
Katz and Kahn
Kolodny
Lawrence and Lorsch
Likert (1967)
March and Simon
Scott, W.
Taylor and Eagle
Weiss and Jacobson
Woodward
Wright

1b International Organizations:

Dennison
Feld
Gibson
Krause
Langrod
Spero
Steinacker
Tharp

1c Aerospace Organizations:

Dewhirst (1970)
Gibson
Herner (1979)
Ludevig
Meadows and O'Connor
Pinelli
Pryor (1975, 1976)
Sheppard

1d Management Aspects:

Badawy
Barnard
Burns
Daft
Davis (1953b, 1969)
Fischer (1979)
Gibson
Jerkovsky
Likert (1961)
Myers and Myers
Poppel
Redfield
White
Wright
Zand

1e <u>Productivity</u>:

Culnan and Bair
Pelz and Andrews
Poppel
Rice and Bair

1f <u>Performance</u>:

Allen (1980)
Bhalla
Deutsch
Dewhirst (1978)
Fischer (1980)
Indik
Leavitt
Schuler and Blank
Tushman and Katz

1g <u>Innovation and Change</u>:

Baker, N.
Bennis (1961)
Garvey and Gottfredson
Goldhar
Herbert
Johnson and Gibbons
Murphy
Robertson
Rogers and Shoemaker
Rothwell and Robertson (1973, 1975)
Souder and Chakrabarti

1h <u>Technology Transfer</u>:

Allen (1966, 1976, 1977)
Moravcsik

1i <u>Improvements</u>:

Herbert
Murphy
Pelz and Andrews
Rubenstein (1971)
Srinivasan
Smith, F.
Woelfle

1j <u>Organizational Climate</u>:

Constance
Litwin and Stringer
Schuler and Blank

1k <u>Marketing</u>:

Condous
Cronin
Davies, A.
Kennedy
Raitt (1980a)
Smith, B.
Souder and Chakrabarti

1l <u>Information Resources Management</u>:

Becker
Meltzer
Raitt (1982b)
Synnott and Gruber

1m Office Automation/Information Technology:

Christie
Commission of the European Communities
Culnan and Bair
Dordick
Dunning (1982, 1983)
Giuliano (1981a, 1981b)
Grant
Lancaster
Lee
Nash
Otway and Peltu
Raitt (1982a)
Rice and Bair
Rostron
Suratt
Watanabe
Wilson (1983)

1n Information Services:

Breton (1981a, 1981b)
Chakrabarti
Dewhirst (1970, 1978)
Holland (1976)
Matarazzo
Meadows and O'Connor
Orr (1977)
Pryor (1975)
Raitt (1982a)
Sheppard
Slater

2. GENERAL COMMUNICATION ISSUES

2a Formal and Scientific Communication:

American Psychological Association
Anthony
Bensahel
Brookes
Crane (1967)
Garvey (1970a, 1970b, 1972a-e)
Garvey and Gottfredson
Garvey and Griffith (1968, 1979a, 1979b)
Grunig
Halbert and Ackoff
Hawkins
King and Roderer
Kornfeld and Hewitt
Lin (1970)
Lin and Garvey (1971)
Meadows (1974, 1980)
Menzel (1968)
Nelson and Pollock
Roberts
Senders

2b Invisible Colleges

Crane (1969, 1970, 1971b, 1975)
Crawford (1971)
Griffith and Miller
Hagstrom
Solla Price (1963, 1965)

2c Information Content:

Campbell
Chakrabarti
Dodd and McCurtain
Grossman and Lindhe
Schachter
Woelfle
Wolek (1970)

2d Overload/Information Processing:

Harkins
Miller
Orr (1970)
Tushman (1976)
Tushman and Nadler

2e Barriers to Communicating:

Brasey
Campbell
Clutterbuck
Davies, J.
Deutsch
Hoslett
Large
Michel
Nelson
Patterson
Rothwell and Robertson
Schachter
Schlesinger
Spero

3. COMMUNICATION IN ORGANIZATIONS

3a Organizational Communication in General:

Carter, L.M.
Cherry
Christie
Commission of the European Communities
Davis (1981)
Farace
Ferguson and Ferguson
Jackson
Jacobson and Seashore
Koehler
Likert (1967)
Lin (1973)
Martin and Fuerst
Myers and Myers
Newcomb
Ramström
Rogers and Agarwala-Rogers (1976)
Voos

3b Informal/Grapevine:

Bensahel
Brown
Crawford (1971)
Davis (1953b)
Dobrowolski
Festinger (1950, 1968)
Garvey and Griffith (1968)
Griffith and Miller
Menzel
Nelson and Pollock
Sutton and Porter

3c Vertical:

Athanassiades
Fenn and Head
Indik
Read

3b Interpersonal Communication/ Interaction

Allen (1976)
Baskin and Aronoff
Bennis (1961a)
Berger and Roloff
Bland
Bormann
Chapanis
Festinger (1950, 1968)
Goetzinger and Valentine
Grossman and Linde
Gullahorn
Hinrichs
Howton
Katz
Leary
Lindzey and Byrne
Newcomb
Robbins
Schein
Schlesinger
Triandis (1959, 1960)
Wolek (1972)

3e <u>Channels</u>

Allen (1966)
Chakrabarti
Daft and Lengel
Dennis
Dobrowolski
Garvey and Griffith (1968)
Holland (1976)

3f <u>Information flow/communication patterns:</u>

Allen and Cohen (1966, 1969)
American Psychological Association
Bavelas
Berkowitz and Bennis
Brown
Davis (1953a)
Dodd and McCurtain
Dunning (1982, 1983)
Frost and Whitley
Goldhar
Johnston and Smith
Ladendorf
Leavitt
Marquis and Allen
Menzel (1960)
Nelson
Olson (1977, 1977a)
Paisley (1965)
Robertson
Shotwell
Shuchman
Wolek (1970)

3g <u>Networks</u>

Allen (1970a, 1970b)
Allen and Cohen (1966)
Bavelas
Baston and Aronoff
Cohen
Crane (1971b)
Dodd and McCurtain
Farace and Mabee
Festinger (1949)
Griffith and Miller
Guetzkow
Jacobson and Seashore
Krause
Ritchie and Hindle
Taylor and Eagle
Tushman (1981)

3h <u>Groups</u>

Anzieu
Ardoino
Bavelas
Burns
Cartwright and Zander
Cohen
Davis (1981)
Deutsch
Dodd and McCurtain
Fisher
Guetzkow
Hurwitz
Jacobson and Seashore
Katz and Kahn
Leavitt (1951)
Luce and Perry
Rubenstein (1971)
Schein

3i <u>Gatekeepers</u>

Allen (1971)
Crane (1967)
Herzog (1976)
Paollilo
Persson
Tushman and Katz

4. PERSONAL CHARACTERISTICS

4a General Characteristics:

Dobrowolski
Egan
Exon
Gerstl and Hutton
Gray
Holland (1972)
Katz
Pelz and Andrews
Sampson
Tarnopol
Young and Harriott

4b Behaviour/Motivation

Auster
Davis (1981)
Deutsch
Gullahorn
Kagan and Havemann
Koehler
Lindzey and Byrne
Litwin and Stringer
Mitchell
Robertson and Cooper
Rogers and Agarwala-Rogers (1980)
Selznick
Walton

4c Roles of Individuals:

Allen (1970b)
Guetzkow
Tushman and Nadler
Weil
Woelfle

4d Education and Training:

Brooke
Casteleyn
Evans
Fjällbrant
Hilgard and Bower
Hills
Keenan
Raitt (1980b)
Schmidt
Streatfield (1980)
Sullivan
Tedd
Tocatlian
UNESCO (1976)
Veenhoff-Lovering
Wilson (1981b)

5. INFORMATION NEEDS/USES/SEEKING STUDIES

5a General:

Allen (1969)
Auster
Barnes
Bayer and Jahoda (1979)
Carter, M.P.
Chen and Hernon
Commission of the European Communities
Crane (1971a)
Crawford (1978)
Disch
Hall
Herner, S and M
Lin and Garvey (1972)
Lipetz
Martyn
Menzel (1964a)
Mick
Paisley (1968)
Saha
Srinivasan
UNESCO (1981)
Wersig
Wilson (1981a)
Wolek (1973)
Wood
Garvey (1972, 1979)

5b Science in General:

Bayer and Jahoda (1981)
Fishenden
Glass and Norwood
Herner (1954)
McAlpine
Menzel (1960, 1964)
Rubenstein (1970)
Skelton
Swinburne

5c Physical/Earth Sciences:

Belew
Flowers
Gralewska-Vickery
Gralewska-Vickery and Roscoe
Krause
Krawitz and Newhouse
Ludewig
Meadows and O'Connor

5d Life/Social Sciences:

Getz
Nosok and Gorlov
Shelton
Wilson (1979)
Wilson and Streatfield

5e <u>Chemistry</u>:

Flowers
Menzel (1966b, 1970)

5f <u>Science and Technology/R&D</u>:

Berul
Corridore
Dewhirst (1970)
Hogg and Smith
Katz
Nelson and Pollock
Rawdin
Scott, C. (1959, 1962)
Törnudd

5g <u>Engineering</u>:

Lufkin
Shuchman
Sutton
Wood and Hamilton

6. METHODOLOGY AND TECHNIQUES

6a Survey Methods:

Coleman
Festinger and Katz
Jahoda
Kahn and Cannell
Lindzey and Aronson
Moser and Kalton
Parten
Yates

6b Questionnaire Design:

Mucchielli
Muchinsky
Oppenheim
Payne
Sims and Lafollette

6c Data Analysis:

Coleman and MacRae
Festinger (1949)
Holsti
James
Maxwell
Mosteller and Tukey
Richards

6d Statistical Analysis:

American Management Association
Boot and Cox
Dunn and Clark
Enslein
Huber
Hull and Nie
Johnson and Leone
Kendall
Levin and Rubin
Luce and Perry
Monge and Capella
Moroney
Nie (1970, 1975)
Torgerson

APPENDIX A

BRIEF SUMMARY OF ORGANIZATIONS TAKING PART IN STUDY

CENTRE NATIONAL D'ETUDES SPATIALES (CNES) - FRANCE

Founded in 1961 CNES is charged with putting into effect a policy of technical and industrial space research at the national level. This involves developing and directing the necessary research for putting space activities into operation. As part of this brief are the realization of policy, cooperation and the active stimulation and involvement of industry. To do its work CNES has established a number of industrial, scientific and technical research programmes, which it conducts not only on a national level, but also on an international level by cooperative ventures in the USA, USSR as well as Europe and elsewhere. Important programmes include the Ariane launch vehicle; the SPOT earth resources satellites and telecommunication and TV satellites. Some 1700 staff are employed within CNES including the Space Centre in Toulouse and Kourou.

DEUTSCHE FORSCHUNGS- UND VERSUCHSANSTALT FÜR LUFT- UND RAUMFAHRT (DFVLR) - W. GERMANY

The activities of this major research establishment lie mainly in the aerospace field, where the objectives are to do research, to participate in the planning and implementation of projects, to construct and operate large test facilities and to promote advanced training. The programmes are directed towards the requirements of the Government and Federal States and aim to produce results applicable to future projects in the public interest or of economic importance. Beneath a General Assembly composed of government, state and industrial members, a Supervisory Board decides the research programme and budget. An Executive Board represents the various research establishments of DFVLR and executes the business functions.

DFVLR comprises several research departments covering, for example, Structures and Materials; Communications Technology and Remote Sensing; Energetics. Within these departments are a number of institutes scattered throughout the Federal Republic each specializing in areas of interest such as aerospace medicine, aerodynamics, atmospheric physics. DFVLR attributes particular importance to international cooperation, particularly in scientific activities and has joint programmes of research with other countries.

EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTRE (ESTEC) - THE NETHERLANDS

ESTEC is the largest of the four main establishments of the European Space Agency (ESA). ESA elaborates and implements long-term European space policy and promotes, for peaceful purposes, cooperation among European states in space research and technology. The main policy-making body is the Council, composed of representatives of the 11 Member States, which works through a Director General and a number of programme boards. ESTEC is responsible for the study, development control and testing of spacecraft which are then built by European industry. ESTEC also carries out the technological research programme for the preparation of future space missions. Besides broad scientific and applications programmes, which have culminated in the launch of over 15 satellites, ESA is involved in the Spacelab programme wth the USA. Although most cooperation is carried out with Member States, relationships with non-Member States are also developed for promotional purposes, to encourage international cooperation and to offer technical assistance and facilities. ESTEC employs some 535 of the 1360 staff in ESA.

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) - AUSTRIA

Founded in 1957 as an inter-governmental organization within the UN system, IAEA is directed by a General Conference composed of members from each of the 100 or more Member States and a Board of Governors with some 30 members.

Working through an Executive Secretariat of about 1650 people, IAEA fosters and encourages, guides and advizes the development of peaceful uses of atomic energy throughout the world. Operating through a number of laboratories, IAEA has a wide range of activities in nuclear power, nuclear safety and radiation, radioactive waste management, theoretical physics as well as agriculture, medicine, hydrology and marine science in general. Through its technical assistance programme with developing countries IAEA gives training and assistance in siting nuclear power stations and subsequent safeguards evaluation.

NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM (NLR) - THE NETHERLANDS

NLR, the Dutch National Aerospace Laboratory, is governed by a Board composed of various research organizations, government ministers and aircraft companies, including airlines. A scientific committee of independent experts advises the Board in problems of a scientific or technical nature. NLR carries out research into all areas of aerospace, for example, aerodynamics, air traffic control, aircraft performance, advanced materials, space activities, informatics. Emphasis is placed on the provision of test facilities, e.g. wind tunnels, for the aerospace industry and much work is done under contract. NLR is cooperating with certain other countries (e.g. DFVLR in W. Germany) to build various wind tunnels as well as satellites.

UNITED NATIONS EDUCATIONAL, SCIENTIFIC & CULTURAL ORGANIZATION (UNESCO) - FRANCE

A specialized agency of the UN system with 155 Member States, UNESCO aims to promote collaboration among nations through education, science and culture. A General Conference, in which every Member State has equal voting rights, meets every two years to decide policy, programmes and budgets, which are carried out by an International Secretariat of some 3300 staff.

UNESCO's fields of competence embrace education, natural sciences, social sciences, culture and communications. Numerous offices and links to thousands of schools, clubs and institutes throughout the world enable UNESCO to carry out its tasks. Within the education field these tasks include coping with illiteracy, scientific and technical education and the training of specialists to teach in rural areas. In the natural science area global-scale programmes are supported to mobilize the cooperation of the international scientific community in order to tackle world problems. These programmes include the Intergovernmental Oceanographic Commission, and others in hydrology, geology, energy and the biosphere. In the social science and communications areas emphasis is placed on endogenous development, human rights and promoting the free flow of ideas by word and images.

APPENDIX B

THE QUESTIONNAIRE

RESEARCH PROJECT ON INTERPERSONAL COMMUNICATION

A survey is being conducted on the communication and information use patterns of scientists and engineers, in both international organizations (eg. UNESCO, IAEA, OECD, FAO) and national aerospace establishments (eg. DFVLR, CNES, ONERA, NLR).

I should be grateful if you would cooperate by completing the attached questionnaire - which is completely anonymous - and returning it to me by 18 December 1981.

It is expected that, as a result of your response, the Library and Information Services can be improved to better meet your requirements.

Thank you.

D. Raitt
AOL

PROJET DE RECHERCHE SUR LA COMMUNICATION ENTRE INDIVIDUS

On procède actuellement à une enquête sur les moyens de communication et d'utilisation de l'information qu'ont les scientifiques et ingénieurs travaillant dans les organisations internationales (UNESCO, IAEA, OCDE, FAO) et les établissements nationaux de l'aérospatial (CFVLR, CNES, ONERA, NLR).

Je vous serais reconnaissant de votre coopération si vous pouviez remplir le questionnaire ci-joint - complètement anonyme - et de me le retourner si possible avant le 18 décembre 1981.

Nous espérons que, grâce aux réponses obtenues, la Bibliothèque et les Services d'Information pourront améliorer leur service et satisfaire au mieux vos demandes.

Merci d'avance.

D. Raitt 12/11/81

D. RAITT

AOL.

QUESTIONNAIRE ON

COMMUNICATIONS AND INFORMATION USE

Your organization has agreed to participate in a study on interpersonal communications being undertaken in conjunction with Loughborough University, Department of Library and Information Science.

The project will seek to discover the patterns of information usage of diverse groups of scientists and engineers and the methods and frequency of communication between them.

To this end you are invited to complete this questionnaire - which is completely anonymous - and return it to the location and by the date specified in the attached covering letter.

383

I hope you will enter into the spirit of this joint venture which should prove most beneficial to the efficient use of information and its transfer.

D. Raitt

D. Raitt
Deputy Head, Library and Information Services
European Space Agency

INSTRUCTIONS

Most of the questions require either a tick (✓) in the appropriate box or a word or two of text. For questions 15, 18b, 19, 20, 21, 25, 26, 31 and 33, however, you are asked to assign a number of between 1 and 6 inclusive for each relevant case. In all instances 1 is a low score (eg. rarely, little) and 6 is a high score (usually, very much).

In order to take up as little of your time as possible many potential responses have been given. These may not necessarily be complete in which case please feel free to add any new ones which apply to your case.

812996

BACKGROUND INFORMATION

1. Sex (M or F) ☐   2. Year of birth ....   3. Nationality ....

4. Are you in a supervisory position? Yes ☐ No ☐

5. In which subject speciality were you educated or trained? (eg. structural engineering, astrophysics) ....

6. In what field are you now working? (eg. composite materials, cosmic rays) ....

7. What was your previous work environment?
government ☐ industrial ☐ academic ☐ other (*please specify*) ....

8. What percentage of your work time did you spend away from the office on official mission or duty travel during the last 6 months? ....%

   a) Was this more or less than usual?
   more ☐ less ☐ about the same ☐

COMMUNICATING WITH OTHERS

9. How many national or international conferences have you attended in the last two years?
0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ >5 ☐

10. How many papers have you presented at conferences during the past two years?
0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ >5 ☐

11. During the last two years how many -
   a) papers have you had published externally? (*count journal articles, reports, books, conference papers*)
   0 ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ 11-20 ☐ >21 ☐

   b) papers have you had published internally, i.e. within your organization? (*count working papers, scientific and technical reports*)
   0 ☐ 1-2 ☐ 3-5 ☐ 6-10 ☐ 11-20 ☐ >21 ☐

12. Which languages can you speak? *(please underline mother tongue)* ....

....

13. Which languages can you read sufficiently well to understand a technical article/report?

....

14. Do you frequently communicate for work purposes in languages other than your own?

No ☐ Yes ☐ Which? ....

15. Would you estimate how much of your working time during the <u>last 6 months</u> was spent on any of the following work-oriented communication or information transfer activities *by assigning a value of between 1 (little) and 6 (very much) to <u>each</u> relevant activity.*

formal (prearranged) meetings

- staff meetings .... ☐
- contractor/consultant meetings .... ☐
- presentations .... ☐
- progress meetings .... ☐
- brainstorming sessions .... ☐
- committee meetings .... ☐
- other *(please specify)* .... ☐

  ....

informal meetings (during which you discuss work matters)

- in corridors .... ☐
- in canteen .... ☐
- impromptu visits to offices/labs .... ☐
- at sport/social events .... ☐
- elsewhere *(please specify)* .... ☐

speaking on the phone .... ☐

writing/dictating letters .... ☐

writing/dictating memos/telexes/faxes .... ☐

writing reports/working papers for internal circulation ..... ☐

writing papers for presentation at conferences .... ☐

writing reports/articles for external publication .... ☐

videoconferencing .... ☐

giving someone documents containing relevant information ... ☐

other *(please specify)* .... ☐

16. What is your preferred way of keeping in touch with colleagues about your work?

....

....

a) Would you explain why? ....

....

....

17. Given the following methods of communicating would you say for each why you might use or avoid them?

<u>phone</u>

use because ....

....

avoid because ....

....

<u>letter</u>

use because ....

....

avoid because ....

....

<u>videoconferences</u>

use because ....

....

avoid because ....

....

<u>telex/fax</u>

use because ....

....

avoid because ....

....

<u>formal meeting</u>

use because ....

....

avoid because ....

....

<u>informal meeting</u>

use because ....

....

avoid because ....

....

<u>internal report/paper</u>

use because ....

....

avoid because ....

....

<u>reports/papers published externally</u>

use because ....

....

avoid because ....

....

18. Let A, B, C, D and E represent the 5 people with whom you have communicated most over the past 6 months for work-oriented purposes.

a) *For each person please put a tick (✓) in whichever box applies making sure that only one tick per person is given in each of the groups i to vi.*

i Status of person	A	B	C	D	E
person is a superior					
person is a subordinate					
person is a peer i.e. neither of above					

ii Work assignment of person	A	B	C	D	E
Works in your division on same project as you					
Works in your division on different project					
Works in different division on different project					
Works in different division on same project as you					

iii Usual physical work location of person	A	B	C	D	E
in immediate vicinity					
on different floor in same building as you					
in different building on same site					
in different site/establishment					

iv Frequency of contact	A	B	C	D	E
once or twice a day					
several times a day					
once or twice a week					
several times a week					
several times a month					
less often					

v Basis for contact	A	B	C	D	E
hierarchical					
same language/nationality					
personal friendship					
similar interests					
qualifications/experience					
best informed person/only source of information					
contractual					
other					

vi Who initiates contact	A	B	C	D	E
usually me					
usually him/her					
fifty-fifty					
someone else suggests it					

b) For the same people (still labelled A, B, C, D and E) *would you assign a value of between 1 (rarely) and 6 (usually) for the categories which apply in each of the groups vii to xi. You may mark more than one category in each group.*

vii Usual nature of contact	A	B	C	D	E
supervisory/advisory/management					
progress reports/reviews					
technical discussions/problem solving					
information seeking/information exchange					
briefings/debriefings					
training/instruction					
other (*please specify*)					

viii Information transferred or communicated	A	B	C	D	E
facts					
ideas					
advice					
opinions					
other (*please specify*)					

ix Average duration of communication	A	B	C	D	E
<½ hour					
½ - 1 hour					
1 - 1½ hours					
1½ - 2 hours					
2 - 3 hours					
>3 hours					

x Usual form of contact	A	B	C	D	E
face to face					
telephone					
tele/video conferencing					
letter					
telex/fax					
internal memo					
other (*please specify*)					

xi Usual location where communication takes place	A	B	C	D	E
your own office/lab					
his/her office/lab					
meeting room in organization					
canteen					
corridors					
airport lounges/transport					
other (*please specify*)					

19. How often do you encounter any of the following constraints to your work-oriented communication? *Please assign a value of between 1 (rarely) and 6 (very often) to each constraint which applies in <u>both</u> columns.*

	when you want to <u>give</u> information	when you want to <u>receive</u> information
language barrier	☐	☐
time differences	☐	☐
cultural factors	☐	☐
complexity of topic	☐	☐
political influences	☐	☐
economic factors	☐	☐
organizational structure	☐	☐
personality clashes	☐	☐
technical competence not sufficient	☐	☐
work environment influences	☐	☐
geographic location (person in different region/country)	☐	☐
spatial location of offices in building	☐	☐
person not there when you want him/her	☐	☐
competitiveness	☐	☐
poorly written documentation	☐	☐
other (*please specify*)	☐	☐

AWARENESS AND USE OF INFORMATION

20. How often do you encounter any of the following problems in getting the information you need to solve a problem or complete a task? *Please assign a value of between 1 (rarely) and 6 (very often) to each relevant problem.*

- not available in library ☐
- delay in getting it ☐
- in microfiche form ☐
- in language you can't understand ☐
- unhelpful colleagues ☐
- unhelpful library staff ☐
- no references found ☐
- too much available ☐
- information is confidential ☐
- other (*please specify*) ☐
  ....

21. With what frequency do you obtain needed information from the following sources? *Please assign a value of between 1 (rarely) and 6 (very often) for each relevant source.*

- colleagues in your own section/division ☐
- colleagues working on same project/topic (but <u>not</u> in your own division) ☐
- other colleagues in the organization ☐
- people <u>outside</u> the organization ☐
- library staff ☐
- reference books/encyclopaedias/dictionaries ☐
- text books/manuals ☐
- conference papers ☐
- trade literature ☐
- journal articles ☐
- reports/working papers/progress documents ☐
- standards/specifications/patents ☐
- library announcement lists ☐
- abstracting/indexing journals ☐
- formal report at a meeting ☐
- own work or sources/files ☐
- computer files ☐
- other (*please specify*) ☐
  ....

22. Do you use the library/information services in your organization more or less now than you did 12 months ago?

More ☐ Less ☐ About the same ☐

a) Is this because of your current position ☐ current task ☐ reliance on other sources ☐ experience ☐

other (*please specify*) ....

23. <u>On average how often do you visit the library per week?</u>

<once/week ☐ 1-2 times ☐ 3-5 times ☐ 6-8 times ☐ >9 times ☐

24. <u>How long do you spend there on average at any one time?</u>

<5 mins. ☐ 5-15 mins. ☐ 15-30 mins. ☐

30 mins.-1 hour ☐ 1-2 hours ☐ >2 hours ☐

25. What are your main reasons for visiting the library?
Please assign a value of between 1 (rarely) and 6 (usually) for each relevant reason.

read new books .... ☐
read newspapers .... ☐
read journals .... ☐
browse .... ☐
request literature search .... ☐
do own literature search .... ☐
borrow document (eg book, journal, report) .... ☐
return document .... ☐
consult reference book/manual/dictionary .... ☐
work quietly .... ☐
other (*please specify*) .... ☐

26. How often do you require the following types of information for your work? *Please assign a value of between 1 (rarely) and 6 (very often) for each type.*

facts ☐ ideas ☐ advice ☐ opinions ☐

a) Of course it depends on the situation, but when do you normally need this information by? *Please assign a value of between 1 (no hurry) and 6 (urgently) for each type.*

facts ☐ ideas ☐ advice ☐ opinions ☐

b) How long, on average, do you spend seeking this information? *Please assign a value of between 1 (not long) and 6 (as long as necessary) for each type.*

facts ☐ ideas ☐ advice ☐ opinions ☐

c) How old can the information be which you are willing to accept? *Please assign a value of between 1 (very recent) and 6 (no time limit) for each type.*

facts ☐ ideas ☐ advice ☐ opinions ☐

27. Would you say that you get most of the information you need for your work from the library?

Yes ☐ No ☐

If you have answered NO

a) Would you please indicate what kind of information you cannot get from the library?
....
....

b) From where do you normally get this information?
....
....
....

c) Do you feel the library should be able to supply this kind of information?

Yes ☐ No ☐ Why? ....
....

KEEPING UP TO DATE

28. Do you spend as much time as you would like on information seeking?

Yes ☐ No ☐

29. Do you feel that you are sufficiently aware of the sources of information in your field?

Yes ☐ No ☐

30. Do you feel that you adequately cover these sources? Yes ☐ No ☐

31. In which ways do you regularly keep up to date with what is going on in your field?
Please assign a value of between 1 (rarely) and 6 (usually) for each relevant method.

computerised current awareness profile .... ☐
scanning journals in library .... ☐
scanning library announcement lists .... ☐
own journal subscriptions .... ☐
attending conferences .... ☐
talks with colleagues at work .... ☐
reading new books/reports .... ☐
other (*please specify*) .... ☐
....

32. How much time on average do you spend per week on background reading to keep you abreast of developments in your field?

<1 hour ☐ 1-2 hours ☐ 3-5 hours ☐ 6-8 hours ☐ >9 hours ☐

33. How familiar are you, in general, with the work of sections or divisions other than your own in your organization?

very familiar ☐ familiar ☐ not very familiar ☐ not at all familiar ☐

a) If you have said that you <u>ARE</u> familiar with other work going on in your organization where do you normally get this information from? *Please assign a value of between 1 (rarely) and 6 (usually) for each relevant source.*

informal internal newsletters .... ☐
official publications of the organization .... ☐
colleagues in <u>own</u> division or project .... ☐
colleagues working in <u>other</u> divisions/projects .... ☐
staff meetings .... ☐
other (*please specify*) .... ☐
....

b) If you are <u>NOT</u> too familiar with the work of other divisions/projects in your organization would you like to become <u>more</u> familiar? Yes ☐ No ☐

c) Would you find a regular (say monthly) newsletter giving what's happening elsewhere in your organization useful? Yes ☐ No ☐

34. Does your library/information centre run courses in information use? Yes ☐ No ☐

35. Would you like a short introductory session on the use of the library and sources of information in your field to be organized for you? Yes ☐ No ☐

36. Have you any general comments to make on how to improve communications and information use in your organization?
....
....
....
....

THANK YOU VERY MUCH

FOR THE TIME AND EFFORT YOU

HAVE PUT IN TO COMPLETING THIS QUESTIONNAIRE

IT IS VERY MUCH APPRECIATED

D. RAITT
AOL/ESTEC
EUROPEAN SPACE AGENCY
PO BOX 299
2200 AG NOORDWIJK
NETHERLANDS

TELEPHONE (31)-1719-82561

TELEX 39098

RESEARCH PROJECT ON INTERPERSONAL COMMUNICATION

A few weeks ago you were sent a questionnaire on your information seeking and communication activities. I should like to thank those members of staff who completed and returned the questionnaire so promptly.

If you have not yet responded, may I ask you to make an effort to do so as soon as possible please.

Your input is needed!

ENQUETE SUR LA COMMUNICATION ENTRE INDIVIDUS

Nous vous avons fait parvenir il y a quelques semaines un questionnaire sur vos activités de recherche et de transfert d'information. Merci à tous ceux et celles qui ont pris la peine de répondre si promptement à notre enquête.

Au cas où vous n'auriez pas encore répondu, nous vous demandons de prendre un tout petit peu de votre temps pour remplir votre questionnaire et nous le retourner au plus vite.

Nous avons besoin de votre concours!

D. Raitt 15 Jan 1982

D. RAITT,
AOL.

820107-

APPENDIX C

COMPLETE LISTING OF NATIONALITIES, MOTHER TONGUES AND SUBJECT FIELDS OF RESPONDENTS

TABLE 63 - LIST OF NATIONALITIES OF RESPONDENTS

NATIONALITY	N=	% OF TOTAL
AMERICAN	30	10.5%
ARGENTINIAN	1	0.3
AUSTRIAN	4	1.4
BELGIAN	5	1.7
BRAZILIAN	1	0.3
BRITISH	65	22.6
CANADIAN	4	1.4
DANISH	7	2.4
DUTCH	41	14.3
FILIPINO	1	0.3
FINNISH	1	0.3
FRENCH	35	12.2
GERMAN	59	20.6
INDIAN	1	0.3
IRANIAN	1	0.3
IRISH	1	0.3
ITALIAN	13	4.5
NEW ZEALANDER	1	0.3
NIGERIAN	1	0.3
PAKISTANI	1	0.3
PANAMANIAN	1	0.3
POLISH	2	0.7
ROMANIAN	1	0.3
SPANISH	4	1.4
SWEDISH	1	0.3
SWISS	3	1.0
TURKISH	1	0.3
VENEZUELAN	1	0.3
TOTAL	287	100.0

TABLE 64 - LIST OF MOTHER TONGUES OF RESPONDENTS

MOTHER TONGUE	N=	% OF TOTAL
DANISH	7	2.4%
DUTCH	42	14.6
ENGLISH	97	33.8
FINNISH	1	0.3
FRENCH	37	12.9
GERMAN	68	23.7
GREEK	2	0.7
HINDU	1	0.3
ITALIAN	12	4.2
PERSIAN	1	0.3
PILIPINO	1	0.3
POLISH	2	0.7
PORTUGUESE	1	0.3
ROMANIAN	1	0.3
SPANISH	8	2.8
SWEDISH	1	0.3
TURKISH	2	0.7
URDU	1	0.3
VIETNAMESE	1	0.3
YORUBA	1	0.3
TOTAL	287	100.0

TABLE 65 - BROAD AND SPECIFIC SUBJECT AREAS IN WHICH RESPONDENTS WERE EDUCATED AND/OR ARE PRESENTLY WORKING

CHEMISTRY AND MATERIALS

Chemistry; physical chemistry; electrochemistry; materials; metallurgy.

EARTH SCIENCES

Geology; geophysics; hydrology/water resources; oceanography; marine science; mining; remote sensing.

ENGINEERING/ELECTRONICS

Engineering; mechanical engineering; aeronautical engineering; electro-mechanical engineering; systems engineering; electrical engineering; electronics; instrumentation/avionics; tribology; chemical engineering; optics; structural engineering.

INFORMATICS/MATHEMATICS

Informatics/computer science/edp; software/programming; networks; computers/micros; mathematics; control theory.

LIFE SCIENCES

Biology/biotechnology; microbiology; biophysics; aerospace medicine; agriculture/agronomy; soil science/chemistry; insect/pest control.

MANAGEMENT/FINANCE

Management/administration/personnel; contracts; project management/control; cost control/finance/economics; business/commerce/purchase; configuration management.

NUCLEAR ENGINEERING

Nuclear engineering; reactor engineering; nuclear fission; nuclear electronics; isotope hydrology; nuclear fusion reactor physics; radioactive waste management.

PHYSICS/SPACE SCIENCES

Physics; plasma physics; atomic/high energy/particle physics; solid state physics; space physics/astrophysics/cosmic rays; astronomy/comets; extra-terrestrial; microgravity; radiation physics; aeronomy; crystallography; aerodynamics; thermodynamics.

SAFETY ENGINEERING

Radiation safety/nuclear safeguards; risk assessment; product assurance/reliability.

SPACE TECHNOLOGY

Space technology/aerospace engineering/operations; spacecraft technology/integration/testing/simulation; orbits/mission analysis; spacecraft design/configuration; power supplies; onboard equipment/instrumentation; systems engineering/control; propulsion/launching; payloads.

TELECOMMUNICATIONS

Telecommunications; antennas; signal processing; data handling; satellite communications.

MISCELLANEOUS

Energy/power; science/technology; civil engineering/public works; social science/psychology; translation/languages; library/information/documentation; publishing/editing/technical writing; education.