Lib Sc. 25; 1988; Paper G.

A SOCIOMETRIC ANALYSIS OF INFORMAL COMMUNICATION AMONG INDIAN SATELLITE TECHNOLOGISTS

M S SRIDHAR, *Library & Documentation, ISRO Satellite Centre, BANGALORE-560 017*

By and large, librarianship seems to have ignored the informal communication flourishing among their clientele. Informal communication both within and with outside the organisation and various informal and interpersonal sources of information a found to play crucial role in the work of an engineer/technologist. Some of the reasons for such an importance of informal communication for an engineer are discussed. A study of interpersonal communication looks at the 'transciever' role of an engineer and leads to inquire into his information potential and identification of communication networks, their characteristics like density, connectedness, centrality and cluster, communication stars, isolates and technological gatekeepers. The informal and interpersonal communication among a defined set of over 800 Indian satellite technologists is investigated by sciometric analysis of the number of persons they regularly contact for work related information and with the names of five most often contacted persons provided in response to a questionnaire. The intra and inter-organisation communication of respondents and their relation with some characteristics of respondents are examined. A sociometric analysis of upto five most often contacted persons named by the respondents revealed that 391 respondents mentioned 515 individuals/organisations 1538 times. As much as 87% of contacts within the organisation and the rest represented inter-organisation communication. An average satellite technologist found to be simultaneously a source of information for about 3 others in the response population (connectedness of the network). The analysis helped identification of communication stars or high information potentials (HIPs), isolates and technological gatekeepers.

An examination of dyadic reflexive communication revealed existance of a cluster and some linking pins in the network. Further, similarities and dissimilarities of participants of dyadic communication are also analysed.

1 INTRODUCTION

Some of the factors which decide the choice of a source of information by user, apart from task and purpose of seek-

ing information, are physical proximity, accessibility, perceived quality and utility, ease of use and previous experience about the source or acquaintance with the source. It is fairly established that the least effort principle operates in the choice of alternative sources or channels of information by users. This does not mean that many sources of information are non-complimentary. Another simple principle on which use or nonuse of a source of information is based is Mooer's law. It states that "an information retrieval system will tend not to be used whenever it is more painful and trouble-some for a customer to have information than for him not to have it" (1).

The most popular way of classifying sources of information is formal and informal or nonformal sources. The other overlapping criterion often used are internal and external sources, interpersonal and intrapersonal sources, seeker generated sources and sources external to the seeker, personal and impersonal sources, written or documentary and oral sources, auditory and visual sources, etc. No way of classifying sources of information is fully satisfactory and the groups are neither exhaustive nor mutually exclusive. For example, participation in a conference could be both formal and informal and information obtained in a conference could be written as well as oral. Some have labelled such sources of information as semiformal sources.

In the arena of information user research, librarians appeared to have concentrated more on formal sources of information and the nonlibrarians particularly sociologists, psychologists, communication specialists, educationists, managers, have concentrated on informal communication. Hatt says "... Librarians seem to be ignoring the below-ground network of informal incidental communications while the D & U [Dissemination and Utilization] workers are ignoring the mushrooms of formal communication in organised stores. What is needed, perhaps, is an approach that views the two kinds of growth as one system, rather than two" (2).

Many past studies have confirmed that both formal and informal sources of information are equally important for a user. There appears to be a neat interlinking of formal and informal sources that each stimulates the use of the other in many situations and thus acts as mutually supportive dependent and complimentary sources of information. Hence it is more appropriate that librarians know about the informal and interpersonal communication of their clientele in order to suitable suppliment it by formal sources of information. Infact the broad purpose of an information system is to establish effective communication between people (3). Communication as a complex phenomenon forms an integral part of day to day scientific and technical work. One of the approaches of quantitative analysis in librarianship is to explore or inquire the morphology of information flow or the unknowns in the communication process (4). "Work in this area is less rigorous than the bibliometric techniques, purely because the survey data is difficult to collect. To study citations is far easier than studying people" (5).

It is attempted in this paper to highlight the importance of informal and interpersonal communication, and examine the informal and interpersonal communication network, patterns and behaviour of Indian satellite technologists in the form of a sociometric analysis based on the data collected as part of a larger and comprehensive information behaviour study (6). Due to limitations of space, findings of earlier research on informal communication could not be given here.

2 IMPORTANCE OF INFORMAL COMMUNICATION

Communication is considered successful if it brings desired change in the receiver. It is very difficult to say that reading is a superior way of transferring or acquiring information than hearing or other ways of transferring or acquiring information. Many past user studies have confirmed that informal, oral and interpersonal sources within the organisation are very important sources of infromation for engineers whe-

ther they are direct or indirect (two step/multistage flow), vertical or horizontal in the organisation structure and it is estimated that "...professional researcher may receive upto 55% of his useful technical information by informal means " (7). The relatively greater role played by informal communication for practitioner is emphasised by Brittain, (8) especially under the conditions of uncertainity and/or anxiety which make him to seekout others similar to him for comparison (9) and for a tailormade solution synthesised to support a finding (10). Hall in his review of user studies summarises and says "first, the information which scientists and engineers want is frequently some detail concerning procedures or experiments which is therefore unlikely to be easily found in a written source, and it may be more conveniently obtained by word-of-mouth. Second, professional interaction is an important source of confidence. When a scientist or engineer is uncertain about the reliability of information he needs, he is likely to turn to colleagues for judgement. There are other possible reasons for predominance of oral communication such as reassurance or just wanting to cut the lag in publication time" (11). It is well known that the word-of-mouth experts play significant role in getting across the message through mass media. Crane (12), has traced the reason why technologists depend more on informal source than scientists to the fact that many technological problems have to utilize knowledge from a very diverse set of research areas and hence expert assistance is needed in locating published material rather than information concerning unpublished material. Crane further observes that "Scientists who have no informal contacts with the large groups of collaborators in their research areas have the greater difficulty in locating information since... the latter serve to link the smaller groups and isolates" (13). It is also established that members of invisible college do decide the direction of research in a given area and technological gatekeepers and communication stars exert substantial influence on others when they transmit information.

Wolek (14) based on the intensive interpersonal communication in mission-oriented research hypothesise that the need for interpersonal communication varies directly with the complexity of messages to be communicated. Kunz and others conceive the same reason in a more general way as "the gap between supply of and demand for information is bridged to a large extent by informal means of communication..." (15). Glass and Norwood (16) reported that casual conversation was the most-mentioned first source of information on items chosen by each scientist-respondent as representing scientific concepts and research of major or crucial significance to the development of his own work. A similar result was found in DOD's Project Hindsight (17) that in 70% of the cases information and ideas originated (in the development of 20 successful weapons systems) from personal contact. The studies of Rosenbloom and Wolek (18) also confirmed that verbal sources inside the organisation were the most important sources of information for technologists. Among the verbal sources, Gralewska-Vickery (19) found that the most used verbal sources were colleagues (80%), conferences (58%) and external personal contacts (49%) and the least used were manufacturers (16%) and consultants (17%). Kelly found almost universal praise for casual table-talks following a conference as most important sources of new ideas for scientists. He quoted an award winning biologist that, "I have the impression that a great body of information is getting around by a mechanism that can only be termed gossip" (20).

3 'TRANSCEIVER' ROLE OF INFORMATION USER

The study of informal communication emphasises the 'transceiver' role of scientists, engineers and technologists. A user of information is often a producer and transmitter of information and hence information users are also interpersonal 'sources' of information. While the information seeking behaviour emphasise the 'user' role, the communication behaviour emphasise the role as a 'source' of information. In

the informal and interpersonal communication, the flow of information from person to person also highlight the information potential of participants of communication, identification of communication networks, communication stars, technological gatekeepers, isolates and invisible colleges.

The morphology of information flow in the context of an organisation is described in three types viz., input, throughput and output. The throughput could be horizontal or vertical one and the vertical in turn could be downward or upward and the horizontal could be intragroup or intergroup flow of information (21). The informal communication studies are almost similar to that of the multistep flow of communication referred to in mass communication. The important diferences being that in science and technology, informal communication is more audience motivated, the links are more cognitive than in mass communication and the massages often precede the appearance in print (22).

4 THE MEASURES OF COMMUNICATION NETWORK ANALYSIS

The patterns of communication among members of a group are referred as communication network or sociogram (constructed by sociometric analysis or by snowball technique). There has been a suggestion to classify a subject based on its communication structure than its contents (23). Brittain observes that "each area of scholarship and practicce may be associated with special communication networks, and fundamentally different information requirement" (24). The network analysis has been applied in many subjects and some of the measures of network analysis borrowed from other subjects are density, connectedness, centrality and cluster (25).

The density measures the degree to which members of a network are in touch with one another and is the ratio of the actual number of links to the maximum possible. The connectedness is the average number of relationships that each person has with others in the same network. The centrality of

a network location is the ratio of the communication activity at that location to the mean communication activity over all locations in the network. The cluster is a set of persons who have many links with one another, with a density of not less than 80%.

5 INFORMAL AND INTERPERSONAL COMMUNICATION OF THE INDIAN SATELLITE TECHNOLOGISTS

51 Size of Informal Communication Network

The entire population of little over 800 Indian Satellite technologists of ISRO Satellite Centre (ISAC) were asked though a questionnaire to give approximate number of persons they generally contact regularly for work related information. The respondents were requested to indicate the size of informal communication network in two ways, viz., the number of persons contacted within ISRO and those outside ISRO and the responses are shown in Table 1. The frequency distribution shows 10 as the mode number of persons contacted within ISRO and 5 outside ISRO. Naturally, the mode is in the range of 11-15 under the column 'total number of persons contracted' in the Table. It is also clear from the table that contact of upto 5 persons (both within ISRO and outside ISRO) are made by 27% and upto 15 persons by 65% of the Indian satellite technoligists. As the cumulative percentages in the table shows contact of more than 25 persons within ISRO and outside ISRO are respectively maintained by about 8% and 4% of the respondents. A considerable number (i.e., 94 or 27.5%) of the respondents do not contact persons from outside ISRO for information (and it corrobarates well with the fact that 29.4% of the respondents said that they do not consider fellow professionals outside ISRO as a source of information in the broader study). The average number of contacts per person within ISRO and outside ISRO respectively are 11.8 and 6.6.

TABLE 1

Frequency Distribution of Number of Persons Contacted as Informal Sources of Information

No. of persons contacted	Within ISRO			Outside ISRO			Total		
	No.	%	Cum. %	No.	%	Cum. %	No.	%	Cum. %
00	4	1.2	1.2	91	27.5	27.5	NA	—	—
01	2	0.5	1.7	10	2.9	30.4	2	0.5	0.5
02	32	7.5	9.2	59	17.3	47.7	30	6.7	7.2
03	32	7.5	16.7	18	5.3	53.0	26	5.8	13.0
04	29	6.8	23.5	23	6.7	59.7	22	4.9	17.9
05	65	15.3	38.8	44	12.9	72.6	42	9.4	27.3
06	24	5.6	44.4	1	0.2	72.8	22	4.9	32.2
07	12	2.8	47.2	1	0.2	73.0	21	5.0	37.2
08	9	2.1	49.3	3	0.9	73.9	11	2.5	39.7
09	1	.2	49.5	1	.2	74.1	12	2.7	42.4
10	92	21.6	71.1	41	12.0	86.1	29	6.5	48.9
11-15	41	9.6	80.7	8	2.3	88.4	73	16.4	65.3
16-20	23	5.4	86.1	16	4.7	93.1	34	7.6	72.9
21-25	24	5.6	91.7	9	2.6	95.7	40	9.0	81.9
26-30	7	1.6	93.3	6	1.8	97.5	17	3.8	85.7
31-35	0	0	93.3	0	0	97.5	14	3.2	88.9
36-40	0	0	93.3	1	0.2	97.7	9	2.0	90.9
41-50	19	4.5	97.8	2	0.5	98.2	12	3.0	93.9
51-60	1	0.2	98.0	1	0.2	98.4	10	2.3	96.2
60-70	0	0		0	0	98.4	2	0.5	96.7
71-80	1	0.2	98.2	0	0	98.4	6	1.4	98.1
81-90	0	0	98.2	0	0	98.4	0	0	98.1
>90	6	1.4	99.6	4	0.3	98.7	11	2.5	100.6
Total	424	99.6	99.6	339	98.7	98.7	445	100.6	100.6

Key : NA, Not applicable

Note : Not answered, and invalid responses to the extent of 111 (69+42) for 'within ISRO' and 196 (179+17) for 'outside ISRO' are excluded. In the total column the partial responses to either 'within ISRO' or 'outside ISRO' are not excluded. The number of 'not answered' and invalid responses in total column is 202.

52 Correleation of Number of Regular Informal and Interpersonal Contacts with User Characteristics

Results of association/correlation tests of the number of regular informal, interpersonal and intraorganisational contacts with the user characteristics are shown in Table 2 (the individual contingency tables are not shown). As revealed in the Table, there is a linear and positive association of status, qualifications and management/supervision content of job with the number of interpersonal contacts within the organisation. There is also a slight positive correlation ($r = 0.17$) of number of interpersonal contacts within the organisation with the professional activities and achievements (26) of the satellite technologists. Specialisation and experience, on the other hand, have no bearing on the number of interpersonal and intraorganisational contacts (27).

Table 3 presents the results of association/correlation tests of number of regular informal/interpersonal interorganisational contacts with selected user characteristics. The number of contacts outside the organisation, like the number of contacts within the organisation, also shows positive and linear relationship with status, qualifications and management/supervision content of the job of the users. It also shows a low positive correlation ($r = 0.20$) with professional activities and achievements and a slight positive correlation ($r = 0.14$) with experience of the satellite technologists (the individual contingency tables are not shown). On the other hand, specialisation of the satellite technologists has no bearing on the number of interpersonal contacts outside the organisation (28).

53 Pattern of Informal Communication Network

In the second part of the above discussed question the respondents were requested to name the five most often contacted persons for work related information. Though this part of the questionnaire was rather embarassing to the respondents, as many as 391 (out of 535) have positively reacted (i.e.

TABLE 2

Results of Association/Correlation tests of number of Regular *Interpersonal Contacts within ISRO (for Information)* with Selected User Characteristics

	Status (X^2)	Qualifications (X^2)	Nature of work (X^2)	Specialisation (X^2)	Experience (r)	Professional Activities & Achievements Index (r)
X^2/r	71.80*	61.27*	28.93*	16.66	0.07	0.17*
Degree of freedom (*df*)	14	8	12	10	308	153
Tabulated value of X^2 at p=0.05	23.69	15.51	21.03	18.31	–	–

Key: * the association/correlation is statistically significant at 0.05 significance level.

TABLE 3

Results of Association/Correlation tests of number of Regular Informal Contacts outside ISRO (for Information) with Selected User Characteristics

	Status (X^2)	Qualifications (X^2)	Nature of work (X^2)	Specialisation (X^2)	Experience (r)	Professional Activities & Achievements Index (r)
X^2/r	39.41*	42.51*	31.68*	17.93	0.14*	0.20*
Degree of freedom (*df*)	14	8	12	10	261	132
Tabulated value of X^2 at p=0.05	23.69	15.51	21.03	18.31	–	–

Key: * the association/correlation is statistically significant at 0.05 significance level.

excluded are 138 who did not answer, 4 who made invaid answers and two for whom the question was not applicable). However, as a special case 29 generic type responses mentioning 'Division/Section/Project staff' are included in the response group. But generic responses, like library staff (6).

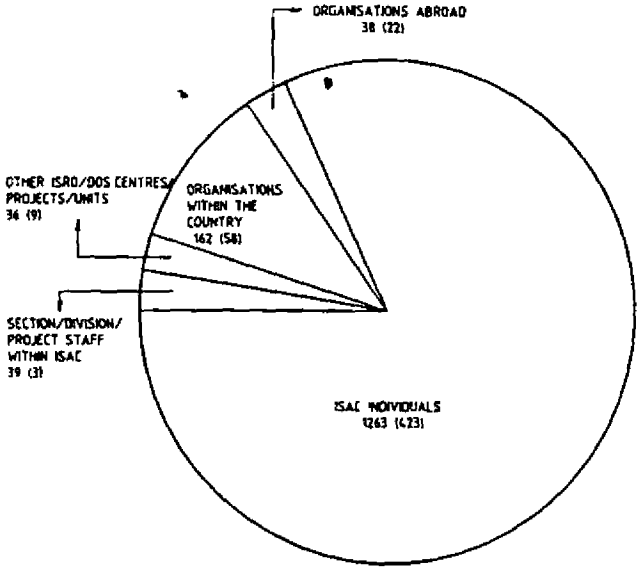

DIAGRAM 8.1

COMPOSITION OF INFORMAL COMMUNICATION NETWORK

(NUMBER OF INDIVIDUALS/ ORGANISATIONS WITHIN BRACKET)

Project manager or other designations [4] and names of outside organisations [4] without specific names of individuals are invalidated. Among the not answered, about ten expressed their inability to answer in the following words: 'persons are contacted only occasionally depending upon the problem and situation; 'many', 'not interested to reveal', 'no regular contact for information, but will meet persons regarding work related problems', 'I do not want to mention', 'not interested in giving any names', 'find it difficult to name such person', etc. Further, a very few individuals outside ISAC have figured in more than one respondent's list of names and hence further analysis of all outside ISAC individuals is restricted to the names of the organisations to which they belong.

Thus, all the responses having names upto five most often contacted person (i.e., individuals most frequently chosen as sources of informal information) have been processed to examine the nature of relations that exist between the respondent and the named individuals within ISAC (i.e., within the population under study) or names of other centres, units and projects of ISRO/DOS (Department of Space, Government of India) or organisations outside ISAC. Totally 391 respondents had contacts with 515 individuals/organisations and mentioned from totally 1538 times. The break-up of the number of individuals and organisations contacted together with number of times cited by the satellite technologists is shown in Table 4 and in Diagram 1. It is clear that 87% of the contacts are within the organisation (i.e., ISRO) and inter organisational communication is represented by a meagre 13%. Satellite technologists as practitioners have maintained a very high intraorganisational communication. About 19% of the respondents in aerospace establishments communicated with people outside their organisations in Raitt's study (29). A slightly higher percentage of external communication which is noticed in Raitt's study is attributable to the fact that his sample consisted of only higher level scientists and engineers.

TABLE 4
Pattern of Informal Communication Network

	No.	No. of times cited	Percentage of total citations
Individuals within ISAC	423	1263	82.1
Section/Division/Project staff within ISAC	3*	39	2.5
Other ISRO/DOS Centres/ Units/Projects	9	36	2.3
Other organisations within the country	58	162	10.5
Organisations abroad	22	38	2.5
Total	515	1538	99.9

Key: * Refers to three types of generic statements. Section S to 88: division 5 to 88: and 'Project staff'

54 Informal and Interpersonal Communication Behaviour and Interpersonal Information—Potential

While the contacts of the satellite technologists with individuals within ISAC are discussed further in this sub section, the contacts outside ISAC are discussed in a subsequent sub section (i.e., 58 Institutional and Individual Sources Outside the Organisation).

Now by looking at the same data from the angle of most often contacted persons within ISAC (i.e. individuals most frequently chosen by the respondents as informal sources of information), we can get a lot of insight into the informal communication network and the informal and interpersonal communication behaviour of the Indian Satellite technologists. Incidentally, as far as interpersonal communication within the population is concerned, seeking as well as communicating information are complimentary to one another. Here, a respondent mentioning the name of another respondent or any member of the population is treated as a

'relation' in the formal communication network. However, one limitation of the data at this level of analysis is that the official superior-subordinate relations are not excluded.

The frequency distribution of the five most often contacted persons cited and the corresponding number of citations is presented in Table 5 for individuals within ISAC. Since 423 persons are cited as informal sources by 391 respondents as many as 1263 times (i.e., 1263 dyadic relations), one can see on an average a person cited is simultaneously a source for about 3 (i.e., 3.23) others in the response population (30). In a limited sense, this represents the connectedness of informal communication network.

55 Communication Stars and Technological Gate Keepers

It may be noted that one of the criteria of technological gatekeeper and communication star is his greater communication particularly with wide range of persons. Further they are information rich/high information potential, sociable, most accessible persons holding high status. they make greater use of literature, they are experienced, professionally active, well educated senior members or first line supervisors.

Assuming that communication star is one who is contacted as an informal source of information by more than one standard deviation over and above mean number of contacts by respondents (i.e., 2.99 + 3.03 = 6.02 in Table 5), there are 44 such communication stars or High Information Potentials (HIPs) in the population. These 44 stars forming just 10.2% of the total persons cited, account for 36% of total citations as most often contacted persons for information. Compared with general formula that the population of size 'n', approximately contains $\sqrt{n}$ elites, the star-elites or HIPs identified is much more than square root of the population (i.e. $\sqrt{807} = 28.4$). Further, excluding 423 who have been cited by one or more of others in Table 5, the remaining 384 persons in the popula-

TABLE 5

Frequency Distribution of Most Often Contacted Persons Within ISAC as Informal Sources

Frequency-source of citation	Persons cited			Citations		Total
	No.	%	Cum. %	No.	%	Cum. %
01	180	42.6	42.6	180	14.3	14.3
02	83	19.6	62.2	166	13.1	27.4
03	48	11.3	73.5	144	11.4	38.8
04	33	7.8	81.3	132	10.5	49.3
05	22	5.2	86.5	100	9.0	58.3
06	13	3.1	89.6	78	6.2	64.5
07	5	1.2	90.8	35	3.0	67.5
08	13	3.1	93.9	104	8.2	75.7
09	6	1.4	95.3	54	4.3	80.0
10	4	0.9	96.2	40	3.2	83.2
11	6	1.4	97.6	66	5.2	88.4
12	2	0.5	98.1	24	2.0	90.4
13	1	0.2	98.3	13	1.0	91.4
14	2	0.5	98.8	28	2.2	93.6
15	1	0.2	99.0	15	1.2	94.8
16	1	0.2	99.2	16	1.3	96.1
17	1	0.2	99.4	17	1.3	97.4
18	1	0.2	99.6	18	1.4	98.8
23	1	0.2	99.8	23	1.8	100.6
Total	423	99.8	99.8	1263	100.6	100.6

Note: 1. Persons from outside ISAC are tabulated in the name of their respective organisations in the previous Table (8.4).
2. One hundred and thirty eight not answered, 2 not applicable and 4 invalid responses are excluded.
3. The mean and standard deviation of number of times a satellite technologist is cited are respectively 2.99 and 3.03.

tion could be considered 'isolates' or Low Information Potentials (LIPs).

Such of the stars who link the organisation to external environment can be called technological gatekeepers. Out of 44 stars spotted in this method, 29 found to have responded to the questionnaire. But only 19 of them gave provided upto

five names of most often contacted persons for information. Out of a total of 88 such citations made by these 19 stars, 41 (46.6%) to other stars, 28 (31.8%) to nonstars within the population and the rest of 19 (21.6%) to persons outside the organisation. As against a 13% outside contacts by the response population as a whole, the communication stars have 21.6% outside contacts. The 'discussion stars' in Hall's study (31) have maintained much lower (15%) outside contacts. It is interesting that communication stars have maintained almost half of their contacts among themselves. However, outside the organisation contacts of communication stars are marginally more than others. Though all the 19 respondent communication stars do not appear to be technological gatekeepers, six of them who have higher than average external contacts for information could be considered as technological gatekeepers (32).

The characteristics of forty four communication stars as compared to characteristics of the population/response population as a whole have differed significantly in some respects (Table 6). Firstly, the communication stars are predominantly males (with the sole exception of one). Secondly, they are more aged (average age of communication star is 36 years against the average age of 31 years in the population) and they are more experienced (the average total experience of star is 11.8 years as against the average total experience of 7.4 years in the population) (33).

Surprisingly there is no difference between communication stars and others in their job satisfaction. However, the communication stars have tended to acquire more promotion than others (75.7% have secured two or more promotions as against 35.5% in the population). In fact all the communication stars (i.e., 16 for whom normalised data was available) were considered high performers based on frequency of promotion. They also scored a very high professional activities and achievements index values (34). This is in conformity with findings of earlier research that performance and com-

TABLE 6

Characteristics of Communication Stars

Sl. No.	Characteristics	Population	Communication stars
1.	Average Age (in years)	31	36
2.	Males (in %)	92.4	97.7
3.	Average Experience (in years)	7.4	11.8
4.	Secured 2 or more Promotions (in %)	35.5	75.7
5.	Professional Activities and Achievements (Index)	7.6'	23.8
6.	Status H and above (i.e., Gazetted Officers in %)	45.4	95.5
7.	Technocrats (in %)	13.3	100.0
8.	Managers, Supervisors, Planners and System Analysis (in %)	20.5	56.0
9.	Change in Nature of Work (in % having changes)	28.9	55.2
10.	Postgraduates and Doctorates (in %)	31.8	66.6
11.	Library Use (index)	15.4*	21.4
12.	Library Interactions (index)	5.1*	13.7

Key: * the score is based on indexes developed and for an average non-star and not for a typical satellite technologist in the population.

Note: Communication stars do not differ from others in their job satisfaction.

munication are highly correlated. For example, Bethell (35) found that stardom in the oral communication network has a strong tendency to depend on the number of laboratory reports written and on the amount of attention that is paid to them. He also found that a high performance in formal communication is a significant characteristic of a communication star in the informal network.

Communication stars tend to be higher status persons (95.5% of communication stars are in gazzetted rank as against 45.4% in the population). They tend to have jobs with more of management/supervision contents than operational activities (while 56% of stars have management/supervision and planning/system analysis jobs, only 20.5% have these

jobs in the population). Further, all the communication stars, (i.e., 23 for whom data is known) are found to be technocrats and 55.2% of the communication stars have some change in their nature of work in recent years as against 28.9% for the response population as a whole.

Communication stars are also found to be better qualified than others (while 31.8% are post graduates and doctorates in the population, the same is 66.6% among communication stars). There are disproportionately more communication stars among physicists and electronics engineers and disproportionately less stars among mechanical engineers.

Lastly, though the library membership status remained same among communication stars and others, the former are found to be heavy users of library (average library use index value of a star and non-star, respectively, are 21.4 and 15.4) (36) and they interact more frequently with their primary library (the average value of library interaction index of a star is 13.7 and the same for a nonstar is 5.1). Interestingly, there is no nonuser (zero score in library use index) of library among the communication stars.

Discussion with selected communication stars and technological gatekeepers revealed that it is part of their duty to collect information from others particularly outsiders and pass on the same to appropriate persons working with them. They also felt that their contacts with information potential persons (especially those from outside the organisation) are their assets. They appear to read widely on general interest from library books and reports. They had a feeling of self sufficiency as far as work related information is concerned.

56 Dyadic or Mutual or Reflexive Communication in the Network

Another interesting observation of the most-often-contacted persons cited by 391 respondents (as far as 423 ISAC individuals within population are concerned) is that 72 cited persons (i.e., 36 dyadics or pairs) have mutually cited each

other as one of the most-often contacted persons. However, there are only 56 unique persons in 36 pairs or relations (37). Further, out of 36 pairs of such reflexive relations, 34 pairs are between persons from the same divisions and of which 32 pairs are between persons from the same sections (38). Interestingly, ten pairs of persons are of exactly equal status in terms of their designations and of which eight pairs are in the same sections. Out of the remaining 26 pairs of reflexively related persons, the status differences between the persons are, 3 levels in 2 pairs, 2 levels in 11 pairs and just 1 level (or grade) in the rest of 13 pairs.

By assuming that the above 'reflexive relations' satisfy the other conditions of 'equivalence relation', one can decompose the above set of 56 unique respondents into mutually exclusive groups of persons called 'equivalence classes'. Such an analysis has resulted in identifying one class of 9 persons, another class of four persons and other five classes of three persons each. The rest of them form independent small classes of two each. This has also given an indication that respondents with codes C0068, C0095, C0110, C0136, C0209, C0255, C0344, C0482, C0565, C0587, C0719, C0768 & C0774 act as linking pins (39) in the first seven classes and the nine respondents of the largest class form a cluster of the network in a limited sense.

57 Similarities and Dissimilarities of Participants in Informal Communication

The communication behaviour and the information potential of the Indian satellite technologists are further examined in this sub-section to find out whether some of the characteristics such as technocrat nature, experience, status, specialisation, field of activity, division and section affiliation have any relation for a satellite technologist in seeking another satellite technologist as interpersonal source of information. It has been noted that the average number of times a person (in ISAC) is cited by the respondents is about 3. In

other words, an average satellite technologist is a regular informal source of information for three others. However, when we segregate all persons with functional designation (representing technocrat, i.e., managerial and supervisory nature in addition to technical nature) from the rest, the data of Table 5 could be grouped as shown in Table 7.

Technocrats. From the data in Table 7, one can see that an average technocrat communicates frequently & informally within the population with more than double the number of persons an average non-technocrat communicates. At the same time, the technocrats in general having sought by more than six others (i.e., over and above one SD on mean contacts), satisfy one of the criteria of technological gatekeepers and communication stars.

TABLE 6

Information Potential of Technocrats as Inormal Source

	No.	No. of times cited	Mean citation
Technocrats	45	279	6.2
Others	378	984	2.6
Total	423	1263	3.0

Experience. Two hundred and sixty eight out of 423 most often contacted persons (whose length of experience is known) are further examined and the Table 8 presents their experience against the number of persons contacting them for information. As contacts by more than 6 persons (i.e. meant one SD) is the basic criterion for one to be a technological gatekeeper or communication star, we find 29 persons in the Table with 7 or more contacts. Further, except one person with 18 years of experience all these communication stars have an experience from 5 to 13 years. In other words, both highly experienced as well as less experienced are not communication stars. Looking at the overall data in the Table, it appears that more experienced persons are slightly more information po-

TABLE 8

Experience in ISRO Vs Frequency Score of Most Often Contacted Persons Within ISAC

Fre. Score	Experience in Years																Total
	1	2	3	4	5	6	7	8	9	10	11	12	14	16	17	23	
00	04	01															05
01	17	04		03	02												26
02	06	03	02	01	01												13
03	04	03			02												09
04	09	02			01	01		01									14
05	24	06	07	01	02	01	01										42
06	10	06	04	01	01	01	01	01	01								27
07	10	05	02														17
08	02	02		01	01				01								07
09	02	01	04	01		01		02									11
10	20	08	02	03		03	01	02		01	01	01					42
11	04	06		04	01	02		02		01	01				01	01	23
12	01	02	01		02					01		01	01	01			10
13	02		02	02	02		02			01							11
14			01			01											02
15			03	01		01											05
16					01												01
17	01																01
18											01						01
22	01																01
Total	117	49	28	18	16	11	03	10	02	04	04	02	01	01	01	01	268

tential than less experienced. In fact, the Pearson Product Moment Correlation (r) between the experience and number of informal contacts is +0.27 which indicates a slight positive correlation between the two variables. In other words, the null hypothesis that there is no correlation between the number of years of experience of the satellite technologist and the number of other satellite technologists considering him as an informal source for work-related information cannot be completely rejected. The t-test has indicated that the correlation

value is significant much beyond 95% significant level. Thus, some minimum experience appears to be a prerequisite for a 'technological gatekeeper' or 'communication star' but too much of experience appears to be working in the opposite direction. The finding that new recruits do not communicate to many is in aggreement with what Gerstberger (40) has reported, but the highly experienced do not communicate to many colleagues, is a totally new and unexpected result.

Table 8 also reveals to a limited extent that the number of satellite technologists to whom another satellite technologist communicates is curvil linearly related to the experience of the person communicating. In the initial years it appears that he communicates with less number of persons and as the experience exceeds the initial period of say 5 years, he communicates to more colleagues and again declines after about 12 years. In other words, both less experienced and highly experienced technologists communicated to relatively less number of colleagues and those with 6-12 years of experience communicated to the maximum.

Status. As noted in the previous section, 391 space technologists (as respondents to the questionnaire) have cited 423 names from the same population as their most often contacted persons for information and the number of times cited is 1263. By considering the organisational status (or grade) of both citing as well as cited persons (upto five in each case) one can examine the nature of seeking as well as communicating information informally and inter personnally. By eliminating such of the cases where the designation of citing person or cited person or both persons are not known, 330 respondents whose designations are known and the designation of at least one of the persons cited by them is known, have been listed. The total citations of persons are reduced to 1223 from 1263. The results are tabulated in Table 9.

It is obvious from the table that almost half of the respondents have informal and interpersonal linkage for in-

TABLE 9
Relative Status of Most Often Contacted (Information Potential) Persons

Status	Information sought ONLY from		Information NOT sought from any		Most often contacted (citing) relations	
	No.	%	No.	%	No.	%
Lower	9	2.7	244	73.9	146	11.9
Equal	2	0.6	209	63.3	186	15.2
Higher	163	49.4	18	5.5	891	72.9
Total	174†	52.7†	471*	142.7*	1223	100.0

Key: * The categories are not mutually exclusive;
† Mixed types are not shown and hence total do not tally to 330. However, percentages worked out are based on 330.

formation with persons of higher status only. A negligible 2.7% and 0.6% have such contacts with lower status and equal status persons respectively. On the other hand, nearly three-fourth of the respondents have sought informal and interpersonal contacts with colleges of lower status. About 63% have not considered euqal status colleagues as informal sources of information. However, a marginal 5.5% have not cited any person of higher status. This indirectly supports two of the earlier findings. Firstly, the technological gatekeepers tend to be of higher status or senior persons. Secondly, seeking of information from the informal and interpersonal sources of information, is largely confined to higher status persons. Further, even when number of citing relations or dyadics (i.e. 1223) are examined it is seen from the table that nearly three-fourth (72.9%) of such relations are with higher status persons. The equal status and lower status relations are 15.2% and 11.9% respectively.

Though not totally surprising, by and large, the results indicate that the Indian satellite technologists are status conscious is seeking informal and interpersonal communication. It may be noted that, this does not naturally apply for communicating to others. Hence, it can be concluded that the satellite technologists seem to have considered status as a self

created artificial barrier for free interpersonal communication with colleagues.

This finding partly confirms the findings of Allen and Cohen (41) i.e., there is a greater volume of communication from a higher status persons to lower status person but not as much as that takes place between equistatus persons. But it very well supports the findings of another Indian study (42) where more communication flourished among persons of different status than equistatus. However, Raitt (43) found more lateral communication among peers than others.

It is also found in the larger survey that the Indian satellite technologists believed that peers and colleagues share information more freely compared to the superiors and subordinates. Thus, inspite of the fact that superiors and subordinates feel less free in sharing information, the amount of communication among persons of different status (not necessarily superiors and subordinates) is more than among persons of same status.

Specialisation & Field of Activity (44) : The broad specialisation and field of activity of persons citing as well as cited are compared and the results are presented in Table 10. All such relations where specialisation and field of activity of either citing or cited persons is not known are excluded. The result appears to be inconclusive as far as relation of field of activity to information seeking though interpersonal communication is concerned, as slightly more persons of different fields of activity have been contacted than persons of the same field of

TABLE 10
Specialisation and Field of Activity of Most Often Contacted Persons

	Specialisation		Field of Activity	
	No.	%	No.	%
Same	325	57	223	45
Different	245	43	272	55
Total	570	100	495	100

activity. As regards specialisation, slightly more interpersonal contacts are found among persons of similar specialisations than different specialisation. One can safely conclude that the Indian satellite technologists not only have regular contact for information with colleagues of the same specialisation and field of activity, but also with persons of different specialisations and fields of activity. This probably, is a reflection of system engineering and multidisciplinary nature of work and a way of cross fertilisation of ideas.

Division and Section Affiliation. The divisions and sections to which the persons contacting as well as contacted for informal communication belong are examined and the results are presented in Table 11. The data in the Table indicates that while little less than half of the informal and interpersonal communications cut-across the official section-barrier, only one-fourth of such communication relations are beyond division barrier. The following inferences can be drawn from the table: (i) Intra-division contacts (74.3%) are almost three times the inter-division contacts (25.7%) (ii) Intra-section contacts (53.6%) are slightly higher than inter-section contacts (46.4%) (iii) Intra-division contacts (74.3%) are considerably higher than the intra-section contacts (53.6%) (iv) Inter-section contacts (46.4%) are nearly double the inter-division contacts (25.7%). Raitt's (45) finding that 53% of contacts were within the division or project is comparable with 53.6% of contacts found within the same section or project in the present study.

TABLE 11
Division and Section Affiliations of Most Often Contacted Persons

	Division of contacting and contacted persons		Section of contacting and contacted persons	
	No.	%	No.	%
Same	913	74.3	653	53.6
Different	316	25.7	566	46.4
Total	1229	100.0	1219	100.0

In Bethell's study (46) of communications in an i: tional research laboratory, the intersection choices for ___. sion were 51 out of 183 (28%) which is quite comparable with interdivision contacts (25.7%) in the present study. Shuchman also reported that "for many engineers, contact with colleagues takes place exclusively in their own work group" (47) and the contacts within work group were rated useful by about 90% of respondents whereas contacts outside the work group were rated useful by 40% in case of within the firms and 47% in case of outside the firms (48).

Qualifications. Since doctorates represented a much smaller fraction (4.5%) of the total population in the present study, the earlier findings of Allen and Cohen, Bethell and many others that 'doctorates choose other doctorates for discussion and nondoctorates tend to contact doctorates', could not be clearly validated.

Thirteen doctorates have cited 56 names as most often contacted persons for information. Only one-fourth of such contacts of doctorates are with other doctorates and they have a slightly higher rate of contacts outside the organisation than others (30.4% as against 13% by response populationas a whole and 21.6% by communication stars). The doctorate communication stars tend to be the technological gatekeepers.

Out of 32 doctorates, 'communication stars' and 'isolates' are eight each. Twenty four doctorates are cited totally 132 times by 391 respondents. In other words, an average doctorate is a frequent informal source of information to 5.5 persons in the reponse population (this is against the average citation score of 2.99 for population as a whole in the questionnaire among the persons cited as sources of information).

58 Institutional and Individual Sources of Information Outside the Organisation

Lastly, any user of information has to depend on information outside one's own organisation. The present subsec-

In Bethell's study (46) of communications in an international research laboratory, the intersection choices for discussion were 51 out of 183 (28%) which is quite comparable with interdivision contacts (25.7%) in the present study. Shuchman also reported that "for many engineers, contact with colleagues takes place exclusively in their own work group" (47) and the contacts within work group were rated useful by about 90% of respondents whereas contacts outside the work group were rated useful by 40% in case of within the firms and 47% in case of outside the firms (48).

Qualifications. Since doctorates represented a much smaller fraction (4.5%) of the total population in the present study, the earlier findings of Allen and Cohen, Bethell and many others that 'doctorates choose other doctorates for discussion and nondoctorates tend to contact doctorates', could not be clearly validated.

Thirteen doctorates have cited 56 names as most often contacted persons for information. Only one-fourth of such contacts of doctorates are with other doctorates and they have a slightly higher rate of contacts outside the organisation than others (30.4% as against 13% by response populationas a whole and 21.6% by communication stars). The doctorate communication stars tend to be the technological gatekeepers.

Out of 32 doctorates, 'communication stars' and 'isolates' are eight each. Twenty four doctorates are cited totally 132 times by 391 respondents. In other words, an average doctorate is a frequent informal source of information to 5.5 persons in the reponse population (this is against the average citation score of 2.99 for population as a whole in the questionnaire among the persons cited as sources of information).

58 Institutional and Individual Sources of Information Outside the Organisation

Lastly, any user of information has to depend on information outside one's own organisation. The present subsec-

tion examines the interactions of the satellite technologists with the institutions and individuals outside ISAC who act as informal sources. The number of outside ISRO contacts (i.e., roughly same as number of persons) has already been discussed and it is found that on an average a respondent expressed that he has regular contact with 6.6 persons outside ISRO and it is almost half of the average number of persons with whom regular contacts are maintained within ISRO (i.e. 11.8). One observation at this juncture is that the average number of persons contacted within ISAC does not differ much from that within ISRO. It is also, noted that the outside ISAC contacts of the Indian satellite technologists amount to about 18% (13% outside ISRO) of the total contacts. The further break-down with frequencies of these contacts are presented in Table 12. As noted earlier, though the respondents have cited names of individuals, the analysis is restricted to names of institutions as very few individuals of other organisations have scored more than one in the frequency list. The contacts of the respondents, though limited within other centres, units and projects of ISRO and moderate with organisations abroad, are widespread over 58 different institutions within the country. A very large number of contacts are made with organisations or their wings, which are situated within the Bangalore City. Secondly, the number of contacts with 15 academic institutions within the country are alone almost equal to the number of contacts made with remaining 43 organisations (i.e., research organisations, industries, business firms, and other organisations) within the country. However it is noticed that contacts are more with research organisations than industries and with industries than business firms. Thirdly, almost all the business firms contacted are computer or electronics related firms for the purposes of product infromation. Fourthly, the educational institutions contacted are mainly the almamaters of the satellite technologists. Lastly, the large majority of the rest of the organisations within the country, have projects sponsored by ISRO or joint projects with ISRO or got ISRO as their customer or are

themselves user agencies/customers of ISRO. Among the organisations contacted abroad, NASA and ESA (with their subsidiaries) are significant.

TABLE 12

Frequency Distribution of Most Often Contacted Organisations* Outside ISAC as Informal Sources

Frequency score of citations	Other Centres, Units Projects of ISRO/ DOS	Organisations within the country	Organisations outside the country
01	2	38	14
02	0	9	4
03	3	3	3
04	1	0	0
05	0	1	0
06	0	3	0
07	3	0	0
08	0	1	1
09	0	1	0
10	0	1	0
47	0	1	0
	9	58	22

Key: * Respondents were asked to name individuals with their organisations. Since very few individuals from outside ISAC have been cited by more than one respondent, all such responses have been coded by the name of the organisation of the person cited.

6 CONCLUSION

In conclusion, we may recapitulate that an engineer seeks informal communication to circumvent the uncertainities and/or anxities of his work, to get a tailor made solution to a problem, for details concerning procedures or experiments, to build the confidence in the unique work he does, for quick professional judgements on issues, to gain reassurance on the work he does, in order to cut time lag in publications, for expert assistance in locating published material in diverse subjects, to overcome the problem of formally communicating the complex messages and to fill the gap between supply

of and demand for information. It is very clear that even-though some of the above needs are met by informal communication system, libraries do have a role to play, both directly and indirectly to fulfil these needs. To highlight one or two, however unique the work of an engineer he claims it to be, the ongoing research and bibliographic databases could yield references close to one's work. The grey literature like technical reports do provide details about procedures or experiments. Other semiformal publications like preprints do help cutting time lag in publications. A different type of tailor made library services are needed by engineers. The expert assistance an engineer seeks in locating published documents in diverse subjects is a challenge to the organised information system.

The linear and positive relation of number of persons contacted for information with status, qualifiactions, professional activities, experience and management/supervision content of the job indicates that more provision for formal services is needed to those who have been denied access to intensive informal communication networks.

In a highly intra-organisation oriented communication like the one discussed so far, 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-organisation communication due to communication stars and technological gatekeepers and tours and visits abroad (mostly of higher status persons) may have to be increased by encouraging more contacts outside the organisation especially at middle and lower levels. As communication stars have maintained almost half of their communication with other stars, a more liberal organisation structure which places communication stars accessible to more number of colleagues and make many of them as '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' to the communication network is needed. In addition high information potentials, communication stars, technological gatekeepers and linking pins should be provided with extra formal information services so that they act as disseminating agents for formal informal system.

The 'psychological cost' or 'status inhibition' exhibited in seeking information has to be overcome by process of confidence building among lower level workers and colleagues.

Apart from accelerating informal communication among respondents and between respondents and sources outside the organisations, a systematic effort to blend the formal and informal services of information should take place. Development of 'components databank', 'components coordination group', 'panel of experts' from different specialisations, inhouse technical seminars, colloquia, inhouse technical journal, information bank of internally generated information, journal clubs, etc. may go longway in this direction.

These are only a few implications of the sociometric analysis of informal communication of Indian satellite technologists. Many more can be deduced from the detailed interpretation of communication structure presented above and results are useful to both management and the formal information system.

7 ACKNOWLEDGEMENT

Author remains highly grateful to Shri. Tarsem Singh, Deputy Director, ISRO Satellite Centre, Bangalore for his kind encourgement in professional work and studies as well as permission to submit this paper to this journal.

of and demand for information. It is very clear that even-though some of the above needs are met by informal communication system, libraries do have a role to play, both directly and indirectly to fulfil these needs. To highlight one or two, however unique the work of an engineer he claims it to be, the ongoing research and bibliographic databases could yield references close to one's work. The grey literature like technical reports do provide details about procedures or experiments. Other semiformal publications like preprints do help cutting time lag in publications. A different type of tailor made library services are needed by engineers. The expert assistance an engineer seeks in locating published documents in diverse subjects is a challenge to the organised information system.

The linear and positive relation of number of persons contacted for information with status, qualifiactions, professional activities, experience and management/supervision content of the job indicates that more provision for formal services is needed to those who have been denied access to intensive informal communication networks.

In a highly intra-organisation oriented communication like the one discussed so far, 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-organisation communication due to communication stars and technological gatekeepers and tours and visits abroad (mostly of higher status persons) may have to be increased by encouraging more contacts outside the organisation especially at middle and lower levels. As communication stars have maintained almost half of their communication with other stars, a more liberal organisation structure which places communication stars accessible to more number of colleagues and make many of them as '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' to the communication network is needed. In addition high information potentials, communication stars, technological gatekeepers and linking pins should be provided with extra formal information services so that they act as disseminating agents for formal informal system.

The 'psychological cost' or 'status inhibition' exhibited in seeking information has to be overcome by process of confidence building among lower level workers and colleagues.

Apart from accelerating informal communication among respondents and between respondents and sources outside the organisations, a systematic effort to blend the formal and informal services of information should take place. Development of 'components databank', 'components coordination group', 'panel of experts' from different specialisations, inhouse technical seminars, colloquia, inhouse technical journal, information bank of internally generated information, journal clubs, etc. may go longway in this direction.

These are only a few implications of the sociometric analysis of informal communication of Indian satellite technologists. Many more can be deduced from the detailed interpretation of communication structure presented above and results are useful to both management and the formal information system.

7 ACKNOWLEDGEMENT

Author remains highly grateful to Shri. Tarsem Singh, Deputy Director, ISRO Satellite Centre, Bangalore for his kind encourgement in professional work and studies as well as permission to submit this paper to this journal.

8 REFERENCES AND NOTES

1. MOOERS, C. N. "Mooer's Law or Why Some Retrieval Systems are Used and Others are Not", American Documentaion, 11, No. 3, (July 1960) (ii).
2. FRANK HATT, The Reading Process: A framework for analysis and description, (London: Clive Bingley, 1976) p.96.
3. WERNER KUNZ, et.al, Methods of Analysis and Evaluation of Information Needs: A Critical Review (Munich: Verkeg Documentation, 1977) p.6.
4. GERTRUDE (H. Lamb), "The Rediscovery of Librarianship", In Irene Branden Hoadley and Alice S. Clark ed. Quantitative Methods in Librarianship: Standards, Research, Management: Proceedings and Papers of an Institute held at the Ohio State University, 3-16 August 1969. (Connecticut: Green Wood Press, 1972) pp. 113-114.
5. ROWLEY J. E. and TURNER C. M. D. The Dissemination of Information, (London: Andre Deutsch/ A Graffon Book, 1978) p.45.
6. SRIDHAR M. S. A Study of Information Seeking Behaviour of Space Technologists with emphasis on Correlating User Characteristics with such Behaviour. Ph.D Thesis, (Mysore: University of Mysore, Jan. 1987).
7. BODENSTEINER W. D., Information Channel Utilization Under Varying Research and Development Project Conditions: An Aspect of Interorganisational Communication Channel Usage. Ph.D Thesis (Austin: University of Texas, 1970). Quoted from Winford E. Holland, "The Special Communicator and his Behaviour in Research Organisations - A Key to the Management of Informal Technical Information Flow", IEEE Transactions on Professional Communication, PC-17 No. 3/4 (Sep.-Dec. 1974) 48.
8. BRITTAIN J. M., User Studies in Education and the Feasibility of an International Survey of Information Needs in Education, (Bath, England: Bath University, Sep. 1971) p. 15.
9. HAVELOCK RONALD G. Planning for Innovation through Dissemination and Utilization of Knowledge. (Mictigan: Centre for Research on utilization of Scientific knowledge, 1969) p. 4, 12.
10. ACKOFF RUSSEL L. et.al Designing a National Scientific and Technological Communisation System. (Pennsylvania: University of Pennsylvania Press, 1976) p. 148.
11. HALL ROBERT W, Personal Effectiveness in Industrial Research, Ph.D. Thesis. (Indiana: Indiana University, Graduate School of Business, 1972) p.14.
12. DIANA CRANE, "Information Needs and Uses", In: Carlos A Cuadra ed. Annual Review of Information Science and Technology. Vol. 6 (Chicago: Encyclopedia Brittanica Inc. for ASIS, 1971) p.30.
13. DIANA CRANE, Invisible College: Diffusion of knowledge in Scientific Communities (Chicago: Chicaga University press, 1972) p.117.

14. FRANCIS WOLEK, W. "The Complexity of Messages in Sciences and Engineering: An influence on patterns of Communication", In Carnot E. Nelson and Donald K. Pollack, ed. Communication Among Scientists and Engineers (Massachussets: D C Health, Lexington, 1970) pp. 233-265

15. KUNZ, et.al, Methods of Analysis and Evaluation of Information Needs: A Critical Review, op.cit., p.9.

16. GLASS B and NORWOOD S. H. "How Scientists Learn of Work Important to them" In: Proceedings of the International Conference on Scientific Information, Washington, D.C 16-21 Nov. 1958. (Washington, D.C. National Academy of Sciences, National Research Council, 1959) Vol. 1, 195-197 Quoted from Edwin B. Parker and William J Paisley, "Research for psychologists at the Interface of the Scientist and his Information System" In: Tefko Saraevic comp & ed Introduction to Information Science (New York: R. R. Bowker Co., 1970) p.86.

17. SHERWIN C. W. and INEMSON R. S. First Interim Report on Project Hindsight (Summary) (Washington D.C: Office of the Director of Defence Research and Engineering, 13 Oct. 1966). Quoted from Krishna Subrahmanyam, Scientific and Technological Information Resources, (New York: Marcel Dekker Inc., 1981) p.14.

18. RICHARDS ROSENBLOOM S and WOLEK FRANCIS W. Technology and Information Transfer: A Survey of practice in Industrial Organisations (Boston Massachusetts: Harvard Business School 1970).

19. GRALEWSKA-VICKERY, "Communication and Information Needs of Earth Science Engineers" Information Processing and Management 12 No. 4 (1976) p.269.

20. KERVIN KELLY, "Information as a Communicable Disease: Infected by Ideas", Computer Today, 1 No. 11 (Jan. 1986) 46.

21. HAVELOCK, *et. al,* Planning for Innovation op.cit., p. 6.3-6.5

22. MENZEL H. "Science Communication: Five Sociological Themes", American Psychologist, 21 No. 11 (Nov. 1966) 1001.

23. PRITCHARD A. Information Transfer: Some Applications of Graph Theory and the Geography of Transport. Unpublished Report (London: The City of London Polytechnic, 1977). Quoted from Pat Jones, Some Social Aspects of Information Transfer. Research Report No. 4 (London: The Polytechnic of North London, School of Library, 1981) p.72.

24. BRITTAIN J. M. User Studies in Education and the Feasibility of an International Survey of Information Needs in Education, op.cit, p.11

25. JONES, Some Social Aspects of Information Transfer, (London: Polytechnic of North London, School of Librarianship, 1981) p.63.

26 An Index of professional activities and achievements of the respondents is developed based on activities like papers published, patents held, conferences attended, tours, lectures delivered, etc.

27 Contrary to expectation women and men respondents did not differ significantly in number of persons contacted regularly for information within the organisation ($X^2=4.89$, df=2, 0.10 "Information and Communication Behaviour of Woman Space Technologists" R&D Management, 17 No. 4 (Oct. 1987) p.301-309. p. >0.05) vide SRIDHAR M. J..

28 Again as found in intra-organisational contacts, women and men respondents did not differ in number of interpersonal contacts outside the organisation ($X^2=4.89$, $df=2$, $0.10 > p > 0.05$) vide SRIDHAR M. J.

29 RAITT DAVID I. The Communication and Information seeking and use Habits of Scientists and Engineers in International Organisations and National Aerospace Research Establishments in Europe. Ph.D. Thesis. (Loughborough: Loughborough University of Technology, May 1984) p. 213-214.

30 It is interesting to note that 13 women space technologists were mentioned as most frequently contacted persons for information 22 times (average 1.69) and 410 men space technologists are mentioned as most frequently contacted persons for information 1241 times (average 3.03). Further as many as 48 out of 61 women space technologists in the population (i.e., 78.7%) are not considered as one of the five most frequently contacted persons for information by any of the 391 respondents. This shows a substantial difference in the information potentiality for interpersonal communication between men and women in the given environment. In other words, the information potential of women space technologists in the informal communication structure/network is limited. There appears to be an inhibition on the part of men to contact women colleagues for information even though woman are intrinsically information potential as they have all other information related activities almost on par with men. Women space technologists apparently appear low information potentials in the sociometric analysis possibly due to socio-cultural background vide SRIDHAR cp.cit.

31 Hall, Personal Effectiveness in Industrial Research, op.cit. p. 121

32 The stars or gatekeepers could not be clearly identified by both Shuchman and Raitt in their recent studies.

33 BETHELL found that age is not a significant point of difference but the length of service of a communication star is, vide J. P. Bethell Communication in an International Research laboratory, (London: The City University Centre for Information Science, Sep. 1972), p. 63.

34 The average professional activities and achievements index values of communication stars and nonstars respectively are 23.8 and 7.6.

35 BETHELL, op.cit, p.72

36 The library use index and library interaction index are also developed in the study for each user.

37 A relation between elements 'a' and 'b' is reflexive if 'b' chooses 'a' whenever 'a' chooses 'b'. For background details of concepts of relations, any fundamental book on set theory or the first part of following paper may be seen. M. S. Sridhar, "A Mathematical Approach to Relations in Thesauri", Journal of Library and Information Science, 5, No.1 (Jun. 1980), 77-79.

38 Section is a narrower concept than division in the organisation structure, i.e., a division has one or more sections within it.

39 'Linking Pin' concept is originally propounded by Rensis Lickert vide Rensis Lickert, "Motivational Approach to Organisations" In M. Haire ed. Modern Organisational Theory (New York: Wiley), 1959), p. 194.

40 GERSTBERGER P. G. The Preservation and Transfer of Technology in Research and Development Organisations. Thesis, (Massachusetts: MIT, Jun 1971). Quoted from Nan Lin and William D. Garvey "Information Needs and Uses", In Carlos A Caudra ed. Annual Review of Information Science and Technology, Vol. 7 (Chicago: Encycolopaedia Britannica Inc, for ASIS, 1972), pp. 14-15.

41 ALLEN THOMAS J and COHEN S. I. "Information flow in research and Development Laboratories", Administrative Science Quarterly, 14, No. 1 (Jan-Feb. 1970), 16.

42 PRUTHI S. and NAGPAUL P. S. "Communication Patterns in Small R & D Projects", R & D Management, 8, No. 2 (1978), 55.

43 RAITT, The communication, Information Seeking and use habits etc., op.cit, p. 254.

44 Specialisation refers to specialisation in highest degree (eg. physics, electronics, etc) whereas field of activity is more related to work and much narrower and/or interdisciplinary in nature.

45 Ibid, pp. 163-164.

46 BETHELL, Communications in an International Research Laboratory, op.cit, p. 47.

47 SHUCHMAN HEDVAH L. Information Transfer in Engineering, (Connecticut: The Futures Group, Jan. 1981) p.40.

48 Ibid, p.41 (Table 2.6).

About the Author

Dr. M. S. Sridhar is a post graduate in mathematics and business management and a doctorate in library and information science. He is in the profession for last 35 years. Since 1978 he is heading the Library and Documentation Division of ISRO Satellite Centre, Bangalore. Earlier he has worked in the libraries of National Aeronautical Laboratory (Bangalore), Indian Institute of Management (Bangalore) and University of Mysore. Dr. Sridhar has published four books ('User research: a review of information-behaviour studies in science and technology', 'Problems of collection development in special libraries', 'Information behaviour of scientists and engineers' and 'Use and user research with twenty case studies') and 74 research papers, written 19 course material for BLIS and MLIS, presented over 22 papers in conferences and seminars, and contributed 5 chapters to books. **E-mail:** sridharmirle@yahoo.com, mirlesridhar@gmail.com, sridhar@isac.gov.in ; **Phone:** 91-80-25084451; **Fax:** 91-80-25084475.