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Information Technology: Applications in Development-Catalysing Activities in India*.

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[Highlights of some recent projects and programmes in India in the application of remote sensing technology, satellite communication, and computers in development-catalysing areas for data and information collection, processing, and accessing, are presented. Issues relating to information manpower development policy, national information policy, and the role of international professional bodies *vis a vis* these developments in information technology and their utilization, are raised.]

1 Introduction

This paper presents highlights of some recent projects and programmes in India in the application of remote sensing technology, satellite communication, and computers in development-catalysing areas for data and information collection, processing, and accessing. Such activities are deemed to be within the scope of information technology. Issues are raised relating to information manpower development policy, national information policy, and the role of international professional bodies *vis-a-vis* these information technology developments and their utilization even in developing countries.

2 Development, Technology, Information

"Development" is the bridge between people's hopes and dreams on the one hand and the realities of the world on the other. Development is a multifaceted concept comprehending qualitative and quantitative changes and progress in the whole fabric of individual and societal activities. Adequacy in food, clothing, shelter, health, education; quality of environment for work and leisure; facilities to interact with each other, cooperate and work together despite geographical and socio-cultural distances separating people; ability to use information and participate in decision making processes; capacity and facilities to use leisure in a fruitful way in ethical and intellectual pursuits; continued improvement in the standard and quality of life, are just a few aspects of human activity one may consider under the heading "development". Of special interest is the reduction of gaps between the "developed" and "less developed" sections of the society within a country and between countries, on the global progress toward establishing the "new economic order".

Development implies the *efficient management of* resources of all kinds in order to create the knowledge, the skills, and the capability to produce the goods, services, facilities and opportunities to achieve national goals. Efficient management implies the making of *gainful decisions* at the right time, to be able to direct the development process toward the desired goals. The pace of the development process, in an increasing measure, is set by the progress in the *application of modern technology*. The objective of applying technology is to secure optimal use of resources or maximal benefit to a larger number of people, to enable them participate in and devote themselves to more productive and creative pursuits. Therefore, technology, properly chosen and used could help achieve national development goals.

In a given context, a decision is only as good as the adequacy of the information available to the decision maker and the capacity and efficacy with which he processes, handles, and applies the information. The decision-making environment may be a federal government question on resources allocation or a directors' board meeting to consider a company merger, or a laboratory research problem or that of an individual trying to cope with his daily chores. Therefore, a technology that would make available to the decision maker adequate, timely and reliable information and would process and present that information in a manner helpful in decision making is indeed an essential support to development. Such a technology is "information technology". In this paper, information technology is used in this sense — the collection, storage, organisation, processing, analysis, presentation, communication, and dissemination of data and information — using mechanical and/or electronic means such as computers and telecommunication equipment.

The application of technology to catalyze development has a latent aspect which is as important (if not more important) as the application aspect itself. This is the spin-off in terms of:

(*a*) Technology transfer and acquisition of ability to handle similar situations in other environments;

(*b*) Emergence of regional and international cooperation;

(*c*) Credibility and confidence in the nation's capabilities;

* Based on an invited paper presented at the FID Congress Mexico City, September 1976.

(*d*) Development of various facilities and technologies necessary for use of a given technology — e.g. telecommunication facilities for effective information transfer;

(*e*) Emergence of new disciplines, and research and educational areas — e.g., image processing helpful in remote sensing technology;

(*f*) The cyclical and chain reaction, one development leading to another.

All these in themselves form an integral part of the development process.

3 Resource Management: Remote Sensing Technology

31 Application of Remote Sensing

Efficient management of natural resources requires the collection, organization and processing of vast quantities of data and information on such resources in the country in as short a time as possible. Remote sensing technology provides powerful methods for surveying, classifying and monitoring data on such resources. Image (data) acquisition can be done with conventional cameras, aerial and satellite photography, multispectral arrays, and radar and sensor systems. Remote sensing technology with its fast data gathering and generating capability surveying large areas in a short time span, has a low cost basis. Coupled with high speed electronic computer data processing, professional knowledge of the field of application, and complex statistical methods, remote sensing used in diverse environments has great potential for the analysis, interpretation and updating of information necessary for optimal planning, management, and monitoring of resources.

311 *Agriculture*

Agricultural crop survey at different intervals of growth for estimation of yields can be done more accurately instead of on an ad-hoc inspired guess and flair basis. Afforestation and plantations planning, classification of forest types and estimation of yields from forests could be more efficiently done with data collected on vast areas by remote sensing. From such a survey it is possible to note symptoms of any oncoming disease of the crops several months before the disease itself beomes visible. In fact this was demonstrated for coconut trees in Kerala and ranges in Nagpur area and early disease prevention measures taken led to a saving and conservation of resources. The Ahmedabad unit of the Indian Space Research Organization conducted aerial remote sensing surveys in Andhra Pradesh in 1975 to assess the crop yields during the kharif season. A major finding was that the acreage under rice cultivation was appreciably underestimated by the agricultural statistics department; and also several of the "reserve forests" had no vegetation at all.

Water resources management is of considerable importance in India as we have areas of excess water and also of droughts. The utilization of rivers, surface water and ground water for irrigation, power generation, and for drinking and industrial use has to be planned as an integral part of national development programme. It is becoming possible to monitor river basins and survey ground and surface water by remote sensing and use the data for designing a scientific water management programme.

Land use planning and management is becoming increasingly crucial with the haphazard use of forests and other land to house, feed and support the growing population. Multispectral aerial and satellite photography properly analysed would give valuable data for effective land management.

312 *Mineral Exploration*

The search for minerals, energy sources, water etc., is already greatly helped by geological and geographical surveys carried out by aerial and other remote sensing methods.

313 *Updating of Maps*

Human activity, such as new settlements, laying of roads, railway lines, canals, dams, new towns, resource utilization etc., tend to alter the geographical features of the earth much faster than ever before. Satellite imagery would help updating of maps. Also, the data on a physical environment correlated with sociological and anthropological data could provide a better base to plan the development of the country.

314 *Urban Planning*

Urban processes are dynamic in character and require reliable and timely data for planning and decision making. Conventional sources and methods involving a large number of personnel, vast amounts of money, and long delays do not provide adequate information for the purpose. Remote sensing techniques combined with computer data processing has revolutionized urban information systems. The plan for urban planning and development in India envisages the use of aerial photography and other remote sensing methods for collecting and processing data and information for a variety of purposes such as the following: Preparing land use maps, study of changes in land use; measuring the size of different sectors, or of any particular features, selection of site for various urban facilities; study of slums and squatters; quality of housing; reconnaissance surveys; alignment, location and classification study of roads; traffic density, volume and character of city traffic; congestion study for transportation planning; intersection planning and engineering design; origin and destination survey; calculation of earthwork, preparing and alignments; measurement of water channels and natural drainage studies; social characteristics of different parts of town; densities of population in different zones and estimation of population; finding the availability of building materials; planning for spatial distribution of transportation network, location of road links, traffic generating areas and bottlenecks

pollution sources, nature and extent of air and water pollution and the quality of trees in urban areas, etc;

32 National Remote Sensing Agency

Having recognized the potentialities of remote sensing technology as a powerful information support for the effective planning and management of resources the Department of Science and Technology, Government of India, has sponsored the establishment of the National Remote Sensing Agency (NRSA) (4 Sardar Patel Road, Secunderabad–3) with the following objectives (1):

(*a*) To undertake, aid, promote, guide and coordinate research in the field of remote sensing.

(*b*) To operate a research flight facility.

(*c*) To provide consultancy services and airborne survey facilities to user agencies in the country.

(*d*) To carry out surveys by using remote sensing technology for various natural resources, agriculture, hydrology, meteorology, fishing, minerals, oil, soils, environmental monitoring, forestry, ocean resources, topography, land resources and crop disease surveillance.

(*e*) To establish, maintain and manage data banks for acquisition, storage, retrieval, dissemination, evaluation, scrutiny and interpretation of information relating to remote sensing technology.

(*f*) To establish, maintain and manage laboratories, workshops, stores and other units for carrying out scientific and technical work in the area of remote sensing.

(*g*) To provide support to research centres for conducting investigations in specified areas of remote sensing technology and for undertaking design, development and construction of special remote sensing instruments.

(*h*) To conduct field experiments connected with the activities of remote sensing.

(*i*) To organise training facilities, lectures, seminars and symposia for advanced study and research in remote sensing and for advancement of science and technology in general.

(*j*) To co-operate and collaborate with other national and/or foreign institutions and international organisations in the field of remote sensing and allied sciences.

(*k*) To publish and disseminate information relating to results of research conducted in the field of remote sensing.

In order to extend the work already being done, a remote sensing satellite is expected to be launched in 1978, using the experience gained in satellite technology.

33 Library Implications

A different aspect of remote sensing technology, namely, implications to libraries has been highlighted in a recent paper by Bryan (2). With the increasing use of remote sensing there will be a growing demand on libraries to provide information on and that resulting from, the application of remote sensing. Since the data obtained by remote sensing may be in an unconventional form and format, new storage and indexing techniques may have to be developed for providing access to and retrieval of the needed data and information. This implies some basic understanding of the techniques of remote sensing and of the data and information generated by those techniques on the part of librarians, documentalists, and information scientists.

4 Satellite Communication in Development-oriented Activities

41 Satellite Communication and Devfloping Countries

The commercial use of satellite for communication purposes is just over a decade old now. In 1964, as a global enterprise in commercial communication, the International Telecommunications Satellite (Intelsat) organization was established on the basis of

(1) an inter-governmental agreement open to all member countries of the International Telecommunications Union; and

(2) a companion agreement between operating communications agencies of the signatory governments.

Intelsat is now "a mature, successful, paying 'benefit' of the world's investment in space technology" (3).

Within a decade four generations of commercial satellites have been introduced, each a major technological development. The first Intelsat spacecraft, the Early Bird, was launched in 1965 with a capacity for 240 telephone circuits to demonstrate the feasibility of geostationery orbits for transatlantic commercial telephone service. In 1971 the first of the Intelsat IV series was launched, each with a capacity of 4,000 simultaneous telephone circuits. The system is now used by 115 earth terminals in 65 countries including developing countries, such as India, Egypt, Pakistan, Argentina and Zaire.

Intelsat has amply demonstrated the fact that many nations — developed and developing — can continually cooperate in space in an important mission and earn a profit in doing so. The 91 member countries of "every racial, political, and religious stripe, jointly own the satellites and provide for their development, launching and maintenance".

Other features of interest particularly to developing countries include the following:

—some fifty developing countries have joined with advanced nations as partners in a large and complex international commercial enterprise.

—the developing countries contributing to this mutlinational activity have a substantial capital subscription (10%), advanced technical operation facilities, with immediate social, political, economic impact, and growing revenues; they represent more than half of the ninety member states; hold a similar proportion of the voting strength as the advanced countries but account for nearly

double the percentage of the total use of the system; and have no direct investment in developing or producing the hardware component of the space segment of the system.

There are several other practical advantages of using the Intelsat system and arrangements for further benefits to developing countries (4). It has opened up a large new window on the world with direct and independent linkages at reduced costs, relieving the developing countries of the need to go through the US, French, or British metropolis to communicate with neighbouring developing regions.

42 Satellite Instructional Television Experiment (SITE)

421 *Significance of the SITE Project*

The India-United States Instructional TV Satellite Experiment (SITE) project is of special significance as an application of modern communications and information technologies in a developing country so as to bypass the usual historical transition stages. The late Dr. Vikram Sarabhai, the early guiding spirit for the current SITE project in India, had said that the use of satellites for direct broadcasting would help to bring televised instruction to millions spread out in India's half a million villages and in about ten instead of thirty years it would take to construct and extend a conventional TV distribution system on the ground. Briefly, some of the implied aspects of the SITE project of relevance to the topic of this paper are:

(*a*) Utilizing sophisticated communications technology to disseminate information on a massive scale to people spread out in remote villages, which would have been quite difficult by other methods.

(*b*) Harnessing of sophisticated communications technology for providing access to knowledge and education on matters of concern to the Indian villagers and intended to raise their standard of living in a shorter time span.

(*c*) International cooperation in providing means of access to knowledge and information for development purposes.

(*d*) Potential technology transfer and technology development in India in satellite communication and in producing the necessary instructional programme packages.

(*e*) The spin-off in communication technology which may lead, in the long run, to information transfer capabilities and facilities at global distances.

422 *Objectives of SITE*

The educational objectives of the experimental project are to study how the mass communication medium, TV, can contribute to:

— national integration;
— adoption of family planning practices;
— teacher training;
— general school and adult education;
— adoption of improved health and hygiene practices;
— improvement of agricultural practices;
— improvement of other occupation skills.

The technical objectives of the project are:

— to test the effectiveness and efficiency of TV broadcasting in national development programmes;
— to enhance national capability in the design, manufacture, development, installation, operation and maintenance of village direct reception systems;
— to gain experience in the design, manufacture, installation, operation and maintenance of broadcast and/or distribution facilities of the type used in the project;
— to determine the optimum receiver density, distribution and scheduling techniques of audience attraction and organization;
— to gain experience in handling of problems involved in developing, preparing, presenting and transmitting television programme material.

The overall objectives is to stimulate national development with the attendant managerial, economic, technological and social implications.

423 *The SITE System*

By an agreement signed between India and the United States governments, the National Aeronautics and Space Administration (NASA) has provided the Applications Technology Satellite (ATS-6) for one year beginning 1 August 1975 for carrying out the SITE project in India. The ground segment is the concern of India. The Space Applications Centre (SAC, Ahmedabad) of the Indian Space Research Organization (ISRO) has the overall responsibility for the design, development, deployment operation and maintenance of the complete ground system and some TV programmes.

The All India Radio (AIR) is responsible for production of the TV programmes for SITE.

During the experiment 2,400 direct reception community TV sets have been deployed in selected villages in six States (about 400 villages in each State) which are not served by terrestrial transmitters. The criteria for selection of villages were: availability of electricity during the time of experiment at the location of the TV set availability of a public building; such as a school, and absence of obstructions such as buildings, trees etc. in the satellite-to-antenna path population between 300 and 3000; and located within a 40-60 km radius of the maintenance sub-centre.

The broadcasts of four hours duration each day — 1.5 hours in the morning and 2.5 hours in the evening — are in four languages — namely, Hindi, Kannada, Oriya, and Telugu. Each State is allocated one of the two switch selected channels. The morning broadcasts are usually for children of the age group 5-12 years. The evening boradcasts for each state are of 40 minutes duration in addition to the common programme of 30 minutes. Out of the 40 minutes about 15 minutes are given for discussion on local practices in agricultural and related subjects and

the remaining 25 minutes to health and hygiene, family planning and related topics.

Some of the technical details of the system are presented in an article by Bakhshi (5). Some of the pre-SITE developments and pilot experiments are also mentioned in a paper by Fruitkin (6).

424 *Impact Studies and Reports*

A newspaper report of 2 May 1976 mentions that the SITE programme will be used for guiding farmers in 800 villages in the two Southern States, Andhra Pradesh and Karnataka in agricultural operations for the coming kharif season. A three-week package training course for agricultural extension workers and farmers in the two States was organized through the SITE programme from May 24 to June 16.

The multi-lingual character of the SITE programme is being studied by UNESCO to examine its adaptability in African countries. The study covering twenty villages in the two states will test whether the process of communication would get eroded when local idioms and participation are absent in the multi-audio transmission. It may be mentioned that though theoretically eight audio channels and four video channels can be used successfully via the satellite, India is using only two audio and one video channels in the SITE project.

Case studies of a few regular viewers will be made along with those of the non-viewers where the broadcast reached via satellite in the past year for comparison of the "development of the individual".

The telecasts reaching the viewers in both the States will be analysed on the basis of the needs and aspirations of the villagers. The socio-economic aspects of the population, the crop pattern, and the vocations in the villages will also be studied. About one thousand persons from each of the twenty villages will be interviewed to assess how well the massage was conveyed over the SITE programmes.

A team of researchers from the Space Applications Centre, Ahmedabad, and other social scientists and communications specialists have been surveying and studying through interviews, field observations, etc., the impact of the SITE programme on the viewers—children and adults — in the villages. It is perhaps too soon to evaluate the programme. A number of factors are involved in interpreting the data collected and the interviewees' statements.

A survey of ten villages of Rajasthan covered by SITE, showed that children responded enthusiastically and have learnt or become aware of several new scientific and cultural facts through TV, which they might have learnt by rote from dull text-books and easily forgotten thereafter. Several teachers — most of whom were high school dropouts — admitted that they had learnt from TV. However, in these villages the attendance of adults had dwindled. So also the turn out of women and girls has not been satisfactory.

Some adult viewers in the evening programmes appeared to look for entertainment on TV rather than for the hard core programme on agriculture, health and hygiene etc. The argument is that after a hard day's work on the farm they do not want to be told again on farming methods etc on TV. On the other hand, some farmers have learnt new things via the TV and adopted them in practice. New enriched food preparations and family planning ideas have been introduced in this way. There are also the cases where the farmer admits of regular viewing of the TV programmes, but on deeper questioning indicated that some of the practices demonstrated or discussed could not be adopted for reasons of cost, non-availability of materials etc.

A greater awareness of the 20-point economic programme, social rights etc has been noticed among villagers and the backward classes thanks to the TV programmes.

Poor attendance by women and girls has in part been due to the inconvenient timing of the programme — that is, when they had other work to do.

A general observation is that wherever the subject of a programme is close or similar to the local practices and cultures it has been adopted to some extent; and the impact is greater where the TV message is implemented by some other agency at the local level — e.g., a youth organization.

Even in the case of the school or children's programmes, the impact is greater where the teacher and teaching programme kept close to or followed up the TV programme subject.

There is also some indication that the opinion leaders and the rich, who generally belong to the higher castes, tend to stay away from the SITE programmes.

A carefuly study of the actual needs and problems of the local village community — e.g., credit facility, fertilizer and water usage in farming, seed transport communication, working of the bureaucracy — and developing programmes on or around such topics would appear to ensure greater impact of the TV message.

Many of the technical and maintenance problems encountered at the early stages of the experiment have now been overcome. A good deal is being learnt on the social, cultural, and behavioural aspects of villagers, so that future programmes can be designed to make the desired deeper, wider and consistent impact.

The fact that the Government of India is considering various alternatives to continue the satellite TV broadcasting even after the ATS-6/ satellite is moved away in August-September 1976 and will not be available for broadcasting in India, is evidence that the impact of the SITE experiment is significant from several angles — technological, sociological, economic and managerial. Fruitkin sums up the significance of the SITE project as follows (7):

"The India-United States TV satellite broadcast experiment will be the first to provide direct broadcasting of television programs from a satellite into small village receivers without the need for relay stations on the ground. It is of great significance on a number of grounds. It represents an important experimental step for India in the development of a national communications system and the underlying technological, managerial, and social supporting elements. It is a constructive step forward in cooperation between one of the world's superpowers and a developing nation. For other developing countries, it should serve on a no-cost basis to test the values, the feasibility, and the requirements of a multipurpose tool that could be critical to accelerating their progress in an increasingly technological world".

43 Other Satellite Communication Experiments and Programmes

431 The first Indian Satellite, *Aryabhatta*, was launched in 1975, through a collaborative effort between India and the Soviet Union. Among the various technological achievements signified by this event, experiments in satellite communication and transmission of data are relevant to the topic of this paper. Among such experiments successfully completed using the satellite include:

- point-to-point live-voice communication between Sriharikota in Andhra Pradesh and Bangalore in Karnataka via the satellite;
- transmission of electrocardiogram signals between the two ground stations; and
- transmission of weather data from Sriharikota to Bangalore in real time via the satellite, using standard weather data collection platform.

These experiments are forerunners of future developments in satellite communication to remote areas in India.

432 *Satellite Meteorology*

Climate is an invaluable natural resource as well as a decisive factor in many areas of human activity. Climatological information is needed in:

- siting, layout, airconditioning, heating, lighting, etc., in industry and home
- civil aviation
- multipurpose hydel projects
- maritime commerce
- agriculture and irrigation projects
- microwave tower and port installations, telecommunication and powerline projects, and the design and construction activities in many other projects
- strategic and tactical planning during war and emergency.

We shall consider here one major area — agriculture. Agricutlture is a major occupation and sustaining industry for a vast majority of India's village population. And another appreciable proportion of the population is sustained by several agro-based industries. Agriculture—that is, farming practices, yields, labour deployment, etc — is greatly dependent on rain, surface and ground water, sunshine, and other weather conditions. Inadequacy or excess of any of them can adversely affect crop yields, the entire agro-based industries, the food situation and thereby the health of the people and economy of the country. Therefore, to assist the farmer and to minimize the risks of his being taken unawares by the weather, the collection and dissemination of meteorological information is essential. Not only does the farmer needs quick information about imminent weather conditions, but long-range forecasts as well to facilitate advance planning, introduction of new agricultural practices, taking of preventive and remedial measures against harmful effects of weather, etc. Long range forecasts require data collection about various meteorological phenomena almost globally and facility to process the information quickly to study the movement of winds, cloud patterns, and various other atmospheric phenomena. This implies the development of national capability and expertise in sophisticated meteorological techniques to be able to participate in meteorological information networks. In this regard satellite technology could provide a major support and India is taking advantage of its experiences in the field. Meteorological information systems would also assist navigational planning, irrigation and water resources planning, and environmental studies.

An important programme of ISRO is the establishment of a versatile earth station to collect and process meteorological data from the US, Soviet, and Japanese satellites. The station will be able to receive directly the data transmitted by the high resolution radiometers on board the two satellites orbited by the USA. The pictures thus obtained will be of a higher magnification than those presently obtained by the India Meteorological Department and will help in understanding weather phenomena and in making reliable weather forecasts.

Further, the earth station will also receive data from the French satellite Metcosat, the Soviet satellite GMS and the Japanese geostationery satellite to be placed over the Pacific. The data collected would thus cover a broad sweep and help in correlating meteorological developments over and near India with atmospheric developments elsewhere. The French, Soviet and Japanese satellites are to go into a stationery orbit in 1977–78 as part of the Global Atmospheric Research Programme (GARP) sponsored by the World Meteorological Organization (WMO).

Another major data gathering effort and meteorological study would be Monsoon 77 of the IMD, a research programme to be conducted in the Indian Ocean. This would be followed in 1978–79 by participation in a more comprehensive international experiment Monex, a sub-programme of WMO's GARP.

433 Another satellite telecommunication project using the French satellite Symphonie is expected to help study India's telecommunication needs.

5 Computer Applications in Data and Information Handling

51 Computers in Development

The great potential of electronic computers in data storage, processing, retrieval, and dissemination, and their consequent role in aiding decision making, planning, problem solving etc., in development-catalysing activities in government, business, industry, research and other sectors are well recognized. In a keynote address on "Computers in Development" presented at the Seventh Asian Electronics Conference (Delhi, 5–10 Dec 1973), Prof R Narasimhan (Computer Group, Tata Institute of Fundamental Research, Bombay) enumerated the following as some of the development-catalysing application areas for computers (8):

1 Planning and Forecasting.—National, state, regional planning; Data base on national resources (materials, manpower); Census; Demography; Technology forecasting; Weather forecasting.

2 Economic Indices.—Savings, debts; Trade balance; Prices; Foreign exchange reserves; Taxes, customs, and other revenues.

3 Government Administration.—Budget preparation and control; Inventory control; Registries of voters; Staff records; Patents; Pensions etc; Internal security files; Crime detection and prevention.

4 Commercial and Financial Institutions.—File management and processing in banking; Insurance and commercial administration.

5 Industries and Construction.—Industrial and corporate planning (OR studies); Scheduling (PERT/CPM); Materials management; Production statistics.

6 Process Control.—Control and optimization in process industry and technology: Monitoring, scheduling, and management of utilities (power, communication).

7 Design Optimization.—Engineering calculations and designing: System simulation studies; Development of design aids and tools.

8 Education and Research.—Educational statistics; Teaching and training; Research calculations; Educational data processing.

9 Public Health.—Data base for public health administration; Hospital management; Patient monitoring; General diagnostic aid.

10 Tourism and Transport.—Control of passenger and goods traffic in railways, roadways, waterways, airways; Air traffic control; Road traffic control; Scheduling of rolling stocks; Hotel reservation; Ticketing and reservation in transport.

52 Data/Information Processing in India

Electronic computers were introduced in India just about two decades ago. Until recently, developments for the extensive use of sophisticated computer technology in data and information processing have been comparatively slow and sporadic. But one can find at least a few instances of the application of the computer in the areas mentioned above. A recent publication (9) presents an overview of the use computers in India as of August 1974. Forecasts of and proposed plans for computer development and utilization, and the impact of computers in India are also discussed in that book. Therefore, no attempt will be made here to review the situation. I shall briefly mention a few areas of application in the information field.

Over 250 computer installations are operating in the country. Several are of the second generation and a few of the third. Computer facilities in institutions of higher learning—universities, engineering colleges, institutes of technology, science institutes—are extensively used in education and research in computer science and information science, and in practical applications in information systems development and operation. For instance:

The IBM 370/155 facility at the computer centre of the Indian Institute of Technology, Madras, is used for implementing the CAN/SDI experimental project, in operating the Police Information System for the Tamil Nadu Government, and in other management information system developments. An experimental terminal has been installed in Bangalore. The Tata Institute of Fundamental Research (TIFR), Bombay, has an active computer/information research group developed over the past decade, with a CDC 3600 and other support facilities. A DEC 1077 system with a PDP 11 support has recently been installed. At the Indian Institute of Science, Bangalore, besides basic studies in computer science, information processing, automation etc, there have been interesting developments in the computer searching of chemical substructure, image processing, linguistics, etc, which have direct applications in the information field. The Institute has an augmented IBM 360/44 facility. The computer facility of the Delhi University has been used extensively by the Indian National Scientific Documentation Centre (INSDOC) in the preparation of various data bases, indexes, directories, etc.

The Indian Statistical Institute, Calcutta, has been a pioneer in the use of computers and in computer science education. Its division, the Documentation Research and Training Centre, in Bangalore, has been developing programs and pilot computer-based information storage and retrieval systems, indexing methods, thesaurus construction etc, and offering courses in the subject as part of its programme of edutcaion in documentation and information science.

The Office of the Registrar General (Census Operations), the Central Statistical Organization, the Life Insurance Corporation of India, and several central and state government departments, and industries use computers in data and information storage, processing and retrieval.

Application of computers in patient data monitoring in hospitals, in cardiological studies, police

information systems, chemical structure coding and searching, online seismic data processing, climatological data processing, image processing, etc, are among the more recent developments in the country.

Indigenous computer production.—The Trombay Digital Computer (TDC series) designed and developed by the Computer Group, Electronics Division of the Bhabha Atomic Research Centre, Bombay, has been produced and marketed by the Electronics Corporation of India Ltd. (ECIL). ECIL has introduced three computer main frames in four years, capable of handling small to medium class computer applications. These computers are all primarily designed to handle real-time data acquisition and control applications. They are fully supported by a complement of general purpose or special purpose peripheral equipment, interface electronics, and total systems software packages for scientific data processing and real-time control applications.

53 Plans and Programmes

531 *National Information System for Science and Technology*

The plan for the National Information System for Science and Technology (NISSAT) and the progress made in developing the infrastructure to implement the plan have been presented in various papers, seminars, etc (10). Among other things the plan envisages the development and use of computer facilities in bibliographical information processing, data base creation and information transfer and services based on them, in information storage and retrieval, in SDI service based on international tape services, etc. Over the past five years, progress has been made in all these areas. India has also been participating in global information systems, such as INIS and AGRIS. Beginning in March this year, Insdoc, with Unesco (UNISIST) assistance, has been able to implement successfully a SDI experimental project based on the CAN/SDI software at the Computer Centre, IIT, Madras, using Chemical Abstracts Condensate tapes and some 150 user profiles (a few from neighbouring countries). Other tape data bases are expected to be used in the regular national/regional SDI service in due course.

Another recent Unesco-UNISIST assisted project successfully carried out was the RECON on-line demonstration. The Department of Science and Technology in collaboration with the Posts and Telegraphs Department, the Overseas Communication Service (OCS), the Tata Institute of Fundamental Research (TIFR), the Bhabha Atomic Research Centre (BARC), the Indian National Scientific Documentation Centre (INSDOC), and the European Space Agency-European Space Research Information (ESA/ESRIN) in Frascati near Rome, organised at TIFR, Bombay, during 20–25 September 1976, a demonstration of on-line access to data bases at remote locations using ESRIN's RECON system. The primary objective of the project was to demonstrate to scientists, engineers, technologists, medical men, information specialists and others, the application of computer technology in association with telecommunication technology for providing almost instant access to information held in data banks at global distances. This is the first time that such on-line data transmission via satellite and ground communication has been organized in the region.

Five terminals were set up at TIFR, linking the ESRIN computer in Frascati. Of these, two were provided with video screens and high speed on-line printers, and three others were for dial up facilities. Technical personnel from ESRIN set up the equipment and demonstrated the operations on the terminals. Some of the Indian information scientists also were able to provide demonstrations to the visiting scientists and engineers. Over 1500 scientists from all over India, particularly from institutions in Bombay, visited the facility during the 6-day demonstration period, freely interrogated the ESRIN data bases and received current information on the specific subjects of their respective interest. Some 500 questions were handled. A detailed account of the users' reactions and advisability of having an on-line facility of the kind demonstrated is being compiled at BARC.

532 *Computer Network to Support Government Planning and Policy Making*

The Electronics Commission (EC) was constituted in 1971 to lay down an overall national policy for the electronics field, to formulate plans and goals, and to coordinate and guide activities on the technical and economical aspects of the electronics industry, including the computer field. The Information, Planning and Analysis Group (IPAG) of the Commission (1972) through various technical panels, has been studying various aspects of the electronics industry, and coordinating the work of the Task Force VII on telecommunication and electronics under Steering Group on Engineering Industries set up by the Planning Commission. EC has submitted to the Planning Commission a Five-Year Plan (1974–79) for electronics, based on the recommendations of the Task Force VII.

The general philosophy on progressive computerization is one of selective support in the use of computer. Priority is given for computer applications in programmes of national importance in industrial and engineering fields, vital sectors such as defence, and for export-oriented activities, as also to projects which have a development-catalysing effect on the economy, projects which directly increase productivity and computations which boost exports. Examples of such programmes and projects are: agricultural information system, management decision information systems, data banks, computation aiding research and development, on-line control, engineering design automation, optimum net-work design etc. The EC has also advocated the setting up of minicomputer networks as a viable alternative

to the importation of a large number of maxi-computer systems.

In order to facilitate the availability of timely and reliable data and information for decision making in general and policy making in particular, the need to develop a central competence in Government, closely associated with the central planning machinery and the financial and man-power controls and in a position to advise the government on various policy aspects, is well appreciated. For this purpose, the EC has proposed a National Informatics Centre (NIC) at Delhi, to function as an inter-disciplinary support to national planning and decision making, as well as to development-oriented projects. The NIC project objectives include (11):

(*a*) Contributing substantially to the streamlining of the information base in Central and State Governments; through

(*b*) Establishment and operation of a national information system to support government planning, policy formulation, and management;

(*c*) Maintaining a focal point for such activities, and coordinating data handling on the national level and maintaining inventories of available data bases;

(*d*) Operating appropriate computer systems to support the functioning and the use of the national information systems;

(*e*) Maintaining and further improving the data management systems related to the software for national information systems;

(*f*) Participation in the formulation of policies and decisions in the context of national information systems.

To acheive these objectives, initially three projects considered to be of national importance have been proposed. These are:

1 Information system for the agricultural sector with participation of the Planning Commission, Indian Council of Agricultural Research, Central Water and Power Commission, India Meteorological Department and the Jawaharlal Nehru University.

2 Information system for science and technology, with a data bank designed primarily to assist those associated with planning, coordination, execution and monitoring of science and technology development in the country at the highest levels, and providing input to those involved in related planning functions for industry, education etc.

3 Information system for manpower development designed for developing and testing systems for measuring in all fields of university activity — such as, instruction, research, public service — involving data about manpower, students, facilities, finance, etc.

An important spin-off from the projects is the possibility of training a large number of computer specialists in the area of data bank management and computer-aided decision making. Many government organisations which have information and planning problems would be able to utilise the facility as well as the expertise of the NIC at Delhi.

A UN expert team has commended the NIC project, and action is underway to implement EC's proposals. Large regional computer facilities, with UNDP assistance are expected to be set up. Progress has been made with the Calcutta and Bombay projects.

A National Centre for Software Development and Computing Techniques (NCSDCT) has been set up at TIFR. The initial programme of NCSDCT would cover the following areas:

(1) Interactive computing and graphic techniques;

(2) Advanced programming;

(3) Basic software development techniques;

(4) Special general purpose operating system design techniques; and

(5) Technology relevant to the remote use of computers and networking.

6 Issues for Consideration

In the preceding sections a few instances of end programmes for, the application of three modern technologies — remote sensing technology, satellite communication technology, and computer technology — in data and information collection, storage, processing, and accessing in development-catalysing areas, in a developing country, namely, India, have been briefly described. In this section some issues are raised for consideration.

61 As a first issue,we might consider whether the technology applications mentioned fall within the purview of information technology and information science. Today there may not be much of an argument about computer applications in information processing being within the scope of information technology and information science. But twenty years ago this was a point of debate: at least the notions were vague. In any case, the admission of such computer applications into information science and technology field has mutually benefited and accelerated advances in both areas — information science and technology and computer science and technology. It should not be another two decades before information scientists grasp the significance and value of the applications of remote sensing and satellite communication (and other technologies not mentioned here) in information and data handling area even though one might now debate the question as to whether they fall within the purview of information science and technology. Especially those concerned with the planning of national information systems should take cognizance of these technological developments and use them to advantage.

62 As a second issue, we might consider as to the ways in which information scientists could involve themselves and be participants in these developments beyond being mere witnesses. Firstly, at a minimal level, information scientists need to study and be aware of the information generating, collecting, processing, and dissemination potential of the new technologies, and provide information services on them to those specialists actually involved in the

development of the technologies. Secondly, it may become necessary to develop new indexing and retrieval methods for handling the records of data, pictures, etc,, produced by some of these technology applications. Thirdly, information scientists, with their generalist knowledge of the information field, may be able to identify and suggest areas of application of the technologies. Fourthly, information scientists could be involved in the study of user reactions and behaviour to the information disseminated and presented by the new technology applications. Fifthly, the information scientist's expertise could be useful in developing suitable methods of data and information organisation, classification etc, for the data generated and collected by the new technology applications. Sixthly, a few information scientists may get technically involved in the application of the new technologies in data and information recording, collecting, processing, etc. There is a sort of hierarchy in the nature of involvement and participation of the information scientist in the sequence mentioned above. His knowledge of the new technologies may be minimum in the first and increases to a maximum in the sixth type of involvement.

63 As a third issue, we might consider the education of information scientists who could effectively involve themselves in the ways mentioned under issue 62 in the new technology applications.

64 As a fourth issue, we might consider the following sub-issues:

— What are the guidelines for apportioning national resources between information infrastructure development activities on the one hand and other sectors — R and D, economic, political and cultural activities — on the other ?
— What are the returns and social cost of the investment on information and how these may be measured and evaluated ?
— What are the criteria for placing differential weightage and priorities for the allocation of resources on different information generation, collection, processing and transfer technologies in different socioeconomic and technological contexts ?
— In the interest of maximal benefit to the majority of people, how should the controls over the existing stock and the new flows of information be distributed, nationally and internationally ?

65 As a fifth issue, we might consider the role of international bodies *vis-a-vis* the developments in technology applications in the information field. Developing countries in particular, engaged in formulating plans, developing infrastructures for national information and systems look to international bodies, including professional organisations, for guidance. In the context of the newer technologies and their recognized national and global implications, the spin-off from them, and the kinds of issues raised in Sec 64, the scope of and approach to guidance should be such that developing countries are not made to lag behind in, the utilization of the powerful new information support possibilities for development. Most of the developing countries have to make a few quantum jumps in the information field to reach the level of some of the technologically advanced countries, in information handling capacity. Modern technology wisely chosen and properly applied can provide the needed quantum jumps. Otherwise, the gaps between the developed and developing nations will only widen. Information handling capacity of a nation is a major indicator of its capacity for growth (12). International bodies have a crucial role to play in enabling developing nations to take advantages of the applications of the new information technologies in development—catalyzing areas.

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