Information seeking behaviour of the indian space technologists *

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ABSTRACT

States the objectives and hypothesis of the study, highlights the scope and limitations, explains the research design, multiple methods and data collection tools used, enumerates significant findings of the study under three main objectives, namely the information-seeking behaviour of the space technologists, characteristics of the space technologists and correlation of information-seeking behaviour with characteristics of the space technologists. Various aspects of information-seeking behaviour examined includes motives and purposes of seeking information, nature and type of information sought, sources of bibliographic information used, delegation of information-gathering work, time spent on information-gathering activities, dependence on different sources of information, inter-personal information-sharing, intra- and inter-organisational communication, informal and formal communication behaviour, use of and user-interactions with the `primary library'. Compares and contrasts the results with results of other similar studies, and finally concludes by highlighting the implications of the results and by projecting the areas for further research.

1 INTRODUCTION

Information behaviour in general and information seeking behaviour (ISB) in particular of Indian space technologists (IST) comprising of scientists, engineers, managers, technocrats and technicians of ISRO Satellite Centre (ISAC), Bangalore are investigated. The study is timely as there is a greater need for continuous, focussed, localised and organisation oriented user-research for design and operation of better information systems in the country.

1.1 Objectives and Hypothesis

The main objectives of this study are to probe information transfer process and to determine ISB of IST, various characteristics of IST as variables of their information behaviour and relate selected characteristics with their information behaviour. The positive hypothesis of the study is that ISB of space technologists has a definite relation to their characteristics like status, qualifications, nature of work, specialisation, experience and professional activities and achievements based `performance'.

1.2 Scope and limitations

The study confined to the current work-related scientific and technical information in all its manifestations. While the term `information behaviour' includes information seeking, gathering, receiving and communicating, the ISB is defined to include aspects like motives and purposes of seeking information, the nature and types of information sought, the ways and means of accessing, searching, identifying and acquiring information, the communication behaviour and use of and interactions with the `primary library'.

The study is primarily an `applied' user-research and not `basic' user-research ie., why a user behaves as he does is outside the scope of the study.

Some of the related aspects which are not covered under ISB are how information is applied to work, the satisfaction or dissatisfaction of users about information system, frequency and urgency with which information is needed, nature of demand for information, information search strategies adopted, the success/failure rates, stimulus value of information, user assimilation capacity, problems of information overload and redundancy in information system.

Not all characteristics of IST are covered in the study. For example, psychological factors/variables, personality traits, social roles, semiofficial roles, etc., are kept outside the scope and only six characteristics as mentioned under objectives and hypothesis are tested for their relation with ISB of the space technologists without implying any cause and effect relationship. The study has not attempted for exploring inter-correlation of various aspects of ISB as well as user characteristics, multiple and partial correlation, factor analysis of ISB with two or more characteristics of the space technologists.

This is not a participate user-research and hence respondents are naturally conditioned by what is known to them and available to them presently. Lastly, the study has not attempted for generalising the findings.

2 RESEARCH DESIGN AND METHODS

An exploratory survey approach and a cross sectional research design with emphasis on norms of critical incident technique and occasionally on longitudinal approach and activity sampling technique are followed in the study. Multiple investigation methods and data collection tools and techniques are employed in the study.

Different methods are applied in a helpful sequence such that each tries to gain from and supplements the preceding method/s. At the same time all methods are directed towards the core problem so as to depict different perspectives like users'

opinions, researcher's observations, results of discussions, self reported activities of users, historical records, etc.

About 180 men-weeks of summary of information related activities to a maximum of six consecutive weeks per respondent (with a 20% response from 20% systematic random sample) is collected. In addition, a near census survey of over 800 space technologists through largely self administered independently designed and tested questionnaire with 68.5% response yielded rich, adequate and representative data. Thirty space technologists are interviewed for about an hour each with a semi structured interview schedule designed and tested for the purpose. A semi controlled/quasi experimental study of use of library documents and observations of user-interactions with the library and analysis of records of the `primary library' provided further rich and critical incident data. In addition, certain indirect methods are also employed.

The chi-square non parametric test, Spearman rank order correlation (rs), Pearson product moment correlation (r) and t-test are employed in the analysis and interpretation of the data.

3 SUMMARY OF FINDINGS

3.1 Realisation of Objective 1: Information-seeking Behaviour of the Indian Space Technologists

3.1.1 Motives and Purposes of Seeking Information

Unlike scientists, the space technologists are not motivated much by recognition, competition, visibility among peers and urge to write and publish (in the decreasing order of priority) while seeking information. On the other hand they are primarily motivated by a need for self-improvement, the desire to be up-to-date in the field of specialisation, maintaining professional competence, self-satisfaction and achieving the desired result in work (in that order).

This is in conformity with Shuchman's (1981, p29) observation about American industrial engineers that "most professionals are concerned with appearing technically competent to their colleagues". A typical respondent says "I gather information mainly to improve my knowledge... I want to spend my leisure time for information gathering". The findings are also on line with Menzel's (Columbia University, 1958) observation that achievement, curiosity, self-evaluation and affiliation are the main motives of seeking information. Keeping up-to-date with latest developments in the field of specialisation/activities and relating present work with the current body of knowledge are the main/purposes of seeking information by the space technologists. This again is close to the findings of Menzel (Columbia University, 1958, p67

and 80) and Voigt (1959, p177-179). To quote a respondent "information is gathered to increase the general sense of awareness about the state-of-the-art in the area of work, to see how it can be applied in the work and to identify and pursue desirable degree of professional competence."

The space technologists do not seek information much for the purpose of data treatment and processing, crystallising broad and vague assertions, participating in seminars and conferences, writing papers and delivering talks (in that rank order).

3.1.2 Nature and Type of Information Required

In consistency with the high ranked motives and purposes of seeking information, the requirements of S&T news and basic S&T information have ranked high for the space technologists. In addition, the space technologists seek more of theoretical background, experimental results, methods, processes and procedures, product, material, equipment and apparatus information and physical, technical and design data (in that rank order) than state-of-the-art, review literature, standard and patent specifications.

The ranking is almost close to that of Shuchman(1981, p32-83;1982, p106-109) about American industrial engineers, Rawdin (1975, p41-42) about American users of technical libraries, Wood (1967, p217) about British mechanical engineers and Slater and Fisher (1969, p32-33, 36, 47 and 49) about users of British technical libraries and roughly close to the findings of Auerbach (1965, p1-19), Cole (1958), Herner and Herner (1959, p67) and Raitt (1984, p204-208). Discussions with respondents revealed that general information to keep abreast with current developments and specific work related information to solve practical problems are two main types of information required by the space technologists. Further, Information is sought only when it is utmost needed and there is a strong need for internally generated information and product information. A respondent says "when I want some information on any component or equipment I will go through the text books to build up the theoretical background and then refer to data and product catalogues and application notes. Then I will go through the journals, if necessary".

This shows the intermittent and intermixed use of different types of information by the space technologists depending on the nature of work.

Further, change in the nature of work of the space technologists is found to affect both the intensity of need and the type of information required. The problem of information overload, enlargement of boundaries of interest and intensification of space activities in the country, impact

of electronics boom and resultant need for condensed information-services and need for fast serving information intermediaries or agents are felt by the IST.

3.1.3 Sources of Bibliographic Information Used

Library catalogues, colleagues and fellow professionals, direct browsing of library shelves, experts in the field, citations in current reading materials (in that order) are major sources of bibliographic information to the space technologists.

Except higher dependence on library catalogues (which need further probing) the rest of the sources of bibliographic information are almost in the same order as found in many earlier studies (Voigt, 1959; p179-180; Hanson, 1964, p71; Raisig et al, 1966; B.N.Singh, 1981, p172). As against 38% of British physists, 48% American physists (Gray, 1950, p417, Urquhart, 1965), 33.5% American engineers (Davis, 1965, p31) and 14.9% British mechanical engineers (Wood, 1967, p220), 46.6% of the IST used abstracting and indexing journals.

The space technologists have consulted library catalogues half of the time to locate specific documents, one-fourth of the time to interact with loaning system, one-tenth of the time for literature search. The subject catalogue is consulted most frequently (Sridhar, 1986).

A respondent says "searching in library shelves may not be scientific but more practical". The space technologists felt that relevant references are rarely available in a ready to use way, but a lot of browsing, searching and digging is necessary. In the process they have sought free reprints and reports and used indirect methods like cyclic way of generating references. Thus intermittent use of various sources of bibliographic information and interdependence among the sources, indirect cyclic way of generating useful references and more practical way of directly searching the shelves are adopted by the IST for bibliographic references. The following report of a respondent in his weekly summary of information related activities make it clear:

"I needed more information on Realising switching function. I went to library and scanned through latest books. I wondered that there are so many new techniques. I selected a latest book on digital design which I have not yet read. A colleague suggested another book; when I searched in the library through author and subject indexes, I could not get more details of the book. I found it is better to take some other book available on the shelf with the required information than searching through indexes".

3.1.4 Delegation of Information-gathering Work

Just 6% of the space technologists have frequently, and another 40% moderately or occasionally, delegated information-gathering work to juniors and subordinates, mainly due to lack of time and/or for involving team members.

Though the degree of delegation by the space technologists is close to social scientists (Line, 1971, p425), it is slightly lower than that found with atomic scientists (Hogg and Smith, 1959, p 33) and industrial technologists (Scott, 1960, p 33).

The reasons for delegation are unique to the IST. The tasks delegated are mainly collection of factual data, documents/literature and latest references on specific topics. The nature of information gathering work delegated conformed to that found by Raitt (1984, p 304)as well as Line (1971, p 425) except that IST have delegated more of (even) current search for latest references (48.6%) than retrospective and exhaustive search (26.6%) and analysed and digested literature (34.2%). Those who tend to seek more of physical, technical and design data have delegated more of factual, design and physical data and those who tend to seek more of state-of-the-art and review literature have naturally delegated more of retrospective and exhaustive searches.

Those who do not have assistants and those who believe strongly in serendipity value of information-searching process have naturally tended not to delegate information-gathering work. A respondent says "while searching there are ample chances for me to sight other titles which will be of immense help in my field". Though it is felt possible to communicate to others and train others in one’s way of information gathering, it is felt that there are not many people in the organisation with similar background to delegate. Majority of the space technologists do regular unfocussed browsing of current literature which lead them, at times, to highly useful accidental or chance acquisition of needed information. This is on line with the observations of earlier studies (Rosenbloom et.al. 1965; Columbia University, 1958; Scott, 1959; Bernard et.al. 1963/1964; Schuchman, 1981, p 15). Respondents have narrated specific incidents of accidental acquisition of inforamtion while skimming through the current journals, unintentionally looking here and there, browsing library shelves and reorganising personal and departmental collection.

3.1.5 Time Spent on Information-gathering Activities

The IST have spent, on an average, 9.2 hours per week or one-fourth of their working time for gathering work-related information which is close to that found by Raitt (1984, p151-

154)and higher than 7 hours per week spent by Indian scientists in another study (Garg and Ashok Kumar, 1984, p71). Nearly 80% of the space technologists spent 4-15 hours per week on information-related activities and is slightly lower than that found in many earliear studies (Schussel, 1969; Halbert and Ackoff,1959; Jahoda, 1969; and Gilmore et.al. 1967, p 41-42).

As many as 86% of the IST have spent more than half of such time in seeking/gathering information from formal and documentary sources of information. This is in conformity with what Raitt (1984, p 153) has found but differed from that found by Halbert and Ackoff (1959).

The helplessness about lack of time is reflected in the following statements of respondents:

"I could not find enough time for information related activities as I was more involved in routine works such as development and testing" ; "It is not possible to have information gathering activity on a regular basis due to pressure of work. Hence, it is done as and when time permits"; "Pressure of routine works has prevented me from collecting information as much as possible, as regularly as possible and as much as I would like to do".

The space technologists could not spend as much time as they wished (a reinforcement of a finding of Raitt, 1984, p 228). By and large, more time is spent in the initial phases of projects for information-gathering (except where the project is a feasibility study or the project itself is defined and assigned from outside the group) than during later stages. The reverse is true with engineers not involved in conception and definition of projects.

3.1.6 Dependence on Sources of Information

The space technologists indicated slightly more dependence on formal and documentary sources of information compared to informal and inter-personal sources.

This does not support the general findings of DOD user study (Auerbach, 1966, p 106-107; 1965, p 1-12) and that of Raitt (1984, p 209, 211 and 214) and Shuchman (1981, p 30, 53-55) that users depended heavily on informal sources. A typical statement like the following indicates the primacy of `ease of use' in accessing a source of information: "My information gathering habits are mostly dependent on things easily come across in everyday life".

Among the formal sources, they depend heavily on journals followed by books, reports, trade literature and internal reports in that rank order. This is in conformity with the

findings of Tornudd (1959), Herner and Myatt (1954) and Davis (1965, p 30-34). However, in Raitt ‘s study (1984, p 253) reports occupied more predominant position than books for his respondents. Conference proceedings, reprints and preprints, standard and patent specifications and theses and dissertations have ranked lowest (in that order) for the IST. The degree of dependence on journals showed a low positive correlation with degree of requirement of S&T news (r=0.25).

The IST have qualitatively stressed the importance of trade literature, technical reports, data sheets, conference papers and proceedings, personal and departmental collections and even newspapers. The following statements of respondents make it clear that trade literature is a significant source of information to the IST and they have greater dependence and need for it.

"I depended mainly on the trade catalogues and data sheets available in the section to meet the information needed during the week"; "I always use the readers service cards in the journals to get catalogues and more information from the manufacturers"; "I collect information by scanning journals like `Machine Design’, `Industrial Product Finder’, etc., contacting suppliers, studying product catalogues and visiting other similar installations elsewhere"; "I make regular correspondence with manufacturers and their representatives, visit exhibitions and other centres where information about products are displayed".

Personal and departmental collections of the space technologists consist mainly of internally generated information, free reading materials, preprints, journals, trade catalogues, standard specifications, reprints, reports, diagrams, handbooks, manuals and are not generally well organised.

A typical respondent says "I get most of the information required for my work from the departmental collection and from books in the library."

Among the informal sources, the space technologists have depended heavily on two intra-personal sources, namely, personal experience and results of their own experiments.

This very well goes with the observation of Shuchman (1982, p 5) about American engineers that "the primary source of engineering information is largely what the engineer keeps in his head". The discussion with respondents revealed that the "personal experience plays a major role and only when there is a vague resemblance one is lead to formal literature". Due to high specialisation and need for practical processes the nucleus of information-gathering activities of the IST is often oneself. The inter-personal contacts are mainly for opinion, suggestions and references.

The high dependence on intra-personal source is followed by inter-personal sources like superiors, peers and colleagues in the organisation. This again is on par with findings of Glass and Norwood (1959), Sherwin and Inemson, (1966), Rosenbloom and Wolek (1970) and Gralewiska-Vickery (1976, p 269).

The IST have depended least on fellow professionals outside-the-organisation for work-related information.

Some ways of blending formal and informal sources of information are:

(1) organisation of internally-generated information (2) inhouse technical journal (3) databank of expertise (4) component co-ordination group (5) inhouse seminars (6) liberal tours (7) presentations from outside speakers and (8) journal clubs.

In order to keep uptodate in the field, over 52% of the respondents depend mainly on journals (similar to that found by Shuchman, 1981, p 44), another 13% on discussion with colleagues and 9% on trade literature. In addition seminars, newspapers, preprints, lectures and sales representatives are considered quite useful for keeping uptodate. As found in the past, discussion with similar minds and conscious reading are the two activities which stimulate new ideas to the IST. The tolerable delay in supplying information and documents ranged widely depending on specific instances. Many instances of late detection of information are pointed out by the respondents. Depending on the specific field of work, the technological gap is found to be 5-15 years. The respondents are, by and large, fairly satisfied with the sources of information presently available to them. But they are optimistic on their devoting increasingly more time in future to explore various sources of information.

3.1.7 Inter-personal Information-sharing

There exists greater and more free inter-personal communication among peers and colleagues than among subordinates and superiors. There is a general lack of confidence or trust among the respondents about their superiors freely sharing information even though many depend on superiors for information and even superiors claim that they collect information for the purpose of sharing it with other members in the team.

Information sharing is dependent on content (information), context (time and space) and personality (person with whom information is shared). Some covert inhibitions and conditions that exist for free interpersonal flow of information are professional jealousy, potential threat arising out of

competition, lack of motivation, conducive atmosphere, team spirit and group discussions, compartmentalised organisation structure, status consciousness and fear of getting ridiculed about ignorance on the part of seeker of information.

A typical engineer frankly says "I do withhold information on selective basis". Another admits that "a great deal of improvement results if one overcomes the inherent hesitation to admit ignorance". Yet another says "when approached people give information if they can readily and easily do so. But they are not likely to take extra trouble to give information". This is very much close to the findings of Collins (1974) and Wolek (1984, p 226). The degree of dependence for information by respondents related much better with the degree of information sharing in case of subordinates and peers as interpersonal sources of information than superiors.

3.1.8 Intra- and Inter-organisational Communication

A very high intra-organisational communication exists among the space technologists (similar to practitioners vide Wilkin, 1981, p2.10) as 87% of the five most often-chosen persons for information are from within the organisation and less than one-third of the respondents kept absolutely no inter-personal contacts outside-the-organisation. The most often-contacted persons outside-the-organisation for information are spread over 50 organisations within the country and 22 outside the country. A large majority of communication outside-the-organisation is confined to the persons within the same city and nearly half of such communication is with persons in the academic institutions, where the space technologists have had their education earlier.

3.1.9 Informal Communication Behaviour

The communication network based on five most frequently-chosen persons for information revealed that on an average a space technologist is chosen by 3.23 respondents (ie., average inter-personal information-potential is 3.23). An average `technocrat' communicated (informally) most often with more than double the number of persons an average non-technocrat communicated. Those with 6-12 years of experience have maximum informal communication(r=0.27). The findings that new entrants do not communicate to many is in agreement with findings of Gerst berger (1971) but highly experienced also do not communicate to many colleagues is a totally new and unexpected result.

Status or organisational rank is a self created barrier in inter-personal information-seeking as nearly three-fourth of the contacts are with higher-status persons but status is not a barrier in providing information.

Relatively more lateral communication among peers found by Raitt (1984, p254) and more communication among persons of different status found by Pruthi and Nagpaul (1978, p55) are in conformity with this result. But the finding of Allen and Cohen (1970, p16) that there is a greater volume of communication from a higher status persons to lower status persons but not as much as that takes place between equistatus persons is partly supported.

Similar barriers do exist in the form of official organisation structure especially divisions, as just one-fourth of the contacts are outside-the-divisions.

This is comparable with 28% intersection choices of respondents of Bethell (1972, p47). On the other hand Raitt's (1984, p163-164) finding that 53% of contacts are within the division or project is comparable with 53.6% similar contacts found within the same section or project in the present study.

There exists substantial cross fertilisation of ideas among the IST as almost half of the inter-personal communication are among persons of different specialisations and fields of activities. Doctorate space technologists are high (informal)communicators even though equal number of `stars' as well as `isolates' exist among them. Doctorates (30.4%) are twice likely to receive communication from outside-the-organisation than others (15.3%) and 50% more than `communication stars' (21.6%). Information-potential of an average doctorate space technologist (5.5) is double that of an average person in the population (2.99). One-fourth of the frequent contacts of doctorates for information is with other doctorates.

3.1.10 Communication Stars and Technological Gatekeepers

Forty four `communication stars' (including six `technological gatekeepers') in the response population have maintained nearly half (47%) of their informal communication among themselves. They have marginally higher communication (21.6%) outside-the-organisation than an average respondent (15.3%) and even the `discussion stars' in Hall's study (1972, p121). The `stars' are characterised by higher age, experience, status, qualifications, professional activities and achievements, use of library and interactions with the library. They are predominately male technocrats with a confidence of self sufficiency and satisfaction with respect to information-use and transfer and more willing to share information with others. Communication stars do not differ from others in their job satisfaction but they acquired promotion more frequently than others.

This is close to the general finding of the past studies that performance and communication are positively related (Rothwell

and Robertson, 1975, p393; Bethell, 1972, p93; Pelz and Andrews, 1976, p47; Hall and Ritchie, 1975, p234-244 and Hagstorm, 1965).

3.1.11 Formal Communication Behavaiour

The formal communication through internal reports has been a more popular method than publishing research papers in journals as space technologists of different status, qualifications and nature of work are involved in preparing internal reports.

This goes well with the observation of Shuchman (1982, p5) that the most important output of American engineers is inhouse technical reports. The percentage (25%) of the IST involved in publishing papers is same as that found by Shuchman (1981) but less than that (35%) found by Tornudd (1959).

The space technologists have shown an inclination for oral conference presentation of papers rather than archival publications in journals. Indian journals have served more as publishing outlets for the space technologists than sources of information and sources for citation.

The ranking of various forms of literature in citations of the IST is journals (61%), books (14%), reports (10%), conference papers (10%), theses (2%), preprints (2%) and lecture notes, standards, product catalogues and private commmunications (1%).

This is close to that found by Herner et.al. (1979); and Srinivasan (1970), but differed from that of others. Citations to reports and self citations (16%) are on a higher side compared to results of other studies (Burton and Green Jr, 1961, p 35, B.N.Singh, 1981, p 179; Srinivasan, 1970; Herner, et.al. 1979); Meadows and O'Conner, 1969, p 160). Almost 97% of journal articles and 79% of reports cited by the IST are of foreign origin.

The IST have a high co-authorship and collaboration in publishing and research as 81% of the sample papers are multi-authored papers with a `multiplicity index' of 3.17 and `productivity ratio' of 0.32. There exists sufficient vertical as well as horizontal co-authorship and collaboration as nearly 80% of co-authorship relations are between persons of different status. Further, 42% and 52% of co-authorship relations are respectively between persons of different divisions/sections and different fields of activities.

3.1.12 Use of the Library and User-interactions with the Library

The `primary library' is used by a large majority i.e., 88% used library documents and 60% interacted with library.

As against, 50% of UK electrical engineers (Scott, 1960, p 3), 26.3% and 22.6% in UK industrial firms and government laboratories (Slater and Fisher, 1969, p 21) and 37% at MIT (Bush et.al. 1956, p 94) used their respective libraries.

But it is mainly for keeping up-to-date rather than for increasing their work performance. The space technologists are aware of the consequences of using as well as not using formal sources of information like the library. While the theoretical and basic science oriented persons considered `papers' as their `backbones', developmental persons felt that the information from written documents are not often directly applied in the work but are used to have an intuitive guess about future work. After a certain basic level of use, the amount of use of the library is not commensurating with the results of work. The innovative ideas cannot always be put into use due to risk, reliability and cost factors.

The frequency-distribution of use of journals is less skewed than that of books, and books than that of reports. In other words, the interest of the IST is more widely spread among different journals than in case of books and more widely among books than in case of reports. Unusually, more use of the library is made during reviews for promotion although the space technologists do not attribute seeking information for getting promotion as a major motive or purpose. The borrowed use of books is quite intensive (80%), journals moderate (14%), reports marginal (5%) and standards negligible (0.2%). The inhouse use of journals is much more than borrowed use.

Though the use of journals is much less than that of books, the average time spent by the users in journals section of the library is much longer than that spent in books and reports area. Interestingly, there exists a statistically significant moderate positive rank order correlation (rs=0.55) between inhouse use of library documents and the nearness of the functional division/project of the user to the library. The average inhouse use by project personnel is maximum and that of the service sector personnel is minimum.

Interestingly enough, the chances of reserving a document by the IST increases by 56% when the interest of colleagues in the new books is publicised. A user who used library documents has greater chances of interacting with the library for other purposes and vice versa. Even a user of a single type of document has a greater chance of using other types of documents and one who interacts with the library for one purpose/service has a greater chance to interact for other purposes /services.

3.2 Realisation of Objective 2 : Characteristics of the Indian Space Technologists

The Indian space technologists are working in a young organisation and are themselves quite young. The average age of the IST is (31 years) much less than that of respondents of Raitt (1984, p 191) and DOD user study (Auerbach, 1965, p B-3). The response population of the study consists of 6.5% females which is slightly more than the overall employment pattern in R&D institutions in the country (India, DST, 1982, p 5) and much higher (2.8%) than that found by Raitt (1984, p 121). The average experience of the respondents in ISRO, and before joining ISRO, are respectively, 5.9 years and 2.5 years. The frequency distribution of age of space technologists is close to that of DOD user study (Auerbach, 1965, p B-6). A large majority of the respondents brought prior experience from industry (41%), R&D organisations (30%) and academic institutions (18%). A reverse trend was found by Raitt (1984, p 129) in aerospace establishments of U.K.

The space technologists are motivated mainly by `self-improvement' followed by `work progress' in seeking information. Of the respondents, nearly three-fourths (73%) are fairly or fully satisfied with their present jobs. They have shown a high job mobility within and outside-the-organisation. The performance rating by peers has mostly coincided with the promotion based performance measure. Based on frequency of promotion, 158 `high performers' are identified. The frequency distribution of performance based on professional activities and achievements shows that about 13% claim zero value, 37% score a low value of 1 to 5, 45% score 6 to 10 and the rest of 5% a high value of 11 or more.

Nearly 55% of the population are scientists and engineers by designation and the rest are non-gazetted technical staff. About 12% of the space technologists are technocrats and a little over 5% are working exclusively in project management offices and core teams. Of the respondents, over two-thirds (68%) are involved in design, development, fabrication and testing activities and about one-fifths (20.5%) in management , planning and system-analysis work (as against 60% in Raitt's study, 1984, p 123). Large-scale developmental work has necessitated more middle and lower-level and less qualified personnel, particularly in various service sectors. The space technologists show a wide professional diversity in terms of their specialised fields of activities. A majority of the respondents work in the areas of mechanical engineering, communication engineering, computer science, instrumentation and physics which is close to that found in DOD user study (Auerbach, 1965, p B-8).

The population consists of just 4.5% doctorates, which is lower than that (11%) found elsewhere in the country (India, DST, 1982, p 5). On the other hand undergraduates and diploma holders

who constitute 40% of the population are more than (28%) the country's average (India, DST, 1982, p 5). By the criterion of subject of specialisation, there are 44% electronics engineers, 27% mechanical engineers, and 8% physicists. Nearly two-third of the respondents are from applied science, engineering and technology, one-eighth from pure science and a meager 1.3% from management disciplines. The low percentage of doctorates as well as pure science personnel indicate lack of `pure research' nature in the space technologists.

By and large, the IST is a heterogeneous group in terms of their characteristics. But the response-population is highly representative of the total population of the study by almost all characteristics. Many user-characteristics of the IST are highly related to each other and status, nature of work, qualifications, specialisation and performance(based on professional activities and achievements) fairly represent the characteristics of the IST for a correctional study of ISB.

3.3 Realisation of Objective 3 : Correlation of Information-seeking Behaviour of the Indian Space Technologists with their Characteristics

A summary of correlation/association test results of various aspects of ISB with status, qualifications, nature of work, specialisation, experience and professional activities and achievements of the IST revealed that almost all the aspects of ISB are related to one or more characteristics of the IST. Though experience of the IST is related to their ISB, only in 28 of the 108 aspects, other-characteristics relate significantly in 57 to 81 aspects. Thus the null hypothesis that there is no significant relation, other than due to chance, between the ISB and the characteristics of the IST is, by and large, rejected. Hence it can be concluded that the ISB of the IST varies significantly with status, qualifications, nature of work, specialisation and professional activities and achievements.

A majority of the significant relations of the status of the IST with information-seeking activities are positive. However, seeking information for the purpose of equipment setup and use, need for standard and patent specifications, consulting library card catalogues and library staff for bibliographic references, chances of delegating information-gathering work due to unfamiliarity with the sources, dependence on standard and patent specifications, superiors and educational and training courses as sources of information and relative dependence on informal and inter-personal sources compared to formal and documentary sources of information decrease as the status of the IST increases.

Even in case of qualifications of the IST, most of the correlation's/associations are positive. However, the motive of gaining promotion while seeking information, consulting library card catalogues and library staff for bibliographic references, delegating information-gathering work due to unfamiliarity with the sources, dependence on superiors as sources of information and relative dependence on informal sources compared to formal sources of information decrease as the level of qualifications of the space technologists increases.

The nature of work of the IST arranged in the ascending order of management/supervision content or descending order of operational activity of the job is highly interrelated to their status structure and level of qualifications. As such, the relation of the nature of work to information-seeking activities runs almost parallel to that found with status and qualifications. However, a strict linear positive relation to the ascending order of management/supervision content of the job is found in the case of seeking information for the purposes of participating in seminars, keeping abreast with developments, crystallising broad and vague assertions and evolving innovative ideas/techniques, seeking state-of-the-art and review literature, degree of delegation of information-gathering work, involving team members as a reason for delegation, dependence on fellow professionals outside-the- organisation and professional meetings and seminars as sources of information, the number of inter-personal contacts both within and outside-the-organisation, communication stardom, inter-personal information-potential and use of reprographic service of the library. Yet, the relative dependence on informal sources compared to formal sources decreases as management/supervision content of the job increases. Interestingly, the amount of time spent on information-gathering activities is independent of the nature of work of the IST.

The IST is a heterogeneous group by considering the subject of specialisation of its members. Some of the information seeking activities of specialists within the IST differed from one another. Physicists, mathematicians, mechanical engineers, aeronautical and structural engineers, electrical engineers, electronics engineers have their own profiles of information-behaviour. Physicists, being scientists, are highly active in seeking information and are oriented to literature and formal information-system. Mathematicians are also active seekers of information but not to the extent of the physicists. Among engineers, aeronautical and structural engineers are most active in seeking information and they are close to scientists in their information-behaviour. Out of the rest, electronics engineers are more active seekers and users of information than mechanical engineers and electrical engineers within the IST. The specialisation

of the IST has no bearing on the delegation of information-gathering work. Even the motives of seeking information, use of sources of bibliographic information and communication-behaviour are almost independent of specialisation of the space technologists.

As mentioned earlier, the experience of the IST is found to be correlated with just one-fourth of the information-seeking behaviour items tested for correlation. Interestingly, experience correlated positively with building professional competence as a motive and guiding the team as a purpose of seeking information, need for state-of-the-art and review literature, standard and patent specifications, S&T news, dependence on citations in current reading materials, involving team members as a reason for delegation of information-gathering work, dependence on conference proceedings and papers, journals, standard and patent specifications, reprints and preprints, subordinates, professional seminars as sources of information, inter-personal information sharing by subordinates, number of inter-personal contacts outside-the-organisation and the chances of becoming communication star. The aspects negatively related to the length of experience of the IST are: data treatment and processing as a purpose of seeking information, need for theoretical background, computer programs and model building information, time spent on information-gathering activities, percentage of time spent on informal sources of information, dependence on books, internal reports, superiors, educational and training courses as sources of information and library-use index. Yet experience is not significantly related to majority of the motives and purposes of seeking information, use of bibliographic sources, delegation of information-gathering work, use of library documents and interactions of the IST with the library.

The professional activities and achievements-index developed in the study appears to be a good measure of the intensity of information-seeking activities of the users. A majority of the information-seeking aspects correlated positively with this index. The aspects of ISB which correlated negatively with the professional activities and achievements-index are: getting promotion as a motive of seeking information, equipment set and use as a purpose of seeking information, the need for standard and patent specifications, consulting experts and library staff for bibliographic references, unfamiliarity with the sources as a reason for delegating information-gathering work, dependence on standard and patent specifications, trade literature, superiors as sources of information and relative dependence on informal sources of information compared to formal sources of information. Yet majority of the nature and type of information sought

and bibliographic sources used are independent of professional activities and achievements of the IST.

4 Implications of the Results and Findings

It is not feasible to enumerate all the implications of the results and findings of this study. However, an attempt is made here to highlight selected, significant and direct implications of the findings. The multifaceted approach in seeking and collecting information adopted by the heterogeneous group of the IST makes generalisation too difficult. The IST are specialised in different disciplines, yet have a common mission and thereby exhibit the duality of the discipline and mission orientation (Weinberg, 1967) in their information-behaviour and provision of uniform or common service to all is highly unsuitable.

The formal information system should be clear about its objectives (including derived and assumed objectives, if any). Information-services for increasing productivity and enhancing work performance, self progress, departmental promotion, continuing education do differ very much from one another. The excessive dependence on library for departmental promotion and for continuing education has to be taken note of. For example, a text book bank facility either in a centralised or semicentralised way would not only meet the bulk of such needs of continuing education of the space technologists, but also substantially relieve the burden on central work-related information facility or the `primary library' of providing information-services to enhance work performance.

Provision of increased opportunity to browse latest literature in core as well as related/peripheral areas and carrying current awareness services to the work spots and laboratories of otherwise busy IST is necessary. Yet provision for secondary journals, state-of-the-art and review literature can be reduced at the primary library'. On the other hand, the library should house more of primary news magazines, trade journals, reference books, data manuals for providing quick and up-to-date information and factual data. More efforts need to be made to provide extensive subject catalogues in the `primary library'. The resources needed for maintaining author and title catalogues for reports be reallocated for updating the subject catalogues and providing extensive reference service in selection and location of documents by the users.

There is a necessity to provide information-services of the `primary library' on a regular basis right at the place where the space technologists work. Further, a provision for trained information specialists in an adequate ratio with user-strength be made so that the space technologists can be persuaded to delegate some information-gathering tasks to them

whenever they lack sufficient time to undertake such work or whenever their time can be better utilised more productively elsewhere.

A large part of the work-related information needed by the space technologists can be met from a well-organised, comprehensive and internally-generated information in the form of technical reports (of various kinds), preprints and reprints of journal articles, conference papers, software documents, design drawings, photographs, slides, transparencies, etc. Since all such information cannot be put at the disposal of all the users, surrogates of such documents should be made available with a note about their location and security clearance, if so needed. The `reinventing of the wheel' within the organisation can be avoided with a well organised system of internally-generated information. Due to security reasons or lack of clear policy on security classification many such internally produced documents are not collected, processed and organised at one place within the organisation.

The product catalogues and trade literature, which are considerably sought after by the space technologists are not systematically collected, indexed, organised, stored and updated at one place. Though trade catalogues are normally available free, they are, at times, arbitrarily priced for those not buying the concerned product, component or equipment. Enormous trade literature is getting `buried' in the purchase files denying current information to prospective buyers, and servicing and maintenance personnel. Such literature should be taken care of as multiple requests for free copies of manuals and other related trade literature from the same organisation are normally discouraged by the manufacturers and even when they wish to supply either free or on nominal payment, copies may not be available for equipment's and components sold earlier. A fairly centralised data bank of trade literature which acquires, indexes, organises and systematically weeds obsolete product literature is necessary.

There is a need for intermediary information-specialists who can act as data and information-gathering and analysing agents and support the local information-analysis centre. These intermediaries should work closely with the senior space technologists, projects and the `primary library'. They should screen and sift the reading material to be browsed by the senior space technologists and provide highly reliable and accurate data/information to those who need it.

A process of generating confidence among subordinates and juniors for seeking information from superiors and seniors is necessary to overcome the `psychological cost' or `status inhibition' exhibited in the transfer of information. In a highly intra-organisation-oriented communication of the space

technologists, there is a need for cutting recirculation of ideas or information among members of tight and closed loop informal network of `old boys'. The marginal inter-organisational communication due to communication stars and technological gatekeepers and tours and visits abroad (of mostly of higher-status persons) may have to be increased by encouraging more contacts outside-the- organisation especially at middle and lower-levels. A more liberal organisation structure which places communication stars accessible to more number of colleagues and makes many of them `linking pins' in the organisation structure might optimise use of such high- information-potentials. In addition, increasing the ratio of technocrats to non-technocrats, periodic reassignment of jobs, more encouragement of inter-section, inter-division and inter-project communication bringing `isolates' into the communication network is needed.

Encouraging and giving due credit for publishing activity is more likely to result in an increased use of literature more frequently and systematically and intensify engineers' information-behaviour.1 The publishing activity also encourages more co-authorship and collaboration and in turn informal communication. Further, a proper security classification scheme could be evolved to give publication status to all unclassified and declassifed (1 Raitt (1984, p275) also make similar observations) internal reports of the organisation. This not only aids internal generation of information but also motivates authors to be more literature and documentation oriented in production of internal reports. Moreover, the cost of production and distribution of such reports can be recovered by charging those buying such reports and/or by exchanging such reports with reports of other similar organisations.

For the purpose of blending formal and informal sources of information the following options can be considered: (i) Developing `components databank' and `components co-ordination group', (ii) disseminating various technical information and activities through the in-house technical journal, (iii) developing a panel of experts on whom technologists in the organisation can look upon for getting authentic information quickly on a given specific area without much `psychological cost', (iv) conducting regular in-house technical seminars, and circulation of brief summaries, detailed summaries and the complete documents relating to such seminars, reviews, etc., to appropriate persons, (v) establishing `journal clubs' and (vi) creating more opportunities for the space technologists to meet fellow professionals outside the organisations by allowing liberal tours and/or by inviting outside professionals for presentation of papers/reports in in-house seminars.

The formal information facility i.e., the primary library, needs to be strengthened in respect of nature and type of information needed by the IST. The overall organisation planning in general and planning of various projects and activities (including TDPs), in particular, have to make provision for information-support needed. The members of the projects and groups should be made to develop the habit of participating in the collection-development process of their primary library. It is necessary to see that each section, division and project formulates a systematic way of circulating current awareness services and other surrogates, announcements about documents and summaries among members of their sections, divisions and projects.

The primary library, on its part, should evolve a more liberal policy of promoting the use of journals, reports, standards and trade catalogues among the users concerned without expecting the space technologists to visit the library to consult a document or to reserve a document or to borrow a document for a limited period and, at times, pay a heavy fine as penalty for having not returned in time. This may necessitate a need to be more flexible in the application of library rules and regulations excepting a few areas like textbooks and popular books. For example, nearly three-fourths of the sample reports of the primary library which are not borrowed could be sent to the work tables of the potential users concerned (atleast copies of the title pages, abstracts and document control data sheets) for perusal rather than passively storing them on library shelves. Above all, the primary library has to find the ways and means of inducing and inducting the nonusers. There is a need to give orientation programmes to the space technologists (especially to new entrants and less frequent users) in the use of the primary library. The experimental services like the `pathfinder' and `aid to space science and satellite technology orientation' have been well received and efforts need to be continued on similar lines. The space technologists also need an informal training in organising their personal information system consisting of references, notes, abstracts and documents in various forms like registers, notebooks, files, loose sheets, cards and desk diaries.

It is necessary that the organisation and the primary library take cognizance of various information-behaviour aspects and activities which are shown to be functions of one or more variables and accordingly plan, design and operate the information-system. These relations of the user-characteristics to information-behaviour may be kept in view in providing information-services to various groups within the IST.

The professional activities and achievements index developed in this study has fairly represented the intensity of information-seeking, information-orientedness, the information-

potential and the library /literature orientation of the space technologists which could be made use of in re-patterning the information-services.

5 Suggestions for Further Research

The present study is confined to pursuing and achieving the three objectives and testing the hypothesis stated earlier. In this pursuit many related issues/problems are noticed. Though they are delimited as outside the scope of the study, many of them are worth considering as areas for further research. Here, then, are presented such areas as well as areas for further research on ISB of the IST.

5.1 User-Research in General

There is a strong need for a meta-analysis1 (i.e., the analysis of (1 Meta-analysis is a methodology quantitatively cumulating and integrating findings across studies (Gooding and Wagner, 1985, p465).several analyses) of many past user-studies over the last four decades in science and technology areas so that a thorough sifting and stock taking as well as consolidation of the findings of user- research takes place. It is worthwhile to arrive at a generalised user-behaviour research model using the pattern of the present and other past studies as bases so that each one of the major organisations, disciplines and missions within science, engineering and technology in the country could be studied preferably by the information-specialists `living with the tribe'1. Further comparisions and meta-analysis would become meaningful and dependable only if such a research model is adopted for series of studies covering different user populations. Such a model could also be used for periodic information-behaviour studies of the same set of users.

There is also a need for a national level multidisciplinary research organisation in India on par with BASR (ISR), CRUSK, CRUS, etc., of the western countries to take care of continuous research on communication and information-behaviour of the Indian scientists, engineers, technicians and technologists.

The basic aspect of user-research, namely, `why does the information-seeker behave as he does?', `Why does ISB vary with user-characteristics?", "Is ISB contingent to the work atmosphere or dependent on attributes of individuals?" are some of the fundamental areas which demand in-depth studies.

More surveys are necessary not only to confirm general patterns of information-behaviour but also to identify departures from the norm (Hanson, 1974). Some of the areas needing urgent attention (2 This should have been the foremost task of the apex bodies like NISSAT in the country.) are assessing the

impact of different kinds and levels of presentation of reading materials, ways of measuring accessibility to information and ascertaining the effects of such accessibility, impact of information on its receipient and on the progress and outcome of his work. In addition, extensive local, organisation, discipline and mission oriented user-research within the country is needed.

5.2 Other Aspects of Information Behaviour

An intensive multidisciplinary research of motives of seeking information, a study of how unmet needs of users get dissipated, ways of measuring `information overload' and impact of `information overload' on use of information are some of the other areas for further research. A thorough review of the need for catalogues and indexes in libraries and their functions in serving engineers and technologists, how they can be made more attractive and useful to users in providing bibliographic information, how the library can aid specialists and experts in providing bibliographic information and how subject specialists be developed as information intermediaries for providing information-services so that scientists, engineers and technologists can confidently delegate their information-gathering work to them are the other wider avenues for further research.

More research is also needed about the information-processing behaviour of scientists, engineers, technicians and technologists, i.e, the way they use documents and information as well as relating use of information to the purposes of seeking information and the requirements of information. How the use of information varied at different stages of a work or project, what sources of information under what setting (bringing text and user together) generates new/novel ideas, increases `accidental acquisition' of information and reduces chances of `late find' of information need to be explored.

More research by librarians about informal and inter-personal sources of information as well as informal communication of scientists, engineers, technicians and technologists is needed. In particular, the ways and means of increasing effectiveness and efficiency of informal communication have to be explored. A semi-controlled experiment to test the hypothesis that `high performance causes high communication and not vice versa' would be quite interesting. Similarly, a study to distinguish the effects of formal organisation structure and informal social relationships on communication of scientists, engineers, technicians and technologists is highly desirable. One specific hypothesis could be that "the effect of informal social relationship is much stronger than the formal organisation structure on communication".

Another potential hypothesis to be tested could be that "the informal communication among peers and colleagues is much more effective and cordial than between a superior and a subordinate".

Further, can communication stars and technological gatekeepers be formally appointed? and, if so, how do they differ from self-chosen communication stars and technological gatekeepers in their effectiveness? Such issues require systematic studies. To put it in the form of a hypothesis "the communication stardom and technological gate-keepership are intrinsic to individuals and not contingent to a particular organisation.

Another less explored area is that of informal communication among coauthors. There is a need to compare the characteristics of coauthors and also to determine the nature and amount of work shared by coauthors in producing a paper or a document. "Does co-authorship-relations result in lasting and highly effective informal communication among coauthors?" is quite speculative in nature. A qualitative study of citations which could throw light on how use of information is related to its citation is necessary. Why one cites a reference and whether all the references cited have been read and used by the author are to be answered. Further, research regarding various interactions of scientists, engineers, technicians and technologists with formal sources like a library is needed to assess their real time responses for arriving at their information-behaviour as well as their attitude towards information.

5.3 Further Research on Information-Behaviour of the Indian Space Technologists

The present study may be extended to cover other scientists, engineers, technicians and technologists, in general, and space technologists working in sister organisations in particular, in India, so that results could be compared. There is a vast scope for further research in terms of different types of users, different aspects of user-behaviour and attitudes and comparison of user-behaviour and attitudes of different types of users. In addition, the basic research aspect of ISB of the space technologists could also be explored. The information requirements of about 100 industries which worked with ISRO and supplied materials, equipment and services and another 25 industries which used ISRO-developed technology for non-space uses as well as the organisations which undertook sponsored projects and contracts of ISRO are worth probing. Many other user-characteristics / attributes including personality traits and psychological dimensions of information-seeking and using need to be identified and their relation with information-behaviour of the IST tested.

Further analysis of the database created in the present study could also be taken up especially by cross tabulating the data. For example, the nature and type of information sought against the sources of information preferred and ranking of various factors within ISB aspects (like motives and purposes of seeking information, nature and type of information required, dependence on sources of information, etc.) can be compared for different user-characteristics. There is ample scope for finding inter-correlation among various factors within each aspect of information-behaviour as well as inter-correlation of various aspects of information-behaviour. Thus, the findings of the present study as well as its database could serve as a starting point for many independent short and long range research projects which may in turn throw better light on the ISB of the IST.

5.4 Use of Refined Methodologies and Data-Analysing Technique

From the point of view of methodology and data-analysing techniques, there is a need for the use of semi-controlled experiments, multiple correlation, partial correlation, factor and cluster analysis, analysis of variance, regression-analysis and other techniques. For example, the quantitative data like age, experience, professional activities and achievements, library-use and library-interactions of the space technologists can be subjected to linear regression-analysis.

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About the Author

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