INFORMATION SYSTEMS FOR SPACE TECHNOLOGISTS: A PROSPECTIVE VIEW

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Abstract: Sketches the nature of space technology and characteristics of the space technologists of ISRO Satellite Centre (ISAC), presents the information requirements including motives and purposes of seeking information and degree of dependence on various sources of information, highlights the implications of the study for future planning, discusses some policy issues needing immediate attention and concludes by stressing the need for long-term planning of information systems for space technologists.

1. Introduction

I cannot claim to have fair knowledge of information requirements of users of other libraries of ISRO/DOS. Yer I attempt here to present few proposals for organising future information systems for space scientists, engineers, technicians and technologists based on what I have understood as nature of space technology and characteristics and information requirements of space technologists at ISAC (Sridhar, 1987).

2. Nature of Space Technology

Before we think of future plans for organisation of information for space technologists, a look at the nature and characteristics of space technology/space technologists as well as nature and type of information required by space technologists may be worth as knowledge of the population being served by an information system is an essential requirement for providing useful services. Just like understanding the user is half the battle in providing information services, knowing the structure and composition of the user-community in terms of various characteristics by which they can be compared and contrasted is half the task in understanding the users.

"A clear picture of the distribution and principal characteristics of the population in the community to be served is therefore essential to the planning of library development" (Parker, 1983, p.17)

Some characteristic features of space technology are: (i) HIGH TECHNOLOGY activities characterised by very large developmental efforts in state of the art and substitution or augmentation of mind power than muscle power. (ii) COMPLEX AND LARGE SCALE ACTIVITIES (iii) Though the work is often described as R & D, it is LESS OF RESEARCH AND MORE OD DEVELOPMENT in nature. Organisational pressures and role strains are more in development than research-oriented organisation (evan, 1962,

p.346) It may be more appropriate to classify it somewhere in between R & D and industry. (iv) The work is predominantly SYSTEM ANALYSIS AND SYSTEM ENGINEERING in nature, involving project management, reliability and quality control. (v) The teams are of a HETROGENEOUS AND MULTIDISCIPLINARY NATURE, with diverse specialisation. Hence the work involves a high degree of coordination. Discussing the duality of the discipline and mission oriented research, Weinberg (1967, p.42) says that NASA with the exploration of space as the mission covers almost all the traditional disciplines like chemistry, physics, astronomy, biology, etc. The duality is that the information generated in the discipline is useful in the mission and vice versa. The heterogenous nature of the space technology is very much evident in the following subject wise analysis of literature covered in International Aerospace Abstracts.

LITERATURE COVERAGE OF IAA

Subject	%
Aerospace, Astronautics, space sciences	30
Chemistry, Materials, Geosciences, Physics	35
Engineering, Mathematics, Computer sciences	32
Life sciences	3

(Source:Barbara Lawrence, AIAA)

(vi) Space technology involves a HIGH DEGREE OF RISK AND HIGH COST which leads to a ned for high degree of reliability and stringent quality control as well as considerable redundancy and hence increased cost. Thus, there exists a trade off of cost, time and risk. (vii) Use of IMPORTED COMPONENTS, PARTS AND EQUIPMENT. (viii) The tasks/projects are TIME BOUND in nature.

3. Characteristics of Space Technologists

The space technologists are quite young and the average age of a space technologists is (31 years) much less than that of aerospace workers of UK (Raitt, 1984, p.191) and USDOD workers (Auerback, 1965,p B-3). The work experience of an everage space technologist in the organisation and before joining the organisation, are respectively, less than six years and less than three years. A large majority of the space technologists have prior experience from industry (41%), R &D organisations (30%) and academic institutions (18%). A reverse trend of majority having academic experience was found by Raitt (1984,p.129) incase of aerospace establishments of U.K.

The space technologists have shown a high job mobility within and outside the organisation, especially in the case of juniors and less experienced staff. This is in addition to mobility due to redeployment of manpower within the organisation. An analysis of membership turnover at IASC Library indicated that there is about 16% addition and 4% deletion in a year and the organisation strength has almost doubled in every five to six years.

Leaving the administrative staff and those working in services like library, medical transport, canteen, etc., nearly 55% of the population are scientists and engineers by desgination 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. 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. Large scale developmental work has necessitated more middle and lower level and less qualified personnel, particularly in various services sector. The space technologists show a wide professional diversity in terms of their specialised fields of activities. A majority of the space technologists work in the areas of mechanical engineering communication engineering, computer science, instrumentation and physics.

The population consists of just 1.5% 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 of 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 space technologists are from applied science, engieering and technology, one eighth from pure science and a meagre 1.3% from management disciplines. The percentage of doctorates as well as pure science personnel indicate lack of Pure research nature in the space technologists.

4. Motives and Purposes of Seeking Information by the Space Technologists

In an information-behaviour study (Sridhar, 1987) at ISAC, we found that unlike scientists, the space technologists are not motivated much by recognition, competition, visibility among peers and urge to write and publish 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 and desired result in work. This is in conformity with Shuchman's (1981,p.29) 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 know'edge.....I want to spend my leisure time for information gathering". Keeping uptodate 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. 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 persure desirable degree of professional competence."

The space technolcgists do not seek information much for the purpose of data treatment and procession, crystallising broad and vague assertions, participating in seminars and conferences, writing papers and delivering talks.

5. Information Requirements of the Space Technologists

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 adddition, 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 and review literature, standard and patent specifications. 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 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 fast serving information intermediaries or agents are felt by the space technologists.

6. Dependence on Sources of Information by the Space Technologists

The Space technologists depend more on formal and documentary sources of information than informal and inter-

personal 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. Conference proceedings, reprints and preprints, standards and patent specifications and theses, and dissertations have ranked lowest for the space technologists. The space technologists 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 space technologists 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., contracting 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 experiements which 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". This is followed by dependence on superiors, peers and collegues in the organiation. The space technologists have depended least on fellow professionals outside-the organisation for work related information. The discussion with respondent 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 information relating to

practical processes the nucleus of information gathering activities of the space technologists is often oneself. The inter-personal contacts are mainly for opinion suggestions and references.

In order to keep upto date in the field, over 52% of the respondents depend mainly on journals, another 13% on discussion with collegues and 9% on trade literature. In addition seminars, news papers, preprints, lectures and sales representatives are considered quite useful for keeping up to date.

7. Some Implications f the Study for Future Planning of Information Systems

7.1 Need for Tailor Made Services

The multifaceted approach of the space technologists makes generalisation too difficult. The space technologists are specialised in different disciplines, yet have a common mission and thereby face the duality of discipline and mission orientation (Weinberg, 1967) discussed earlier. Hence provision of unoform or common service to all is unsuitable.

7.2Book Bank Facility for Educational Need

The formal information system should be clear about its objectives (infuding derived and assumed objectives, if any). Information services for increasing productivity and enhancing work performance, achieving self progress including departmental promotion and 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.

7.3 Intensified Current Awareness Services And Extensive Provision for Browsing

Provision of increased opportunity to browse latest literature in both core as well as related/peripheral areas and carrying current awareness services (tailored to the need) to the workspots and laboratories of otherwise busy space technologists is necessary. Yet provision for secondary journal, 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 magaziners, trade journals, reference books, data manuals for providing quick and up to date information and factual date. 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.

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.

7.4 Information Analysis Centre and Intermediary Information Specialists in Adequate Ratio with User strength

There is 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 rpersuaded to delegate some information gathering tasks to them whenever they lack sufficient time to undertake such work or whenever their time can be utilised more productively elsewhere.

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. There intermediaries should work closely with the senior space technologists, projects and the primary library. They should screen and sift the reading materials to be browsed by the space technologists and provide highly reliable and accurate data informatin to those who need it.

7.5 Repository of Internally Generated Information

A large part of the work related information needed by the space technologists can be met from a well organised and comprehensive 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 may such internally produced documents are, at present, not collected, processed and organised at one place within the organisation.

7.6 Databank of Space Component and Trade/Product Information

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 catalogue are normally available free they are, at times, arbitrarily priced for those not buying the

concerned product, component or equipment. Enormous trade literature which could have formed sound basis for a databank of space components 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 multile 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 equipments and components sold earlier. A fairly centralised data bank and collection of trade literature which acquires, indexes, organi es and systematically weeds obsolete product literature are necessary.

7.7 Facilitating Informal Communiction and Blending it with Formal Organised Information System

It is necessary to overcome the psychological cost or status inhibition exhibited in the interpersonal 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 may have to be increased by encouraging more contacts outside the organisation especially at middle and lower levels. A more liberal organisation structure might optimise use of such high information potentials. In addition, increasing the ratio of technocrats to nontechnocrats, 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. The publishing activity also encourages more coauthorship and collaboration and inturn informal communication. Further, a proper security classification scheme could be evolved to give publication status to all unclassified and declassifed internal reports of the organisation. This is not only aids internal generaion of information but also motivates authors to be more literature and documentation oriented in production of inteernal 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 space components databank and components coordination group, (ii) dissemination various technical information and activities through the inhouse 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 inhouse technical seminars, and circulation of brief summaries, detailed summaries and the complete documents relating to such seminars reviews etc., to appropriate persons, (v) establishing journals 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 inhouse seminars.

7.8 Incorporating Information Requirements in Project and TDP Plans and User participation in collection Development

User participation facility i.e., the primary library needs to be strengthened in respect of nature and type of information needed by the space technologists. The overall organisation planning in general and planning of verious projects and activities (including TDPs), in particular, have to make provisions 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. In a study at ISAC it was revealed that overt participation of users in collection development was quite low (Sridhar 1983). It is necessary that all relevant documents such as reprts, conference proceedings standsrds, are purchased or obtained on exchange or gratis basis from primary sources throughout the world so as to develop an exhaustive collection in anticipation of need and the same becomes a sound base for developing a bibliographic data base. The global approach adopted by two giant information systems in the filed (ie., NASA and ESA) should become guideline for this purpose.

7.9 Direct Mode of Service and Inducting Non-users to Libraries

The prime 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, apy 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 examples, less used reports of the primary library may 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. Aboveall the prime library has to find the way and means of inducing and inducting the nonusers.

7.10 User Orientation and Organisation of Personal Information Systems

There is a greater need for exhaustive 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, aid to space science and satellite technology orientation and user-orientation programme have been well received and efforts need to be econtinued on similar lines.

As the space technologists have regarded personal and departmental collection as a key source, there is also a need for an informal training in organising personal information systems consisting of references, notes, abstracts and documents in various forms like registers, notebooks, files, loose sheets, cards, and desk diaries of the space technologists.

The personal libraries are considered more important than institutional libraries even elsewhere. For all the concern librarians have lavished over management and automation of institutional collection and for all the expertise they have gained as a result, not much effort/interest is shown in personal information management (Dow, 1987,p.30). Using the knowledge and experience of management of bibliographic environment, libraries can help their pattrons in searching literature through online or CD ROM databases and further processing of downloaded data through PC using several onlines utilities and offshelf softwares in addition to organising traditional personal collection. It possible the personal and departmental systems should be integrated with the organised formal information systems.

8 Other Policy Issues

8.1 Locally Developed Bibliographic Databases

It is unfortunate that development of (local) bibliographic databases is lagging behind in the country inspite of long term economic prospects of local databases. It is true of space technology information systems also. It is neither economical nor strategically sould to buy/hire a service or database or information product and even to subscribe to document supply from secondary and commercial sources where own arrangements can be made with in the country. Eventhough buying an information service or product initially looks attractive and easy, it is derogative in the long run and in the overall interest of country's self reliance approach. Though initial cost is more for building collection, developing databanks and databases, it is worth attempting in a phased way to develop own databanks and databases. Evenwhere it is essential for us to buy or hire an information service/product it should be bought with least of derogatory conditions so as to distribute and share the service among different sybsystems. One of the urgent requirements as on today, is to either hire databases of NASA or atleast enter into agreement with NASA to enable us to search their databases. This

should be a good reason/example for us to develop our own bibliographic databases rather than depending on others for ever with constraints such as recurring cost, compatibility/suitability, subjecting to outside scrutiny and other conditions of lease. In this direction of satellites with details of subsystems and parameters coupled with bibliographical sources for additional information. Another databank of space components on line with HEYSTACK of IHS would be highly useful.

8.2 Self supporting Systems

Generally, information systems are paternamistic and not self-supporting. Looking at the two giant information systems in space technology, namely ~STIF of NASA and IRS of ESA, it becomes clear that in the long run all information systems should aim to become self supporting. At least special services and those services offered outside the organisation/system should be charged to generate sufficient resources. Otherwise the system degenerate without having sufficient justification in terms of cost benefit analysis and the growth is difficult. Unlike any other industry, information industry has the versatality of producing innumerable customer oriented products and bye products to generate resources. A good example is NTIS which is now covertly aiming at even profit making.

8.3 Integrating Space Technology Information Systems with National and International Systems

It is necessary to have a clearing house function in the information systems for space technology so as to interface them with national and international systems. Probably with this clearing house function only we can hope to achieve accessing databases of NASA and other counterparts in the world.

8.4 Harnessing (Prospects of) Information Technologies

I do not intend to go in detail about prospects of verious information technologies for orgnising better information systems as every one is talking about these opportunities. I wish to stress here that out prospects of having decentralised yet integrated or coordinated information systems will be made possible by communication technologies like data communication networks, digital fax machines, telecommunication/satellite communication, etc,. Our documentation outputs could be more timely, effieient elegant and appealing to users than ever before due to graphic arts technologies like laser printers, colour copies DTP etc.

On the front of mass-storage mass copying and retrieval technologies, it is pertinent to note a finding of a recent study by M/S. Coopers & Hyubrand (Hendley, 1988, p.17)

".....of the information that enters an organisation in paper form only 1% is coded and entered into computer systems, under 5% is converted to microfilm at some stage of its life and

94% remains, in paper from throughout its life time. In addition as the volume of transactions grows the volume of paper handled is rising at the rate of 25% per year".

Thus inspite of many mass-storage devices like microforms, optical discs, etc., paper form continues to have a major share. But having surrogates/bibliographic databases and unconventional documents on these media may help in many ways. At ISAC we are shortly acquiring a CD ROM drive with NTIS database on disc. The other databases like DACONDISC, WILSONDISC, computer database, etc., and many reference documents are also being considered.

We have already been able to use computer for many of our house keeping operations and information retrieval function. But there is a lot of scope to improve them. Information processing technologies also offer increasingly more powerful tools like high resolution PCs PSs etc., in the years to come. A microcomputer based expert system for providing referral service on space technology on line with PLEXUX (of University of London) should be our aim for the next dacade in addition to development of a comprehensive bibliographic database.

9. Conclusion

No doubt there is an urgent and greater need for a long term, comprehensive plan for information systems for space technologists taking self-sufficient and self supporting clearing house function into fold and on line with STIF of NASA and IRS of ESA. Development of comprehensive collections, local databanks and databases are also equally necessary. Many latest information technologies can be adopted in achieving our objectives probably skipping the intermediary generation of technologies.

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